Product-Oriented Environmental Management System (POEMS): a sustainable management framework for the food industry

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Abstract POEMS is a new tool designed to bring together traditional environmental management systems and tools oriented to the environmental evaluation of products. The aim of this paper is to present the preliminary results of the Eco-Management for Food Project (PRIN No. 2008TXFBYT) co-funded by the Italian Ministry of Education, University and Research that has the purpose to design and implement a POEMS framework for the agri-food industry in which: 1. the underlying basis is an Integrated Quality and Environmental Management System; 2. product orientation is guaranteed by a simplified methodology of Life Cycle Assessment; 3. the exploiting of environmental performance of products in terms of commercial advantages is obtained with a suitable environmental label.

1 Introduction

Management of the environmental variable in the agri-food sector, as in many other sectors, is overwhelmingly carried out through the voluntary use of system standards (e.g. ISO 14001). Indeed, system certifications, in general, are the most widely used, as they can be adapted to the real situation of each business, especially regarding management of contractual and mandatory aspects, as well as continuous improvement processes; however, they have the significant disadvantage of being poorly perceived by final consumers. This is partly due to the low visibility of the relative acronyms (ISO 14001, ISO 9001, etc.), which can

only be used on packaging with considerable limitations, so as not to create confusion among consumers regarding what is being certified (the organization's management system and not the product), whereas regulated certification logos (quality marks and organic products) can properly be given greater prominence. These observations lead us to suggest that a more suitable approach to environmental quality management in the agricultural and agri-food sectors is probably one based on using direct means of ensuring the environmental performance of products; capable of guaranteeing and facilitating social acceptability on the one hand and, on the other hand, greater appeal in more environmentally aware markets, which are growing.

Nowadays businesses are held responsible for the impacts of their activities (so-called extended producer responsibility) in every phase of the life cycle of the products they make and this means that companies have to manage processes that extend beyond their factory gates.

Therefore, the boundaries between an organization pursuing its competitive strategies and other actors in the economic system, as well as those between process management and product/service management, have proved to be permeable whenever businesses decide to make a concrete commitment to improving their environmental performance.

Thus, more environmentally aware organizations are experiencing more and more the need for integration between system standards and product standards (e.g. the ISO 14040 series of standards), gradually moving the emphasis from the system/process to the product/service. As a result of this, alongside management “tools” that are already widely used (ISO 14001 and EMAS), companies have started to appreciate other “tools” that are oriented more towards the environmental performance management of products, bringing about an increase in the number of organizations beginning to “work on products” and on the whole chain of production [1].

This push towards moving the emphasis from the environmental impacts of individual production sites to those associated with products can be seen from numerous aspects including, for example, in the EU Green Paper on Integrated Product Policy (IPP), in the EMAS III Regulation, in the revision of the ISO 14001 standard and in the indications emerging from businesses with experience of a possible integration of the previously separate system (EMS) and product (LCA, Eco-design, ecological labelling) fields, with the development of positive synergies.

These aspects can be considered as clear signs of the introduction of product management into EMS, which have thus permitted the emergence of a new specifically product oriented environmental management tool: POEMS (Product-Oriented Environmental Management System).

2 The modular structure of a POEMS framework for the agri-food industry

One of the most widely used definitions of POEMS to be found in the limited literature available is the one provided by Rocha and Brezet: “an environmental management system with a special focus on the continuous improvement of a product's eco-efficiency (ecological and economic) along the life cycle, through the systematic integration of eco-design in the company's strategies and practices” [2]. Another definition of POEMS, which is more appropriate for the agri-food sector as it is not unequivocally tied to eco-design and is, thus, also applicable to companies that do not deal with product design, is the one coined by de Bakker: “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” [3].

Currently, there are no prescriptive standards for POEMS and the only elements that can offer methodological references as a starting point for their wider use are: corporate practice, a few pilot trials, the few studies available in literature, the Spanish UNE 150.301 standard and the final draft of ISO 14006 (the latter two relating to the insertion of Eco-design in environmental management systems). None of these, however, concern the agri-food sector, where the only experiment reported is one relating to the wine-making industry [4].

Thus, within a context in which organizations are showing increasing interest in ways of integrating system standards and product standards, there is certainly great interest in being able to create a POEMS model that reflects the real needs of companies and their stakeholders, also considering the lack of a uniform and widely accepted methodology.

This is particularly true of the agri-food sector, which has seen the setting-up of a research project - EMAF [5] - that sets out to test, implement and then promote a POEMS model specifically designed for this sector, which is of huge importance in Italy and Europe, both from an economic and from an environmental point of view (the latter deriving from the substantial use of natural and energy resources and by the emission of numerous pollutants).

In the light of the current state-of-the-art and of preliminary results of the EMAF project, the basic specifications identified for the development of a POEMS model can be summarised as follows:

- fundamental structure composed of a management system conforming to ISO 14001 or to Reg. EMAS, integrated with ISO 9001 and other possible management systems typical of the agri-food sector;
- 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;

- product orientation ensured by the integration of a simplified Life Cycle Assessment methodology suitable for organizations in the agri-food production chain, which can be used to evaluate different cultivation methods, production technologies and alternative materials;
- ability to transform the environmental measures taken into commercial advantages in the best possible way for the organization, thanks to the use of guidelines that can support organizations in their choice of the most suitable form of environmental message, closely linked to the product.

The POEMS model proposed is simple and straightforward thanks to the simplification of certain operational aspects and the reduction of "bureaucracy"; it is general in character, making it applicable to any type of activity in the agri-food sector, whatever the organization's size, nature and position in the agri-food production chain; it has a 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 organizations' specific requirements and of the objectives they aim to reach. The modular structure of the proposed model is illustrated in Fig.1, while its fundamental elements are described below.

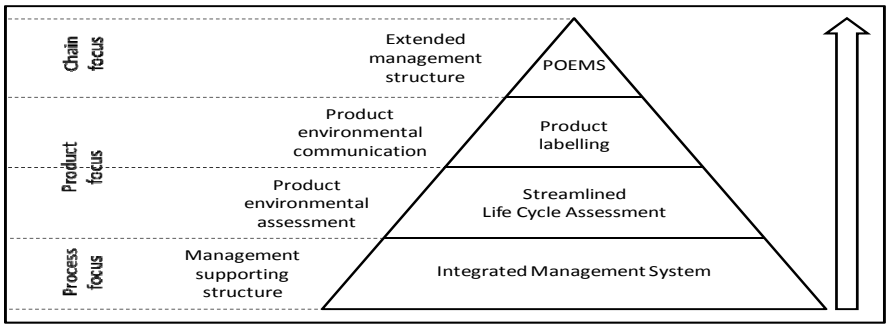

Fig.1: The modular structure of the POEMS framework

2.1 Integrated quality and environmental management system

2.1.1 Integrated management systems: the state-of-the-art

The modern day challenge of market globalization, increasingly characterized by complexity and turbulence, cannot be faced up to exclusively with product quality, but rather through the adoption of a wide variety of instruments suited to

satisfying the express and implicit needs of all the parties interested in an organization's activities. From this, we see the emergence of a new approach to the concept of quality, which is viewed in a wider and multidimensional way, as it now tends to incorporate dimensions linked to environmental protection, workers' health and safety, as well as the many-sided aspects connected to social responsibility [6].

A fundamental contribution comes from the adoption of Integrated Management Systems (IMS) of the different approaches to quality for continuous improvement of the effectiveness and efficiency of the numerous processes involved, both internal and external [7]. This with an eye to satisfying the requests that come from the complex network of stakeholders with which the organization systematically interacts. To this end, the voluntary adoption of the various Management Systems (Quality ISO 9001:2008, Environment ISO 14001:2004, Health and Safety OHSAS 18001:2007, Social Responsibility SA 8000:2008) is of highly strategic value for organizations. Indeed, the characteristics of these systems (all based on the Deming Cycle) allow for synergic integration, which strengthens their operativeness, thus amplifying the results. While this sort of approach is valid for all types of organizations, it is even more so for enterprises operating in the agri-food sector because of its peculiar complexities. Moreover, these organizations can take advantage of another management system focusing on food safety aspects (ISO 22000:2005), which is able to reconcile the mandatory and voluntary aspects of agri-food processes, but which is also highly consistent with the most widely used international standards.

Table 1 shows the data relating to the certifications of the various management systems registered in Italy with details for the agri-food sector [8,9]. From what is shown briefly, we can see a clear need for movement towards a unitary vision of the systemic approaches to the various dimensions of quality, since their integration allows the creation of significant advantages, which can be traced to bureaucratic and organizational simplification, the carrying out of combined audits and the optimization of resources, that is to say to the improvement of overall management efficiency.

Tab.1: Management system certifications registered in Italy at 31.12.2010

	ISO 9001		ISO 14001		OHSAS 18001		SA 8000		ISO 22000	
	n.	%	n.	%	n.	%	n.	%	n.	%
Total certifications	122,818	100	14,787	100	3,829	100	834	100	68	100
Sector EA01	293	0.24	64	0.43	1	0.03	1	0.12	-	-
Sector EA03*	3,444	2.80	727	4.92	57	1.49	62	7.43	68	100

EA 01-Agriculture & Fishing; EA 03-Food products, beverage (*except tobacco).
Data sources: Elaboration from [8,9]

2.1.2 Towards a framework of IMS for the agri-food industry

Currently, it is hard to see a valid pathway towards implementing an IMS in all organizations, since this can vary according to the level of integration considered appropriate to achieve, as well as to the type and number of management systems to be integrated. However, in the light of the potential significant advantages that may be obtained, various operational procedures have recently been outlined in literature [10-11]. As regards the agri-food sector, the pathway towards implementing an IMS would probably follow certain fundamental steps, which can be schematized, for simplicity, on three different levels. This pathway starts with the identification of compatibility and complementariness between the requirements included in the standard relating to the various management systems considered. This "first level" of integration has a "strategic character", in that it identifies principles, objectives, policies and actions for the continuous improvement of economic, environmental, health and safety and social responsibility performances, adopting a Triple Bottom Line perspective. The "second level" of integration involves aspects linked to the "systemic implementation" of the model, through appropriate organization and management of resources, a synergic realization of outputs, correct measurement and analysis of the results achieved in each of the fields under consideration. Indeed, the conspicuous similarity in terminology, the considerable structural analogies and the common methodological formulation mean that, on an operational level, there is complementarity which goes beyond merely formal aspects and incorporates others of a substantial nature. The "third level", on the other hand, is of a "unifying" nature, in that it has to extend to complete integration of the more operational aspects, that is to say those relating to procedures and instructions. These three levels of integration constitute the basic structure on which to build an integrated management system scheme, specifically for the agri-food sector.

2.2 Streamlined Life Cycle Assessment (S-LCA)

2.2.1 Critical methodological issues in conventional food LCA

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 was to identify: a) the main methodological issues in the food sector and how they

have been dealt with, b) whether some environmental impacts are more affected than others, and c) whether there were specific stages in products' life cycles more impacting than the others. All the above purposes were related to identifying the information needed for a simplified tool suitable to be implemented in this field. As far as methodological aspects are concerned, the main elements discussed were: functional unit (FU), data quality and availability, system boundaries, allocation, specific environmental impact categories and the need for harmonization [12]. It has been identified that uncertainties, mainly due to climate conditions, can affect production and therefore could lead to diverse results in LCAs. Thus, it cannot be found whether any environmental impacts are more important than others, since focus was given to specific ones each time and for different reasons. However, most case studies address the Global Warming Potential; this can be partially explained due to the current global concern for climate change. Furthermore, no safe results can be drawn on which phases are the most impacting ones, with the agricultural phase being, however, the most frequently mentioned as a critical one. Agriculture also appears to be one of the most difficult steps to evaluate, because of several complexities involved, e.g., modelling of pesticides and fertilisers. All the aspects identified highlight the fact that performing a food LCA is a very demanding task, both because of the methodological challenges involved and because of the high data demand. Given that the agri-food sector in Italy mainly consists of Small- and Medium-sized Enterprises (SMEs), which lack the knowledge and the resources to perform such a task, the spread of LCA would require the use of a simplified, though robust approach, based on sound scientific bases. Section 2.2.2 describes some simplified LCA tools and methods, reviewed on a general level, in order to identify those that could be useful for implementing LCA in the food sector.

2.2.2 Towards a framework of streamlined Life Cycle Assessment (S-LCA) for the agri-food industry

A total number of 31 papers were reviewed, of which only 6 were directly related to food, 3 were somehow related to the food sector (for instance, packaging) and the rest focused on a variety of other products/sectors. It should be stressed that the tools reviewed did not include those focusing on a single environmental impact category (such as global warming; e.g., Carbon Footprint). Due to limitations of space, however, it is not possible to cite here all the literature found.
Most papers identify that the need to simplify an LCA comes from the costs (especially for SMEs) and time needed to carry out a full LCA [13]. Moreover, an S-LCA may help deal with issues met in full LCAs, such as data gaps and

asymmetries, and inconsistencies in LCI [13], and obtain a more pro-active attitude in design. Regarding the approaches proposed for the food sector, the following were found: a) an S-LCA where a production system can be regarded as a "black box" [14] (e.g., instead of measuring energy consumption for each process and then summing them up, the whole farm or factory can be considered and the entire energy consumption can be allocated to the main product); b) a method based on principles of stoichiometry applied to grain or fruit growth, where the mass balance is focused on them and not on the plant or tree as a whole, considering the elementary composition of the product and the photosynthesis principle [15]; c) eVerdee, a software tool, which was also suggested as a tool for EPDs in this sector [16] (this tool uses the LCM2001 method for the LCIA and possesses an integrated sector-specific database); d) MEXCALCA, which allows for LCIA results for a crop in a specific country to be derived from LCIA data of the same crop from another country [17] (use of proxy data and generalisation).
More in general, several interesting simplified tools were found in the literature, such as:

- the "Bilan Produit" worktool, designed by ADEME as an eco-design software utility (information gathered for the LCIA is based on the ICPE environmental classification);
- a semi-quantitative LCA for LCIA, as part of an Iterative Screening LCA [13] (the adopted approach is aimed at lowering the quality requirements for non-energy related emission data through quali-quantitative LCI data);
- Materials, Energy, Chemicals and Others (MECO) method [13] (here, no production-specific data were required);
- Environmentally Responsible Product Assessment (ERPA) matrix method [13] (here, a 5x5 matrix is proposed, where the environmental categories are on one axis and the life-cycle stages on the other);
- Component Manufacturing Analysis (CMA), an LCI method for the manufacturing stage (here, a product is regarded as an integration of intermediate outputs);
- indicator approaches (environmental indicators and estimators);
- various types of streamlining LCA, which appear to have more qualitative approaches, etc.

In order for a more ISO-compliant approach to be adopted in the framework of the overall EMAF project, attention will be focused on the tools designed according to ISO standards. Further criteria for selection or development of a project-specific simplified tool also need to be identified on the basis of the food LCA case-study review results. As soon as such a tool is identified, it will be tested in the framework of a small Italian winemaking firm for its robustness and effectiveness.

2.3 Guidelines for environmental labels in the agri-food industry

2.3.1 Environmental labels in the agri-food industry

Ecological labels are marks, subject to specific regulations, which are used to provide information on the environmental performance of products and services, allowing consumers and other companies to choose products with a lower environmental impact. The ISO standards provide for three different types of environmental labels: a) Type I Labels (ISO 14024:2000): based on criteria of excellence (single or multiple criteria developed by a third party) which lay down the threshold values to be respected; the Ecolabel mark, for example, belongs to this category; b) Type II Labels (ISO 14021:2002): based on self declarations by the producer (e.g. Der Grune Punkt); c) Type III Labels (ISO 14025:2006): based on the quantification of the potential environmental impacts associated with the product life cycle; the EPD (Environmental Product Declaration) belongs in this final category [18]. In recent years the use of these labels has also begun to be appreciated in the agri-food sector, both by those operating in the sector and by users of the end product, who have realized that they could become an innovative tool for environmental management of products, able to provide credible information on their main characteristics and the environmental impacts associated with their chain of production, increasing their visibility and social acceptability.

Their importance is demonstrated by the following aspects:

- as regards, type I labels, following revision of the Ecolabel Regulation (Reg. CE 66/2010), the European Commission has recently extended the scope of Ecolabel application to foodstuffs and animal feeds, which were specifically excluded under the previous regulation. In particular, Reg. EC 66/2010 allows for a study to be carried out for the determination of Ecolabel criteria for foodstuffs and animal feed, to be completed by 31 December 2011;
- as regards type III labels, the number of EPDs is constantly rising in the food sector; indeed, up to March 2011, 27 EPDs are reported (7 of which relate to Italian products) concerning the following kinds of product: mineral water, wine, milk, pasta, beer, flour of various kinds, bread, barley, Danish pastries, pancake mixtures, crisp bread;
- the presence of other environmental logos, such as: the European organic logo (Reg. EC n. 1254/2008, n. 889/2008, n. 834/2007), which can be used for fruit and vegetables, livestock (including fish), mushrooms and yeast, containing at least 95% organic ingredients; environmental certification of forests (FSC and PEFC),

applicable to wood products and non-wood products (small fruits, mushrooms and honey) which come from forests managed according to rigorous environmental, social and economic standards; third party certification for social and environmental responsibility in agriculture and the food industry (Food Alliance) for salami, eggs, dairy products, mushrooms, cereals, pulses, a wide variety of fruit and vegetables, and products made with these certified ingredients [19].

2.3.2 Towards a framework of guidelines for environmental labels in the agri-food industry

As agri-food products are the result of a collection of subsystems ranging from agricultural practices to processes of transformation and marketing, the implementation of a system of voluntary environmental labelling in the sector is somewhat complex. This is because there are so many variables to be considered, linked to territorial characteristics, methods of cultivation, the quality and safety of products, the context in which the business operates and to the final destination markets. Given growing consumer sensitivity towards the environment and the proliferation of types and systems of environmental labelling, the organizations engaged in improving the environmental performance of their products often operate in a climate of uncertainty when choosing the most effective environmental messages suitable for the specific characteristics of the company and this is even more the case in certain sectors of production, such as the agri-food sector. Thus, there is a need to create guidelines that take into account the specific nature of products, the characteristics of the chain of production, territorial peculiarities, types of market, etc., and that can supply businesses in the sector with a carefully thought out and solidly motivated direction on how to choose the environmental labelling most appropriate for their agricultural and food products [20]. Starting from an analysis of business activities, from the expectations and perceptions of management and interested parties and from their environmental awareness, these guidelines have the objective of helping businesses that wish to apply environmental labelling to their products to choose the message most appropriate to their situation. The main characteristics of the guidelines can be synthesized as follows: a) consistency with the provisions of series ISO 14020 and ISO 14063 standards; b) general character, that is to say all organizations can apply them, regardless of size, sector, location; c) structure based on iterative procedural steps, so as to support companies' decision-making processes in the choice of the labelling most suitable for the requirements and characteristics of their products; d) ease of grounding in a product-oriented environmental management system (POEMS).

3 Conclusions and future developments

In order to verify the effective functioning of the POEMS model and of its individual fundamental elements (IMS, streamlined LCA and labelling guidelines), the EMAF project provides for its application in various pilot companies, so as to highlight the strong and weak points of the individual structural parts and to detect elements that could help their continuous improvement. Application has already been started up preliminarily to coincide with completion of the structural models for the various "modules" of the POEMS. In particular, procedures are under way for study and initial evaluation of production chains for the following applications: a) integrated management system in the tomato puree production chain; b) streamlined LCA of the wine growing and producing chain; c) guidelines for ecological labelling in the pasta chain of production; d) POEMS in the olive growing and producing chain; e) POEMS in the coffee production chain.

The application of individual modules and the POEMS model in its entirety in various businesses in the agri-food sector (involving businesses of various sizes, with different organizational structures, as well as consortium organizations) derives from a precise methodological choice that will allow us to better highlight the general character of the model, which is well suited and easily adaptable to the numerous differentiations to be found in this highly complex sector of production.

Finally, we need to underline that the general character of the proposed model, though designed specifically to answer the particular requirements of the agri-food production chain, can also be applied in other sectors of production, with slight modifications, thus "amplifying" the results of the EMAF project.

4 References

[1] Luciani R., Andriola L., Sibilio S., *I sistemi di gestione ambientale orientati al prodotto (POEMS),* Technical report RT/2003/10/PROT, ENEA, 2003.

[2] Rocha C., Brezet H., Product-oriented environmental management systems, *The Journal of Sustainable Product Design: a case study*, No. 10, 1999, pp. 30-42.

[3] de Bakker F.G.A., Fischer O.A.M., Brack A.J.P., Organizing product-oriented environmental management from a firm's perspective, *Journal of Cleaner Production*, 2002, Vol. X, No. 5, pp. 455-464.

[4] Ardente F. et al., POEMS: a case study of a winemaking firm in the South of Italy, *Environmental Management*, Vol. XXXVIII, No. 3, 2006, pp. 350-364.

[5] <http://ww2.unime.it/emaf>, (Accessed 05/04/2011).
[6] Proto M., Malandrino O., Supino S., *Sistemi e Strumenti di Gestione per la Qualità*, Ist Ed., Giappichelli Editore, 2010.
[7] Salomone R., Franco G., *Dalla "Qualità Totale" alla "Qualità Integrata"*, Ist Ed., FrancoAngeli, 2006.
[8] <http://www.accredia.it>, (Accessed 05/04/2011).
[9] <http://www.saasaccreditation.org>, (Accessed 05/04/2011).
[10] Jørgensen T.H., Mellado M.D., Remmen A., Integrated Management System- three different levels of integration, *Journal of Cleaner Production*, Vol. XIV, No. 8, 2006, pp. 713-722.
[11] Salomone R., Integrated Management Systems: experiences in Italian Organizations, *Journal of Cleaner Production*, Vol. XVI, No. 16, 2008, pp. 1786-1806.
[12] Peacock N. et al., Towards a harmonised framework methodology for the environmental assessment of food and drink products, *The International Journal of Life Cycle Assessment*, Vol. XVI, No. 3, 2011, pp. 189-197.
[13] Zamagni A. et al, Critical review of the current research needs and limitations related to ISO-LCA practice, Deliverable D7 of Work Package 5 of the CALCAS Project (Project no.037075), ENEA, Rome, 2008.
[14] Hospido A., Moreira M. T., Feijoo G., Simplified life cycle assessment of Galician milk production, *International Dairy Journal*, Vol. XIII, No. 10, 2003, pp. 783-796.
[15] Mourad A. et al., A simple methodology for elaborating the life cycle inventory of agricultural products, *The International Journal of Life Cycle Assessment*, Vol. XII, No. 6, 2007, pp. 408-413.
[16] Porta P. et al., A simplified LCA tool for Environmental Product Declarations in the agricultural sector, 6th International Conference on LCA in the Agri-Food Sector, Zurich, Switzerland, 2008, pp. 318-324.
[17] Roches A. et al., MEXALCA: a modular method for the extrapolation of crop LCA, *The International Journal of Life Cycle Assessment*, Vol. XV, No. 8, 2010, pp. 842-854.
[18] Meissner Schau E., Magerholm Fet A., LCA studies of food products as background of environmental product declarations, *The International Journal of Life Cycle Assessment*, Vol. XIII, No. 3, 2008, pp. 255-264.
[19] Smith G., Interaction of public and private standards in the food chain, OECD Food, Agricolture and Fisheries, Working Papers n. 15, France, 2009.
[20] Lo Giudice A., Clasadonte M.T., The EPD for the agro-food chain products, *Calitatea-acces la success: facing the challenges of the future – excellence in business and commodity sciences*, Vol. XI, No. 116, 2010, pp. 472-480.