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Editors

Life Cycle Assessment in the Agri-food Sector

Case Studies, Methodological Issues and Best Practices

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ISBN 978-3-319-11939-7 ISBN 978-3-319-11940-3 (eBook)
DOI 10.1007/978-3-319-11940-3

Library of Congress Control Number: 2014954801

Springer Cham Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

The economic, social and environmental importance of the agri-food sector is well known. The present challenge is how to provide a growing population with good, safe, healthy food while decreasing the pressure and impacts on ecosystems, resource and human health.

LCA is the appropriate method to identify, with high degree of detail, environmental hotspots, compare techniques and crops and inform with scientific data the decision makers both at firm and political level. However, LCA application in the agri-food sector is a complex and challenging endeavour. This book represents a major step forward, identifying complex methodological issues, presenting good examples of case studies and best practices.

The main methodological and data availability issues, involving biological processes and technical systems are exhaustively described in the first chapter of this book, together with a complete survey of major international initiatives and of the (too) many labels used to inform customers about the environmental quality of products.

In the subsequent chapters, case studies on five important product groups, i.e. wine, oil, cereals, fruit, livestock, are thoroughly addressed in terms of best practices, data sources, major environmental impacts, and mitigation strategies.

The book is a very valuable source of data and information for many people, with a primary focus on the LCA practitioner community that will use it as a state-of-the-art reference anytime they have to model agri-food products decision makers and consumers will enjoy the deep and exhaustive description of environmental problems and mitigation strategies, finding scientific basis for informed decisions.

This book is really timely: next year on May 2015 the World Expo titled "Feeding the planet, Energy for life", will present the most advanced solutions of the agri-food sector as source of food, materials and energy. In the meantime, the second wave of pilot Environmental Footprint promoted by the European Commission is starting with, besides others, case studies on wine, oil and meat.

Let me conclude this short foreword with some proud words. Editors and authors of this book are all members of the Associazione Rete Italiana LCA[1], the Italian

[1] www.reteitalianalca.it

LCA Network I am honoured to chair. The “Rete” is a scientific, not-for-profit association whose mission is to foster environmental protection through the wide application of the Life Cycle Assessment. So far it has been capable to convene major Italian LCA experts, organise several scientific conferences, award young scientists, and, now, promote and support the writing of this book. Not bad for a 3 year old association.

ENEA, Chair of the Italian LCA Network Paolo Masoni
Bologna
25 May 2014

Preface

This book stems from a joint effort of some members of the Italian Network of LCA, who are particularly interested in Life Cycle Assessment (LCA) of agri-food product systems, with the aim of thoroughly and critically evaluating the state of the art of food LCA and its application to some particular food chains.

The Italian Network of LCA was launched in 2006 as an initiative of the "Italian National Agency for New Technologies, Energy and Sustainable Economic Development" (ENEA) with the aim of creating a network useful for the exchange, in Italy, of information, methodologies and good practices on the state-of-the art and on the prospects of the LCA methodology.

Six years later, during the VI Conference of the Italian Network of LCA hosted in Bari (Italy) in June 2012, a step forward was taken and the Network became a scientific Association founded by ENEA, the Politecnico di Milano, the Universities of Bari, Palermo, Chieti-Pescara, and Padova, and the "Interuniversity Consortium Chemical Reactivity and Catalysis (CIRCC)". Nowadays, membership association is open to all physical persons interested in the promotion of the development of the LCA methodology within the Italian territory.

The main aims of the Association of the Italian Network of LCA are: promoting the exchange of information and good practices on the state-of-the art and prospects of LCA studies in Italy; promoting the dissemination of the LCA methodology at national level; stimulating the interaction between the parties that deal with LCA and encouraging the process of networking among various stakeholders for the implementation of projects at national and international level; finally, the Association supports the life-cycle approach and the LCA methodology among the institutional bodies. Among the Association's activities, apart from the annual conference, are those of the information services (website, newsletter and mailing list) and of the "Working Groups" (WG).

In particular, along the years, nine WGs have been created: Food and Agri-industrial; Energy and Sustainable Technologies; Construction sector; Chemical products and processes; Tourist services; Management and waste treatment; Wood furniture; Automotive & Electric-Electronic; Development and Improvement of LCA methodology: Research and Exchange Board of experience (DIRE). Some of these WGs have been (and still are) involved in the definition of databases and methodological

approaches mostly applicable to the specificities of the Italian territory and economy.

As far as the "Food and Agri-industrial" WG is concerned, it was constituted in 2008 with the aim of increasing the specific knowledge regarding the application of the LCA methodology to the Italian food and agro-industrial sector and also with the aim of spreading its use for the improvement of the environmental performances of the involved supply chains. The WG is made up of five sub-working groups which study some of the most important food supply chains, namely wine, olive oil, cereals and derived products, meat and fruit.

Among the past activities developed by this WG, the LCAFood 2010– VII international conference on "Life Cycle Assessment in the Agri-food sector" (hosted in Bari in September 2010) is worthy of mention.

This book represents another challenge undertaken by the "Food and Agro-industrial" WG aiming at highlighting, in an as much as possible exhausting manner, environmental hotspots, methodological issues and best practices for the agri-food sector from a life cycle perspective. Its writing has involved several Life Cycle Assessment (LCA) researchers and practitioners (from both private and public Italian organisations) with the aim of creating some practical guidelines for the LCA community and the main actors of the agro-food chains (e.g. farmers, manufacturing companies, consumers, etc.). The book is focussed, in particular, on some of the most relevant and productive agri-food supply chains within the European context, namely: olive oil, wine, cereal and derived products, livestock and derived edible products, and fruit.

In fact, since the end of the 1990's, researchers have scientifically highlighted the fact that most food chains are not sustainable from an environmental perspective due to the impacts occurring in different phases of their life cycle. So, in order to address these relevant issues, several European policies related to sustainable production and consumption began to be promoted with the aim, among others, of quantifying environmental performances of agri-food products. In particular, in 2003, the so-called Strategy for Sustainable Production and Consumption (SPC) was launched aiming at reducing the environmental, social, and economic impact of products and services throughout their entire life cycle. The concept of SPC can be applied to all the existing products sold and bought on the market and hence also to food and drink products. These products in particular play a fundamental role in the everyday life of consumers, whose demand for high quality food has increased in the last few years. In a similar manner to other products, their production and consumption (from farm to fork and end of life) have environmental implications; nevertheless, because of specific aspects related to health, nutrition, well-being, cultural identity, and lifestyle, they need to be considered and treated differently from all other products. In the same period, the Directorate General Joint Research Centre/Institute for Prospective Technology Studies (DG JRC/IPTS) launched a project called Environmental Impacts of Products (EIPRO) in an attempt to identify those products with the most relevant environmental impacts throughout their life cycle, from cradle to grave, taking into account the full food production and distribution chain from farm to fork. Among its results, the report, published in 2006,

highlighted that the food and drink sector accounts for 20–30 % of the environmental impact of private consumption. Subsequently, in 2007, the Strategic Research Agenda (SRA) (2007–2020) of the European Technology Platform (ETP) Food for Life was published defining sustainable food production as the most important challenge that facing the European food industry.

Sustainability tools and, in particular, LCA have been applied for more than 20 years to agricultural and food systems for finding more sustainable ways of food production and consumption and as a means of supporting environmental decision-making via the identification of the environmental impacts throughout the systems' life cycles.

One of the reasons for the growing consideration of the academic community for aspects regarding food LCA is the fact that methodological issues (for example, the definition of the functional unit, difficulties in data collection, pesticides and their exposure, fertiliser dispersion models, impact categories of land use and water use) are different from the typical ones arising from industrial product LCAs. Until now such topics have been tackled with many different approaches that do not represent standardised methods, hence much has to be done to build a consistent, practical and life cycle science based approach to product level sustainability information reporting for all food, beverage, and agriculture products.

This book has been written with the intention of contributing to the identification of practical recommendations to these still open key issues, adding value to the international discourse. It consists of six chapters.

The first chapter has been designed to be propaedeutic to the subsequent ones, providing the reader an as exhaustive as possible overview of the key concerns, applications, and methodological uncertainties of agri-food life cycle assessment (LCA). It comprises: a review of the main international initiatives, eco-labels and declarations, and footprints together with some of the most important LCA initiatives developed by the main stakeholders of the agri-food chains; a general synopsis of the main methodological issues strictly linked to the application of the LCA methodology to the agri-food sector; a state of the art of the major existing international LCI databases and of the national and international initiatives currently under development; finally, an overview of the main dietary issues in the sense that in the context of food sustainability the importance of consumer behaviour and, in particular, dietary behaviour is becoming increasingly recognised, together with the product and its production chain.

On the contrary, each of the other five chapters focuses deeply and critically on one of the chosen agri-food supply chains. Even if each one is developed in its own different way, they are built on a common framework consisting of:

- an as comprehensive as possible state-of-the art of all the international LCA case studies developed on a specific agri-food sector, which represents a building block and a starting point for the subsequent steps;
- the identification of the main environmental hotspots and of the still open methodological issues specifically related to each sector;

- a critical analysis of these key points for identifying and developing practical guidelines to overcome these issues.

These "lessons learnt" are intended to be a support for LCA practitioners and for all the involved stakeholders when developing an LCA study in the agri-food sector.

Specifically, regarding Chaps. 2–6:

- the second chapter focuses on the olive oil industry, one of the most significant sectors within the European Union. The related production process is characterised by a variety of different practices and techniques for both the agricultural and processing phases, causing several adverse effects on the environment. After a description of the international state of the art of LCA implementation in this specific sector, a brief description of other life cycle thinking methodologies and tools (such as simplified LCA, footprint labels and Environmental Product Declarations) is given by the authors. Then, the methodological problems connected with the application of LCA in the olive oil production sector are analysed in depth, starting from a critical comparative analysis of the applicative LCA case studies in the olive oil production supply chain. Finally, guidelines for the application of LCA in the olive oil production sector are proposed.
- the third chapter regards the wine sector; a critical review of LCA case studies is presented by the authors in order to compile a list of scientifically-sound environmental improvements suggested by published LCAs. Next it identifies: the critical environmental issues of wine production and the essential elements that an LCA case study in the sector should consider; optimal sets of indicators and methodologies for the evaluation of the environmental impacts of wine; finally, best practices for environmental improvement in the wine sector are presented;
- the fourth chapter is focussed on cereal and derived products, vital for the production of commodities of worldwide importance that entail particular environmental hot spots originating from their widespread use and from their particular nature. After a brief introduction to the sector and supply chain, the chapter reviews some of the current cereal-based life cycle thinking literature, with a particular emphasis on LCA. Next, an analysis of the LCA methodological issues emerging from the literature review is carried out. The following section discusses some practices and approaches that should be considered when performing cereal-based LCAs in order to achieve the best possible results. Conclusions are drawn in the final part of the chapter and some indications are given of the main hot spots in the cereal supply chain.
- the fifth chapter regards livestock and derived edible products; like the olive oil industry, it is one of the most significant sectors from an economic perspective in Europe representing more than 40 % of the economic value of EU primary productions. This sector consists of a huge diversity of processes and techniques depending on the animal species and the final products. Because of these differences, livestock productions are associated with several adverse effects on the environment, especially in the breeding phases and feeding composition and management. In this chapter, after an overview of the structural and economic characteristics of the most significant livestock supply chain and its main

environmental problems, a description of the international state of the art of LCA implementations for livestock is given. Methodological problems connected with the application of LCA are investigated, starting with the critical analysis of international papers and the few Italian papers in the scientific literature. Finally, the best practices regarding LCA methodology implementation are proposed, in order to improve results and manage the methodological problems identified.

- finally, the sixth chapter focusses on fruit products, generally considered to be some of the less environmentally damaging foods in western diets. In fact studies investigating the carbon footprint of different food choices have reported that fruit is the category with the least environmental impact. However, these studies use data from environmental assessments of generic fruit production, which take no account of specific issues within orchard systems and fruit supply chains. Indeed, modern food production is very diverse, with high levels of specialisation and complexity. This chapter starts with an overview about the fruit industry in Europe and the main environmental burdens related to fruit production. Then, life cycle thinking methodologies and approaches in the sector are presented reporting a state of the art of international LCA practices and other life cycle methodologies and tools for product environmental assessment. Finally, based on the results of the critical analysis of international experiences, methodological problems concerned with the application of LCA to the sector are described and lessons learnt and practical guidelines are proposed.

The authors of this book would like to thank the Italian Network of LCA for its financial support.

The views expressed in this book are those of the authors and do not necessarily represent the views of the European Commission, THE UN Food and Agriculture Organisation or any other organisation cited in the text.

Bari
6 June 2014

The Editors

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Chapter 1
Life Cycle Assessment in the agri-food sector: an overview of its key aspects, international initiatives, certification, labelling schemes and methodological issues

Bruno Notarnicola, Giuseppe Tassielli, Pietro A. Renzulli and Agata Lo Giudice

Abstract Sustainable development and, above all, sustainable production and consumption in the agri-food sector have been key issues since the 2000s, stimulating the creation of many international initiatives and strategies aimed at reducing environmental impacts deriving from food production and consumption and at finding more sustainable ways of production. This first chapter is designed to provide the reader with an as exhaustive as possible overview of the key concerns, applications, and methodological issues of agri-food life cycle assessment (LCA). On this scale the major international initiatives (with a special focus on two relevant and recent European ones), eco-labels and declarations, and footprints (at product level, based on an LCA approach) developed so far are reported. Some of the most important LCA initiatives developed by agricultural and livestock operators, the industry sector, logistics sector, trade, and the end of life of packaging and/or food waste operators are also described in the chapter. Considering that one of the key issues within the agri-food sector is the lack of reliable and up-to-date inventory data on food products and processes, the state of the art of the major existing international LCI databases is reported, and the national and international initiatives currently under development highlighted. Finally, the chapter takes into account dietary issues in the sense that in the context of food sustainability the importance of consumer behaviour and, in particular, dietary behaviour is becoming increasingly recognised, together with the product and its production chain.

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B. Notarnicola et al. (eds.), *Life Cycle Assessment in the Agri-food Sector,*
DOI 10.1007/978-3-319-11940-3_1

Keywords Agri-food chains · Sustainable initiatives · Environmental labels · Databases · Methodological issues · Dietary issues

1.1 Introduction to Life Cycle Assessment (LCA) in the Agri-food Sector

During the last decades, scientific studies have shown that most food chains are not sustainable because of the environmental impacts occurring in different phases of their life cycle. In this context, in 2006 the European Science and Technology Observatory (ESTO) published a report on its project "Environmental Impact of Products" (EIPRO). One of the findings was that the contribution of food and drink products to the environmental impact of private consumption is between 22 and 34%.

The Strategic Research Agenda 2006–2020 of the European Technology Platform Food for Life has defined sustainable food production as the most important challenge facing the European food industry. In general, sustainability tools and life cycle assessment (LCA) have been applied for more than 20 years to agricultural and food systems to identify methods of sustainable food production and consumption and as a means of supporting environmental decision-making via the identification of the environmental impacts throughout the systems' life cycles. One of the reasons for the growing consideration by the academic community of aspects regarding Food LCA is the fact that methodological issues (for example, the definition of the functional unit, difficulties in data collection, pesticides and their use, fertiliser dispersion models, impact categories of land use and water use) are different from the typical ones arising from LCAs of industrial products. Until now such topics have been tackled with many different approaches that do not represent standardised methods, hence much needs to be done to build a consistent, practical and life cycle science-based approach to product level sustainability and reporting of all food, beverage, and agricultural products.

It is in this context that this first chapter arises, being designed to provide the reader with a detailed overview of the key concerns, applications, and methodological issues of LCA with regard to the food sector. In the later chapters these aspects will be analysed in detail with specific regard to the chosen sectors (olive oil, wine, cereal and derived products, livestock and derived edible products, and fruit).

In particular, at the beginning of this chapter the major international initiatives, eco-labels and declarations, and footprints (at product level, based on an LCA approach) developed so far are reported. Among the international initiatives, a special focus is placed on two relevant and recent European ones which highlight governments' commitment toward issues of sustainable production and consumption and eco-labelling harmonisation. As far as the eco-labels/declarations and footprints are concerned, only the most important are reported.

In addition to governments, other actors in the supply chain play a fundamental role in the development and consolidation of the LCA methodology as an essential

tool for the assessment of the environmental performance of food products. This aspect is highlighted in this chapter, which reports some of the most important LCA initiatives developed by agricultural and livestock operators, industry sector, logistic and trading sectors, and end of life of packaging and/or food waste operators.

As already mentioned, one of the key issues within the agri-food sector is the lack of reliable and up-to-date inventory data on food products and processes for developing not only accurate LCA studies but also for hotspot analysis, communication, and labelling. Consequently there is a growing need for comprehensive, clear, well-documented, and consistent data for increasing the accuracy and comparability of LCA studies. In this context, the state of the art of the major existing international LCI databases is reported, and the national and international initiatives currently under development are highlighted.

The final part of the chapter deals with dietary issues in the sense that in the context of food sustainability the importance of consumer behaviour and in particular dietary behaviour is increasingly being recognised, together with the product and its production chain. The dietary choices of the consumer and consumption style strongly affect results in terms of environmental sustainability.

1.2 International Initiatives, Labels, and Footprints in the Agri-food Sector Based on a Life Cycle Approach

1.2.1 Introduction

Agriculture and food production and consumption are arguably some of the most important drivers of environmental burdens, such as habitat change and loss of biodiversity, land use and soil degradation, climate change, water use and pollution, water scarcity, eutrophication of water bodies, and toxic emissions.

Nowadays, food production is becoming more and more globalised and industrialised, leading to its standardisation; agricultural practices, above all in the developed countries, have been intensified in order to increase the ratio yield/ha as much as possible. Furthermore, this globalisation has led to an increasing loss of local markets with a consequent increase in "food miles", i.e. the transport distances between farmers, industry, and consumers, with the consequences of social and environmental costs (Notarnicola et al. 2012a; Reisch et al. 2013).

Recent statistical studies have reported that the global population growth and the change in the dietary habits in emerging countries over the next 40 years will cause an increase in food (about 60%), energy and water demands, the so-called energy-food-water nexus (Alexandratos and Bruinsma 2012). At the same time, the depletion of fossil hydrocarbons will increase the demand for biofuels and industrial materials, which may compete with food for biomass. All these changes will cause a destabilisation of the sustainable use of natural resources, possibly causing social and geopolitical tensions.

In this context, sustainable development and, above all, sustainable production and consumption in the agri-food sector have been key issues stimulating the creation of many international initiatives and strategies designed to reduce environmental impacts deriving from food production and consumption and to find more sustainable ways of production.

Since the 1980s, the European Union (EU) has been one of the main actors within the international context, showing high sensitivity to these issues, sustainable development being one of its key objectives in terms of continuously improving the quality of life and well-being of present and future generations. Starting from the year 2001, an interesting initiative on sustainable development was pursued by European governments to develop a strategy for strengthening and steering environmental politics towards a more ecological product market. It was followed, in 2003, by the so-called Strategy for Sustainable Consumption and Production (SCP), which aimed to reduce the environmental, social, and economic impact of products and services throughout their entire life cycle. The concept of SCP can be applied to all the existing products sold and bought on the market and hence also to food and drink products. These products in particular play a fundamental role in the everyday life of consumers, whose demand for high quality food has increased in the last few years. In a similar manner to other products, their production and consumption (from farm to fork and end of life) have environmental implications; nevertheless, because of specific aspects related to health, nutrition, well-being, cultural identity, and lifestyle, they need to be considered and treated differently from all other products.

During the same year the EU adopted a Communication on the Integrated Product Policy (IPP) (COM (2003) 302 final) with the aim of reducing the environmental impact of products and using, when possible, a market-driven approach combining competiveness with social concerns

In this context, the Directorate General Joint Research Centre/Institute for Prospective Technology Studies (DG JRC/IPTS) launched a project called Environmental Impacts of Products (EIPRO) in an attempt to identify those products with the most relevant environmental impacts throughout their life cycle, from cradle to grave, taking into account the full food production and distribution chain from farm to fork. The report, published in 2006, concluded that there are three areas which have the greatest impact: food and drink, private transport, and housing. Together they are responsible for 70–80 % of the environmental impact of consumption, and account for some 60 % of consumption expenditure. In particular, the food and drink sector accounts for 20–30 % of the environmental impact of private consumption (Tukker et al. 2006).

The Strategic Research Agenda (SRA) (2007–2020) of the European Technology Platform (ETP) Food for Life was published in 2007 and defined sustainable food production as the most important challenge that will be faced by the European food industry.[1]

[1] The newly revised Strategic Research and Innovation Agenda (SRIA) "2013–2020 and Beyond" now focusses specifically on innovation.

The consequence of the evolution of the IPP approach was the birth of a new European strategy in the SPC field that, during the 5 year period from 2007 to 2011, was considered a priority by the EU. In fact its action lines were implemented in environmental politics in order to prevent, reduce, and manage the impact of product life cycles. In this context, in 2008, the European Commission (EC) published the "Action Plan for Sustainable Consumption and Production and on the Sustainable Industrial Policy" (SCP/SIP) (COM(2008) 397 def) in order to define the interventions necessary for implementing the actual models developed for SPC: a dynamic framework was then proposed for improving the energy/environmental performance of products during their life cycle, increasing demand for better products and helping consumers to make decisions regarding such products (Lo Giudice and Clasadonte 2010).

It is important to underline that the SPC community, built on innovative instruments, should be able to boost the capabilities of both producers and consumers, in terms of making "sustainable" choices and influencing each other: these tools are based on a life cycle (systemic, cradle-to-grave) approach, using the LCA methodology.

1.2.2 Environmental Labels and Declarations

Today's consumer society has a strong impact on the environment, depending on the choices that consumers make to satisfy their needs. Choosing more sustainable products can certainly be decisive in terms of impact reduction, i.e. the selection of products that provide environmental, social, and economic benefits while protecting public health and environment over their whole life cycle, from the extraction of the raw materials until the final disposal. The consumer demand for environmentally friendly products is a powerful incentive for companies, who are thus stimulated to find new ways of producing more sustainable products, to intensify efforts at environmental management, and to improve product performance throughout the life cycle. It is important, therefore, to give consumers the right data for correct product choice, which means giving accessible, understandable, relevant, and credible information on the environmental quality and performance of the products.

Nowadays the increasing awareness of the effects of societies and lifestyle on the environment means consumers are inclined towards more sustainable behaviour. In this context, the information provided by the different certification/labelling systems, found on/with some kind of product/service/packaging, could be of crucial help. These systems are referred to as "eco-labelling" or "environmental labelling" and give information on the overall (the whole life cycle) environmental performance of the product/service/packaging or on one or more specific environmental aspects (for example, raw material origin and recyclability). In terms of sustainability, an eco-labelling system has a dual role in the market: first, by awarding seals of approval (in terms of environmental information—fewer impacts on the environment than functionally or competitively similar products) to products, it can influence the market's behaviour towards goods and services with lower environmental

Table 1.1 Current eco-labelling programmes available in the agri-food sector

Name	Website
China environmental labelling (CEL)	http://www.sepacec.com/cecen/
Living planet (Ukraine)	http://www.ecolabel.org.ua/
Vitality leaf (Russia)	http://www.ecounion.ru/en/site.php?&blockType=251
Ecomark (India)	http://www.cpcb.nic.in/Eco_Label.php

impact; second, by acknowledging those firms producing in a more sustainable way it ensures the environmental properties of their products and, in this way, they obtain added value compared with competitors (Udo de Haes et al. 2010).

The environmental assessment of product behaviour can be done through an independent quality assurance process (so-called certification) based on strict procedures and criteria.

According to the ISO Standard 14020:2002 (ISO 2002a), voluntary environmental labels/declarations aim at "*encouraging the supply and demand for those products and services able to cause low damage to the environment so that it will stimulate a continuous environmental improvement process managed by the market*".

Three types of labels/environmental declarations have been identified and regulated: Type I (ISO 14024) (ISO 2001), for example the EU Ecolabel, the most widespread and well-known Type I label; Type II (ISO 14021) (ISO 2002b), for example the "Mobius Cycle", related to the percentage of recycled material in a product; and Type III (ISO 14025) (ISO 2006a), for example the International EPD® system, the most widespread and well-known Type III declaration; there is also another category, not regulated by ISO standards, which has been defined as "environmental labels of Type IV", for example the trademarks Forest Stewardship Council (FSC), Dolphin Safe and Fair-trade Global.

1.2.2.1 Eco-labelling (Type I Labels)

In 2013, four Eco-labelling programmes were suitable for the agri-food sector, as reported in Table 1.1.

These Eco-labelling schemes are briefly discussed in the following paragraphs; in addition, a short description of the results of the feasibility study about the possible extension of the use of the "EU Ecolabel" to the agri-food sector is given.

China Environmental Labelling (CEL) (China) The "China Environmental Labelling" (CEL) programme (Fig. 1.1) is a public voluntary Chinese eco-label scheme established in 1993 by the State Environmental Protection Administration (SEPA, today the Ministry of Environmental Protection of China, MEP).

The programme aims at encouraging businesses to use resources and energy rationally to develop and produce environmentally friendly products, guide consumers to choose and identify sustainable green products, and provide a way for businesses and the public to participate consciously in environmental protection

Fig. 1.1 The China environmental labelling logo

Fig. 1.2 The Ukraine living planet logo

(IISD 1996). As far as the label types are concerned, two types, based on the criteria of ISO 14020 and ISO 14024, are available: Type I, for products within the scope of existing technical standards (issued by MEP); Type II for products not contained in the former: in this case, it is possible to generate a self-declaration that has to be verified by China Environmental United Certification Centre (CEC). The standards may be applied to many product categories, such as food, building materials, textiles, packaging supplies, etc. (International Trade Centre 2013). The only SEPA Technical Requirement Standard suitable for the agri-food sector is HJ/T 210–2005 (replacing HJBZ 13–1996), applicable to soft drinks (CEC n.d.).

Living Planet (Ukraine) This Eco-labelling programme was implemented in 2003 on the initiative of the all-Ukrainian non-governmental organisation Living Planet, with the assistance of the Committee of Verkhovna Rada (Parliament) of Ukraine on Ecological Policy and the Ministry of Environment and Natural Resources of Ukraine. The programme was developed with the aim of implementing an Eco-labelling programme of Type I (Fig. 1.2), according to the requirements of ISO 14024.

For the label development, the best practices of other Eco-labelling programmes, such as those of the EU, Germany, the USA, the Nordic countries and others, were taken into account (Berzina and Shevchenko 2011).

By the end of 2013, the following criteria were developed for the agri-food sector (Table 1.2).

Vitality Leaf (Russia) This Eco-labelling programme (Fig. 1.3) for products, work and services was developed, in 2001, by the non-commercial partnership Saint-Petersburg Ecological Union (SPbEU), a member of the Global Eco-labelling Network (GEN) since 2007. The system is based on the requirements of ISO 14024 and

Table 1.2 Ukraine living planet criteria for the agro-food sector

Standard number	Standard
OEM.08.002.03.010	Pasta
OEM.08.002.03.011	Vegetables and vegetable products
OEM.08.002.03.014	Cultivated mushrooms
OEM.08.002.03.015	Fruits and fruit products
OEM.08.002.03.016	Honey
OEM.08.002.03.018	Vegetable oils
OEM.08.002.03.023	Wine products
OEM.08.002.03.024	Vodka and alcoholic drinks
OEM.08.002.03.025	Bottled water
OEM.08.002.03.027	Bottled mineral water
OEM.08.002.03.031	Cereals
OEM.08.002.03.045	Instant cornflakes
OEM.08.002.03.046	Natural fermentation soft drinks
OEM.08.002.03.052	Food additives
OEM.08.002.03.054	Spreads and oily foods
OEM.08.002.03.053	Coffee and coffee drinks
OEM.08.002.03.056	Salt
OEM.08.002.35.069	Dairy and processed meat products

Fig. 1.3 The vitality leaf logo

it represents the only Russian eco-label recognised by the international community (Ecological Union 2013).

As far as the criteria for Eco-labelling are concerned, they include the following specific areas: level of environmental pollution; level of safety for human health; content of recyclable/recycled components; rational use of natural resources during the product's life cycle; use of renewable resources during the product's life cycle; waste management; and use of the best available technologies (NEASPEC 2012). In 2013, just three criteria existed for the agri-food sector: STO −56171713–1.01–2007 (Alcoholic beverages), STO VL 2.02.9730–11–1.0 (Vegetables), and STO VL 2.01.0131–10–1.0 (Drinking water).

Ecomark (India) To increase consumer awareness, in 1991, the Ministry of Environment & Forests (MoEF) launched, through the Central Pollution Control Board

Fig. 1.4 The ecomark label

Fig. 1.5 The new ecolabel logo

(CPCB), the Eco-labelling scheme Ecomark for easy identification of environmentally friendly products. The label (Fig. 1.4) is applicable to all goods which meet the specified environmental criteria and the quality requirements of Indian standards: the criteria follow a cradle-to-grave approach, i.e. from raw material extraction, to manufacturing, to disposal.

By the end of 2013, sixteen final criteria for product categories had been developed by the government of India: Soaps & Detergents, Paper, Food Items, Lubricating Oils, Packaging Materials/Packaging, Architectural Paints and Powder Coatings, Electrical/Electronic Goods, Food Additives, Wood Substitutes, Cosmetics, Aerosol Propellants, Plastic Products, Textiles, Fire Extinguishers, Finished Leather Goods, and Coir and Coir Products. Among them, just one is applicable to the agri-food sector: Food Items (Edible Oils, Tea, and Coffee).

A research report was published in 2007, highlighting that the scheme had not gained the expected appeal among consumers or industry; in fact only a few manufacturers of products like paper, pulp, leather, and wood particleboard had applied for and obtained the Ecomark licence, and they rarely used the symbol on their packaging as none of them had gained any benefit from it (Mehta 2007).

EU Ecolabel (Europe) The EU Ecolabel represents the best European recognition of products (and services) meeting specific environmental criteria and the highest environmental standards: these products are characterised by high performance and environmental quality, verified by a robust and independent certification process, and are recognisable by a specific logo represented by a flower (Fig. 1.5). Obtaining such a label can help a product to emerge and differentiate itself from its competitors on the market since the label certifies that it has a reduced environmental impact throughout its entire life cycle. As far as the eligibility criteria are concerned, the EC defines the groups of products/services that can be certified and, for each of them, the environmental criteria that must be met for the release of the label.

This voluntary scheme is an important component of the EU's Sustainable Consumption and Production Action Plan, and was launched in 1992 (with the adoption of the Council Regulation (EEC) n. 880/92) when the European Community decided to develop a Europe-wide voluntary environmental scheme that consumers could trust.

With its first review (Ecolabel II, Council Regulation (EC) n. 1980/2000) the application of this label was extended to services, and in 2010 the EC issued a new Regulation "Ecolabel III" (Council Regulation (EC) n. 60/2010) with the aim of: streamlining the developing path for eligibility criteria by focussing on the most significant environmental impacts throughout the product/service life cycle; ensuring that the top 10–20 % of environmental performers on the market could meet the criteria; reducing the label costs to encourage the interested stakeholders to undertake the certification path; widening the label application field by evaluating the possibility of including food (under conditions emerging from a feasibility study). Ecolabel III confirmed the application of environmental criteria to all consumer goods and services, with the exception of food, beverages, and medicines. It also foresaw the possibility of developing specific criteria for food and feed, depending on the results of a feasibility study to be conducted by the Commission by the end of December 2011. This study was conducted with the aim of evaluating:

- the feasibility of establishing reliable criteria applicable to the entire life cycle of food, feed, and drinks products, including the stages of cultivation;
- the impact and the added value of establishing these criteria and implementing this scheme in various sectors, and the possible impact on organically certified products (including the risk of consumer confusion);
- the possibility of restricting the label to organically certified products.

The feasibility study highlighted these main aspects.

1. The main environmental impacts (for example, biodiversity or soil fertility loss) linked to the food, feed and drink products life cycle are mostly owed to the primary production phase (or "extraction of the raw material"), even if dependent on the product category. Because of their nature, these impacts are not easily measurable and thus cannot be ranked in terms of environmental impact. The same can be said of ethical or social questions (for example, animal welfare, labour standards).
2. The environmental impact of food, feed and drink products in the "extraction of the raw materials" arises from the combination of the practice employed and the place where it takes place because of the use of physical elements such as land, water, etc. As a consequence of this, the environmental impacts for a particular product, on a specific site, using specific production technologies can vary significantly.
3. A deficiency within current labelling systems was highlighted by the study: existing labels focus only on the environmental impacts arising from the primary stage and not (or only to a limited extent) on the ones from the processing life cycle stage. This deficiency could represent a key point for the success of the