MIRA – AMS 2012 Topic Report

TRANSITION to a sustainable agro-food system in Flanders: a system analysis

VLAAMSE MILIEUMAATSCHAPPIJ
Landbouw en Visserij

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sustainable agro-food system
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Environmental problems are becoming more complex and require an integrated approach. Collaboration and consultation between various policy domains and, by extension, all social sectors, are keywords here. This is also reflected in the demand for integrated knowledge of environmental issues.

The MIRA topic report is based primarily on an integrated approach. The topic report focuses on strategic policy issues in and for Flanders. It presents an in-depth review of the domain, using a variety of scientific methodologies such as system analysis, policy evaluation and future outlook.
The policy relevance is illustrated by the inclusion of policy recommendations.
Given the need for integrated considerations of environmental, economic and social aspects, the publications are the result of a collaboration, to varying degrees, between administrations and organisations with specific domain expertise.

A MIRA topic report is aimed, in particular, at policymakers, civil society, academics and domain experts. The aim is to strengthen the knowledge base and thereby contribute to the social debate.

TRANSITION to a sustainable agro-food system in Flanders: a system analysis

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VMM Vlaamse Milieumaatschappij
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Summary

Like many other regions in Europe and in the rest of the world, Flanders is facing a number of major societal challenges such as climate change, the increasing scarcity of fossil fuels and materials against the backdrop of a steadily growing world population and world economy, limited availability of space, and financial and economic turmoil. These are obvious hot issues that make visible and tangible the need for effective efforts towards more sustainable development.

An important characteristic of sustainability challenges is complexity: various systems, activities and actors are linked with one another in very many and different ways, and also interact with one another. Hence, the emphasis is increasingly on the need for system approaches and system innovations in developing true sustainability solutions. In this report, a system analysis of the Flemish agro-food system, from production to consumption, has been performed. The purpose of this analysis is to promote system thinking and the further design of more sustainable system configurations.

First, the how, what and why of a system analysis within the context of transitions to sustainable development are explained. There is, in fact, no such thing as a blueprint or recipe for performing a system analysis. Based on available scientific literature, we will present the approach used, and identify those elements of the approach that are vital to a functional system analysis. For this, the multi-level perspective (MLP) is used. An analytical framework developed specifically to study complex, socio-technical systems, it holds that transitions are the outcome of interactions between three levels: landscape, regime and niche.

At the landscape level greater forces and social dynamics are at play: dominant trends and developments that are so powerful that they can hardly, if at all, be influenced and/or that change very slowly. These macro level movements exert strong pressure on the prevailing system and may increase awareness of the need for change (sense of urgency). This report will outline ten broad landscape developments that exert pressure on the operation of the existing system: growing world population and welfare, globalisation, greying of the Flemish population, urbanisation, climate change, scarcity of resources, changing values and ethical standpoints of consumers, other growth paradigms, hunger and inequality, and the digital revolution.

A regime refers to a dominant culture and dominant world view embedded in structures and practices, physical and immaterial infrastructures such as organisations, buildings and roads, energy networks, routines, actor networks, legislation and regulation, government and policy, etc. Regimes are the stable backbone of socio-technical systems and have a characteristic rigidity that often prevents innovations from impacting or fundamentally changing existing structures. They can, in other words, be viewed as a lock-in. Their dynamics therefore exhibit a significant path dependency: choices in the present are limited by choices from the past. Due to landscape pressure and/or the operation of the regime itself, a number of system mechanisms may

experience frictions or problems. These are described as nine ‘hotspots’ that are related to food security and health, food diversity and quality, non-food applications, specialisation, scarcity of natural resources, absorption capacity of the natural environment, social capital, innovation, and openness of the system. These nine hotspots operate within a prevailing system logic, with the economic system being the dominant system, trying to remedy potentially inhibiting factors from the social and ecological context, mainly through technological innovation. More specifically, efforts are made to increasingly decouple the economic subsystem from the social and ecological subsystem, on the one hand by increasing resource efficiency, and on the other by improving labour efficiency.

The niches, finally, refer to radical innovations that are generated in the periphery of existing regimes. They are the outcome of the co-evolutionary process of an entrepreneurial impulse within heterogeneous social and technological networks. Niches are protected, little visible and small-scale segments of society where radical innovations can emerge and be tested. These can be (combinations of) new technologies, new rules or legislation, new organisation forms, etc.

To tackle the different sustainability challenges, (system) innovations or solution approaches addressing the above-described hotspots are needed. Inspiration can be found in existing niches that have been bundled into four niche regimes, or clusters of niches that, in terms of scale size, hold the middle between regime and niches and that are capable of influencing the regime towards sustainability: urban agriculture, organic agriculture, eating differently, and new production paradigms.

The report ends with a number of conclusions and recommendations for the various actors in the Flemish field of agriculture and food in general and policy in particular. The basic point of departure is the approach that niches are in fact embryonic innovation systems that can only reach their full potential through the following functions: experimentation by entrepreneurs, knowledge development, knowledge diffusion in networks, steering of the search process, creation of markets, mobilisation of resources, and creation of legitimacy. The implementation of these functions is the shared responsibility of all actors – entrepreneurs, knowledge institutions, investors, government, social organisations and citizens – and can be brought about both via a broad transition network and by the reinforcement of small, but focused innovation networks.

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Like many other regions in Europe and in the rest of the world, Flanders is facing a number of major societal challenges such as climate change, the increasing scarcity of fossil fuels and materials against the backdrop of a steadily growing world population and world economy, limited availability of space, and financial and economic turmoil. These are obvious hot issues that make visible and tangible the need for effective efforts towards more sustainable development.

Just like the various other social subsystems, the agro-food system, both locally and globally, has to deal with these great sustainability challenges. The essential challenge is to ensure the healthy nutrition of a growing world population with a production system that respects the environmental limits of the planet and will therefore have to operate within the confines of increasingly scarce resources, climate change, etc.

An important characteristic of sustainability challenges is complexity: various systems, activities and actors are linked with one another in very many and different ways, and also interact with one another. Hence, the emphasis is increasingly on the need for system approaches and system innovations in developing true sustainability solutions. A concept providing a potential thinking and working framework for such systemic changes is that of transitions and transition governance. Transitions are profound changes in the structure, ways of thinking and ways of working of social systems. Transitions have always taken place, but science and policy increasingly assume that transitions can also be deliberately set in motion or accelerated and oriented towards greater sustainability. The specific approaches that can create such acceleration are termed transition governance.

In the Netherlands, investments in and experiments with different transition approaches, not least in the field of agriculture and food (Transforum, Syscope, InnovatieNetwork), have been going on for some years. In Flanders too, two transition networks have been active for a number of years. One is DuWoBo, which focuses on sustainable housing and building, the other is Plan C, which works on sustainable materials management. The transition concept is receiving growing attention in Flemish policy. Various initiatives taken by the Flemish government in recent years, such as Flanders in Action (ViA), Pact 2020 and the Flemish Strategy for Sustainable Development (VSDO), explicitly state that transitions towards sustainability are required to tackle some of these major societal challenges. Within ViA, thirteen transversal themes have been identified to which a transition approach will be applied. Work is also ongoing on the preparation of a transition path for the agro-food system, as recommended by the VSDO. Furthermore, the Policy Research Centre on Transitions for Sustainable Development (TRADO) has been active since 1 January 2012. As a partnership between various research institutions, it conducts policy-oriented research on transitions for sustainable development. The aim of the TRADO research is to scientifically underpin and support the transition approach of the Flemish government.

An essential characteristic of transition governance is that thinking and acting is done from an explicit system perspective. A first step in this process is to chart and analyse the system in a structured and practical manner. A system analysis is therefore a framework that promotes system thinking, and an instrument for the further design of more sustainable system configurations in the future.

The purpose of this report is to perform a system analysis of the Flemish agro-food system, from production through to consumption. It consists of six chapters. After this introduction, the how, what and why of a system analysis within the context of transitions to sustainable development is explained in chapter 2. There is, in fact, no such thing as a blueprint or recipe for performing a system analysis. Based on available scientific literature, we will present the approach used, and identify, in particular, those elements of the approach that are vital to a functional system analysis. The following chapters discuss the current agro-food system based on the multi-level perspective (MLP) that is commonly used in a transition context. First, ten broad landscape developments that exert pressure on the operation of the existing system will be outlined (Chapter 3). Due to this landscape pressure and/or the operation of the system itself, a number of system mechanisms experience frictions or problems. These are described as nine 'hotspots' (Chapter 4). Chapter 5 describes a number of niches, bundled into four niche regimes: innovative system configurations that already exist and that can be used as inspiration to turn tensions and problems into opportunities for a future and sustainable Flemish agro-food system. Finally, Chapter 6 ends with a number of conclusions and recommendations for the various actors in the Flemish field of agriculture and food in general and policy in particular.

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Sustainable development calls for system innovation and therefore system thinking. A concept providing a potential thinking and working framework for such systemic changes is that of transitions and transition governance. A first step in transition governance is to chart and analyse the system in a structured and practical manner. There exists no blueprint for performing such a system analysis. Based on available scientific literature, we will here present the approach used, and identify those elements that are vital to a functional system analysis. We will also introduce the concepts of landscape, regime and niches.

2.1 Transitions as a conceptual framework for sustainable development

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The conventional policy approaches alone are not sufficient to find effective solutions to the problems responsible for the unsustainability of today's social systems (Rotmans, 2003). The reason for this is that they are generally too fragmented, incremental and focused only on the short term (in their problem-solving capacity). They often lack an overarching long-term story that accommodates the various elements and their interrelationships. A concept to analyse, understand and, where possible, steer the complex, profound long-term changes of social systems towards sustainability is that of transitions (Grin et al., 2010). Transitions are profound changes of social systems. Such processes have always taken place (e.g. industrial revolution, ICT revolution, etc.). During the last decade, however, the idea has emerged that it is possible to initiate or accelerate transitions and orient them towards sustainability. Such transitions are described as systemic changes in structure, ways of thinking and ways of working, with the explicit aim of a higher level of integral sustainability to be achieved on equal terms and simultaneously in social, ecological and economic domains (Loorbach, 2007). Step-by-step changes are not rejected, but instead receive their rightful place in a broad and consistent story of long-term system change.

To initiate, accelerate and support such processes of profound change of complex systems, a specific policy approach is needed, a form of governance that should be embodied in broad, transparent networks where public and private actors think, act and learn together (Paredis et al., 2009). A specific 'school' of transition governance is transition management, which combines a number of elements that are essential for system thinking and system change into a cyclic process of learning and acting (Nevens et al., 2012):

Analysing the system A first prerequisite for system change is knowledge of the system: identifying the relevant actors and their interrelationships, key system functions, institutions and regulations, physical flows, information flows, accelerators and inhibitors.

Envisioning the future A change path to a more sustainable society is initiated primarily by a compelling and inspiring vision, a set of clear visual or non-visual images of the desired future system.

They are based on shared principles of sustainable development, but also leave sufficient room for individual choice in the quest for a shift towards a sustainable future.

Exploring pathways Starting from a clear and compelling vision, different pathways to the desired future system can be outlined. This backcasting exercise (returning to the present from an image of the future) results in a number of strategic paths that can be followed to establish the new desired system.

Experimenting Transition experiments are real-life actualisations of drastically alternative ways of working and/or thinking that fit in with new, supposedly sustainable system approaches. To allow ground-breaking experimental settings to grow, they often initially need some degree of protection from the ruling regimes of institutions, legislation, power, routines, etc.

Assessing In the course of the different pathways to the desired system, it is best to have access to proper instruments for follow-up of the actions that are undertaken. These instruments should be based on the same principles that were employed to envision the desired system.

Translating To initiate sustainable system changes, experiences from transition activities must be incorporated and multiplied in the actions on the part of relevant system stakeholders and actors (governments, industry, civil society, customers, consumers, researchers, entrepreneurs, etc.). Such translation can take the form of new policy measures or policies, but also legislative amendments, converting best practices into standards, etc.

These essential elements are to be presented in a logically cohesive way, rather than in a chronological order. The emergence, change, and interaction of the various elements often takes place in a spontaneous and environment-dependent way. However, as more knowledge of such processes is gained, it becomes possible to identify appropriate methods and places of managing (i.e. adjusting, accelerating, facilitating, etc.) them. This continuous learning process also implies that during transition paths, the various elements will need to be reviewed and, where appropriate, updated as a function of what is learned from the other activities.

2.2 Place and role of system analysis in a transition context

System analysis constitutes an essential element in the above-described pragmatic framework for transition processes. A meaningful system analysis, due to its place within the broader context, should be instrumental for the other elements of a consistent transition process. A system analysis in such a context should allow one to:

- approach the sustainability-related mechanisms and issues of the system under consideration from the point of view of society as a whole, and to also (learn to) see the thinking of sustainability solutions in such a broader system context (Foxon & Pearson, 2008).
- incorporate all activities into the system in order to clearly identify the (reinforcing and weakening) cohesion between the different system elements.
- support stakeholders and interest groups from different sectors, chains, networks in developing a shared vision on the generic operation of the system and in identifying so-called 'hotspots': places in the system where frictions or problems have occurred that require a profound change in the mechanisms on which the system relies.
- look beyond the elements that are automatically associated with the system. In spite of their limited visibility or obvious evidence, many seemingly 'exotic' aspects can have a significant influence on the current and/or future operation of the system.
- act as a source of inspiration in developing alternative system

configurations of the future that no longer embody the current frictions, problems and unsustainability of the system (or part thereof).

2.3 System analysis: 'methodology'?

Although the need for system analyses for transition processes is explicitly acknowledged, there is no such thing as a recipe or clearly defined methodology. There does, however, exist a knowledge base in the system sciences as well as a number of guiding frameworks and concepts that can be used to elaborate a consistent and instrumental system analysis. An essential distinction is made between 'hard' and 'soft' approaches to system analyses.

The **hard**, positivist approach is based on the development of models that are assumed to be a (simplified) representation of reality. A hard system analysis will attempt to contribute to a demonstrable, measurable and rational weighing of different decision options in a complex situation. It will rely wherever possible on scientific evidence, statistical methods, formal cost-benefit analysis and accurately codified quantitative models that allow statements to be made about the expected system behaviour (Gilbert & Troitzsch, 2005; Voinov, 2008). Typical activities within this rational approach are the prediction of future contexts or scenarios (with models) and the identification, design, screening, comparison and classification of possible alternatives (Quade & Miser, 1995).

The **soft**, constructivist approach explicitly introduces the perspective of the observer. It is assumed that an objective view of a problem situation is not possible, and that the way in which a situation is perceived is always connected with the observer's view of the world. Solution strategies within a soft system approach are therefore invariably based on explicitly confronting different world views in a process of action-investigation.

'Critical system thinking' is often considered an extension of the soft approach that pays additional attention to power relations within the system under study (Reynolds & Holwell, 2010).

Both approaches – hard and soft – have their strengths and weaknesses and can be used in varying combinations. A system analysis in the context of a transition process should be mainly diagnostic and explorative and, as already indicated, capable of inspiring a broad field of stakeholders in developing a vision of a more sustainable system. In such a context, the use of relatively accessible, high-quality instruments is the most appropriate.

For this study, we have chosen a method that combines hard and soft elements: the analysis is based on a system diagram and illustrated with quantitative data. The format used for the system diagram is a causal loop diagram or influence diagram (Vandenbroeck et al., 2007). This representation method distinguishes system variables (each relevant system element whose level can change) and causal links between those variables. This provides an abstract but flexible approach to describing the relationship between very different aspects of a system.

2.4 The multi-level perspective as a structuring framework

A conceptual framework that strongly supports the transition theory and that can be used as a structuring framework for system analyses is the multi-level perspective (MLP). The MLP is an analytical framework developed specifically to study complex, socio-technical systems. It holds that transitions are the outcome of interactions between three levels: landscape, regime and niches (Figure 1; Geels, 2005).

At the **landscape** level, greater forces and social dynamics are at play: dominant trends and developments that are so powerful that they can hardly, if at all, be influenced and/or that change very slowly (e.g. globalisation, climate change, population evolution). These macro-level movements exert strong pressure on the prevailing system and may increase awareness of the need for change (sense of urgency).

A **regime** refers to a dominant culture and dominant world view embedded in structures and practices, physical and immaterial infrastructures such as organisations, buildings and roads, energy networks, routines, energy networks, legislation and regulation, government and policy, etc. Regimes are the stable backbone of social systems and have a characteristic rigidity that often prevents innovations from impacting or fundamentally changing existing structures. They can, in other words, be viewed as a lock-in. Their dynamics therefore exhibit a significant path dependency: choices in the present are limited by choices from the past.

The **niches**, finally, refer to radical innovations that are generated in the periphery of existing regimes. They are the outcome of the co-evolutionary process of an entrepreneurial impulse within heterogeneous social and technological networks (Garud & Karnøe, 2001). Niches are protected, little-visible and small-scale segments of society where radical innovations can emerge and be tested. These can be (combinations of) new technologies, new rules or legislation, new organisation forms, etc.

Transitions occur when evolutions at these different scale levels reinforce each other (see Paredis et al., 2009). Putting sufficient pressure on the regime opens up opportunities to change the regime: so-called windows of opportunity for innovation. Such pressure can be the result of developments at the landscape level or of growing tensions within the regime. When windows of opportunity arise, niches having a certain degree of maturity can break through and help change or even replace the regime.

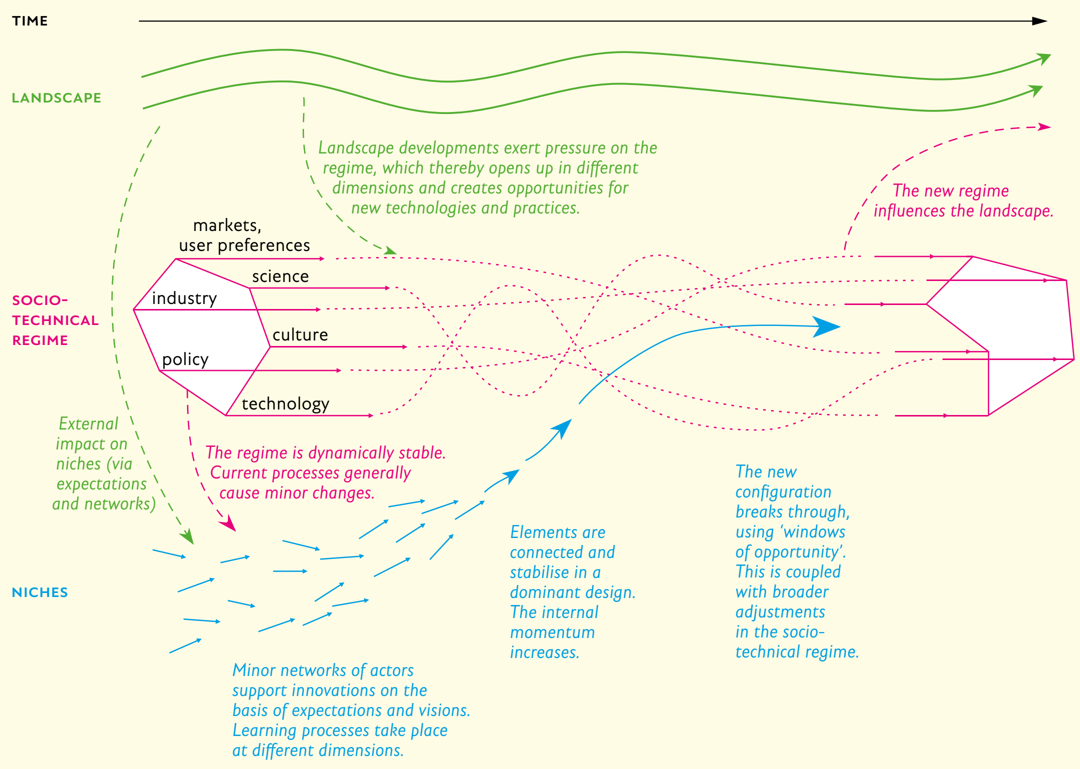
In the following chapters we will discuss the relevant elements for each of the levels of the MLP in the context of the Flemish agro-food system:

Landscape (Chapter 3) We will describe ten dominant trends, developments and dynamics that influence and/or put pressure on the Flemish agro-food system. In the MLP connotation of landscape, these dynamics can occur at any scale level, from worldwide to local.

Regime (Chapter 4) Based on an influence diagram, we will outline the current operation of the Flemish agro-food system (geographical scale of Flanders) and identify a number of hotspots: places in the system where frictions or problems occur as a result of developments at the landscape level or as a result of the operation of the regime itself.

Niche (Chapter 5) Finally, we will describe four niche regimes, or clusters of niches that, in terms of scale size, hold the middle between regime and niches and are capable of influencing the regime towards sustainability.

Figure 1: **Dynamic version of the multi-level perspective**



Source: Paredis et al. (2009), based on Geels (2005)

In this chapter we will demonstrate that the agro-food system in Flanders is facing important challenges as a result of a number of dominant developments from the landscape, the environment on which the system has little or no influence. These developments put increasing pressure on the current agro-food system. At the same time, they can act as driving forces for system changes.

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Table 1 shows an overview of the landscape developments that will be discussed in this chapter.

Table 1: **Landscape developments that affect the Flemish agro-food system**

Development	1	The world's population and prosperity are on the rise
	2	Globalisation is here to stay: the world is becoming a 'village'
	3	The local population (EU, Flanders) is ageing
	4	The world and Flanders are urbanising
	5	The climate is changing: adapting and mitigating
	6	The scarcity of natural resources is becoming tangible
	7	Values and ethical stances of consumers are changing
	8	'Other growth' is increasingly becoming a point of debate
	9	Hunger and inequality remain major global concerns
	10	The digital revolution is here to stay

We use the term 'development' because it best describes the largely autonomous character of the dynamics on the landscape level which, by definition, cannot be influenced or only to a limited extent, but which are already visible and will continue in the future. The choice of the ten developments is partly pragmatic and partly inspired by other studies.

We do not make any claims regarding the completeness of the list and the descriptions, but we do consider the selection to be a fair representation of the developments that are at the basis of many sustainability-related issues and therefore also of today's major social challenges. Developments on the landscape level can take place at different geographical scales: both worldwide and local dynamics are taken into consideration. They are characterised by a high degree of autonomy and consequently the limited possibilities for decisive action on an 'individual basis'.

3.1 Development 1
The world's population and prosperity are on the rise

According to forecasts of the United Nations, the world's population is expected to grow from 7 billion today to 8 billion in 2030 and at least 9 billion in 2050 (this calculation assumes an average growth in the fertility rate). The majority of this increase will occur in low-income countries. Thus, the African population is likely to double by 2050. However, a high degree of uncertainty is associated with the forecasts: population growth is closely linked with factors such as economic growth, education level, access to contraception, gender (in)equality, and female education (Foresight, 2011). Together with the population, the general prosperity level is expected to rise. The generic Human Development Index of the United Nations shows this progress and confirms the steady increase expected for a growing number of countries, increasingly also for so-called emerging market countries and in the future even more so for today's developing countries, including a large part of Africa (UNDP, 2012).

A growing world population and a growing prosperity level (in particular the transition from poverty and hunger to basic prosperity) for an increasingly bigger share of that population will significantly increase the demand for food and therefore also food production in the coming decades (Henningsson, 2004; UNEP, 2012). On top of this increased demand, further shifts are expected in the composition of the human dietary pattern. These shifts, too, will have major implications for the agro-food system because some food products require far more land, water and energy resources per calorie consumed than do other products. It is difficult to predict how diets will change, because cultural, social and religious factors are also at play. However, the so-called Bennett's Law already applies here, which states that as incomes rise, the share of starch products in diets decreases and more calories are drawn from fats, proteins and sugars. A specific issue in the field of increasing protein consumption is the expected increase in the demand for meat. Studies forecast a worldwide increase in average meat consumption from 32 kg per person per year in 2011 to 52 kg in 2050 (Foresight, 2011).

A rapidly growing world population in combination with an increasing prosperity level will also generate more consumption, not only of food but also of other products and services (a number of which are also related to food, such as ready-made meals, packaging, etc.). This in turn results in increased use of natural resources (energy, materials, water, space, etc.) and a growing environmental impact.

3.2 Development 2
Globalisation is here to stay: the world is becoming a 'village'

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Globalisation refers to a process of increasing worldwide interaction (physical and virtual) between people, businesses, governments and cultures, which is characterised by the elimination of boundaries and barriers to the exchange of people, goods, technology, information and capital. This dynamic is supported and reinforced by developments in transport, telecommunication and information technologies. Globalisation not only creates a worldwide marketplace for production and trade, but also promotes increasing mobility of people. Businesses are also no longer linked to a specific country: they have offices and production sites throughout the world or at least a number of international alliances. Several products of various brands can be bought virtually anywhere in the world. The globalisation of markets has been an important factor that has also helped shape the global agro-food system. In high-income countries, globalisation has led consumers to expect to find a cheap, safe and highly varied supply of food the whole year round (Foresight, 2011). Globalisation has also led to the emergence of new food superpowers. Brazil became the third biggest exporter of agricultural products in 2008. China and India invested considerably in the development of their own production capacity, so that both countries have become major exporters, even if China is still a net importer. Russia, too, is a major player in global export markets, with still a large reserve of underused land.

In an underlying theory of comparative advantages, exchange of services and products (in this case worldwide) offers advantages for the various parties involved. Globalisation thus enables developing countries and regions to increase the general prosperity level. At the same time, however, suppliers and producers of local and regional markets often lose control over the market to which they once provided value and which value also flowed back to the production regions. In the absence of appropriate safety nets, this can result in deteriorating rural infrastructure and a dwindling population. This is reflected in an increasing claim on food sovereignty, the right of local actors to define their own agro-food system, as opposed to high dependence on international market forces. A related concern is the role and evolution of worldwide groups and conglomerates of agro-biotech companies that lead to conditions where access to knowledge and raw materials is controlled by a limited number of players who are able to impose an economic model on agricultural producers that are less powerful. These are dynamics that are potentially indicative of unlimited markets going overboard.

Globalisation also affects the cultural level. Our western culture can be found in all corners of the world (music and youth cultures are examples in point), but all forms of non-western cultures can equally be found in the western world ('exotic' food, world music, etc.). Cultural exchange in all directions is therefore also an important aspect of globalisation.

One specific aspect of globalisation is migration. Europe is a prosperous and politically stable continent, which is also why each year tens of thousands of people from other continents try to emigrate to Europe. Driven by aspects such as poverty, conflict, economic growth, environmental degradation, effects of climate change and migration policy, this is, however, one of the megatrends with a very high degree of uncertainty (EEA, 2010). As much as 70 % of the current increase in the Belgian population (2.6 times that of the European average) is to be attributed to immigration (figures for 2010 compared with 2009; Eurostat, 2010a).

The extent to which governments act collectively or individually in addressing tomorrow's challenges, in particular with regard to shared raw materials, trade and volatility in agricultural markets, will be crucial for the future. The political sensitivity of food (together with the fact that food is a primary need) puts great pressure on governments to act in the national interest. This may adversely affect the larger system as in 2007-2008, when price increases were exacerbated by temporary trade restrictions. The suitability of current international institutions to effectively deal with future threats and the political will to let these institutions do their job are not clear. Many institutions address only one aspect of the system (productivity, sustainability, equality, trade and hunger). The extent to which the barriers between these institutions can be eliminated will be a key factor in the consistent approach to addressing the numerous challenges faced by, among others, the agro-food system.

3.3 Development 3 The local population (EU, Flanders) is ageing

The number of people aged 65+ in the Flemish Region is expected to grow from 1.10 million in 2008 to 1.58 million in 2030 (+44 %). The number of small households is also expected to increase considerably, from approx. 770 000 in 2008 to almost 950 000 in 2030. The number of larger households is projected to fall (SVR, 2011).

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The ageing of the Flemish population is reflected in an increasing dependency ratio which indicates the ratio between the non-economically active age group (0-19 and 65+) and the economically active age group (20-64). For the Flemish Region, the dependency ratio increases from 66 to 82 in 100 by 2030. This trend means that the social system will have to organise itself to share the burden of ageing between generations and within generations. Increasing ageing also challenges the further development of affordable and high-quality health care that is accessible to all. Another aspect is the need for optimising the participation of seniors in economic, social, political and cultural life, so that their knowledge, experience and skills can be used to good effect (i.e. with added value).

British research has shown that senior consumers will constitute a key market for various goods, not least for food products. Thus, older people were found to place great value on ease of use, and emphasised the importance of locally produced food. Health aspects also play a decisive role for this growing group of consumers. They were also identified as the foremost 'experimenters' in the field of food (IGD, 2008).

Ageing is also occurring within the group of active Flemish farmers. The fall from 42 282 farm managers in 1999 to 29 394 in 2009 coincided with an increase in the average age of farm managers from 46.2 years to 49.5 years. Moreover, there is only a small number of young managers: in 2009 only 2.3 % of Flemish businesses had a manager aged under 30, and 7.9 % were older than 65 (LARA, 2011).

3.4 Development 4 The world and Flanders are urbanising

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In 2008, for the first time in the history of mankind, more people lived in an urban environment than in a rural one (Seto et al., 2010; Crossette, 2010). This urbanisation trend will continue in the future. The United Nations predict that by 2030 there will be 29 cities worldwide with more than 10 million inhabitants. This increasing urbanisation is also noticeable in Flanders. The population in the Flemish Region is expected to grow to 6.6 million inhabitants by 2030, a 7 % rise compared with 2008. For every 10 000 inhabitants, Flanders gains 18 inhabitants by natural growth and 54 by migration. The growth of the population and the share of migration are greatest in cities. Such sustained urbanisation has a spatial, physical component that is reflected in the increasing loss of open space and pressure on the environment (VRIND, 2011). More than 1.5 million people, i.e. almost a quarter of the Flemish population, live in large or regional cities. Four out of ten inhabitants live in rural or transitional areas.

The demand for energy, buildings, waste treatment, water supply and industrial processes is centred in and around cities. Consequently, cities worldwide are responsible for 75 % of global raw materials consumption and also account for the major share of emissions and adverse environmental impacts (Madlener & Sunak, 2011). Cities are also the places where the majority of greenhouse gases are produced: over 70 % of energy-related emissions are generated by cities (Grimm et al., 2008). This share is even higher if one includes indirect emissions due to consumption (Hoornweg et al., 2011). Cities are thus the primary locations where many, or even most, of unsustainability issues originate.

At the same time, cities are explicitly regarded as the ideal places to effectively tackle sustainability problems (Bulkeley et al., 2011). They can become the motor of sustainable development (Rotmans et al., 2000) or hubs for extreme innovation (Ernstson et al., 2010; Spath and Rohracher, 2012). A broad set of options for the governance of sustainable development is thus in the hands of cities and their actors (administration, businesses, citizens, etc.) and the urban environment is consequently expected to take the lead in sustainable development (Theodoridou et al., 2012).

The context of Flemish urbanisation causes cities to grow beyond their boundaries to form urban regions with a city centre, an agglomeration and a suburb. These urban regions are very large compared with other countries. As a result, the majority of the Flemish population in the highly urbanised Flemish region actually lives outside the city centres (Boudry et al., 2003). Flanders, therefore, has a high level of suburbanisation: people migrate from the city to the surrounding areas, which are therefore becoming increasingly urbanised. This (increasing) urbanisation also puts significant pressure on open space in rural areas (Kesteloot, 2003). Increasing urbanisation not only results in potentially less available open space; a growing demand also results in higher land prices. The urban exodus of young families with children also puts pressure on the availability and prices of land in rural areas.

3.5 Development 5
The climate is changing: adapting and mitigating

Since the beginning of the twentieth century the average temperature on earth has increased by about 0.74 °C. This temperature rise is caused by human activities. Due to the combustion of fossil fuels, deforestation and certain industrial and agricultural activities, the concentration of greenhouse gases in the atmosphere has increased considerably since 1750. There is growing (scientific) consensus about the need and urgency to address climate change in order to somehow limit the severe consequences for humans and ecosystems (Oreskes, 2004). Model calculations show that the average temperature on earth will increase by 1.1 °C to 6.4 °C between 1990 and 2100. Temperature rises of more than 2 °C are very likely to bring major changes for man and nature, as a result of rising sea levels, increasingly long periods of drought and heat, extreme precipitation and other effects (Söderholm et al., 2011). According to the IPCC (Intergovernmental Panel on Climate Change), we have a 50 % chance of avoiding this temperature rise if developed countries reduce their greenhouse gas emissions by 25 to 40 % by 2020 (comparison base 1990). Overall emissions should fall by 50 to 80 % by 2050. For industrialised countries, the reduction rate should be as high as 80 to 95 % (IPCC, 2007).

Climate change has become a very powerful driver of a sense of urgency for change in the direction of more sustainable systems. This is caused not least by its increasingly demonstrable and tangible impact on various ecosystems and human communities. The increased pressure and severity of the issue is reflected, among other things, in the explicit objectives of e.g. European policy. The EU aims to reduce greenhouse gas emissions by 20 % (or 30 % 'if the international context permits') by 2020. There is also a growing number of local initiatives in the field of climate neutrality and low-carbon societies by various actors such as businesses, cities, regions, etc. In particular, the current energy system needs to be thoroughly reviewed (lower energy use, higher energy efficiency, renewable sources). At the same time, the virtual certainty (and irreversibility) of climate change also fuels research and policy that is aimed at adaptation, i.e. preparing for situations of increased drought, rising sea levels and (more frequent) extreme weather conditions.

Climate change influences the agro-food system in two important ways (Foresight, 2011):

Adaptation Growing demand for food must be met against a backdrop of rising temperatures and changing patterns of precipitation. These changing climate parameters will have an impact on the growth of crops and animals, the availability of water, the yields in fisheries and aquaculture, and the functioning of ecosystems and the services they provide. Extreme weather conditions will probably become worse and more frequent, thereby further increasing the volatility of production and prices. Crop production will be affected indirectly by rising sea levels and changes in river flows, although land at elevated areas will become more suitable for agricultural production and there will also be some fertilisation of CO_2. How climate change will impact the agro-food system will to a large extent depend on the degree of adaptation that takes place in the system, e.g. by developing crops and production methods that are better adapted to the new conditions.

In Flanders, climate change is expected to manifest itself primarily in a marked temperature rise with an increase in frequency of extremely hot summer days and in high precipitation variability, with an increase mainly in winter precipitation. Under a high climate change scenario, harvest losses of up to 30 % are likely due to drought stress for shallow-rooted summer crops such as sugar beet, grown in sandy soil.

Potential consequences in the field of animal production are higher wind chill temperatures, leading to production losses, new illnesses and plagues, lower energy demand for heating and higher energy demand for cooling (Gobin et al., 2008).

Mitigation Policy measures aimed at reducing greenhouse gas emissions and therefore the intensity of climate change will also greatly impact the agro-food system. Greenhouse gas emissions must be drastically reduced worldwide to prevent even more devastating consequences. In Flanders, agriculture accounts for 10 % of greenhouse gas emissions (MIRA, 2012); worldwide, this share is even higher. According to the FAO, the global animal production system alone is responsible for 18 % of all greenhouse gas emissions (FAO, 2007). Such findings only add to the challenge of feeding the world's population in a sustainable manner: more food will have to be produced with fewer greenhouse gas emissions. Mitigation policy will greatly affect the cost of fossil fuels, energy supply and transport, and therefore also – where food is to be produced – the use of fertilisers, the choice for land use for food or energy and the general management of agricultural production processes and systems.

3.6 Development 6
The scarcity of natural resources is becoming tangible

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A growing number of critical resources for food production are coming under increasing pressure. When resources become scarce, competition for their acquisition increases, and their prices go up. This in turn puts pressure on the viability of systems that rely to a great extent on the use of these resources. The increasing scarcity of resources, the associated price increases and the high degree of external dependence for many resources (Europe is a continent that is comparatively very poor in resources) increasingly call for economic activities that can decouple satisfaction of human needs from strong material dependence. The European Commission's Roadmap to a resource efficient Europe aims to promote a consistent and effective policy at the European level (EC, 2011a). Scarcity of resources also puts pressure on the agro-food system (Foresight, 2011):

Mineral plant nutrition Production and use of fertilisers is particularly energy-intensive (nitrogen) and/or highly dependent on raw materials (phosphate). Energy use is coming under pressure from climate change and increasing scarcity of fossil fuels, use of phosphate is coming under strong pressure from declining phosphate rock supplies exploited outside the EU. Both elements, which are essential for today's intensive crop production systems (supported by external inputs), are therefore coming under increasing pressure.

Energy Demand for energy is expected to double by 2050. As a result, energy prices are expected to rise significantly and become highly volatile. Quite a number of elements of the agro-food system are highly sensitive to higher energy costs. The production of nitrogen fertilisers, for example, is very energy-intensive.

Water Today's global agriculture already uses 70 % of the 'blue water' that is withdrawn from rivers and aquifers. Demand for water could also double by 2050. In some desert regions, various non-renewable fossil aquifers are being exhausted: Punjab, Egypt, Libya and Australia are cases in point. Competition with consumption for purposes other than agriculture will increase mainly in low-income countries, thereby increasing the risk of over-extraction of groundwater.

While direct water consumption (total water consumption excluding cooling water) may have decreased considerably in Flanders over the past decade (-10 % in 2009 compared with 2000; MIRA, 2012), pressure on water resources remains high. With a value of approx. 32 % in 2007 (EEA, 2009), the Belgian Water Exploitation Index (WEI, actual water consumption expressed as a percentage of water availability) exceeds the 20 % threshold, which is considered as alarming (Alcamo et al., 2000).

Apart from direct water consumption, there is also the water consumption linked to the production of inputs for sectors and to the production of imported foods for consumption in a country or region (see hotspot 5).

Land Increasing demand for food requires more land to produce that food. In recent times, a relatively small amount of additional land has been brought into use for agricultural production. Whereas between 1967 and 2007 crop yields rose on average by 115 %, the global area increased only by 8 % to 4.6 billion hectares, about 1.5 billion ha of which are used for crop cultivation. The area per person has dropped from 1.30 ha to 0.72 ha. The increase in agricultural land has been mainly at the expense of woods, savannah and natural grasslands. Of the 11.5 billion ha of land covered with vegetation, 24 % has been degraded as a result of human intervention, but at the same time the soil quality of 16 % of the cultivated land has improved (Foresight, 2011). In principle, there is still a large amount of land that can be brought into cultivation, but in practice there is growing pressure to use land for other purposes, e.g. biofuels. Moreover, the further opening up of virgin land (felling of rain forests, exploitation of peat soils, permafrost thawing) is not a desirable development, because it puts extra pressure on the carrying capacity of ecosystems that are already under threat.

In addition, an increasing number of claims are being made on the limited available quantity of land. In this context of space scarcity, a number of quantifiable cases of land grabbing have already been reported: often large-scale investments in buying up land by large companies, governments or individuals. The global food price crisis in 2007-2008, in particular, has intensified the practice of large-scale investments in fertile land, especially in the South, inspired by a concern for food supply and biofuel production.

In Flanders, too, numerous claims are putting pressure on the limited available space. Typical local elements of such pressure are the growing demand for construction and industrial sites, 'horsification' and 'gardenification' (Bomans et al., 2009; Bomans & Gulinck, 2008).

Biodiversity Biodiversity is another natural resource that is considered to be a motor of our ecosystems. The prosperity and welfare of societies throughout the world are intimately linked to the proper functioning of those ecosystems. This link is best reflected in the concept of ecosystem services, which break down into four main types (Melman & Van der Heide, 2011):

- *Provisioning services* are the physical products obtained from ecosystems, such as food, (fresh) water, wood and genetic resources (for medicines and new crops/varieties).
- *Regulating services* are the benefits obtained from regulation of ecosystem processes. Examples are air purification through fine particulate removal by trees and shrubs, groundwater purification by the soil and the vegetation cover, natural pest control in agriculture, and pollination of (agricultural) crops by insects.
- *Cultural services* include mainly material and non-material values that people obtain from recreational, spiritual and emotional aspects. They are also identified as services that involve some form of information transfer to individuals and/or contribute essentially to good health, e.g. walking, cycling, or engaging in physical activity in a green environment (De Groot et al., 2010).
- *Supporting services* relate to processes that support the functioning of ecosystems and are therefore needed for the production of the above-mentioned three categories of

ecosystem services. These benefits are not of a direct, but of an indirect nature. Examples include soil formation, photosynthesis, nutrient cycling and the like.

Agricultural production systems or agro-ecosystems are both suppliers and users of ecosystem services (Danckaert & Carels, 2009). Agro-ecosystems primarily supply the conventional provisioning services: food and non-food applications such as fuels and industrial raw materials. In addition, they supply regulating ecosystem services (climate control, air and water purification, water storage, etc.) and cultural/social services (green recreation, mental health, etc.). In order to be able to provide these agro-ecosystem services, agriculture is in turn strongly dependent on ecosystem services (e.g. pollination, soil formation, water, etc.).

The greater the diversity of life forms, the more likely ecosystems are to be able to adapt to a changing environment and therefore be capable of continuing to provide their services. However, global ecosystem diversity and biodiversity are coming under increasing pressure, both quantitatively and qualitatively. In the 2002 Convention on Biological Diversity, world leaders committed to curbing the declining biodiversity trend by 2010. Butchart et al. (2010) observe that the majority of the 31 indicators used to assess the condition of biodiversity continue to decline and do not show any leveling off (in the fields of population trends, extinction risks, habitat area, habitat conditions, etc.), whilst pressure indicators are increasing (natural resource use, invasive species, nitrogen leaching, climate change). They conclude that there is no decrease in the rate at which biodiversity worldwide is declining.

3.7 Development 7
Values and ethical stances of consumers are changing

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Changing values and ethical stances of consumers will have an increasingly important impact on policy makers and on production systems and their supporting structures and institutions. Today, these production systems are certainly suspected of determining and steering to a large extent the consumer's choices. Also food security and the governance of agro-food systems will be affected in this context. Examples are (Foresight, 2011):

- the acceptance of new technology (genetic modification, nanotechnology, cloning of livestock, synthetic biology);
- the importance accorded to particular specified production methods such as organic, biodynamic or sustainable management systems;
- the value of the local character, identity and authenticity of products and services;
- the value placed on animal welfare;
- the explicit attention paid to healthy eating patterns and a healthy lifestyle;
- the importance of ecological sustainability and the protection of biodiversity;
- equality and fair trade issues.

These various shifts must be viewed in the light of a deeper, social trend, which is described by sociologist Ulrich Beck as the shift from an industrial society to a risk society (Beck, 1992). Central in this shift is the paradox that progress appears to be associated with an increase in risks. This subjective perception of more risks goes hand in hand with the individualisation of modern society and the demand from the consumer to safeguard freedom of choice; in other words, not to leave this only in the hands of institutions and structures of industrial society. At the same time, the concept of reflexive modernisation is taking root, whereby people, in response to uncertainty and risk, start thinking about their own actions, and in the process come into contact with like-minded people and thus develop new social forms (Beck et al., 1994). Typical examples are local transition groups, food teams, etc. This also implies that the consumer is more than a 'demanding being'; he is also actively searching for (new) action perspectives.

An additional aspect of this general change in values and ethical stances is the distinction between consumer and citizen: 'the citizen is wholly different from the consumer'. What is meant by this is that when a citizen is or seems to be highly concerned about issues such as animal welfare, the environment and working conditions, such concern is not always apparent from his consumption pattern. Time and again it is found that many consumers base their purchasing strategies mainly on the price-quality ratio without taking account of the way in which the product has been produced (Roosjen et al., 2002). On the other hand, a growing number of consumers are prepared to pay more for 'specific quality' (that meets their concerns about the environment, social justice, animal welfare, etc.) but find that the supply is inadequate. One reason for this is the lack of promotion and support, e.g. of food having a specific quality, origin, production method, etc.

Changes in consumption patterns are long-term processes, because they hark back to fundamental values, standards and culture. Such changes must therefore be initiated and reinforced in time, due to the increasingly explicit sense of urgency with regard to the approach to a large number of unsustainability symptoms.

3.8 Development 8 'Other growth' is increasingly becoming a point of debate

The economic motor, with its inherent spiral of increasing production, increasing income, increasing consumption and increasing production, and the increased consumption (possibilities) have triggered a number of positive developments. In our country, as in other developed world regions, life expectancy has dramatically increased in the course of the last centuries and continues to do so. This development is partly the result of improved hygiene (e.g. sewerage, clean drinking water, etc.), availability of sufficient, good and safe food, improved living conditions (qualitative houses, heating, etc.), advances in medicine, and an efficient health care system. This general positive relationship between higher national income and life expectancy is documented by scientific research.

A remarkable finding in relation to increasing (and shifting) consumption is, however, that beyond a certain limit, further growth of GDP and/or consumption is no longer reflected in increased satisfaction (Figure 2). Thus, it appears that the 'happiness index' for Belgium has stopped growing, and even declined slightly, during the past 40 years. A possible example of the tangible consequences of this decoupling is the significantly high frequency of stress-related phenomena (indicating inadequate satisfaction of needs that fall under the category of mental well-being, self-actualisation, etc.). 'A quarter of the population does not feel at ease with itself', 'The number of people with psychological problems seems to be growing' are titles from the most recent national health survey (Drieskens, 2010). There is a growing degree of decoupling between (increasing) consumption and actual satisfaction of needs. In combination with factors such as climate and energy issues and scarcity of resources, and reinforced by symptomatic financial-economic crises, this fuels the emerging debate on the dominant paradigm of growth as the objective of prosperity and welfare, where growth is conceived in its current connotation of highly material-oriented consumption (Jackson, 2009; Victor, 2008).

The bulk of our consumption consists of the use or consumption of physical 'objects' (goods), which we also own in many cases (we all have our own TV, our own car, etc.). This consumerism reflects a conviction that material things invariably lead to increased prosperity and that we therefore continuously need more 'objects' for our well-being. The challenging of a conventional growth paradigm, linked with connotations of 'material' and 'possession', increasingly intensifies the demand for another system that is based on a new definition of prosperity. This new system does not necessarily challenge growth, but it does question the way in which it is defined by society, notably by the massive presence of material consumption goods. There is an increasingly explicit appeal for an economic system that provides human satisfaction in an equitably distributed manner and that is also in balance with its natural environment, i.e. that does not exhaust the planet. This appeal is also answered and reinforced by those consumer citizens who show their involvement, both individually and collectively, in e.g. food-related issues and their willingness to effectively modify their lifestyle and consumption patterns.

3.9 Development 9
Hunger and inequality remain major global concerns

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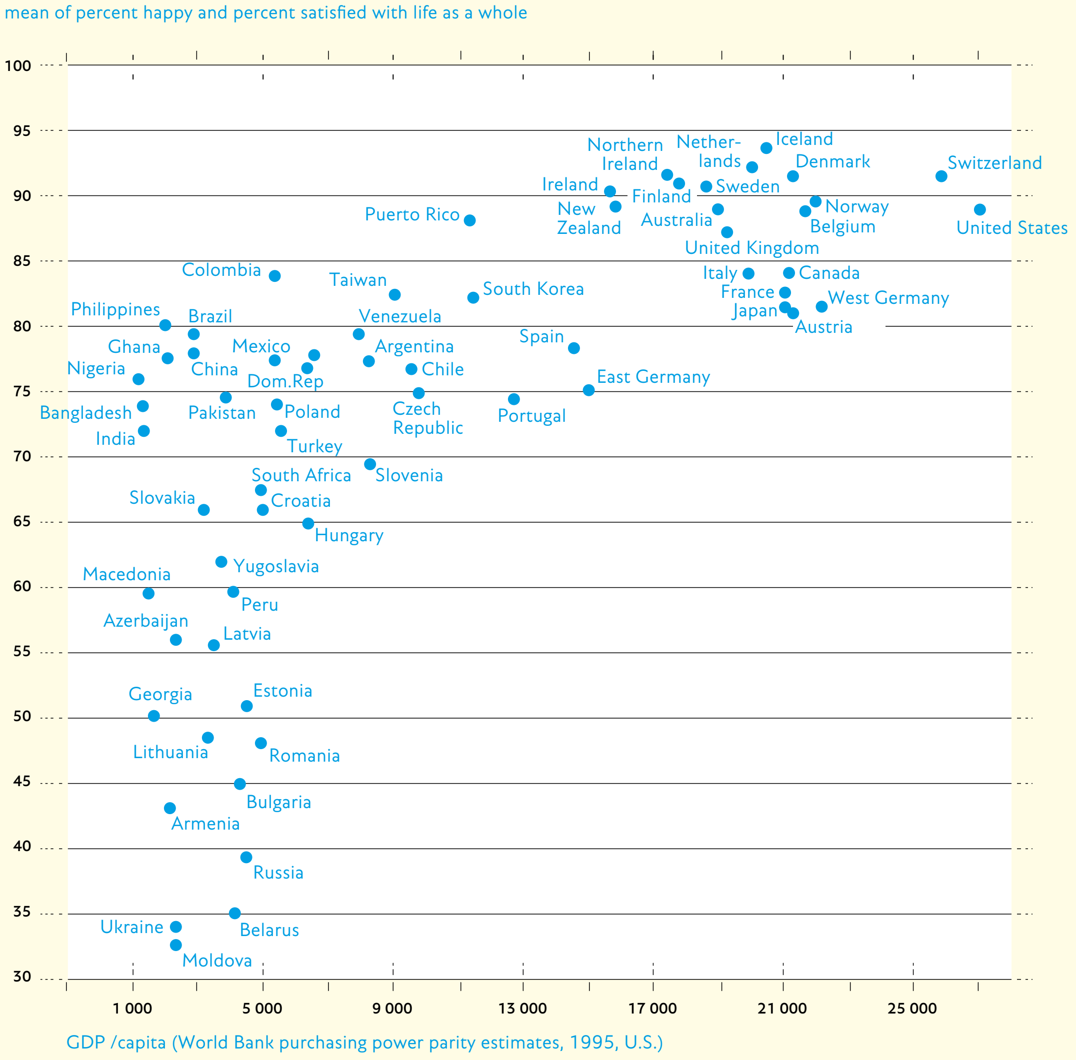
'Global hunger declining but still unacceptably high' reported the FAO in 2010. Although the number has declined, some 925 million people worldwide continue to suffer hunger. This figure is higher than it was when world leaders decided in 1996 to reduce global hunger by half. Hunger needs are greatest in developing countries, where, on average, 16 % of the population suffer hunger, a percentage that is still well above the Millennium objective of 10 % in 2015. Two-thirds of the undernourished human population live in only seven countries (Bangladesh, China, Congo, Ethiopia, India, Indonesia and Pakistan). The key element in global hunger is not the productivity of the agricultural and food production system, but access to food. This access is determined primarily by local economic developments and worldwide food prices, but also by political instability. Developing economies have insufficient resilience, which makes them particularly vulnerable in times of crises (e.g. food prices in 2008), resulting in the (renewed) presence of acute hunger.

A salient fact is that three-quarters of hungry people live in rural areas and are therefore in many cases food producers themselves (farmers, shepherds, fishers). They are caught in a downward spiral of poverty: either the prices are too high to buy food themselves, or the prices are very low so that their income cannot increase. They do not have access to credit, to suitable technology or to the necessary infrastructure. They seldom have the same negotiating power as the intermediaries with which they do business and therefore do not receive a fair price for their products (UN, 2011).

A remarkable fact is that also in Belgium the number of hungry people appears to be rising, although no figures are available. The number of people approaching aid organisations because they are living in poverty continues to grow. These organisations also report the occurrence of a remarkable shift: the ratio between Belgians and foreigners is now approximately fifty-fifty. Moreover, the cases are becoming increasingly distressing (Van den Broek, 2011).

The fact that a number of people worldwide still have insufficient food to live or survive, puts pressure on a Western system of food production that generates a relatively high amount of losses, is characterised by a number of adverse effects of excessive and/or unhealthy food, and weighs production of food on fertile lands against e.g. production of energy crops on the same lands.

Figure 2: **Economic growth versus happiness and satisfaction**



Source: Inglehart & Klingemann (2000)

3.10 Development 10
The digital revolution is here to stay

The digital revolution, also referred to as the third industrial revolution, marks the drastic shift from mechanical and analogue technology to digital technology and the associated shift in computer and communication applications which has emerged since the Eighties. A number of characteristic elements that illustrate the (r)evolution are the personal computer (1980s), the world wide web (1990s), mobile telephony (2000s) and social networks (2010s).

Positive effects of the digital revolution are the worldwide 'connections' between people and their organisations due to faster, more efficient communication media. The internet has opened up unprecedented opportunities for communication and information sharing. The possibility of rapidly and easily sharing information on a global scale has created a totally new potential: it provides individuals and organisations with virtually unlimited opportunities to put anything on the net at virtually no cost. Large collaborative networks can be set up, either within or outside an open source setting. Like-minded people can find each other more easily and establish reinforcing communities. Without the internet, many of today's economic realities would not exist: outsourcing, access by smaller businesses to large markets would never have reached the present proportions. Digital technology has significantly increased the productivity and performance of businesses (Brynjolfsoson & Hitt, 2003). Rather negative consequences of the digital age are the overload of (reliable and less reliable) information, internet crime, forms of social isolation and anonymity of relationships, but also lack of access, e.g. in developing countries.

4

In this chapter we will outline the operation of the current dominant agro-food system in Flanders, within the contours of a broader social system. This system outline is first of all intended to chart the main determining structures, operating modes, mechanisms and their interrelationships. Within the context of the previously described multi-level perspective, this is the description of the regime.

At a number of places we will identify so-called hotspots, or places in the system where frictions and problems have occurred due to the various developments from the landscape and/or the operation of the actual system.

These hotspots are described by means of three symbols:

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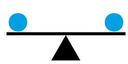

Hotspots are not problematic by nature; they have even contributed to the demonstrable performance and success of certain aspects of the system, e.g. food security, food safety, broad assortment, etc.

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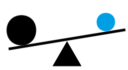

Developments from the landscape and/or the operation of the actual system have, however, caused frictions and problems. Today, hotspots indicate a degree of unsustainability of the current system in the longer term.

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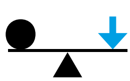
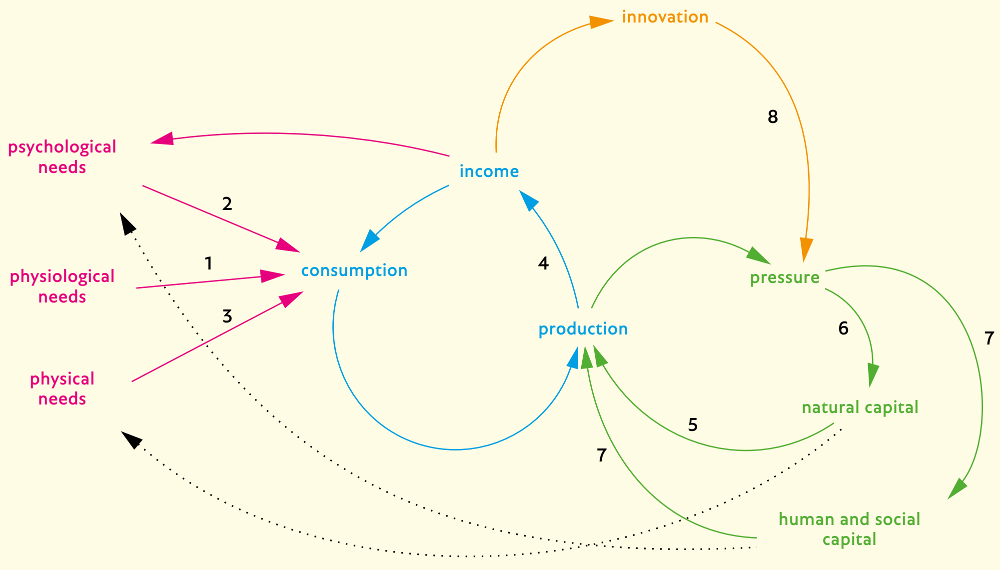


Certain landscape developments can act as levers to steer the system in a sustainable direction.

Figure 3: **Influence diagram and hotspots of the agro-food system**



	Hotspot
Economic motor	**1** Sufficient, safe and healthy food is produced, but still there are food-related health problems
	2 Sufficient tailor-made food, but at the same time much loss of food, high demand for raw materials and significant environmental impacts
	3 Non-food applications are an opportunity but also put pressure on the available resources
	4 Specialisation for the benefit of efficiency but at the expense of system operation
Ecological damping	**5** Input of natural resources increases production but these resources are becoming increasingly scarce
	6 The environment absorbs emissions, but if the carrying capacity is exceeded, the quality of the necessary resources may be jeopardised
Social damping	**7** The agro-food system builds on social capital but at the same time threatens to lose it
Technological lubrication	**8** (Technological) innovation optimises the current system but does not as yet design any innovative system configurations
The system is open	**9** An open system offers many advantages but also leads to shifting of the social and ecological impacts (not shown in figure)

For the regime description we will use, together with an influence diagram (Figure 3), an image of an agro-food system with three core dynamics: an economic motor, ecological damping, and technological lubrication. The economic motor is the dynamics around the supply-demand market mechanism that forms the basis of the market economy. Within this supply-demand mechanism, the specific objective of the agro-food system is to satisfy the demand for food (and non-food applications of biomass: fibres, energy, etc.). Ecological and social damping impose a number of inherent restrictions on this production and consumption system. These restrictions pertain both to the availability of natural, human and social resources and to the quality of the environment where production (and consumption) take place. Social and ecological restrictions therefore act as a brake on the economic motor. This braking action can in turn be reduced by resources in the field of innovation and technology; this is referred to as technological lubrication.

These three dynamics and their specific metaphors (motor, damping, lubrication) are also a major key to the interpretation of the current system configuration. In this interpretation, the economic objectives prevail and the ecological and social aspects are mainly considered to be of secondary importance. Technology is the channel of choice to maximise the economic objectives and/or minimise the ecologically and socially restrictive aspects. We are well aware that this interpretation is a specific way of viewing the relevant system, but it actually represents the hitherto dominant view. If a different, innovative view were adopted, ecological and social aspects could just as well serve as motors or lubrication for a system that satisfies fundamental needs.

An insight into how the three core dynamics operate and the underlying structures and value patterns allows us not only to identify the strengths and weaknesses of the system, but also to find levers to steer the system in a sustainable direction. In the following sections we will further elaborate the three core dynamics to identify the different hotspots of the agro-food system and their place within the system.

4.1 Economic motor

Production side The agro-food system involves many actors. The main actors on the production side are the agricultural sector, the food industry and the distribution sector.

Turnover in the Flemish agricultural sector amounted to € 5.1 billion in 2011. Products with the greatest contribution to the turnover were pork (27 %), dairy (14 %), beef (13 %) and vegetables (11 %). The animal sector accounted for 63 % of total turnover. The share of added value in turnover amounted to 16 %. With an added value of € 820 million and 42 536 work units, the agricultural sector represented 0.7 % of the Flemish GDP and 2 % of employment in Flanders. Raes et al. (2010) calculated that, based on macroeconomic accounts, Flemish farmers earned on average between € 21 000 and € 32 000 (Net Added Value, NAV) per work unit in the period 2009-2011. What cannot be derived from the macroeconomic accounts is that income and profitability in the agricultural sector are highly variable: in time, between sub-sectors and between individual businesses. Based on accounting data, Raes et al. (2012) calculated that a cattle farmer had the lowest (€ 8 963 NAV) and a greenhouse grower the highest income (€ 55 014 NAV) in 2010. In 2008 and 2009 no specialisation made any profit on average, whereas in 2010 glasshouse horticulture recorded a peak return on equity of 9 %, illustrating the great variation within the sector.

In 2010, the food industry was made up of approximately 3 600 businesses which together generated a turnover of € 30.5 billion and created 62 615 jobs

(3 % of employment in Flanders). The largest sub-sector is the meat processing sector, whereas the bakery and pasta sector creates the most jobs. Whilst in the agricultural sector the share of added value in turnover amounted to 16 %, in the food industry this percentage varies widely, ranging from 8 % in the cattle feed sector to 44 % in the bakery and pasta sector. Profitability in the food industry appears to be more stable than in the agricultural sector. In the period 2006-2010, the net return on equity after taxes varied between 5.5 % and 8.3 % (median; FEVIA, 2012).

The distribution sector (the link between production and consumption) is highly concentrated: the 'Big Three' (Delhaize, Carrefour and Colruyt) hold more than 70 % of the market share. Exact turnover figures for food cannot be directly derived from the respective annual reports of the distribution groups. A.C. Nielsen reported that 4 443 shops generated a total turnover of € 11.7 billion (non-food included) in 2009 (Nielsen A.C., 2010).

Consumption side In the current agro-food system, the production side focuses primarily on meeting consumer demand for food. Consumers obtain the money for their consumption from the income they earn by providing labour (or other production factors) in the various flows of the economic production process. This closes the basic macroeconomic loop: the circular flow of income (Fischer et al., 1988).

When consumers earn more income, they can consume more, which in turn stimulates production and therefore economic growth. This loop in the broad-based consumption system is therefore clearly a self-reinforcing dynamic. This dynamic will hereinafter be referred to as 'the economic motor', the motor of growth in market economies (Jackson, 2009). This economic motor also has an associated price dynamic: if wage costs (or the costs of other production factors) increase, consumption prices will increase, which in turn will induce an increase in income to maintain purchasing power. This dynamic is reflected in the 'wage/price spiral', which constitutes an additional reinforcing loop.

According to the annual household budget survey, Flemish consumers spent on average € 1 751 on food products and € 380 on beverages in 2009. At the Flemish level, this represents a total of € 10.25 billion or € 12.47 billion with or without beverages, or 12 and 14 % of household expenditure. Almost a quarter of the food budget is spent on meat and just over 6 % on fish and shellfish. Meat consumption consists mainly of fresh meat and charcuterie. Slightly more than 10 % is spent on cereals, bread and pasta and another 2.5 % on potatoes. Remarkably, a large portion of the budget goes to pastry on the one hand (7.5 %), and to sugar and sugar products such as ice cream and chocolate on the other (7.1 %), together representing 14.6 %, or a percentage that is almost equal to the budget spent on fruit and vegetables (14.9 %). Alongside these direct purchases, a significant amount of food and beverages are consumed in the catering sector.

Demand versus needs Needs are at the basis of consumer demand for food and other goods and services. People's needs are the core of the definition of sustainable development, as formulated in 'Our Common Future' (WCED, 1987). Starting from the notion of needs is right at the heart of what sustainable development is all about and also implies the crucial question: what is the fundamental objective of the system under discussion? Based on Maslow's famous hierarchy (pyramid), the fundamental needs of people can be described as:

- Basic needs
  - physiological needs: food, including water, and health (care) are fundamental requirements for the human body to continue functioning;
  - physical needs: a safe living environment and protection

from external physical conditions (housing).

- Social needs
  - psychological needs: mental well-being and opportunities for self-actualisation are the most important elements;
  - love, sense of belonging (family, friendship, etc.);
  - esteem (recognition, respect, confidence, etc.);
  - self-actualisation (creativity, aesthetics, understanding, discovering, etc.).

In addition to Maslow's approach, there are other approaches to needs, but the most important element in this system analysis is the explicitly central role of needs in the context of the fundamental objective and operation of a system.

Needs can only be met if a number of objective conditions are fulfilled. These conditions are related, on the one hand, to the available resources (e.g. availability of sufficient income or food) and, on the other, to the competencies for meeting the different needs. How these resources and competencies lead to effective subjective well-being is determined by the specific strategies that people adopt. These are in turn dependent on values, norms and culture. To gain esteem, for example, wealth may be important in one context, whereas in another context one's commitment to society may generate more esteem. The combination of objective and subjective elements not only determines whether or not a given quality of life is achieved, but also has an impact on the level of sustainability of the deployed consumption activities. For basic needs, this usually requires the adoption of materialist strategies. For other needs, non-materialist choices are also possible. People's real needs cannot be influenced (they cannot be forbidden, restricted, etc.), but the strategies used to meet those needs can.

When focusing on needs, against the backdrop of sustainable development, it is of fundamental importance to look at those needs through a lens of solidarity and self-sufficiency:

- worldwide: meeting the needs of all people on planet earth is crucial to sustainable development;
- intergenerational: working on more sustainable systems ensures that the needs of present and future generations are met;
- empowerment: giving people opportunities and stimulating them to meet their needs themselves and to acquire and use the skills required for this purpose (Sen, 1985).

Since the beginning of the Industrial Revolution, an efficient agro-food system has made it possible to increase the body weight of people from underweight to normal weight, which has had a positive impact on life expectancy and fertility. This has greatly benefited economic development in industrialised societies (Fogel & Costa, 1997). During the twentieth century, growth in body length reached its limit and people became fatter, the 'milestone' being the year 2000, with just as many underweight and overweight people worldwide and an obesity epidemic in the developed countries (Caballero, 2007), and with documented increased risks of type 2 diabetes, cardiovascular disorders and hypertension (Neilson & Schneider, 2005). Obesity is the result of an imbalance between energy intake and output. The intake has risen (we eat more) and its composition has also changed: more empty calories (sugars) and fewer functional ones (vegetables, fruit, etc.), whilst the output has fallen. Moreover, high-energy foods and drinks often carry low prices, which further lowers the barrier to their consumption (Drewnoski, 2004). Flemish figures for 2008 show that 43.7 % of adult people (aged >18) in Flanders are overweight (Body Mass Index, BMI >25); moreover, 13.7 % of them are also obese (BMI >30) (Drieskens, 2010). In 1997 these figures were still 39.3 and 9.6 % respectively. The average BMI of Flemish people is 25, which corresponds to the limit value between normal weight and overweight.

Results of the first Belgian food consumption survey (2004) show the discrepancy between recommended consumption based on the food triangle and actual consumption. The most striking results are the sub-optimal intakes of vegetables and fruit and the supra-optimal consumption of products from the protein group – almost exclusively animal proteins – and residual group consumption (including alcohol). Also physical exercise – as the basis of the triangle – clearly leaves much to be desired.

The first three hotspots are related to the various needs that we previously categorised: the physiological need for food, the psychological and social needs that attach an additional meaning to food (enjoyment, being together, status, etc.), and (physical) needs other than food that can also be met by the agro-food system.

Hotspot 1 Sufficient, safe and healthy food is produced, but still there are food-related health problems

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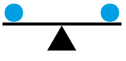

Producing sufficient, safe food of good quality at a low price is an important achievement of the agro-food system as it has developed in (among others) Europe and therefore also in our region over the past centuries. Today we have a plentiful and varied supply of food, which is also guaranteed to be safe and healthy thanks to an efficient monitoring and tracing system.

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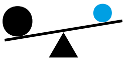

On the other hand, a number of meaningful remarks can be made with regard to the relationship between the current method of food consumption and health. Increasing prevalence of obesity, food allergies, diabetes, cardiovascular diseases, etc. are signals of a decoupling between the fulfilment of basic physiological needs and effective food consumption. The objective resources for need fulfilment are in place (sufficient, safe and healthy food), but the applied consumption strategies lead to undesired, or even counterproductive aspects of quality of life, in this case health. That is why this decoupling is a hotspot in the agro-food system.

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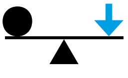

Changes in values and ethical stances of consumers, including growing attention to a healthy diet (landscape development 7), may act as a potential brake on this evolution, and create opportunities for innovations dealing with this obstacle. Also the awareness of the continued existence of hunger in the world (landscape development 9) particularly highlights the harrowing nature of food-related health problems.

Hotspot 2 Sufficient tailor-made food, but at the same time much loss of food, high demand for raw materials and significant environmental impacts

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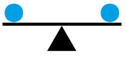

As consumer income grows and basic consumer needs are met, the demand for differentiated food products increases. This creates opportunities to add value in the fields of quality, ease of use, production method, diversity, portioning, etc. In this way, not only the purely physiological basic need for food is met, but also strategies for hedonistic needs can be pursued.

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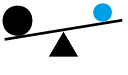

However, excessive consumer wishes, whether or not created and driven in part by the production and distribution chain, call for a heavy and increasingly growing production apparatus and therefore – with equal technology – also a higher input of natural resources and greater environmental impacts, locally but also elsewhere in the world. Perception, too, plays a prominent role in current consumer behaviour: consumers impose requirements on production characteristics that may have limited or no impact on the ultimate objective function of the product. Well-known examples are colours, shapes and package designs. Within this context of abundance and hedonism, a significant waste of potentially healthy and safe food can be observed.

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Under pressure from such aspects as climate change (landscape development 5), scarcity of resources (landscape development 6) and negative impacts of globalisation (landscape development 2) – 'food miles' are characteristic – the increasingly higher consumer requirements and/or the virtually unlimited range of supply are coming under increasing pressure. On the other hand, growing consumer awareness of such obstacles (landscape development 7) opens up opportunities for critical reflection and an effective shift to healthier life and food choices that do not necessarily require pioneering (technological) innovations. In this area, a key role is undoubtedly also to be played by governments and specific organisations in society.

In a general culture of hedonism (pleasure culture), freedom, individualism and social comparison, the following elements play a decisive role in the current forms of food consumption and therefore also in the consequences of that consumption:

- custom-made: the desiderata/requirements of the Western consumer are high, he can and is also willing to pay for them, so they are also met. You can buy whatever you want, whenever you want, wherever you want, in whatever form you want. Unlimited 'exotic' consumption is also possible. In the past decades, the agricultural and food production apparatus has exhibited the flexibility to accommodate these high consumer requirements with a particularly abundant supply (in diversity of nature, processing, packaging, etc.) as a valuable result.
- perception: colour, appearance, size, name, etc. determine to a large extent the characteristics of food that people experience as important (tastier, more beautiful, better quality, etc.). Moreover, aspects such as status, image and financial success encourage peer-to-peer comparison and competition which, in turn, drive a self-reinforcing process of ever more, bigger, more beautiful …

Within this context of abundance and hedonism, a significant waste of potentially healthy and safe food can be observed. Gustavsson et al. (2011) describe food loss as any food that was originally intended for human consumption, but that disappears from the human food chain. Despite the limited amount of available figures (which should therefore be interpreted with due caution), the findings of these authors suggest that globally, roughly one-third of all food is lost or wasted: 1.3 billion tonnes of food is lost somewhere in the food chain. The total loss per capita is said to amount to 280 to 300 kg per year in Europe and North America/Oceania. The OECD (2011) considers three categories: (1) unavoidable food losses, (2) discarded food and (3) inefficient use of food. The causes of food loss are to be found in production (e.g. process losses, by-catches), processing (e.g. process losses), distribution (e.g. aesthetics, preservability), food services (e.g. portion size, kitchen management) and households (e.g. preservability, preferences, knowledge and skills). While a portion of the food loss will probably still be reused in the food chain in one form or another (cattle feed, compost, digestion, etc.), it will be for a less high-quality application than the one for which it was originally intended. To date, there are no reliable figures on food losses in Flanders (Roels & Van Gijseghem, 2011).

Hotspot 3 Non-food applications are an opportunity but also put pressure on the available resources

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Agriculture has always provided not only food but also raw materials for non-food applications.

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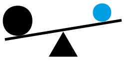

Under pressure from landscape elements such as climate change (landscape development 5), scarcity of resources (landscape development 6) and changing values and ethical stances of consumers (landscape development 7), demand for non-food applications is (again) increasing. The multiple expectations and claims in the field of ecosystem services clearly put pressure on the resources needed for the agricultural production system, in particular space, a pressure that is further intensified by the trend towards increasing urbanisation (landscape development 4).

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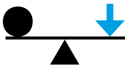

Broadening of the task package creates opportunities, but requires well-considered choices for and coordination of the various production orientations. It also increasingly requires collaboration and arrangements with industry (e.g. chemicals), with energy producers, with nature and environmental organisations and with other specific sectors (e.g. care). In addition, it requires flexibility and the necessary skills and (shift of) infrastructure.

Agriculture has always provided not only food but also raw materials for non-food applications. Examples are flax for textiles, hemp for ropes, and rapeseed for oil lamp fuel (Hardy, 2002). The emergence of the petro(chemical) industry in the nineteenth century and the associated production of cheap, synthetic products largely put an end to that role. Today, under pressure from multiple landscape elements (such as climate change, scarcity of resources), there is a noticeable trend to use renewable resources, including agricultural crops, as an energy source and/or as a basic industrial raw material (Clinton, 2000). This creates a hotspot for the agricultural production systems because there is a growing number of diverse claims or allocation orientations for production flows based on natural products. The logical consequences of this are increasing competition for the limited space and additional pressure on other external inputs for intensive agricultural production systems (water, fossil fuels, phosphate, etc.).

This theme fits in with the broader concept of a bio-based economy: an economy where the basic building blocks for materials, chemicals and energy originate from renewable raw materials (biomass) instead of fossil (non-renewable) raw materials such as petroleum or derivatives. By using biomass, originating from agricultural crops or organic residual streams, in a combination of high- and low-quality applications, optimal use is made of atmospheric CO_2 and sunlight, which are captured by plants and converted into complex organic compounds. Biomass-based products can thereby reduce greenhouse gas emissions and the resulting climate change. They cannot, however, be produced in unlimited quantities because they too are subject to limited production resources such as water and land. Questions also arise in relation to externalities of biomass production (use of external inputs, production conditions in emerging market countries), energy efficiency compared with other renewable resources (wind, sun, water, etc.) and the actual impact on land use. In such a broad context, various new decision mechanisms also come to the fore, ranging from price considerations (high prices for rare derivatives such as fine chemicals and pharmaceuticals, low prices for bulk goods, e.g. for energy) to fundamental ways to prioritise the use of biomass (human food first) (Langeveld et al., 2010). The challenge is to achieve an optimal yield through step-by-step consideration and use of the energy and material content of biomass ('cascading'). Growing expectations with regard to non-food applications obviously put great pressure on the available resources. This applies in particular to land that, as a scarce resource, is subject not only to multiple claims but also to elements such as increasing urbanisation (landscape development 4).

Hotspot 4 Specialisation for the benefit of efficiency but at the expense of system operation

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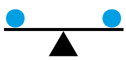

Current production systems are made up of a large number of successive specialised segments in a chain that extends from the procurement of raw materials to the distribution of finished products. Specialisation allows the available resources (materials, capital, labour) to be used as efficiently as possible, and therefore implies both competition and sustainability advantages.

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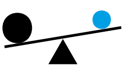

In the case of excessive specialisation with many and/or relatively loose segments in the chain(s), however, actors typically have a strong commitment and focus on their own segment, and far less on the chain as a whole. Possible consequences of this are power concentrations and distorted power relationships. Another consequence is that optimisation, including in the field of environment-related issues, takes place within the individual area or sector and far less between segments. The creation of added value is also considered mainly within the individual segment. Even when there is still some form of networked economy, a large number of segments in the chain inevitably leads to a loss of commitment, a sense of (co-)responsibility and effective 'actorship' of the consumer. Also, the connection between food producers/processors/merchants and the basic ecosystem on which they finally depend has to a large extent been weakened by technological change and specialisation. As a result, the natural environment is often considered as the substrate for intensive work using external inputs and no longer as a resource or service that should be safeguarded with due care and foresight.

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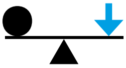


Chains or networks with many segments that are poorly or non-transparently associated with each other, are coming under pressure from concepts such as footprints (see landscape developments 5 and 6) that increasingly stress the need for an integrated view and sustainability approach from whole production systems rather than from individual segments. Growing awareness of this need among citizens/consumers, organisations and businesses (landscape development 7) are dynamics that can initiate and reinforce more system-based thinking and acting. Short chains can again bring about a higher degree of connection and will therefore be able to respond more effectively to the actual (changing) requirements of citizens/consumers (landscape development 7).

In order to become and remain economically competitive, a number of strategies can be adopted. According to Porter (1980), competitive advantage is created by utilising cost or benefit advantages. By combining these two sources of competitive advantage with the strategic scope, Porter identifies the following four generic strategies: (1) 'cost leadership' combines a low cost position with a broad scope, (2) 'differentiation' combines a unique perception by the buyer with a broad scope, (3) 'low cost focus' focuses the low cost position on a specific segment, and (4) 'differentiation focus' focuses the unique perception by the buyer on a specific segment.

While in the current Flemish agro-food system there is a growing number of differentiation strategies (based on location, dedicated supply chains, exclusivity, etc.), cost leadership still remains the dominant strategy in current production environments: producing the same product in the same (or even greater) quantity but at the lowest cost. This dominant strategy, which is logical in a global market of bulk products and raw materials, has led to a process of specialisation (including intensification, rationalisation and scale enlargement). The explicit focus on a specific activity or production orientation allows production resources to be used in the most efficient way on the most appropriate scale. Those who focus on a specific product, a step in a production process, etc. can produce more efficiently, organise themselves more efficiently, etc. and thus have a competitive advantage. From this perspective, specialisation is a productive aspect that mainly enables one to be competitive in a (global) market of bulk products and raw materials. In addition, specialisation makes it possible to perform better in relation to a number of sustainability aspects (e.g. environmental impacts).

A side effect of specialisation is the potential loss of connection within the chain, as a result of which optimisation and creation of added value mainly take place within the individual area or sector and far less between segments. The Flemish agro-food system nevertheless features a number of chains where there is still a high degree of association between a number of successive segments. Examples are sugar beet production, where there is a strong relationship between crop farmers and the sugar plant, and the dairy sector and horticulture, where cooperatives of farmers have worked on 'forward integration'.

A large number of segments in the chain also reduces the connection between the consumer and (the origin of) food. The large distance between the place of production and processing and the place of consumption and the large number of segments 'between soil and mouth' reduces the commitment and sense of co-responsibility of consumers towards the producer. This involves not only the farmer and other segments in the chain, but also the ecosystem where food is produced and the prevailing production conditions. A possible signal of this is that fundamental ecosystem services (soil formation, water storage, etc.) are considered as 'extras', whereas they are essential system conditions that enable production. This loss of connection between the consumer and his food could possibly put pressure on the appreciation of that food. Conversely, customer intimacy is a proven marketing strategy that increases the commitment of the consumer and therefore possibly also his appreciation for the relevant product and its maker (Bügel et al., 2011).

When specific activities can be realised in specialised and large-scale entities, this may also result in power concentrations in the relevant segments. This could explain why in agriculture and food we see the emergence of an image of strong power concentrations in the intermediate segments of supply and distribution. Thus, the large market concentration in the field of distribution (see above: three distribution chains together have a market share of over 70 %) can lead to distribution chains using their market power in their relationships with both consumers and producers. This may be reflected in the incomplete transmission of price increases to the producer and price decreases to the consumer. When this effect persists in the long term, it systematically leads to low prices for producers, who will see their profit margins shrink. This will lead to lack of investments, both in research and development and in the adoption of innovations by agricultural businesses. The elimination of this hotspot can lead to more investment space and more income buffers for dealing with risks.

4.2 Ecological damping

Production and consumption systems – and therefore also the agro-food system – use nature and its resources as a 'source' and as a 'sink':

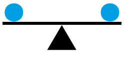
- A production and consumption system requires the use of natural resources that are obtained from a number of renewable and non-renewable sources from the earth.
- A production and consumption system generates residues, waste and emissions.

Both aspects have their limits: available resources are in many cases finite or only slowly renewable, and past a certain amount of waste and emissions, the natural system cannot recover and will lose some of its future potential as source or sink.

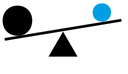
The finite or limited availability of natural resources and the generation of waste and emissions therefore impose inherent restrictions on production and consumption systems, and as such act as a brake on the economic motor.

We wish to repeat here that the metaphor of 'brake' applies from a current dominant system perspective, in which the economic motor is the primary driver, which is also the starting point in this analysis. When viewed from this perspective, aspects like 'changing values and ethical stances of consumers' (landscape development 7) and 'other growth as point of debate' (landscape development 8) are also actual elements of pressure on the dominant steering of the current system configuration.

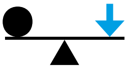
Hotspot 5 Input of natural resources increases production but these resources are becoming increasingly scarce



Fundamental in the various production processes in the agro-food system is the use of natural resources, e.g. water, land, biodiversity, nutrients, fossil fuels and proteins for animal production. Backed up by technological progress and ever better knowledge, agro-food systems have in the past decades managed to significantly increase productivity and thus meet the growing demand for food. Apart from aspects of plant and animal breeding, an important building block in these significant productivity increases is the use of a number of 'external' resources such as pesticides, fertilisers, fossil fuels (for mechanisation), etc.



The increasing scarcity of resources (landscape development 6) is, however, increasingly exerting pressure on the agro-food system, which is highly dependent on these resources. Moreover, certain resources are subject to a high degree of foreign dependence, which makes the system even more vulnerable in a global world (landscape development 2) with growing population and needs (landscape development 1). For a number of resources, scarcity is becoming increasingly tangible in the form of rising prices.



At the same time, scarcity of resources (landscape development 6) and growing world population and welfare (landscape development 1) are a lever for developing management methods that are less dependent on natural resources.

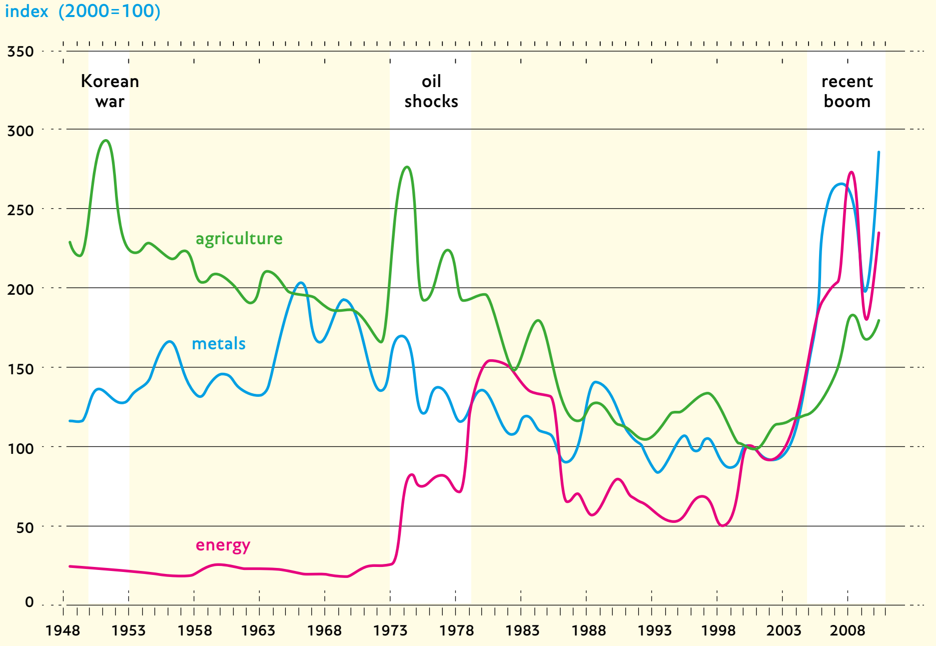
Figure 4 shows the evolution of prices for agricultural products, energy and metals over a period of 60 years. Until 2000, real prices of agricultural products and metals showed a downward trend, whereas the energy price showed a very irregular curve. Since 2000 all these trends have reversed and the prices of metals and energy have increased more sharply than the price of agricultural products (Baffes & Haniotis, 2010).

Phosphorus and phosphate An example of a scarce raw material of extremely high importance in the context of agriculture and food is phosphorus (Cordell et al., 2009). Plants need phosphorus to grow. Phosphorus is an element that cannot be replaced by another substance. Whereas this essential plant nutrient mineral could initially be maintained at sufficiently high levels through recirculation in the primary production system, the intensification of production has resulted in a shift to the application of phosphorus as an external input. Phosphorus is extracted from phosphate rock mines, using energy-intensive and inefficient processes. 90 % of global demand for phosphorus is related to food production. Global demand for phosphate rock is in the order of 150 million tonnes per year. Linked to projections for global population and distribution of dietary patterns, demand for phosphorus is predicted to rise by 50 to 100 % by 2050. However, at such extraction rates, reserves will also be exhausted by that time. As reserves become more scarce, efforts and therefore costs to extract the least accessible and lower quality residues increase. Phosphate rock reserves are held by a handful of countries, mainly Morocco, China and the US. Morocco has a monopoly on extraction in the Western Sahara, China protects its exports to provide for its own needs, and the US has a 30-year reserve. Western Europe and India, for example, are totally dependent on imports. Just as for other scarce resources, there are projections on the availability of phosphorus. These indicate that a peak production is to be expected around 2030 (Figure 5). The accuracy and reliability of calculations of phosphate peaks and exhaustion times are the subject of debate. However, the main purpose of such exercises is to convey the underlying message of the finiteness of the resource and therefore the call for more economical use and more efficient utilisation.

In Flanders there are as yet no signs of the imminent scarcity of phosphate, mainly because of the high phosphate content in the surface soil of arable land and pastures. Until 2007, the portion of arable land with a phosphorus content exceeding the target zone for optimal agricultural production increased in Flanders (MIRA, 2012). The target zone is a reference value at which optimal agricultural production is possible, taking into account costs but no ecological standards. When using animal manure, farmers mainly focused on the application of nitrogen, so that the phosphate application was too high with regard to the actual phosphorus need of the crop. This is also why the government took measures to limit phosphate application from chemical fertiliser as part of its manure policy. Together with the increased chemical fertiliser prices, this led to a halving of the use of phosphate chemical fertiliser in the period 2005-2008 (Lenders et al., 2011). This means that recently factors other than the imminent scarcity have driven the reduction in the use of chemical fertilisers. In light of the imminent scarcity of phosphate, efficient utilisation of animal manure is a meaningful scenario. A further aspect to be taken into account is availability for the plant, because phosphate strongly adheres to the soil. The fact that phosphate is essential for vegetable production implies that more of the nutrient will have to be reused in the future (from waste streams, algae, biomass from natural areas, etc.) (Schuiling et al., 2011).

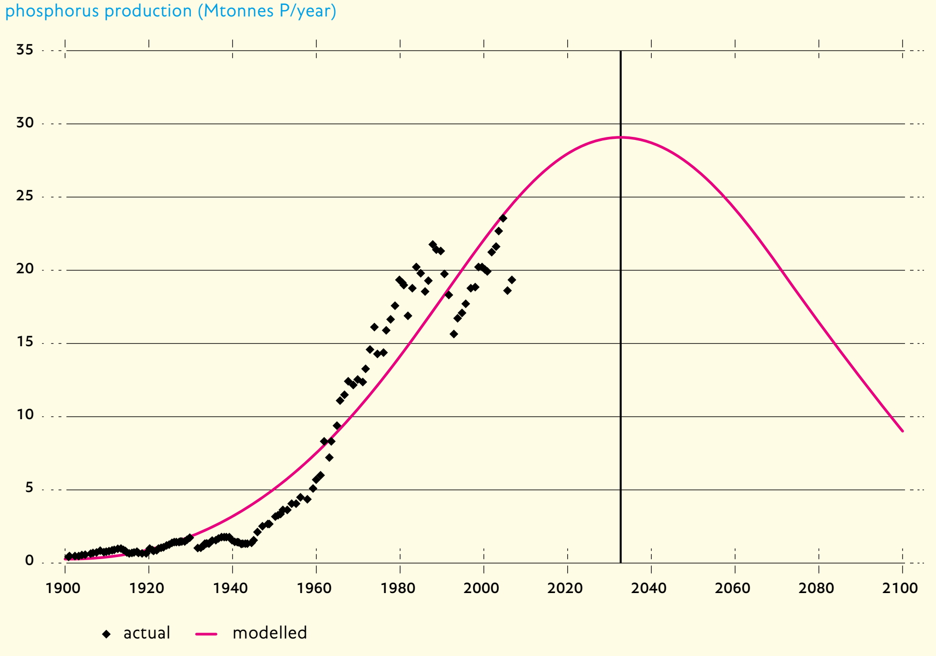
Water The Flemish agricultural and food sectors are highly dependent on water. In 2009 the Flemish food industry consumed 47.6 million m^3 of water (excluding cooling water) and the

Figure 4: **Deflated raw material prices**



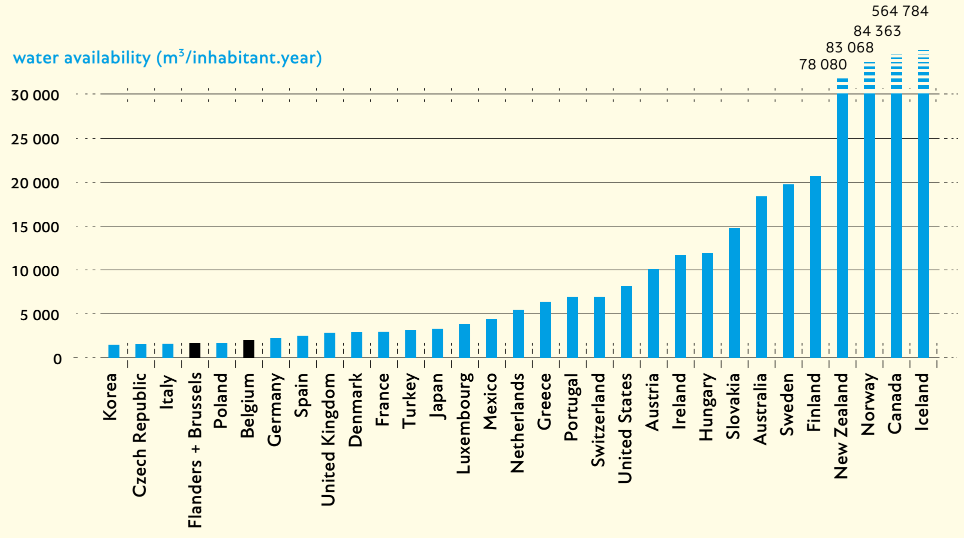
Source: Baffes & Haniotis (2010)

Figure 5: **Indicative peak phosphorus curve**



Source: Jasinski (2006); European Fertiliser Manufacturers Association (2000)

Figure 6: Water availability per inhabitant



Source: MIRA based on OECD, WL, MOW, VMM

Flemish agricultural sector between 54 (figures from AMS) and 68 million m^3 (figures from MIRA). Expressed as a percentage of Flemish water consumption (excluding cooling water), this corresponds to 7 % for the food industry and 10 % for the agricultural sector (MIRA, 2012). Flanders depends both on surface water and groundwater for its water consumption. Figure 6 shows that Flanders places great pressure on its water resources in comparison with other European countries and regions. The annual average water availability of a country or region gives an indication of the quantity of water that is available each year. It is the sum of the average annual precipitation surplus (precipitation minus evaporation) and half of the annual water inflow from neighbouring regions and countries, divided by the number of inhabitants. Depending on the method used, it appears that in Flanders and Brussels the average water availability per person varies between 1 100 and 1 700 m^3. By international standards, this qualifies as 'very low': water is considered scarce when the availability per person is less than 1 000 m^3. Only a few Western countries have even less water per inhabitant (Italy and the Czech Republic). Even in countries such as Spain, Portugal and Greece water availability per inhabitant is greater than in Flanders and Brussels. The most important cause of this low water availability is the large population density in Flanders and Brussels. The available water must be shared with a large number of inhabitants, while the surface area is limited. Furthermore there are also no large rivers flowing into Flanders. The scarcity of water is reflected, among other things, in increasing taxes on the consumption of groundwater in agriculture and also in the restriction of groundwater extraction licences. The amount of the (annually increasing) taxes is layer- and area-specific, as extra protection for over-exploited groundwater layers.

Apart from direct water consumption in the Flemish agricultural and food sectors, there is also the water consumption linked to the production of inputs for these sectors and to the production of imported foods for consumption in Flanders. The water footprint of a country or region indicates the quantity of water that is consumed throughout the life cycle of the consumed goods and services. The concept of water footprint was introduced by Hoekstra and Hung (2002) and has since been further elaborated into a practicable and clear indicator for sustainable water use. The idea of a water footprint is increasingly being supported by policy (e.g. UNESCO, 2006) and by non-governmental organisations (WWF, 2011) but also in a business context (WBCSD, 2006) and the media. Different interpretations have thus far prevented a consensus on what water footprints do and do not imply and on suitable methods to be used to obtain a genuine footprint. The water footprint is usually calculated as the sum of the water volume that is consumed directly in a country or by a sector (internal water footprint) and the virtually imported water (external water footprint, i.e. the water that is consumed in other countries for the production of goods and services that are consumed in that country), minus the virtually exported water (i.e. the water that is consumed to manufacture goods and services that are consumed in other countries). This calculation method does, however, have a number of limitations.

In a report of 2011, the WWF states that the water footprint of the average Belgian amounts to 7 406 l/day or 2 703 m^3/year. This is twice the global average and more than in our neighbouring countries (Netherlands: 2 300 m^3/inhabitant/year; UK: 1 700 m^3/inhabitant/year). The first finding is therefore that our water footprint is particularly high, in fact higher than the 2 500 m^3/capita/year of renewable fresh water that is available at the global level. Furthermore, it appears that three-quarters of the Belgian water footprint is external, i.e. water that is consumed in other countries for the production of goods and services that are consumed in Belgium. This mainly involves agricultural products such as cotton, coffee and cereals. A third finding is that almost 94 % of the Belgian water footprint is attributable to the consumption of agricultural products: of the 7 406 l, 6 931 l is estimated to be linked to the consumption of vegetable or animal products, with beef and dairy products having a particularly high water footprint. Industrial products and household consumption account for 285 l and 218 l respectively.

Fossil fuels Figure 7 shows the evolution of energy consumption in Flemish agriculture and horticulture. In 2010 the figure amounted to 35 PJ, or 2 % of total energy consumption in Flanders. What is clear is the still dominant dependence on fossil fuels, although in the past two decades there has been a noticeable shift from fuel oil to gas and recently also an increase in biomass as fuel.

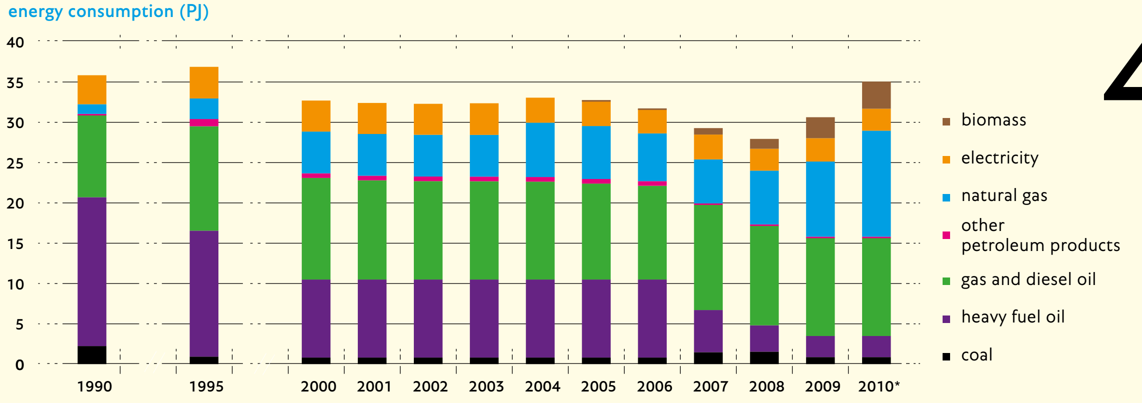
For the food sector the total annual energy use amounts to 39.2 PJ (2010), with 62 % directly from fossil fuels (Elsen & Kielemoes, 2012). With 36 % from electricity, which itself is based for 45 % on fossil fuels (FOD Economy), this sector, too, is still firmly anchored in fossil-based energy supply (Figure 8).

Apart from the direct consumption of fossil fuels in the Flemish agricultural and food sectors, there is also the energy consumption linked to the production of inputs for these sectors, such as chemical fertilisers, and to the production of imported foods for consumption in Flanders. Research results for Flemish agricultural businesses show that indirect energy consumption is at least as high as or even up to 2.3 times higher than direct energy consumption (Meul et al., 2007).

The Flemish agricultural and food sectors are therefore highly dependent on fossil fuels, both directly and indirectly. Fossil fuels are, however, becoming increasingly scarce and expensive. Whereas demand for oil will continue to increase in the future, production will reach a maximum and then decrease. The turning point is called peak oil, i.e. the point in time when oil production reaches the maximum. After this point, supply and demand for oil will increasingly diverge and an energy crisis appears unavoidable. In spite of the vital importance of the concept of peak oil for the world economy, the scientific debate focuses not so much on the economic consequences or the need for finding alternative energy sources as on when peak oil will actually occur. The result is a chaos of predictions. The scenarios vary widely and outline the chaos in relation to the subject. In any case, it is apparent that the remaining reserves will become increasingly difficult to extract, so that the current trend of rising oil prices will continue, which can only make the use of alternatives more interesting. With a society that still almost totally depends on fossil fuels for its energy supply, this is a foreseeable dead end. Even in the most optimistic of scenarios the peak of oil extraction will be reached before 2040, after which a downward trend will set in and alternative systems of energy generation will have to be available (Tsoskounoglou et al., 2008).

Land use Land, and open land in particular, is scarce in Flanders. This scarce land is subject to claims from different angles: businesses, recreation, nature, water management, housing, etc. This means that the available surface for agricultural and food-related activities is under continuous pressure. Moreover, primary production faces an additional problem of choice between production for food, energy, materials, etc. (see also hotspot 3). Slightly more than half (53 %) of the total Flemish land surface (1 357 358 ha) is used for agriculture. This is followed by housing and trade (20 %), forestry and nature (15 %) and infrastructure (5 %) (MIRA, 2009). The average distribution for Europe is as follows: 43 % for agriculture, 29 % for forestry, 16 % for other open land, 8 % for trade & services and housing, and 3 % for industry, energy and transport (Eurostat, 2010b). The Eurostat data show that Belgium (after the Netherlands)

Figure 7: Energy consumption of Flemish agriculture and horticulture, by energy carrier

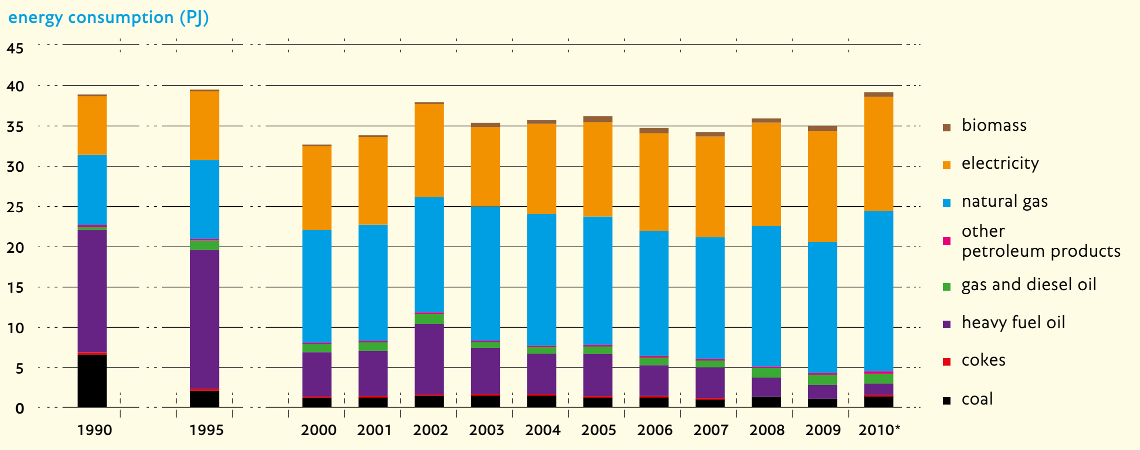


including energy consumption by sea fisheries, forestry and public green

* provisional figures: only consumption of electricity, natural gas and biomass has changed, the other energy carriers (45 %) keep their 2009 values

Source: MIRA based on Flanders Energy Balance, VITO

Figure 8: Energy consumption of Flemish food sector, by energy carrier



* provisional figures

Source: MIRA based on Flanders Energy Balance, VITO has a very high land use for residential, commercial and industrial activities compared with other European countries.

Apart from direct land use, there is also indirect land use linked to the production of biomass. Calculations of the ecological footprint show that 90 % of the Flemish consumption of renewable materials relies on agricultural land and woodland abroad. Flanders is therefore highly dependent on other regions for renewable materials (Bruers & Verbeeck, 2010).

Biodiversity In previous sections of this system analysis we referred to the essential importance of biodiversity and ecosystems for the proper functioning of agro-food systems (see landscape development 6 and hotspot 3). The 22 nature indicators in the Nature Report Flanders 2011 indicate that the loss of biodiversity was not halted in 2011 (Demolder & Peymen, 2011). It is important, on the one hand, to more firmly address the sources of the various disruptions (land use, emissions of nitrogen, phosphorus and greenhouse gases, import and export of species, use of crop protection products) and, on the other hand, to purposively manage sufficiently large natural areas and guarantee a basic nature quality outside those areas.

Hotspot 6 The environment absorbs emissions, but if the carrying capacity is exceeded, the quality of the necessary resources may be jeopardised

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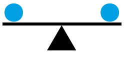

Just as any economic system, the agro-food system generates residues and emissions that may have an adverse impact on the quality of the environment and/or the availability of resources that are needed for the system and/or other systems. Backed up mainly by technological progress and ever improving knowledge, we have in the past decades succeeded in reducing the pressure by residues and emissions on agricultural and food activities, especially in relation to the quantities produced and turnover: in other words, eco-efficiency has increased.

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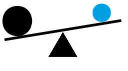

However, the order of magnitude of a number of environmental impacts is still such that it jeopardises the quality of the resources on which the system relies and/or exceeds the carrying capacity of the ecosystems. These environmental impacts include greenhouse gas emissions, pesticides, nutrients, soil degradation and loss of biodiversity.

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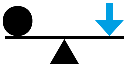


The increasing scarcity of resources (landscape development 6), climate change (landscape development 5) and changing expectations of citizens/consumers in the area of environmental care (landscape development 7) reinforce the pressure to minimise potentially harmful environmental impacts of production systems or at least reduce them to a level below the self-healing capacity of ecosystems. Negative impacts of production systems on natural ecosystems are also one of the driving forces behind emerging movements around 'other growth' (landscape development 8).

Just as with other production and consumption systems, the various processes in the agro-food system release emissions and residues. These may have harmful consequences for the quality of the resources that are needed for the proper functioning of both the agro-food system itself (soil erosion, polluted water, decreasing natural pest control, etc.) and other systems (air pollution, eutrophication, climate change, loss of biodiversity, etc.). Moreover, the environmental impacts may slow down the generic economic motor because costs are incurred (which may or may not be imposed by regulations) to limit the sources of negative impact and/or remedy their consequences (e.g. costs of water treatment, costs of environment-related health care, etc.). In addition, a number of environmental impacts remain to be assessed and therefore do not yet carry a monetary price (e.g. loss of biodiversity).

Greenhouse gases In 2010 the agricultural sector and the food industry accounted respectively for 10.6 and 1.7 % of total greenhouse gas emissions in Flanders (Figure 9). Typical for the agricultural sector is the large share from non-energetic sources: methane (CH_4, originating from manure storage and digestion by ruminants) and laughing gas (N_2O, from nitrification and denitrification in the soil) represented respectively 37 and 24 % of total greenhouse gas emissions in agriculture in 2010 (MIRA, 2012). Between 1990 and 2010 total Flemish greenhouse gas emissions decreased by only 1 %. Both the agricultural sector and the food industry did better with decreases of respectively 17 % and 37 % compared with 1990. On 18 April 2012, the plenary meeting of the Flemish Parliament approved a resolution whereby Flanders supports the commitment of the Member States to reduce European greenhouse gas emissions by 30 % by 2020. This is only a preliminary to a further reduction. In the Roadmap for moving to a competitive low carbon economy in 2050, the European Council in February 2011 re-affirmed the EU objective of reducing greenhouse gas emissions by 80 to 95 % by 2050 compared with 1990 levels, in compliance with the reduction deemed necessary by the IPCC for the group of developed countries (EC, 2011b).

Apart from direct greenhouse gas emissions by the Flemish agricultural and food sectors, there are also greenhouse gas emissions linked to the production of inputs for these sectors, e.g. electricity, chemical fertilisers and imported animal feeds. The production of imported food products, whether or not subsequently processed in Flanders, consumed by Flemish households also involves a significant amount of greenhouse gas emissions. Calculations made with the Flemish input-output model show that a quarter of direct plus indirect greenhouse gas emissions associated with consumption by Flemish households are food-related (Vercalsteren et al., 2012). About three-quarters of these food-related emissions originated in the production and distribution chain of the consumed food products (only food products directly purchased by households, i.e. excluding food products consumed via industrial kitchens, restaurants, etc.). Only a relatively limited part of these emissions occurred in Flanders: the Flemish sectors with the greatest share of emissions (direct emissions, i.e. excluding pre-chain) were the agricultural sector (20 %), the electricity sector (5 %) and the food sector (3 %). The main portion of greenhouse gas emissions associated with the production of food products consumed by Flemish households, roughly 70 %, was thus released outside Flanders.

Crop protection The use of crop protection products in agriculture has decreased sharply during the past decades. Expressed in active substances, total use in 2008 was 24 % lower than in 1990. This consumption roughly breaks down into 50 % fungicides, 30 % herbicides and 20 % insecticides. In terms of harmfulness, expressed as pressure on aquatic life, the ratios are reversed with respectively 3, 32 and 65 % for fungicides, herbicides and insecticides. The total risk of damage to the natural water environment fell by 42 % over the same period. This decrease is due to the reduction in the volume used and aspects such as the development of more efficient products, the ban on extremely harmful products, mandatory control of spray equipment and integrated pest control (e.g. horticulture), and further developments in organic farming and horticulture.

In spite of the decreasing use and the decreasing pressure on aquatic life, pesticides are frequently found in surface water and groundwater in Flanders in concentrations that exceed scientific or legal standards. In 2010 the maximum concentrations of diflufenican (herbicide) were too high in half of the sampled measurement locations in the VMM measurement network; for flufenacet (herbicide), oxadiazon (herbicide) and dimethoate (insecticide) the maximum concentrations were too high in more than 15 % of the measurement locations. Acute effects on aquatic life are to be expected in these surface waters. For oxadiazon (herbicide), the average concentration in 2010 was too high in almost three-quarters of the measurement locations, and for diflufenican (herbicide) it was too high in about 92 % of the sampled measurement locations, which may lead to chronic effects. The situation for non-standardised pesticides is more unfavourable than for those that are governed by environmental standards. In 2010, an exceedance of the quality standard for one or more (degradation products of) pesticides was observed in more than half (56 %) of the investigated locations of the groundwater measurement network.

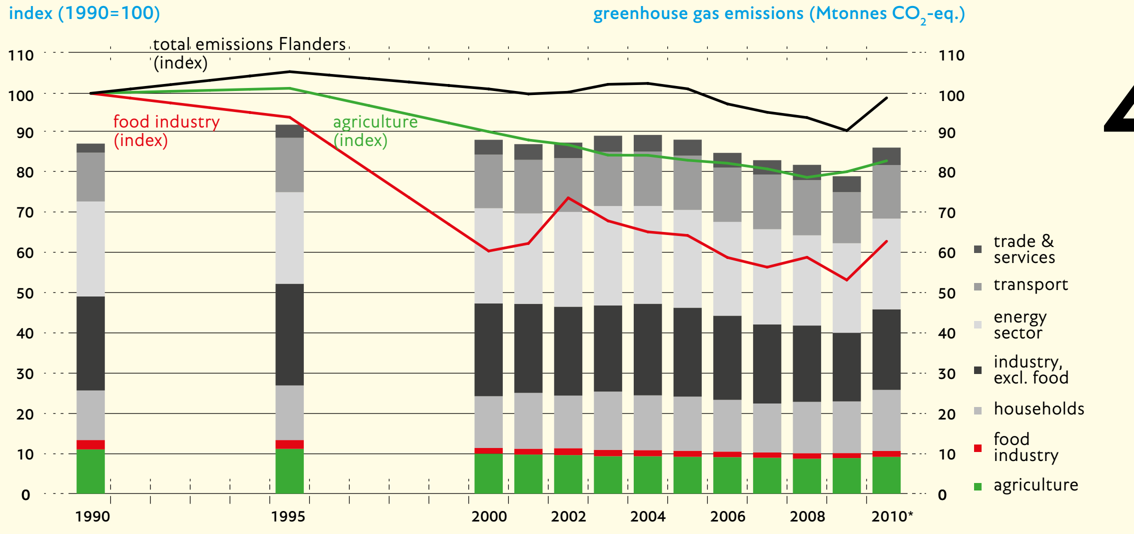
Nutrients The nitrogen surplus on the soil surface balance per hectare of agricultural land is a good criterion for the risk of excessive leaching of nitrogen to groundwater and surface water and has decreased drastically over a 20-year period (Figure 11). This has resulted in a clear and overall improvement in the nitrate quantities measured in the surface water of the measurement points of the Manure Action Plan (the so-called MAP measurement points, Figure 12). The overall improvement in the field of eutrophication is to be attributed to a rigorous policy in the area of fertilisation standards, the reduction in the number of livestock, manure processing, etc.

The improvement at the measurement points is, however, a slow process (in any case slower than suggested by the falling figures of the nitrogen surplus on the soil surface balance), and is not yet sufficient to achieve the quality standard of 50 mg of nitrate per litre on a broad scale. From a statistical trend analysis per measurement point, it appears that the nitrate concentration in surface water in agricultural land shows a significantly falling trend in the period 1999-2011 at 30 % of the measurement points, no significant trend at about 65 % of the measurement points, and even a significantly rising trend at 5 %. This analysis thus shows that the improved situation by no means applies to all measurement points.

As far as the (deeper) groundwater layers are concerned, the percentage of measurement locations with exceedance of the nitrate standard (50 mg/l) has evolved from about 40 % in the first half of 2005 to approximately 35 % in the second half of 2010. The standard exceedances are not proportionately distributed across Flanders. In addition to factors such as local manure pressure, the results are determined primarily by the nitrate vulnerability of the shallow (phreatic) water carrying layers. Due to the greater transport and residence times of the groundwater in deeper aquifer zones, the measurement results for the deeper filter levels remain relatively stable over the years.

The phosphate issue in surface water poses a greater challenge than the nitrate issue. From the statistical trend analysis per MAP measurement point, it appears that the situation is not improving: over the period 1999-2011, only 13 % of the measurement locations show a significantly falling trend, about 78 % of the measurement locations show no significant trend, and for 9 % of the measurement locations there is even a significant increase. To this should be added the fact that in 2010 only 1 in 3 of all measurement locations met the basic quality standard for phosphate in surface water (0.3 mg of orthophosphate-P/l for running waters), which reveals not only the slow progress but also a considerable target distance (MIRA, 2012).

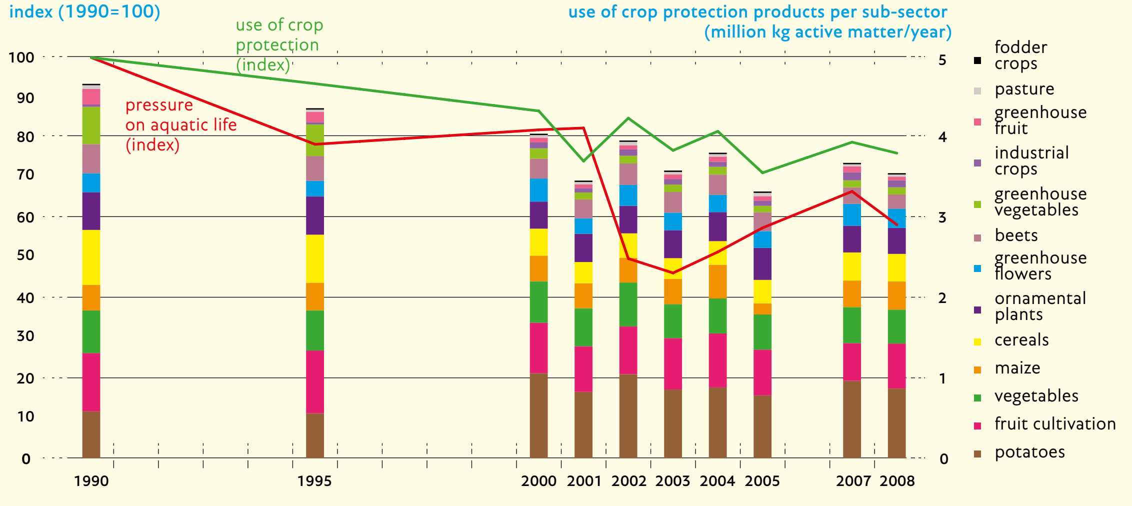
Figure 9: Greenhouse gas emissions in Flanders



* provisional figures

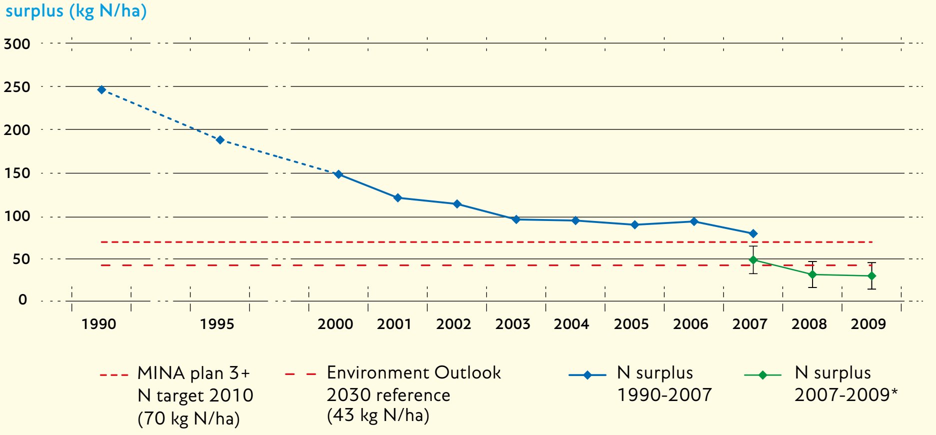
Source: MIRA based on EIL, VMM

Figure 10: Use of crop protection products in Flemish agriculture and pressure on aquatic life, as a measure of the risk of harmful impact on the environment



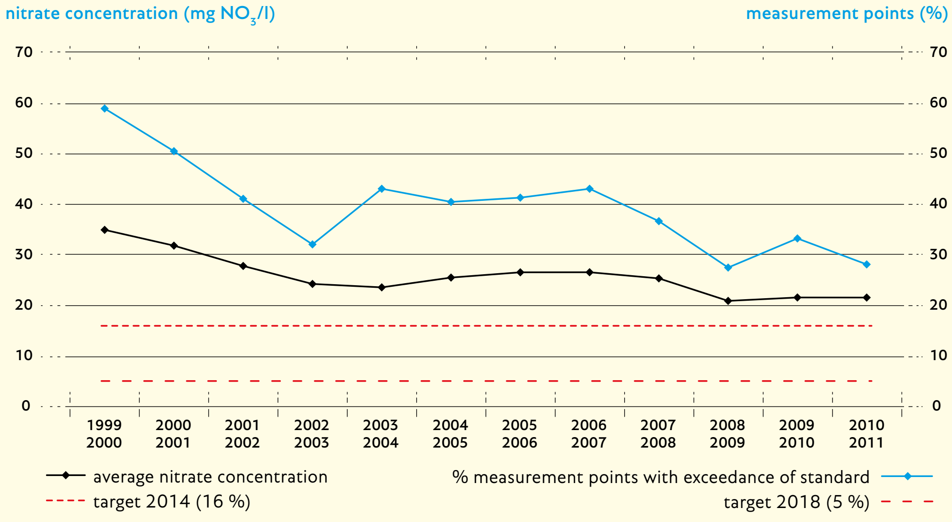
Source: MIRA based on FOD Environment and UGent, Department of Crop Protection

Figure 11: Nitrogen surplus on the Flemish soil surface balance



Source: 1990-2007: ILVO; 2007-2009: AMS-MIRA

Figure 12: Average nitrate concentration in surface water and number of measurement points with exceedance of the standard in Flanders



Source: VMM

Soil quality The general soil quality is defined as 'the capacity of a soil to ensure vegetable and animal production, water and air quality, as well as public health' (Karlen et al., 1997). This involves a broad set of biological, chemical and physical properties and processes. A decisive indicator for soil quality is the carbon/organic matter content of the soil with regard to the target zone. The target zone is a reference value at which optimal agricultural production is possible, taking into account costs but no ecological standards. A recent study shows how the carbon content in Flemish agricultural land dropped in the period 1989-1991 to 2004-2007, with the number of plots that did not meet the target zone rising from 20.9 % to 52.0 % for arable land and from 29.6 % to 52.4 % for pastures. In the period 2008-2011, however, an improvement was noticeable: the number of plots below the target zone dropped to 35.0 % for arable land and to 42.5 % for pastures (Elsen, 2012). Other harmful effects on soil quality are soil compaction (Van de Vreken et al., 2007), erosion (Beel et al., 2006), salinization, contamination, and loss of soil biodiversity.

4.3 Social damping

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In addition to natural resources, social resources are needed as input in the economic process. By analogy with ecological damping, we will here describe a number of social aspects that prevent the economic motor from accelerating less fast than it would do by itself. Here, too, this metaphor of braking is used from a dominant view of the current system that is governed by the primacy of the economic aspects. In the previous chapters we already described an important social aspect of the agro-food system, notably its relationship to the citizen/consumer. The most important elements in this context were the changing requirements of consumers/citizens (landscape development 7), safe and healthy food versus food-related health problems (hotspot 1), unbridled supply in combination with food loss (hotspot 2) and loss of connection between producer, ecosystem and consumer (hotspot 4). In the following sections we will specifically focus on elements of social capital in the 'internal' functioning of the system, both within and outside Flanders.

Hotspot 7 The agro-food system builds on social capital but at the same time threatens to lose it

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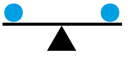

The agro-food system uses not only natural resources (hotspot 5), but also social ones. This social capital includes, first of all, the farmers and workers within the system. They achieve an ever higher labour productivity, also as a result of knowledge, technological progress, scale enlargement and specialisation. Another form of social capital are the social relationships. Thus, agricultural businesses are traditionally strongly embedded (or even act as anchor points) in the social fabric of the rural community.

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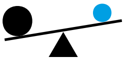

However, a system that mainly operates in an increasingly competitive world market of bulk production also implies that its workers are required to continuously step up their efforts, which may lead to negative stress. At the same time, the necessary human capital is becoming increasingly scarce, as can be derived, for example, from the successor problem in agriculture and the lack of sufficient and properly qualified people in the food industry. One of the causes of the successor problem in agriculture is the fact that lower prices and falling incomes often force farmers and/or their partners to take on extra work outside the business. This makes it increasingly less interesting for potential successors to take over the business. Furthermore, there are little or no contacts with the consumer, resulting in loss of respect and recognition and therefore also loss of professional pride, but also in lack of appreciation by the consumer in the form of the price he is willing to pay for his food. Just like natural capital, social capital has a carrying capacity that must not be exceeded.

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Changing values and ethical stances of consumers/citizens (landscape development 7) act as a lever for the relevant actors of the various sectors and organisations and policy to also pay due attention to the social aspects of production systems. Changing values of consumers/citizens and growing attention for welfare creation in forms other than consumerism (landscape development 8) also act as a lever for repairing contacts and collaboration between producers and consumers.

Just like natural capital, social capital contributes, on the one hand, to the generation of welfare (the source function), but, on the other hand, it is also subject to erosion (the sink function). In contrast with natural capital, however, social capital is much more difficult to express in quantitative terms. Social aspects are the least well defined and the least well documented. We will here confine ourselves to the findings of the Agriculture Report (LARA, 2011) and the Sustainability Report of the food industry (FEVIA, 2011). We will use the two categories of the Agriculture Report: working conditions and health & safety. Themes related to governance in the chain were discussed in the context of hotspot 4, whilst social impacts outside Flanders will be discussed in section 4.6.

As regards human capital as input in the production system, we see that an increase in labour productivity has resulted in a dramatic improvement in the quality of life for farmers during the last decades. At the same time, the professional agricultural population is declining steadily (to 44 590 full-time equivalents in 2009), on the one hand, precisely as a result of the increasing labour productivity, which means that the same work can be done by fewer hands, and, on the other hand, because there are increasingly fewer sons or daughters to take over the business. Only 13.8 % of Flemish farm managers aged over 50 have a potential successor. Moreover, certain tasks are outsourced, either to contractors for specialised operations that require expensive machinery, or to labour migrants from Eastern Europe (mainly Poland, Romania and Bulgaria) for seasonal work for which local workers are hard to find. Furthermore, an increasingly greater portion of income is earned outside the business. Thus, 54 % of agricultural households derive income from non-agricultural activities. A positive aspect of human capital is that starters in the agricultural sector are relatively well trained: 18 % hold a higher education diploma, 28 % a higher secondary diploma in agriculture, 12 % a higher secondary vocational diploma in agriculture, and 33 % an installation certificate.

The decrease in the number of farmers, although increasingly better trained, goes hand in hand with scale enlargement, specialisation, high capital intensity, and small profit margins. This puts continuous pressure on business management: business managers are required to manage increasingly bigger units and are ever more dependent on uncertain markets (and therefore income) and capital markets to finance their business. Poverty and cash flow problems are therefore still considerable, but also difficult to estimate. In 2009, 254 farmers applied for aid from the non-profit association Farmers at a crossroads. However, farmers identify administrative burden as one of their main professional problems, which also generates a great amount of stress. No data are available on social capital, e.g. degree of integration in social life (e.g. membership of associations). Farmers traditionally invest more in professional networks than in networks where actors outside the sector are active.

The food sector is a sector where many low-skilled workers are active: 11.1 % hold only a primary education diploma (versus 6.8 % in the private sector), 19.8 % a lower secondary diploma, 48.8 % a higher secondary diploma, and 20.6 % a higher education diploma. On the one hand, the food industry plays an important economic role as an employer for low-skilled workers, but, on the other hand, only a relatively small amount of resources are spent on training: only 0.74 % of the wage mass. Employees with a higher education diploma more frequently attend a training course (1 in 4) than those with a primary education diploma (1 in 10). In 2010, 88 639 persons were employed in the food industry, to which some 10 000 temporary workers should be added. 74 % of blue-collar workers are men, and 57 % of white-collar workers are women. Employees are, on average, aged between 35 and 39, whereas ten years ago most employees were aged between 25 and 29.

For the food industry, even less data are available on the development of human and social capital. As already mentioned, only a relatively limited amount is invested in human capital. Working conditions are, however, continuously improving. In the food industry, the frequency of work accidents shows a downward trend to 31.36 accidents per million hours worked. Sickness absence amounted to 5.11 % (versus 4.47 % in the private sector). There is a slight increase in the number of temporary work contracts (11.6 % in 2009 compared with 9.4 % in 2000).

4.4 Technology-based lubrication

With the economic motor as the permanent dominant driver of the current social system (from a paradigm of growing world population and striving for a higher level of welfare for 'all'), attempts are being made to reduce ecological and social damping. Strategies used to reduce ecological damping are:

- eliminating the causes of negative impacts. This is accomplished via (technological) innovations. Such end-of-pipe solutions do not, or hardly, affect the prevailing processes of production (or consumption) but they do make them 'clean'. End-of-pipe will not remedy the scarcity of resources either.
- reducing the negative externalities of production processes. Fewer emissions, waste streams, waste per unit of production are possible by applying ever better techniques (Best Available Techniques) or better managing existing techniques.
- applying systems where fewer resources need to be used per unit of production (food, goods, services, etc.). An increase in input efficiency (or better, productivity) is traditionally achieved through new or improved technologies and/or reuse of waste or residues.

The same reasoning can be applied in relation to social damping. Innovation has enabled the mechanisation of heavy labour and allows a shortage of workers to be absorbed by mechanisation and robotisation. In addition, innovation allows the improvement of working conditions.

For each strategy, a portion of the income from the economic motor needs to be used in (technological) innovation, the dominant idea being that this form of innovation essentially primarily contributes to the optimisation of the existing system.

Each of the above strategies has the potential to reduce ecological and/or social damping on the economic motor, but it should also be stressed that even with less damping per unit of production, the total impact on resource reserves can remain as great, or even increase when the economic motor is further cranked up: the rebound effect denotes the possibility that with higher eco-efficiency the total environmental impact can further increase.

Hotspot 8 (Technological) innovation optimises the current system but has not as yet designed any innovative system configurations

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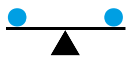

Innovation and technological development are at the basis of an efficient agro-food system and also gradually guide the system towards more sustainable solutions. In the agro-food system, innovation primarily ensures the (technological) attenuation of specific and highly localisable inhibiting aspects for the production processes.

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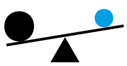


Far less is happening in the field of integrated solutions, drastically innovative value propositions and whole system innovations. However, this type of solution is also required for more drastic changes and innovations in the direction of a more sustainable agro-food system, innovations that are necessary to address the challenges faced by the system (see Chapter 3).

Technological developments revolutionised agriculture in the twentieth century. The tractor, chemical fertilisers, pesticides, etc. had a very big impact on the productivity of Western agricultural and horticultural systems. Yields per hectare rose exponentially in the twentieth century thanks to new techniques. Animal production, too, experienced considerable productivity increases.

A recent analysis and evaluation of the agricultural research programme of IWT shows that the key objectives of completed innovation projects are very much focused on optimising existing processes, and therefore on productivity increase, and mainly on the primary production segment (Kaashoek et al., 2012).

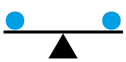
Today, research (financing) often opts for quick wins, i.e. innovations with a demonstrable (economic) result in the short run. Innovations aimed at sustainability in the longer term have thus far received relatively less attention in Flemish research. Also in a European context, a recent report points to the permanent concern for a focus on productivity increases in agricultural and food production (EU SCAR, 2012), albeit with a distinct sustainability dimension. Flanders does very well in involving the sectors in the actual research and therefore also in aligning innovation to the concrete demands of the activities concerned. This has led, and still does lead, to successful incremental innovations with often demonstrable advantages for sustainable development, but which also maintain or even reinforce the system in its current configuration.

Architectural or radical innovations in which new socio-technical systems are devised, occur far less frequently. This forms an inherent dilemma of innovation: within each company and each sector there is a tension between the need for stability and the need for creativity. On the one hand, companies need stability to be able to do their business quickly and efficiently and to stay competitive in the short term, while minimising sourcing and sales risks. On the other hand, companies need to develop creative new ideas and products to remain competitive in the long term as well (Trott, 2008). One of the main causes of the lack of integrated solutions is the fact that the system consists of relatively loose, specialised and independent units (hotspot 4), whereas systemic approaches clearly require more association, arrangements and trust, and the relinquishment of unlimited autonomy. Integrated solutions, value propositions and system innovations are what is needed for innovation towards sustainability. Another cause is that the limited profitability of the current agricultural system acts as a brake on innovation in general.

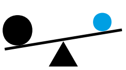
4.5 The system is open

Looking at the above-described system from a Flemish perspective would obviously yield an incorrect image: both consumption and production processes take place on world markets, characterised by a high degree of openness. Goods, services, capital and people can be imported and exported to a virtually unlimited degree (see landscape development 2). The fact that the system is open and therefore in many possible ways connected with the whole world, has a number of important consequences for the basic pattern of the Flemish agro-food system as described in the previous sections.

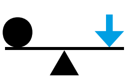
Hotspot 9 An open system offers many advantages but also leads to shifting of the social and ecological impacts



Globalisation (landscape development 2) and the digital revolution (landscape development 10) enable an intensive and worldwide market for food (and other agriculture-related products), with multiple advantages to optimally exploit comparative advantages and translate them into added value.



At the same time, an open system implies the risk of shifting undesired social and ecological effects of production systems to places far away from consumption, and as such also of shifting the responsibility for sustainable solutions.



Under pressure from growing awareness, not only among consumers/citizens (landscape development 7) but also among businesses, and spurred on by the increasingly explicit call for 'another growth' (landscape development 8), global considerations are more and more being incorporated into strategies for sustainable or socially responsible business and trade.

Import/export ... The increasing transport facilities (and the increasing virtualisation of services, see landscape development 10) have eliminated distance as an obstacle to the import and export of goods and services, and the necessary resources for their production. In an underlying context of comparative advantages, this can clearly be considered as a stimulus for an increasingly efficient market where maximum added value is created. Intense international trade also means that a local production system can be put under severe pressure by growing external demand and that local production can be phased out at the same time because the necessary supply for consumption can be procured (cheaper) from elsewhere. This may in turn give rise to situations where large quantities of comparable products are simultaneously imported and exported (Flanders imports, for example, as many dairy products as it exports; for half of the value of meat that Flanders exports, it also imports meat, etc.), although this trade is mainly conducted with neighbouring countries and therefore within a relatively short distance.

… also of externalities Globalisation and free trade also imply that possible negative impacts of production and consumption are shifted or 'exported'. In other words, the impacts of production systems are no longer linked to the geographical locations where the actual production and consumption take place (see hotspots 5 and 6). Moreover, a number of negative externalities of the economic motor are worldwide anyway. Examples are local greenhouse gas emissions that have a worldwide impact, but also the social impacts in the southern hemisphere of the production and consumption decisions that are made in Flanders. In this way, this highly open configuration can reinforce a number of system hotspots (e.g. scarcity of resource, specialisation) or give rise to them elsewhere in the world.

External social and ecological impacts increasingly receive attention in the sustainability reports of mainly larger companies in the agro-food system. FEVIA, for example, refers to non-compliance with International Labour Organisation standards outside Flanders as an important sustainability issue (FEVIA, 2011). Also the sustainability report of Delhaize, a major distributor with a strong Belgian (Flemish) arm, refers to responsible sourcing as a key aspect in its management. Some food companies apply similar principles for the purchase of products that involve quite a number of ethical issues (child labour, gender, low wages), e.g. cacao, bananas and coffee.

To tackle the different sustainability challenges, (system) innovations are needed, solution approaches addressing the hotspots described in the preceding chapter. Inspiration can be found in existing niches which we have here bundled into four niche regimes: urban agriculture, organic agriculture, eating differently, and new production paradigms. Niche regimes are clusters of niches that hold the middle between regime and niches in terms of scale and that are able to influence the regime towards sustainability. After a discussion of the different niche regimes we will see at the end of the chapter how each niche provides an answer to the different hotspots.

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Table 2 shows an overview of the niche regimes and niches that will be discussed in this chapter.

Tabel 2: **Niche regimes that may serve as inspiration for the transition to a sustainable Flemish agro-food system**

Niche regime	Niche
1 Urban agriculture	Extending the functionality of urban space
	Intensive production units with minimal spatial footprint
	Short chains
	Functional broadening of agriculture
	Agriculture as a provider of ecosystem services and closed-loop cycles
2 Organic agriculture	
3 Eating differently	Reduction of animal proteins
	Slow food
	Customisable food
4 New production paradigms	Industrial ecology
	Bio-based economy
	Factory of the future
	Peer-to-peer production

The following preliminary remarks are necessary to structure the discussion of the niches:

- Niches and niche regimes are complex social subsystems that may interact with the agro-food system in a wide variety of ways. They are therefore more than mere niche markets, small but potentially profitable segments of a larger market.

- Niches may have a competitive or symbiotic relationship (and in some cases both simultaneously) with the regime. The intent here is therefore not to establish a one-on-one relationship between the functioning of a given niche and the way in which it can influence the regime and create more sustainable value in the future. Rather, what we will do here is examine the multidimensionality of those possible interactions between regimes and niches, and of possible value creations.

- Niches as a whole are also not to be interpreted as 'revolutions'. They contain a mix of avant-garde technological developments and longer existing techniques, customs and preferences.

- Inspired by transition thinking, the system analysis is inevitably set within a normative framework and aimed at a transition of the agro-food system to a new, more sustainable balance. The niche regimes are here discussed from their potential to contribute to greater sustainability.

- The multiform and complex character of niches and their normative colouring preclude an objective, ironclad justification of a selection. The choice of niches presented here is inspired by their diversity, their asymmetric overlaps with the agro-food system, their potential to contribute to greater sustainability and the fact that they transcend to some extent the dichotomy between an agro-ecological and an industrialised agriculture.

- No attempt has been made to identify specifically Flemish niche regimes. The reason for this is that technologies, social trends and regulatory frameworks transcend national boundaries. Furthermore, the fact of making a diagnosis at the Flemish level does not imply that the remedy must also be of strictly Flemish origin.

- We have not included a quantitative assessment of the impact of the different niches and niche regimes. For this, we would have to filter elements from a very large and fragmented database of scientific research.

- The social debate on the long-term future of the global agro-food system is governed by very stable and highly normative discourses. We have tried to stay clear of the dichotomy between an agro-ecological versus industrial approach by introducing a more differentiated normative framework that is made up of four value creation models (see box). We use these value creation models as 'lenses' through which we examine and identify the potential of the niche regimes. They are ways of viewing and assessing, to be understood as an analytical filter, not as a system. We simply observe that these paradigms exist without taking any position as to their desirability or undesirability.

Major characteristics of the four value creation models used:

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Market economy

- The consumer is primarily viewed as a rational utility maximiser at the end of the chain.
- Prices are determined in anonymous open markets by the balance between supply and demand. Decisions as to what is produced where, how, how much, by whom and for whom, are decentralised.
- The market mechanism works only with respect to the provision of individual goods. Collective goods (e.g. basic education, defence) must be provided by the government.
- Focus on increase in efficiency and decrease in production cost, e.g. through economies of scale and use of technology.
- Strong specialisation and division of labour as a source of comparative advantage, limited self-sufficiency.
- Importance of 'marginal thinking': weighing of marginal costs and benefits as basis for economic decisions.

Solidarity economy (Laville, 2010; NEF, 2008)

- Broadening the scope of the economy of profit maximisation to include solidarity with vulnerable groups within a community.
- Reciprocity as a basis for informal or formal transactions of knowledge, labour and goods.
- Co-production of services, goods and knowledge; relative neutralisation of the distinction between producer and consumer.
- Status and identity as a basis for voluntary 'production' of use-value through immaterial production (knowledge, design, software).
- Support by local currency and barter systems that mobilise broad human knowledge and experience for public or voluntary service provision; public service providers are viewed as facilitators rather than suppliers.
- Cooperative structures as a basis for linking economic value creation to social responsibility, solidarity, sense of responsibility and autonomy.

Ecological economy (O'Hara, 2010)

- Framing of the economy as an open subsystem in a broader environmental context that is materially and thermodynamically subject to restrictions.
- Use of valuation methods for the internalisation of externalities; valuation and monetisation of ecosystem services.
- Use of discursive and participative methods to arrive at valuation.
- Issues of sufficiency (what is enough, what is needed for a good life) at the intersection of economy and citizenship.
- Attention to uncertainty and irreversibility of time-bound processes.

Local development
(Bryden, 2010; Max-Neef, 1991)

- Economical use of critical resources such as water, nutrients, energy and water.
- Living and working in smaller, relatively independent communities. The molecular composition of the social fabric (micro-organisations, local areas, human-scale relationships) as a basis for an emergent political order (democracy of day-to-day living).
- Community ownership of critical resources and services such as water and energy supply, and land for food production.
- Local production of fresh food.
- Encouraging the use of endogenous, mainly natural and cultural resources.
- Avoidance of economic and political power concentrations; incorporation of local responsibility; emphasis on small businesses.

5.1 Niche regime I
Urban agriculture

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The phenomenon of urban agriculture has been a subject of interest for quite some time. It is also referred to as urban farming, neighbourhood farming and metropolitan agriculture. The multitude of labels already indicates that there is no uniform definition of urban agriculture. In its most elementary form, it means the production of vegetable and animal agricultural products in an urban or peri-urban context, mostly intended for local consumption. This practice is believed to offer many benefits: a lower environmental impact, a heightened sense of community and greater food and income security, in particular for vulnerable groups (Mougeot, 2005).

Urban agriculture is a global phenomenon. It has long been practised informally and opportunistically in developing countries, where it has become an important factor in local food and income generation (Mougeot, 2005). Today urban agriculture transcends the context of developing countries (Pearson et al., 2010). In (post-) industrial societies, however, the separation between urban and rural environments at first sight appears to be more radical than in developing countries. Food production there has long ceased to be an integral part of the functionality that the urban fabric provides. In Flanders, urban agriculture is a relatively new concept. The contrast between city and countryside is here generally institutionalised to a high degree. However, a large part of Flemish agricultural activity can actually be considered as peri-urban. A quarter of the agricultural land and of all agricultural businesses are located in an urban district (Danckaert et al., 2010).

The vagueness of the concept of urban agriculture complicates the exploration of the possibilities. The basic characteristic of urban agriculture is its spatial dimension: food production in and around the city. The geographic scope can vary according to the logic used to determine the city boundaries (fixed distance, political-administrative, bioregional). A second characteristic is the reciprocal relationship between farmer and city, in the form of short chains and a multifunctional contribution of the agricultural activity to the urban needs. However, these two elements combined give rise to widely diverging production and distribution concepts that are all grouped under the generic label of urban agriculture. High-tech vertical greenhouses linking a residential function to a production function, traditional allotment gardens, community-supported farms and intensively cultivated agro-parks in peri-urban areas are just a few examples of what today is meant by urban agriculture.

Urban agriculture as a niche regime is a constellation of different niches. From the above discussion it appears that these niches do not necessarily go hand in hand in terms of structure, technology and culture. We will discuss five different niches:

- Extending the functionality of urban space
- Intensive production units with minimal spatial footprint
- Short chains
- Functional broadening of agriculture
- Agriculture as provider of ecosystem services and closed-loop cycles

Extending the functionality of urban space If agriculture is to be effectively embedded in the urban fabric, urban designers will have to make use of residual space such as gardens, (sometimes highly fragmented) wasteland, underutilised open space, elements of the built-up environment such as roofs, and even balconies. The informal use of this residual space is a frequent phenomenon in many cities of the developing world. In Flanders and elsewhere in north-western Europe, by contrast, food production in the city has been reduced to a marginal activity. Innovative solutions in the areas of regulations, architecture, urban planning and technology are needed if it is to regain a more prominent place. The available space for urban agriculture depends on a number of factors such as urban morphology, rights of ownership and distribution of soil contamination. A rigorous mapping has shown, for example, that in New York some 2 000 hectares can be opened up for urban agriculture (roofs not included) (Urban Design Lab, 2011). Flat roofs of residential, commercial and industrial buildings allow for a significant extension of the area. To this end, various technological options have been elaborated, including specific structures for conventional vegetable gardens or specially designed intensive production units.

Intensive production units with minimal spatial footprint Space is an evident, crucial constraint for the deployment of urban and peri-urban agriculture. The absence of large contiguous cultivated areas virtually rules out the possibility of growing typical arable crops (cereals, beets, potatoes, etc.). Urban agriculture therefore focuses mainly on growing vegetables and fruits. There are probably also options for growing specialised crops such as mushrooms. Animal production in the city is discouraged by environmental regulations. There are nevertheless options for bee-keeping, chickens and even aquaculture. More future-oriented projects explore possibilities of producing fuels and materials from algae. Due to the spatial restrictions and the focus on high added-value crops, urban agriculture invites experimenting with new technologies for intensive production units with a minimal spatial footprint. These can be placed on the ground floor but also on roofs or integrated into buildings. An important strategy is to extend the cultivable area in the vertical dimension. The 'vertical greenhouse', which combines residential high-rise construction with productive infrastructure, has already become an icon that symbolises the future potential of urban agriculture. Other technologies are also finding their way to this niche. They hold out a future where it will be possible to significantly increase production volumes within a strictly predictable growth and harvest protocol, with an advanced level of control over the appearance, taste and nutritional value of vegetables and fruits, and with more efficient use of water, energy, light and pesticides.

Short chains Urban agriculture is largely a concept of short chains (local distribution and consumption). This means that the distance from producer to consumer is short. The benefits are multiple: lower energy use and greenhouse gas emissions, lower transport costs, a renewed bond between producer and consumer, a greater advantage for the producer through the direct sale of products, stimulation of the local economy and identity, and increased local food security. Short chains exist in various forms. Traditionally there are the farm products that are sold off the farm or via collective systems such as food teams or farmers' markets (Cazaux, 2010). Off-farm sales by peri-urban producers can effortlessly be integrated into an urban agriculture context. However, urban agriculture also offers opportunities to develop innovative production and distribution concepts, especially in connection with the previously discussed intensive, high-tech production units. The Farmery, for example, is a concept of small, modular production and distribution units that offer on-site grown produce (lettuce, mushrooms, strawberries) together with produce from regional farmers[1]. Another short-chain-oriented production concept is the so-called agro-park, a term for which there is no uniform definition. In the Netherlands, for example, an agro-park is thought of as a business park, a spatial clustering of different production units from the production chain, for the purpose of increased intensification. Agro-parks are not necessarily located near urban centres, although the latter may be advantageous, especially with regard to the supply of energy and livestock feed and the vicinity of a local market (Innovatienetwerk, 2005). However, high-tech intensification is not the only reason for the existence of agro-parks. The Baix Llobregat agro-park in Spain, for example, was set up to protect an area of high agricultural and scenic value against the pressure of urbanisation and to preserve a tradition of integrated and environmentally sound production.

Functional broadening of agriculture

Flanders has had a centuries-old history of urban agriculture in the form of allotment gardens. Small garden plots in the immediate vicinity of towns and cities were provided by benefactors to impoverished labourers. The intended effect had both a material and a moral dimension: to support the family income through healthy work that would keep the labourer out of the public house (Segers and Van Molle, 2007). In Germany, allotments (so-called Schrebergärten) were promoted by Doctor Daniel Schreber as a crucial element of public education and of the education of youngsters in particular. During the last decades, the focus has shifted mainly to recreational gardening, with pensioners being the major user group. Today, community gardens or allotments again play an important role in segregated metropolitan areas of the post-industrial world where large groups of people (unemployed, ethnic minorities, single women) live in precarious conditions. In the United States, in particular, community gardening is gaining popularity in large cities (Smith, 2010). Community gardening provides an opportunity to increase local food security, to reinforce the sense of community and to teach people (and youngsters in particular) new practical skills. Urban agriculture thus rediscovers a function with which it has traditionally been associated, namely to act as a buffer against proletarianisation and as a means to promote integration, social capital and self-sufficiency. City gardens also play a role in recreation and experiencing nature in the city. With the increasing ageing of the population, increasing immigration and the trend in the real-estate market towards less ground-oriented housing (as a result of rising land prices), the need for allotment gardens for recreational and social purposes is expected to continue to increase (Allaert et al., 2007).

This evolution is also in line with the trend towards the functional broadening of professional agriculture, where farmers and horticulturists engage not only in food production – their core activity – but also provide other services in the areas of product marketing, tourism, recreation, nature and landscape management, education, and child care (Van Huylenbroeck et al., 2007). Elements of co-production between producer and consumer can also be incorporated. So-called self-harvest farms are a form of community-supported agriculture where producers and consumers share the costs and benefits of the enterprise. At the same time it constitutes a special form of a short-chain initiative.

Urban agriculture as a provider of ecosystem services

Urban agriculture has received a significant impulse from increasing climate change that confronts urban areas with less predictable and more extreme weather patterns. In Flanders, wetter winters and warmer summers are expected to result in less pleasant living conditions (Gabriëls, 2005; Gobin et al., 2008). In cities, the higher temperatures (heat stress) are further exacerbated by the so-called heat island effect, whereby the difference in temperature between city and the surrounding rural area can amount to 4 °C[2]. Warm summers may also result in a shortage of water. Wetter winters and irregular precipitation patterns increase the risk of floods, especially in the virtually completely sealed urban area. Urban food production can, if accompanied by the development of a green infrastructure, make an important contribution to controlling these environmental bottlenecks by providing water storage and cooling capacity and reducing the need for air conditioning (e.g. by roof gardens).

However, the potential of urban agriculture to provide ecosystem services extends beyond making a positive contribution to the microclimate. In fact, a city is highly dependent on goods, water and energy that have to be supplied over great distances, and generates a large amount of waste streams and emissions. The integration of food production into the urban metabolism facilitates the closing of loops in the areas of waste, energy, water and nutrients. This is possible at the level of individual buildings, part of a city or a city, or of a city embedded in its bioregion (Birkeland, 2008).

An overview of the potential added value and socio-economic opportunities provided by urban agriculture within the different value-creation models is given below:

Market economy

- Can stimulate greater controllability and efficiency of urban agriculture (intensive production units with minimal spatial footprint)
- Provides peri-urban farmers with additional distribution channels.
- Provides input for differentiation of conventional distribution concepts (e.g. supermarkets with their own production units).

Solidarity economy

- Promotes sense of community, reskilling and self-sufficiency.
- Makes a positive contribution to food security for vulnerable groups.
- Creates opportunities for a more direct bond between producer and consumer, and between consumer and their food.
- Creates opportunities for co-production between producer and consumer (community supported agriculture).
- Appropriates urban space for community-oriented value creation.
- Provides an appropriate leverage point for cooperative structures aimed at the production and marketing of food.

Ecological economy

- Makes a positive contribution to soil quality, biodiversity and urban microclimate (flood water management, reduction of heat island effect, cooling).
- Allows experience to be gained with (quantitative, participative) valuation of ecosystem services.
- Improves energy, water and input efficiency in intensive, controlled production units.
- Reduces transport-related emissions.
- Creates opportunities for closing nutrient and organic waste loops.
- Opens up possibilities for organic agriculture.
- Contributes to the well-being and health of city dwellers through greening.

Local development

- Provides impetus for the exploitation of underutilised local resources (residual space, knowledge, entrepreneurship, organic waste).
- Reduces loss of local resources (water, energy, nutrients).
- Contributes to local resilience through greater food security, increased sense of community and through the creation of livelihoods.
- Provides primary producers and consumers with more influence on the (short) chain.

5.2 Niche regime 2
Organic agriculture

Organic agriculture is an example of a mature niche regime that is, to some extent, closely related to the existing regime. Organic farming is almost one hundred years old. It originated in the 1920s in response to the large-scale introduction of crop protection products and chemical fertilisers in agriculture. The organic farm was touted as a system of closed loops in harmony with the environment that produces fresh food for local consumption, as a radical alternative to the conventional, spatially distributed agriculture that depends on external inputs (Smith, 2007).

Organic farming is a system approach that attempts to bring different elements of agriculture into line with broader social and economic goals. The Danish Research Centre for Organic Farming[3] has summarised the essence of this practice in a number of founding principles: the cyclical principle, the precautionary principle and the nearness principle (DARCOF, 2000). IFOAM[4] uses the principles of health, ecology, fairness and care:

- Organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.
- Organic agriculture should be based on and work with the principles of living ecological systems and cycles.
- Organic agriculture should build on relationships that ensure fairness with regard to the environment and life opportunities.
- Organic agriculture should be implemented in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

This broader approach has taken the form of a cultivation practice that differs considerably from mainstream food production. It is characterised by the focus on closing the loops, thereby avoiding the use of chemical fertilisers and pesticides. Consequently, specifications prohibit the use of these products, and also of genetically modified crops.

Work on the development of a certification and labelling scheme was started in the Seventies. Today, organic products are designated by a legal EU label. Labelling has proved to be an important measure with diverging effects. On the one hand, it provides the consumer with a guarantee of origin of the products, and the organic farmer with commercial added value. On the other hand, a label reduces the complex reality behind organic farming to a binary equation (organic ‘yes’ or ‘no’). For consumers and conventional farmers, this inevitably implies a significant conceptual narrowing. However, the organic farming sector, too, continuously needs to address the issue of how to position itself in relation to this clear demarcation of niche with respect to the regime.

The dilemma facing organic agriculture in its relationship with the regime is illustrated by the way in which the sector deals with growth. There exists both an internal and an external impulse for growth. The internal impulse is driven by the growing demand of consumers and distributors. The external impulse arises from growing competitive pressure on the conventional sector that causes farmers to look for new business models. Organic agriculture is an option that enables farmers to partly escape from this growing pressure.

A possible strategy for the organic farming sector to meet the growing demand is to increase the arable land area and reduce inefficiencies by upscaling, specialisation and clustering of production units. This development is known as the ‘conventionalisation’ of organic agriculture (Kratochvil & Leitner, 2005; Darnhofer et al., 2010). Through the shift from intrinsic to extrinsic motivation of the organic farmer, the use of external inputs, the simplification of the cultivation practice, the internationalisation of transport chains, the shift in attention from process quality to product quality, and the creation of an anonymous interface with the end customer, organic agriculture is gradually settling into a more conventional pattern.

This development is noticeable both in Flanders (where the organic arable land is less than 1 % of the total arable land) and in countries where the organic farming sector accounts for a significant share of agricultural production. This is the case in Austria and Sweden, where the organic arable land area is respectively 18.5 % and 12.5 % of the total agricultural land area (Samborski & Van Bellegem, 2011).

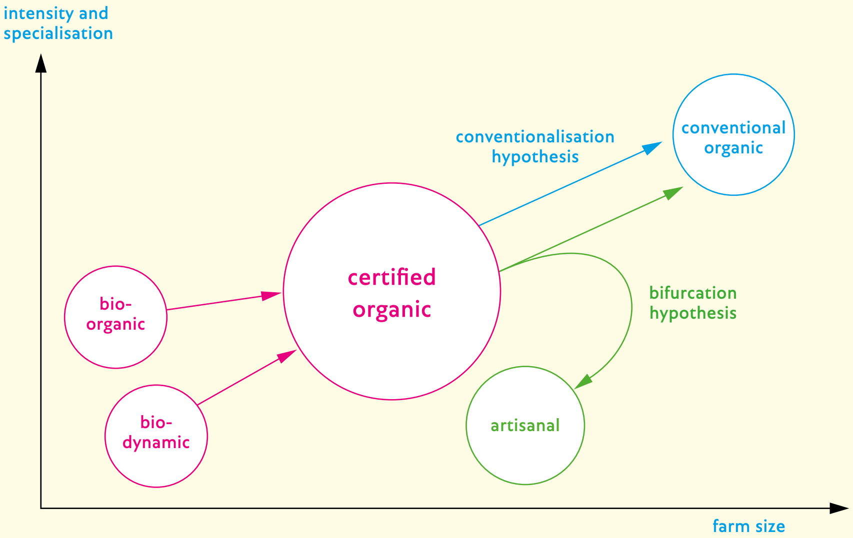
A small organic farming sector that lacks critical mass is, however, also exposed to another kind of pressure. An important trend is in fact the linking of organic agriculture with a 'preservation function' for conventional agriculture. This is stipulated, for example, in the Flemish Strategic Plan for Organic Agriculture, which seeks to reconcile organic and conventional agriculture (Department of Agriculture and Fisheries, 2008). The Netherlands is pursuing a similar policy (Samborski & Van Bellegem, 2011).

It does, in fact, appear to be desirable to transpose the achievements of organic agriculture in terms of sustainability to conventional practice. This could, however, put organic agriculture in a functionally supportive role for conventional agriculture. In other words, the reason for the existence of organic agriculture would then be the preservation of conventional agriculture. This involves the risk that its specific nature is ignored in part, because insufficient attention is paid to the founding principles of organic agriculture.

It is further debatable whether the underlying sustainability concept of organic agriculture can simply be transferred to a different context. Conventional agriculture confines itself to a conventional sustainability concept where the focus is mainly on the efficient relationship between input and output in a production process. Organic agriculture, by contrast, views sustainability primarily as a functional integrity arising from the cohesion and resilience of the human-nature system.

This shows the difficult and, to some extent, paradoxical relationship that may exist between a niche and a regime. The organic label marks a clear difference between conventional and organic agriculture. However, the competitive distinction between both creates its own dynamic that will, to some degree, establish a symbiotic relationship between niche and regime (organic agriculture that, on the one hand, uses the structures and practices of conventional agriculture, and, on the other hand, fulfils a 'gadfly function' with respect to conventional production). It is, however, not always possible to exactly identify the competitive or symbiotic character of the relationship between niche and regime. This is an important dilemma for the organic farming sector (not only in Flanders) and is further exacerbated by the fact that the conventional sector is already undergoing a process of improving its sustainability, driven by regulations and social expectations. It will then be even more difficult for organic agriculture to preserve its identity. Increasing regulations, more stringent specifications, technological development and the existence of 'hard' differentiators (non-GMO), by contrast, provide a margin for organic agriculture to assert its unique identity. A possible consequence is that the sector will specialise and fragment into separate niches (the 'bifurcation' option in Figure 13).

Figure 13: Schematic representation of the historical and expected development of organic agriculture



Source: Darnhofer et al. (2010)

An overview of the potential added value and socio-economic opportunities provided by organic agriculture within the different value-creation models is given below:

Market economy

- Forms a dynamic market niche with globally strong growth.
- Makes it possible for agricultural producers and distributors to differentiate themselves in the market.
- Can function as precursor and catalyst of a more sustainable agriculture.

Solidarity economy

- The fairness principle constitutes a social dimension of organic agriculture. It holds that organic agriculture should base the relationship between humans and between humans and other living organisms on justice and respect.
- In the co-creation of new 'solidarity' producer-consumer chains (e.g. in the context of community-supported agriculture), the actors frequently opt for organic.

Ecological economy

- Care for the health of soil, plant, animal, human and planet is a founding principle of organic agriculture.
- Embodies the principles of living ecological systems and cycles. This explains, among other things, the opposition against the use of GMOs.
- Additional cost is reflected in a higher price for the consumer, thereby allowing a number of external costs to be internalised.

Local development

- Promotes the use of local resources as substitutes for external inputs such as chemical fertilisers.

5.3 Niche regime 3
Eating differently

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Organic agriculture and urban agriculture are to a large extent production-driven niche regimes (although of course consumers need to be found to eat those products). 'Eating differently' as a niche regime is used to bring together a number of consumption-driven niches. New needs in the areas of health, identity and sustainability imply more or less drastic changes in dietary patterns, which in turn may have significant consequences for the agro-food system. They are subdivided into three groups:

- Reduction of animal proteins
- Slow food
- Customisable food

Reduction of animal proteins The various disadvantages of the massive meat consumption in Western countries are being explicitly brought to the fore (Cazaux et al., 2010):

- Various studies point to the negative impact of excessive consumption of animal products on human health. Meat often contains high levels of saturated fats and cholesterol that substantially increase the risk of cardiovascular diseases (Walker et al., 2005). A healthy dietary pattern is high in vegetables, cereals and legumes, and low in meat or meat substitutes.
- The production of animal proteins is also under pressure because of the environmental effects involved. The livestock sector is estimated to be responsible for about 18 % of global greenhouse gas emissions (Steinfeld et al., 2006). Emissions of methane (CH_4) by cattle, laughing gas (N_2O) from manure and chemical fertilisers, and carbon dioxide (CO_2) by land use change and energy consumption in livestock farming are the main sources.
- The livestock industry has also come under attack for its contribution to other environmental issues. A large share of global agricultural land is used for livestock production and suffers from its ecological impact (water pollution, water consumption, eutrophication, acidification, deforestation, loss of habitat, loss of biodiversity, erosion, desertification). The production of meat is, on the whole, more environmentally harmful than the production of vegetable products (Steinfeld et al., 2006).
- In their criticism of industrial livestock production, various interest groups also link an ethical dimension that focuses on the import of vegetable products from developing countries for use as cattle feed in industrialised countries. In the context of the global food issue (food scarcity in various developing countries, feeding an ever-growing world population), questions are raised in relation to the inefficient conversion of vegetable food to animal food for human consumption (energy inefficiency and protein inefficiency).
- Industrial fishing has many of the above-mentioned problems, such as loss of biodiversity, wasting, and presence of residues (mercury, PCBs). Aquaculture as such is not considered a sustainable alternative because it can be highly environmentally polluting and harmful for marine life (wild-caught fish as feed for farmed fish, mixing of farmed with wild populations, etc.) (Huntington et al., 2006).
- Industrial livestock production is also under discussion because of animal welfare considerations. Respect and space for species-specific behaviour in production is a growing consumer concern, and the killing of animals for human consumption remains socially controversial.

However, the production and consumption of meat is not all disadvantageous. Animal products continue to be a source of high-quality proteins. Meat also contains vitamin B12, which is important for human health and is not found in vegetables. In some low-income countries, there are pastoral and other communities where animal products play an essential nutritional and cultural role. The same applies for fish, which is rich in omega-3 fatty acids.

In response to these bottlenecks, scenarios are being explored to obtain proteins from other sources or to switch to vegetable alternatives. Like Cazaux et al. (2010), we distinguish four important new product groups: meat substitutes, in-vitro meat, insects, and algae & seaweed.

- *Meat substitutes:* In recent years, a number of protein-containing foods – all rather unusual by Western standards – have already appeared on the market: seitan, made of wheat gluten, with a fibrous structure that more or less resembles meat; tempeh, made by controlled fermentation of soybeans with a Rhizopus mould; and tofu, based on soy milk curdled with a coagulant.
- *In-vitro meat:* A more controversial scenario for the production of alternatives to animal proteins is so-called in-vitro meat or artificial meat grown in vitro. Different techniques are currently being tested in the lab. A minced meat structure can relatively easily be produced using self-organising tissue culture techniques. More highly structured meats, e.g. a steak, are much more difficult because they require a solid supporting structure that also allows for movement. The most promising scenario is the scaffolding technology, where cells are placed on a matrix and multiply from a growth medium. Other techniques such as organ printing (where cells are printed in layers on gels, after which the cells fuse into larger structures), biophonotics (where light is used for bonding particles to each other), and nanotechnology are still in a highly experimental stage.
- *Insects:* The same applies to the integration of insects as a source of animal proteins into a Western dietary pattern. Although worldwide more than 1 400 insect species are eaten (crickets, grasshoppers, beetles, ants, bees, moths and butterflies, etc.), the average Western individual has great psychological resistance to this kind of food. Superficially similar animals like lobsters and shrimps, by contrast, do appear on our menu and are even considered a delicacy. Insects are a potentially interesting addition to our diet because they have a high nutritional value (rich in protein, vitamins and minerals), and can be produced easily and environmentally efficiently (overall 20 times more environmentally efficiently than conventional animal protein products). Insects are cold-blooded and can therefore efficiently convert plant material into proteins. They are also rich in calcium, a property which is of great advantage, especially for the Asian population, which is mostly lactose intolerant.
- *Algae and seaweed:* Algae and seaweed are a diverse group of water organisms that engage in photosynthesis. Although both belong to the biological group of algae, the term ‘algae’ is used mainly to refer to single-celled plants or phytoplankton, and the term ‘seaweed’ to refer to the larger species. Single-celled algae can capture energy and many nutrients that support metabolism and thus form the basis of the food chains in the sea. Phytoplankton is the food base for most aquatic food chains (Cazaux et al., 2010). Algae cultivation does not need arable or pasture land, fresh water or fossil fuels. Algae and seaweed produce food or fuel through sunlight, waste water or salt water and solar energy; they reproduce very quickly and their production is weather- and location-independent. Algae and seaweed are already being used to some extent for human consumption and as raw material in the food industry, and are considered by some insiders as the ‘new gold’ for the food industry. However, here too it is feared that consumers will be reluctant to embrace the new product. Campina markets its Valess meat substitute under the slogan ‘a nice piece of dairy’, thereby carefully drawing attention away from the alginate as the basic ingredient[5].

Slow food Slow food fits in with the broader trend towards slow living, a lifestyle that addresses downshifting, attention and meaning to compensate for the hectic daily routine in our post-industrial society. It goes beyond a hedonistic focus on relaxation. By consciously dealing with different temporal registers in our life, we create space to pay attention to 'the other', to the creative potential of daily life, to community building and new forms of political commitment (Parkins & Craig, 2006). Slow food embodies this ethic, with special attention being paid to the way in which we deal with food.

Slow food originated in Italy from a movement that aimed to protect the food products (and the artisanal knowledge needed to produce them) of local communities from the pressure of globalisation, industrial food production and urban exodus. Another central element is the experience of shared pleasure. Local chapters of the association are called 'convivia', highlighting the importance of shared table and hospitality. Slow food aims to convey a positive programme, based on the principles of tasty, pure and honest, against the standardisation of food products and habits. Today the movement has over 100 000 members in more than 150 countries[6]. In 1999, Città Slow was founded, an association of towns that seek to put into practice a philosophy of urban development that pays attention to authenticity in food and local craftsmanship, respect for tradition, and an animated cultural life. In Belgium, only four Walloon towns are members of the association. In Flanders, Velt and a few other environmental organisations have for some decades been spreading the idea of ecological food, aimed at reducing the ecological footprint of our eating habits.

The various items of the slow food programme are also conveyed on a broader scale, amongst others, by opinion leaders like Michael Pollan who defend 'real food' against the 'edible foodlike substances' that are produced by the global food industry with an ever-increasing energy use per calorie of food product, a greater dependence on fossil fuels, a steady decline in agrobiodiversity, and an ever-growing number of additives (Pollan, 2010). The slow food movement is at the complex intersection of various trends that are critical of today's society, such as criticism of the anonymisation of food production, of an economic model that is driven mainly by financial parameters, of the growing economisation of daily life (taylorisation), and of the erosion of the natural, cultural and social capital of local communities. For slow food, food is not an anonymous product but a vital impulse for meaning. The cooking hype that has relentlessly dominated the local and international media for the past five years[7] may well reflect this seemingly unquenchable thirst of today's citizen-consumer for new sources of meaning, and for new micropolitical tools to come to terms with the complexity of our modern society.

Customisable food Twentieth-century food science focused mainly on the identification of ingredients (vitamins, minerals) that could be used to reduce the consequences of malnutrition. Over the last decades, however, public health has increasingly been threatened by factors related to overconsumption and changed lifestyles. Obesity is now a generally recognised policy issue in the developed world (Foresight, 2007). However, in other parts of the world too, changes in diets and lifestyles have given rise to similar phenomena[8]. Obesity is associated with an increased incidence of diabetes and cardiovascular diseases.

Food science is now trying to find an answer to the question of how food can contribute to homeostasis (balance) at the cell, tissue, organ, and whole body level. To this end, the action of nutrients at the molecular level needs to be studied. This involves a multitude of interactions at the gene, protein, and whole metabolism level. As a result, food science has evolved from epidemiology and physiology to molecular biology and genetics. That science is now referred to as nutrigenomics[9].

The complete mapping of the human genome in 2000 raised the hope that it would soon be possible to adapt the diet to an individual's genetic profile with a view to optimising the interaction between food and body, both preventively and curatively. This goal is still some way off and a large-scale, commercial application is not yet within reach.

In the absence of these new technologies, the food industry is looking for ways to develop products that nevertheless address specific, health-related needs of certain target groups such as diabetes patients, people with an increased risk of cardiovascular disease, elderly people, etc.

Consumers are nevertheless coming under rapidly increasing pressure to change their behaviour and live healthier lives. Both governments and businesses find it necessary to quickly find solutions to control the ever-increasing expenditure on social security and health insurance. Moreover, growing competition in global markets is compelling businesses to deploy their 'human capital' as effectively as possible. They attempt to encourage behaviour change by a mix of regulations, incentives and unconscious influencing. Many (large) companies have thus in recent years integrated the promotion of a healthy lifestyle (food and exercise) into their human resource policies. This is made possible by the miniaturisation and wide dissemination of technology allowing the continuous monitoring of physiological parameters (blood pressure, heart rate, sleep) and exercise patterns. There is a growing number of service providers on the market that assist companies in making their personnel healthier through a combination of technology, peer support platforms and clinical expertise relating to the impact of diet and exercise on health. Today, users are still required to do a fair amount of diet monitoring themselves, but this is also expected to improve in the future. In exchange, they receive personalised diet advice and behaviour feedback.

An overview of the potential added value and socio-economic opportunities provided by the niche regime 'eating differently' within the different value-creation models is given below:

Market economy

- Reduction of animal proteins as an opportunity for differentiation from other (forms of) agricultural and food production (marine, micro livestock, in-vitro meat).
- Meat substitutes as a new niche and opportunity for differentiation.
- Customisable food as a tool to enhance the productivity of employees and public health in general.
- Customisable food as an opportunity for producers and distributors to differentiate themselves in the market.

Solidarity economy

- Slow living/slow food as an appeal to the creative potential of daily life, community building and new forms of political commitment.
- Alternative sources of animal proteins (notably insects) and local production of biofuels can improve living conditions for the rural population in developing countries.
- Emphasis on taking responsibility for the consumer's health as a form of self-sufficient lifestyle.

Ecological economy

- Switching to a diet containing fewer/different animal proteins can make a very substantial contribution to ecological sustainability on a global level.
- Slow living/slow food as re-evaluation of a differentiated experience of time, social relationships and self-sufficiency as fundamental requirements for a 'good' life.

Local development

- Slow food as a programme to protect food products (and the artisanal knowledge needed to produce them) of local communities from the pressure of globalisation.
- Slow food as a programme for making consumers more critical by enhancing their taste and assessment skills.
- Local generation of bio-energy (electricity, heat) based on waste streams increases self-sufficiency.

5.4 Niche regime 4 New production paradigms

5

Agriculture and food are to some extent 'manufacturing industries' that convert rough materials into finished, consumable products. On the one hand, this production aspect is partly embedded in an industrial production paradigm where standardisation, efficiency and economies of scale are the guiding principles. On the other hand, there is also an artisanal dimension, especially when the human factor in the production process is emphasised. Developments in the field of industrial or artisanal production may therefore be very important for the future of agriculture. Here, we distinguish four niches that could alter the appearance of the agro-food system:

- Industrial ecology
- Bio-based economy
- Factory of the future
- Peer-to-peer production

Industrial ecology The concept of industrial ecology was first introduced in 1989, in an article by Robert Frosch and Nicholas Gallopoulous in the Scientific American (Frosch & Gallopoulos, 1989). The authors asked themselves whether it would not be possible for an industrial system to behave like an ecosystem, where the outputs or by-products of one part serve as input for another part, thereby saving energy and materials and reducing pollution. A well-known example is the Kalundborg eco-industrial park in Denmark, which has since the 1960s been gradually evolving into an integrated system. The project involves five partners: a power station, a refinery, wallboard manufacturer Gyproc, pharmaceutical and enzyme manufacturer Novo Nordisk, and the city of Kalundborg (Figure 14).

At the basis of the industrial-ecological approach lies the notion of 'metabolism'. In a biological context, this notion refers to internal metabolism processes. In the same way, an industrial metabolism is seen as the integrated collection of physical processes that convert raw materials and energy into finished products and waste. In a market economy, the system is maintained in equilibrium by a price mechanism controlled dynamic of supply and demand for products and labour. An industrial metabolism can be described on different spatial scales: from individual businesses over business parks to regions (Ayres & Simonis, 1994). A second central idea in industrial ecology is that of closed loops. A loop can be defined as a number of interrelated water, energy or material flows. When closing loops, waste streams are (re)used as input. Industrial ecology can be described as the preservation of specialised units – and therefore of the logic of specialisation and fragmentation – that are connected to each other, so that loops can be closed.

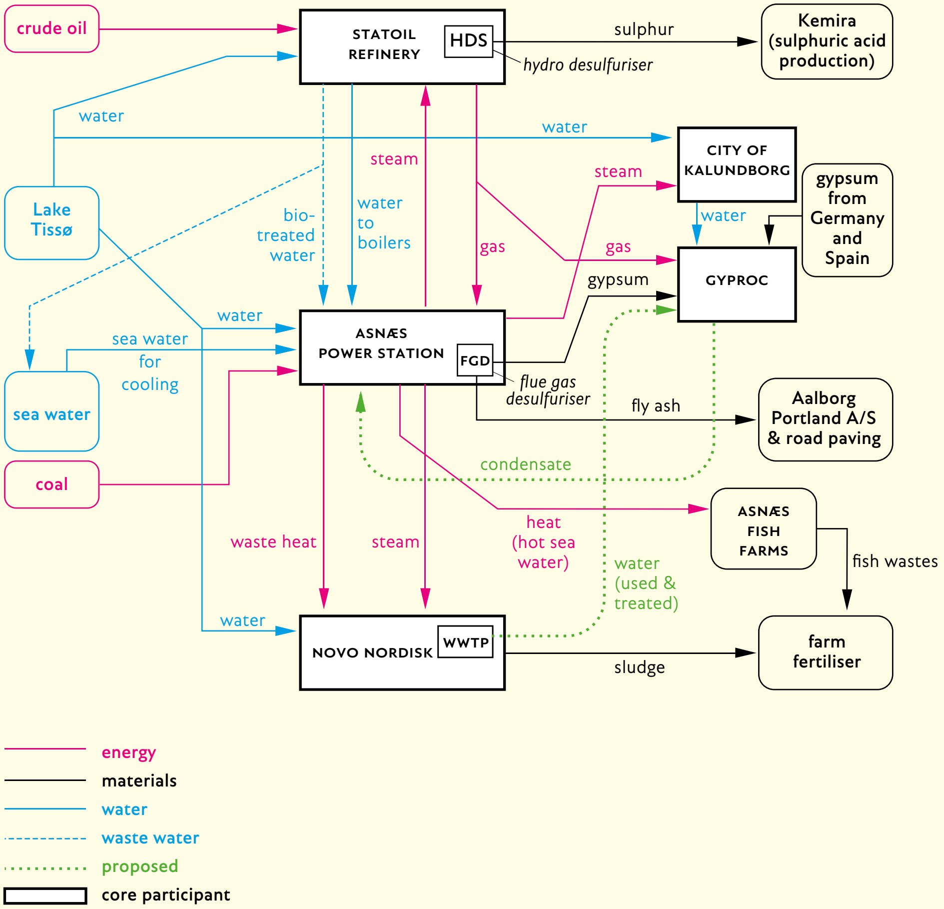
In the course of the last decade, the Cradle-to-Cradle™ (C2C) approach has strongly come to the fore. Propagated by chemist Michael Braungart and architect William McDonough, the ultimate goal of this method is to achieve closed loops (McDonough & Braungart, 2002). The method is strongly related to industrial ecology. Instead of a linear model that makes, takes and pollutes, a system is proposed that generates safe and healthy products and where materials continuously circulate in closed loops. One difference from the approach of industrial ecology is the level of ambition: C2C implies a transition from eco-efficiency to eco-effectiveness: it endeavours to maximise the positive impact of industrial production on man and its environment (Stouthuysen & Leroy, 2010). The purpose is therefore not only to reduce environmental impact, but also to create a positive ecological dividend. The three principles at the basis of the C2C approach are:

- waste equals food: everything is a nutrient for something else. Materials continuously circulate in closed loops: biological loops for natural materials and technical loops for synthetic materials.
- use of the available solar income provides for maximum use of renewable energy sources.
- banking on biological and cultural diversity to enhance the resilience of socio-technical systems.

Industrial-ecological thinking is also beginning to appear in agriculture. In Flanders, Agrocycle was recently founded as a consultation and study platform for mapping and evaluating the potential of closed-loop biomass and energy systems for sustainable agriculture and horticulture[10]. In the Netherlands, work is in progress on the Powerfarms concept, which aims to convert manure as a waste stream from livestock farming into useful products (Figure 15). It works as follows: the manure is refined at a Powerfarm, using a variety of techniques. In this way, methane (CH_4), carbon dioxide (CO_2) and various mineral fractions (N, P, K) are produced from the manure. The CH_4 from the digester is then converted into electricity and heat in a cogeneration plant. The CO_2 and NO_x in the flue gases of the gas engine are nutrients for algae cultivation, as are the mineral fractions recovered from the manure (InnovatieNetwerk, 2008).

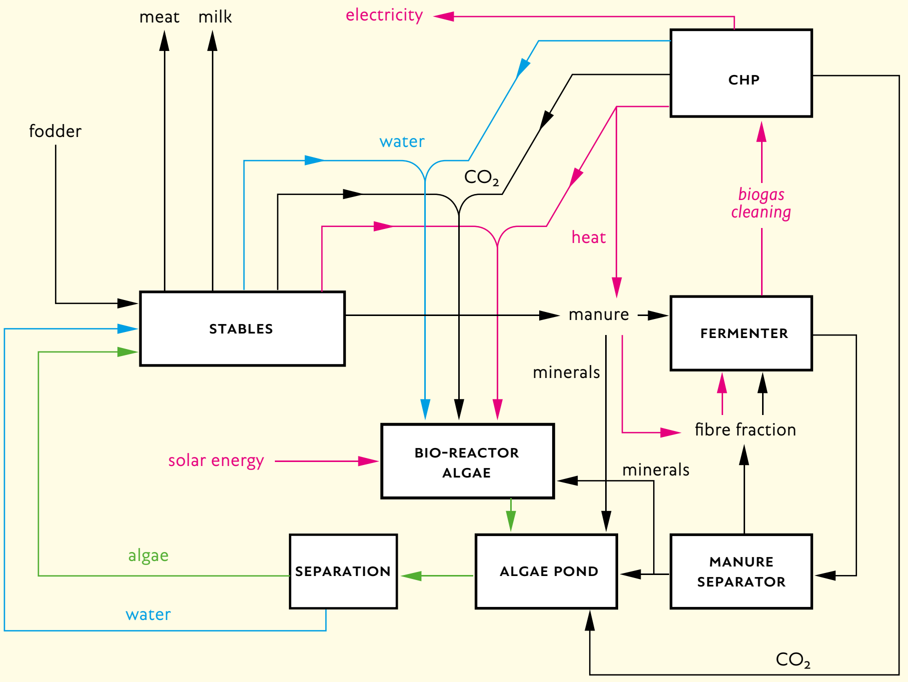
Bio-based economy A bio-based economy is an economy where the basic building blocks for materials, chemicals and energy originate from renewable raw materials (biomass) instead of fossil (non-renewable) raw materials such as petroleum or derivatives. Making our society less dependent on fossil fuels is in fact the main driver for the development of a bio-based economy. It should enable us to reduce greenhouse gas emissions and to become less dependent on politically unstable oil-producing countries. A bio-based economy can also create economic opportunities for rural areas in developed and developing countries (Langeveld et al., 2010). Within the bio-based economy, two main sub-sectors can be distinguished: energy and products. Bio-based energy covers both the generation of steam from biomass through digestion or another process, and the production of biofuels. Bio-based

Figure 14: Kalundborg eco-industrial park, Denmark (1995)



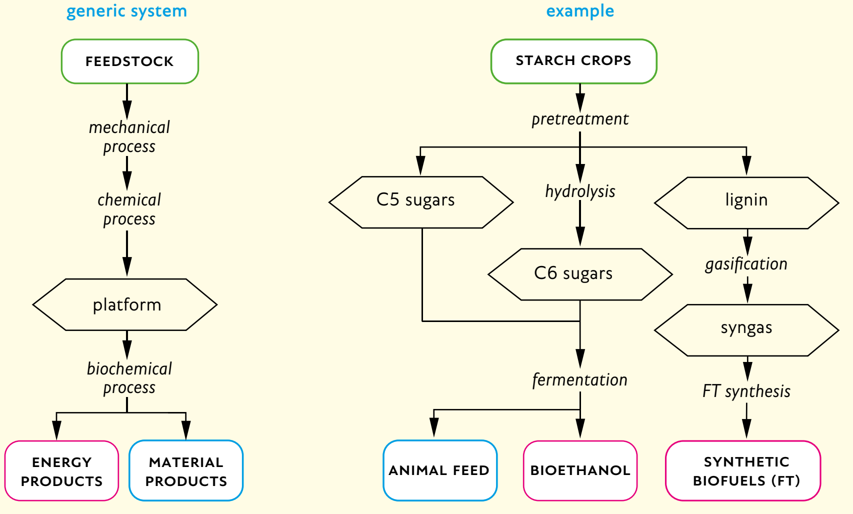
Source: D.B. Holmes, based on various sources, including L.K. Evans, N. Gertler & V. Christensen

Figure 15: Schematic diagram of the processes in Powerfarms, the Netherlands



Source: InnovatieNetwerk (2008)

Figure 16: Generic concept of a biorefinery (left) and a concrete example of its application (right)



Source: Jungmeier & Cherubini (2009)

products are subdivided into materials and chemicals.

The large-scale introduction of a bio-based economy is controversial because it would require large quantities of biomass which could adversely affect the availability and prices of food. One example is the controversy over the contribution of biofuels to the 2008 food crisis. There could also be potentially harmful environmental effects in the areas of biodiversity, soil fertility and water quality.

Advocates of a bio-based economy refer to the biorefinery technology which should ensure that biomass can be converted into a variety of products in a highly efficient and sustainable manner. The biorefinery concept refers to a heterogeneous collection of mechanical, thermochemical and biochemical technologies that enable the conversion of biomass. They can be fed with various raw materials from agriculture and forestry, aquaculture and from industrial or private waste streams (de Jong et al., 2010). Figure 16 shows an example of a generic biorefinery system and an example of conversion of starch crops to biofuels and animal feed additives.

Although the biorefinery concept is not new (the whole food industry in fact revolves around specific forms of biorefinery), quite a number of advanced concepts are still on the drawing board. It is expected that a further series of new technologies, notably for the processing of cellulose-containing raw materials, will move out of the pilot stage in the coming decade. Cellulose-containing raw materials are important in that they represent a potentially abundantly available input, and they are moreover less competitive with food crops. Another promising route is the development of marine biorefineries based on algae that can produce both energy and materials (de Jong et al., 2010). Finally, a trend towards so-called 'multi-platform' production units that can operate on a variety of inputs and process either energy or materials as a function of demand (Jungmeier & Cherubini, 2009) is to be expected.

The bio-based economy still holds a significant development potential. General EU figures show that 8 % of the chemical sector is bio-based. According to Vandermeulen et al. (2010), 1.83 % (expressed in gross margin) of the Flemish economy is bio-based. Therefore, the share of the bio-based sector in the Flemish economy is expected to at least quadruple by 2030. Possible applications are to be found in the area of green power and of bio-based products in general. Today, the necessary raw materials are supplied mainly from abroad (specific plant seeds from France, sugar beets for the production of bioplastics from the rest of the world, maize for the production of bioisoprene tyres from France or Germany). Due to economies of scale, certain biomass materials can be produced more cheaply abroad. It is nevertheless expected that there are hitherto unused possibilities in Flanders for the production of niche products such as special raw materials or high-quality raw materials for processing in the chemical or pharmaceutical sector (Vandermeulen et al., 2010).

Factory of the future

(Zahn & Dillerup, 1994; Fraunhofer IOSB, 2011)
The so-called 'factory of the future' denotes a movement that wants to offer a new future to the manufacturing industries in post-industrial economies. This includes all industrial branches that process materials into new products. The manufacturing industry therefore comprises a wide variety of industrial branches such as the automotive industry, chemicals, the food industry, the plastics industry, the clothing sector, shipbuilding, the electronics industry, the metal processing industry and the graphics industry.

In the course of the past decades, advanced economies have increasingly focused on services and knowledge. However, they often have a significant production and knowledge base in traditional manufacturing industries, but the importance of these sectors has declined due to international competition. Entrepreneurs and policymakers nevertheless feel it is important to continue to support local manufacturing industries. Those sectors remain in fact important centres of innovation, they create jobs for (sometimes) lower skilled personnel, contribute to a more balanced and less vulnerable economy, and will probably play a key role in the transition to a low-carbon society. The context in which these industries must function has, however, thoroughly changed in the course of the past decades under the influence of global competition, technological advances, changing consumer preferences and the growing importance of sustainability.

The transition to the 'factory of the future' requires a comprehensive transformation in which strategic, commercial, technological and social factors will all play a role. Only a few of the eye-catching elements of this transformation are mentioned below:

- New production and organisation techniques need to be developed to be able to deal with a volatile demand in a cost-efficient and quality-oriented manner. The automation of small series and the shortening of the lead time by techniques such as Quick Response Manufacturing (QRM) are central in this approach. In the so-called 'digital factory', product and process design is fully digital and there is no more need for expensive physical prototypes. Moreover, it will be possible to estimate in advance the impact of various possible decisions via advanced simulations. The time to market can thus be significantly shortened. Continuing digitalisation will require massive leaps in the integration of information flows into a production environment[11]. The digital factory is also a 'networked' factory because production is worldwide and complex, and calls for new solutions in the management of material and information flows.
- Human-centred production: the development of advanced production environments also implies a special role for the human factor. New solutions need to be found for the way in which people work in teams, deal with information and uncertainty, and interact with increasingly sophisticated robots in so-called hybrid production systems (at present humans and robots are largely kept separate to avoid accidents).

Peer-to-peer production The above-described new production paradigms imply a certain scale and capital intensity. However, the very small-scale and artisanal manufacturing industry also appears to be on the threshold of a paradigm shift. The reason for this is to be found in the convergence of different developments: new production techniques, new distribution channels, but also a renewed social interest in the activity of 'making things'.

Many artisans have only limited experience with the marketing of their creations. They mostly work alone and lack the expertise to make their business grow. With the advent of the internet and social media, however, they now have new ways to market their products. Designers and artisans can sell their work not only via their own website, but also via online platforms such as Etsy.com and Folksy.com.

What is also special is that these selling platforms can be integrated into a production infrastructure, in particular in the case of 3D printing. This is a relatively new technique, originally designed for rapid prototyping, to print objects in three dimensions. In reality, they are built up layer by layer by a specially developed machine, using powder base materials such as polyurethanes, epoxy resins and plastics. In principle, vegetable materials or derivates such as chocolate or sugar can also be used as input.

Related to the above technique is the emergence of the so-called fab labs. They are based on an idea by Neil Gershenfeld, a professor at the Massachusetts Institute of Technology (MIT), to create a machine that can make anything that springs from the human imagination (the personal fabricator). Today fab labs take the form of a tool shop (with milling machines, laser cutters, 3D scanners and printers) where designers and other creators, notably from the social economy, can make prototypes.

Another development that may open up interesting opportunities for small-scale production is the phenomenon of so-called crowdfunding. A crowdfunding platform enables all kinds of creative individuals to introduce their planned project to a wide audience via the Internet. Kickstarter.com and Rockethub.com are examples of crowdfunding platforms.

These new developments in financing, production and marketing create new possibilities for very small-scale producers. Creative manufacturers cannot only market their products more effectively, they can also develop totally new product categories, and, where appropriate, integrate them into their services.

The importance of these developments should be seen against the backdrop of a number of broader social and economic trends, namely the spread of green innovation, the emergence of productive networks aimed at social innovation and open source practices, and the democratisation and spread of creative possibilities. This results in new paradigms of value creation that are aimed at the emancipation of producers and consumers, the sharing of intellectual property, the creation of social capital and of more environmentally friendly products and services. It is a movement that is driven mainly by small-scale initiatives of entrepreneurs and local communities, as opposed to the traditional, highly institutionalised and compartmentalised social profit sectors (Mulgan, 2007).

An overview of the potential added value and socio-economic opportunities provided by new production paradigms within the different value-creation models is given below:

Market economy
- Savings in energy and materials within a concept of industrial ecology means a significant cost saving.
- The bio-based economy can create new opportunities for biomass producers.
- The operationalisation of the 'factory of the future' can create new opportunities for manufacturing industries in a globalised knowledge economy.

Solidarity economy
- Peer-to-peer production creates economic possibilities based on reciprocality.
- Low-barrier 'manufacturing' technologies can play a role in the emancipation of citizens in society.
- Industrial ecology and Cradle-to-Cradle in particular force companies to form partnerships to exchange flows and knowledge in the operationalisation of new production concepts.
- Grassroots-driven social innovation can address the needs of socially vulnerable groups.

Ecological economy
- Closing of loops and recycling (industrial ecology, biorefinery, 'factory of the future') allow for significant savings in materials and energy flows.

Local development
- Local generation of bio-energy (electricity, heat) based on waste streams increases self-sufficiency.
- Industrial ecology reduces waste of local resources (water, energy, nutrients).
- New possibilities for artisans, designers and other creative small-scale businesses in the areas of marketing, production and financing strengthens the local economic fabric.
- A Small-Local-Open-Connected scenario enables communities to combine local rooting with a global network.

5.5 Relationship between niche regimes and hotspots

In the preceding chapters we have verified the relevance of four niche regimes for the agricultural and food regime against four different value-creation models. From this it appeared that the niche regimes – each of which includes a variety of technologies, organisation concepts, behaviour patterns and values – can be framed in very different ways from the regime. This confirms that it is, in general, very difficult to determine whether a given niche or niche regime has a competitive or synergetic relationship with the regime.

The way in which the different niche regimes can provide an answer to the previously described hotspots (Table 3) is outlined in the following paragraphs.

Hotspot 1 Sufficient, safe and healthy food is produced, but still there are food-related health problems

The niche regimes interact with this hotspot in various ways. A very direct link can be made between the niche 'customisable food' ('eating differently') and the observation that unhealthy diets threaten public health. The trend towards customisable food is, in fact, driven primarily by health considerations.

Other aspects of 'eating differently' are also directly relevant to this hotspot. Reduced meat consumption and the use of other protein sources, for example, will benefit health, because of the strong correlation between excessive consumption of animal products and the incidence of cardiovascular diseases. As for slow food, it addresses the broader health dimension associated with food production and consumption. The emphasis on conviviality, naturalness and purity, the association between consumer and product/producer, and conscious enjoyment meets the need for spiritual well-being and meaning of modern man.

Other niche regimes also influence this hotspot. Organic agriculture, for example, supplies products with fewer pesticide residues. Through the local production of fresh and affordable products, urban agriculture can also significantly contribute to a more balanced diet, particularly among vulnerable groups in an urban environment.

Hotspot 2 Sufficient tailor-made food, but at the same time much loss of food, high demand for raw materials and significant environmental impacts

This hotspot relates to an overshoot in consumer requirements that requires a top-heavy production apparatus, which leads to waste. A number of niches or niche regimes can affect this hotspot, in particular those that are able to exert a moderating influence on consumer requirements through social pressure and better knowledge of and respect for production conditions. In this respect, urban agriculture (through short chains and a greater sense of community), slow food (with emphasis on conviviality and respect for regional production), social innovation (innovate to meet actual needs) and peer-to-peer production (which also involves the building of social capital) can provide a counterweight.

Hotspot 3 Non-food applications are an opportunity but also put pressure on the available resources

Non-food applications feature prominently in the bio-based economy, where agricultural raw materials and waste streams from the food industry are used for high added-value applications for the energy sector and the pharmaceutical and chemical industries. Industrial ecology, and the Cradle-to-Cradle philosophy in particular, also interacts strongly with this hotspot.

Hotspot 4 Specialisation for the benefit of efficiency but at the expense of system operation

This hotspot marks the loss of cohesion with the system as a result of excessive specialisation with numerous and/or relatively loose segments in the chain(s). This loss of cohesion occurs at different levels: between companies in the chain, between consumer and producer, and between producer/consumer and ecosystem.

A niche that explicitly addresses this loss of cohesion between the consumer and the origin of his food (producer and producing ecosystem) is slow food ('eating differently'). This niche has specifically formulated its programme in response to the anonymisation of food production/consumption and the erosion of the natural, cultural and social capital of local communities.

Urban agriculture, too, can play a prominent role in connecting producer and consumer, since peri- and intra-urban agriculture automatically reduces the physical distance between both (short-chain concept). The small scale (at least in Flanders) and the attention to cohesion with the human-nature system of organic farming in principle also leads to a stronger cohesion between producer and consumer. This aspect is, however, compromised to some degree by the growth and conventionalisation of organic agriculture (resulting both in an increased production scale and an increased geographical size of the supply chains). Within the niche regime of new production paradigms, reference can be made to peer-to-peer production, which provides quite a number of leverage points with the subject of cohesion between producer and consumer. New marketing and financing strategies also enable small-scale producers to directly contact potential customers. Moreover, within a peer-to-peer productive community it is not so much financial as reputational and social capital that is valorised.

A number of niches also specifically create more cohesion between companies in the chain. Thus, the short-chain concept discussed within the niche regime 'urban agriculture' is a direct answer to the fragmentation and specialisation within the food chain. The agro-park conceived by the Dutch Innovatienetwerk as a spatial clustering and metabolic integration of supply, production and processing units, takes this principle to an extreme. Within the niche regime 'new production paradigms', it appears that industrial ecology, and the Cradle-to-Cradle philosophy in particular, automatically leads to increased contact and integration between different companies (yet not necessarily within the same chain) as both knowledge and material and energy flows need to be exchanged. The 'factory of the future' mainly revolves around a sophisticated information management. We have seen that this factory is also a networked factory that continuously exchanges information and goods flows with other segments in the chain.

From the foregoing it appears that both the need for a more economical use of natural resources and the desire to provide protection against volatility and uncertainty can lead to integration and exchange between segments within the food chain.

Hotspot 5 Input of natural resources increases production but these resources are becoming increasingly scarce

Industrial ecology (niche regime 'new production paradigms') seeks to provide an answer to the scarcity of natural resources. The same applies for the bio-based economy, which focuses in particular on reducing our dependence on fossil fuels.

Production and consumption concepts such as slow food (niche regime 'eating differently') and transition towns (niche regime 'urban agriculture') that focus heavily on local self-sufficiency simultaneously imply an economic dividend through shorter transport distances, economical use of local resources, and closed loops. Also, the switch to a diet that is less rich in animal products (niche regime 'eating differently') reduces the pressure on natural resources.

Hotspot 6 The environment absorbs emissions, but if the carrying capacity is exceeded, the quality of the necessary resources may be jeopardised

Many elements in the niche regimes discussed attempt to provide solutions to specifically environment-related bottlenecks that are associated with the current regime. Urban agriculture, for example, reduces transport distances and also contributes to the quality of the urban environment. Organic agriculture, with its attention to the health of soil, humans, plants and animals and respect for natural cycles, is specifically viewed as a way to control excesses of industrial agriculture. Also, the trend towards a diet with fewer animal proteins (niche regime 'eating differently') is driven by, among other things, the desire to reduce the significant environmental cost of meat production. Industrial ecology (niche regime 'new production paradigms') is conceived as an approach to achieving more environmentally efficient production. The bio-based economy is controversial because it can lead to undesired environmental effects, but new biorefinery technologies can play a role within an industrial-ecological approach. Also the 'factory of the future' focuses on more efficient use of natural resources.

Hotspot 7 The agro-food system builds on social capital but at the same time threatens to lose it

The social dimension is strongly reflected in the niche regime 'urban agriculture', where the emphasis is on contact between producer and consumer, but also on sense of community, self-sufficiency and cooperative structures. The latter aspects are also addressed in a number of new production paradigms that focus on low-barrier manufacturing technologies, bring about social innovations and where partnerships are needed to enable industrial-ecological applications.

The niche regime 'eating differently' takes a different approach to the social dimension in that it appeals to the consumer's sense of responsibility (landscape development 7). Moreover, certain negative social and ecological impacts in the Southern hemisphere can be mitigated.

Hotspot 8 (Technological) innovation optimises the current system but does not as yet design any innovative system configurations

Here, reference is made to the elements discussed in the context of hotspot 4 (fragmentation and specialisation within the chain). This discussion revealed that several niche regimes (urban agriculture, new production paradigms) increasingly give rise to the search for integrated solutions in an effort to increase the resilience of the chain. Such solutions in principle address three main elements: the integration of metabolic flows (water/energy), the exchange and coordination of information flows (the networked factory), and the building of confidence and social capital within the chain (peer-to-peer production).

Hotspot 9 An open system offers many advantages but also leads to shifting of the social and ecological impacts

We have previously seen that quite a number of niches focus on the saving of natural resources and the reduction of emissions. Some niches explicitly seek to reduce their dependence on globally supplied inputs for the benefit of locally produced inputs. This applies in particular to certain forms of urban agriculture, organic agriculture, and slow food. New production paradigms also focus on this aspect, mainly by closing loops (e.g. industrial ecology).

Table 3: **Relationship between niche regimes and hotspots**

Hotspot	Niche regime:
1 Sufficient, safe and healthy food is produced, but still there are food-related health problems	
2 Sufficient tailor-made food, but at the same time much loss of food, high demand for raw materials and significant environmental impacts	
3 Non-food applications are an opportunity but also put pressure on the available resources	
4 Specialisation for the benefit of efficiency but at the expense of system operation	
5 Input of natural resources increases production but these resources are becoming increasingly scarce	
6 The environment absorbs emissions, but if the carrying capacity is exceeded, the quality of the necessary resources may be jeopardised	
7 The agro-food system builds on social capital but at the same time threatens to lose it	
8 (Technological) innovation optimises the current system but does not as yet design any innovative system configurations	

Urban agriculture	Organic agriculture	Eating differently	New production paradigms
• Fresh, affordable food for vulnerable groups in cities	• 'Natural' products with no residues	• Customisable food • Low meat diet • Slow food: promote identity, mental well-being	
• Short chains • Community building as damping effect on unbridled consumer requirements	• Traditionally more attention to origin than to outward appearance of products	• Slow food: respect for regional production	• Social innovation: actual needs as basis for production • Peer-to-peer production to promote social capital building
• Options for diversification of peri-urban agriculture			• Bio-based economy: use of agricultural products for pharmaceuticals, chemicals, etc. • Industrial ecology/ Cradle-to-Cradle
• Short chains: local distribution and consumption • Reskilling of consumers, community building around food production	• Small-scale (but jeopardised to some degree by upscaling and conventionalisation)	• Slow food as answer to anonymisation of production and consumption, and to erosion of cultural and natural capital	• Peer-to-peer production: new production and financing mechanisms based on direct contact, added value creation based on social and reputational capital • Industrial ecology/ C2C as basis for integration and exchange • 'Factory of the future' as networked factory
• Intensive production units with minimal spatial footprint, agro-parks • Closing of loops • Reduction of transport distances	• Closed loops, avoidance of exogenous inputs • Transition towns: self-sufficiency, economical use of local resources	• Low meat diet as diet with lower input of resources	• Industrial ecology as answer to scarcity of natural resources • Bio-based economy as answer to scarcity of fossil fuels • 'Factory of the future': energy and material efficient
• Reduction of transport distances • Improved quality of urban environment	• Avoidance of externalities through respect for and closing of natural loops	• Low meat diet as diet with fewer environmental impacts	• Industrial ecology, biorefinery as ways of avoiding externalities
• Short chains local distribution and consumption • Self-sufficiency • Cooperation	• Human-nature relationship	• Consumer's sense of responsibility • Lower impact on Southern hemisphere	• Cooperation for industrial ecology • Social innovation • Low-barrier manufacturing industries
• Intensive production units with minimal spatial footprint, agro-parks • Functional broadening of agriculture, ecosystem services	• Attention to cohesion human-nature system	• Increasing resilience through social capital (slow food)	• Increasing resilience through exchange of energy and material flows (industrial ecology) and integrated information management ('factory of the future') • Peer-to-peer: increasing resilience through social capital

6 Conclusions and policy recommendations

This report is the description of a first 'experiment' in system analysis, in a Flemish context and within the specific framework of transitions for sustainable development. In this final section of the report, we give a number of conclusions and recommendations for the various actors in the Flemish field of agriculture and food in general and policy in particular.

6

6.1 Contents

The diagnostic character of a system analysis is common to both the 'hard' and the 'soft' approach. A system analysis should contribute at least to the understanding of the 'how' and 'why' of a problematic situation. At the same time, it also provides a basis for intervention with a view to improving the situation. Knowing that there is no such thing as a recipe or manual for system analysis, we can conclude that the combination of hard (figure-based) and soft (conceptual, qualitative) elements as used here, constitutes a successful combination to build a story about how a (sub)system functions.

The multi-level perspective proved a rewarding framework that can be used to (1) describe the major pressures that act upon the system (landscape developments), (2) identify the tensions within the system (hotspots) and (3) describe seeds of change that contain answers to these tensions (niches). The different elements of landscape pressure that act upon the agro-food system also do so upon other (sub)systems of the current societal system. This also indicates that these pressures effectively reflect a very broad 'system crisis' that calls for drastic and genuinely systemic changes. Finally, the overall dominant logic is therefore one of 'how to deal with a growing world population and a growing world economy on a planet whose resources are exhaustible and whose absorption capacity is finite?'

The influence diagram used has an underlying story that starts from the final goal of the system: to satisfy basic needs of humans, today and in the future. Moreover, it also indicates the system logic that is being used to achieve these goals within the current regime: the economic system prevails and tries to remedy potentially inhibiting factors from the social and ecological context, mainly through technological innovation. More specifically, efforts are made to increasingly decouple the economic subsystem from the social and ecological subsystem, on the one hand by increasing resource efficiency, and on the other by improving labour efficiency.

A generic finding related to the focus on the agro-food system is that probably a great deal of the tensions arising in the system are precisely due to the partial lack or disappearance of useful links. An essential characteristic of systems is that they are more than the simple combination of their constituent elements. The operation and adaptation capacity of a properly functioning system precisely resides in the numerous and various links between the elements. They create the necessary channels for information flows, feedback and control loops, and supportive and restorative interactions.

In the chapter on niches we placed solution orientations that can provide alternatives for the currently dominant system configuration, not for the (known) partial solutions for specific (sub-)sectors, products or technological aspects. In that section we also stressed the value of these initiatives and their role in the initiation of a broader, scaled-up transition process. The necessary transition to a sustainable agro-food system need not be started up, it is already in progress and visible (to a limited extent) in existing initiatives.

The fact that we also included widely varying trends that at first sight are not agriculture- or food-related, shows that an attempt was made to consider 'sustainable agriculture and food' as 'agriculture and food in a sustainable society'.

In many cases, the tensions that were identified in the system are related to elements where interventions or changes initially led to a better functioning of (aspects of) the system, but which subsequently 'overshot the mark', thereby leading to undesired or counterproductive situations. That is also why we avoided a debate in terms of 'for/against' or 'positive/negative', but rather tried to present an 'on the one hand, on the other hand' story.

6.2 Method

Sustainable development calls for system innovation and therefore system thinking. Apart from the changes in the field that are actually required, such a shift in thought is already in itself a transition. This applies not only to highly compartmentalised policy, industrial and sectoral worlds, but equally to scientists and experts who traditionally function within a clearly delineated area, and are also assessed and held accountable for their achievements within that area. It is therefore not surprising that the process conducted was a continuously iterative learning process between the actors involved. The high level of learning that is required implies that this system analysis can be further deepened and broadened. Nevertheless, an innovative product was placed on the market in an innovative context.

This analysis only allows a number of policy recommendations to be formulated for the 'system analysis' activity:

- This systems analysis is not 'complete'. Just as the actual process, it is a first learning experience and work in progress. Transition management is in essence also an iterative process in which the various steps and elements mutually enhance, adapt and reinforce each other. A system analysis should therefore also be a continuous process.
- Create additional space for exercises and assignments within the framework of system thinking and system analysis. Traditional research assignments still fall within a highly compartmentalised landscape of delineated sectors and domains.
- Initiate and provide even more support (also more than in this system analysis) for inter- and trans-disciplinary system analysis processes that will boost acceptance, also during the elaboration of the analysis, through inherent co-creation with various stakeholders and experts.
- Continue to use this system analysis as a tool in a broader scenario for working on the design and realisation of new system settings.

We also hope this analysis of the agro-food system may be a source of inspiration, from both a process and content perspective, for similar initiatives in other sectors and domains. In this way, a society-wide and coherent story may unfold which can be used as a starting point for different sustainability scenarios to be unrolled in a cohesive and mutually reinforcing way.

6.3 Next steps

In Paredis et al. (2009) it was argued that traditional policy instruments are necessary but not sufficient to speed up transitions to more sustainable systems. Here we make use of the leads and working methods they proposed to shape transition governance in Flanders. For this, we use the approach of Hekkert et al. (2007), which holds that niches are in fact embryonic innovation systems where a number of functions need to be fulfilled to allow those niches to reach maturity (Table 4). An innovation system is the whole of actors and (formal and informal) institutions between which a network of relationships exists that influences the development, application and diffusion of innovations (Boschma et al., 2002). The literature distinguishes different types of innovation systems, including the national innovation system, where the boundary of a country is considered the boundary of the innovation system, the regional innovation system, where the focus is on regional clusters of companies, and the technological innovation system, which focuses on a specific technology (Hekkert & Ossebaard, 2010).

To obtain a properly functioning innovation system that increases the probability of innovation breakthrough, a number of key processes or functions need to be fulfilled. Hekkert et al. (2007) describe a set of seven functions for technological innovation systems (Table 4). Although this approach was developed for technological niches, it can also be applied for innovation systems in general (Paredis, 2009), e.g. for the innovation system around agriculture and food.

The implementation of these innovation system functions is a shared responsibility of a large number of actors such as entrepreneurs, knowledge institutions, government, etc. Paredis et al. (2009) note, however, that government can play an important role, not only as regards the implementation of functions through its own instruments, but also as regards the targeted investment in networks that are needed to implement the various functions. 'Investing' does not always mean the creation of new networks. Quite a number of agriculture- and food-related networks are already in place, ranging from sectoral networks (e.g. the Innovatiesteunpunt Boerenbond, which focuses mainly on environmental technology and business development; SIETINET, the Horticulture Technology and Innovation Network, which is mainly active in plant biotechnology, in-vitro technology, plant breeding and physiology; Flanders Food, the competence pool of the Flemish food industry, etc.) to networks of different actors (e.g. food teams where farmers and consumers interact with each other, etc.). As part of a long-term vision for a sustainable agro-food system, the government can, where appropriate, adjust and harmonise existing networks and also set up new networks.

The government can therefore play an important role in the development of a properly functioning innovation system around agriculture and food. A number of recommendations in this respect are given below:

- First, identify those niches that contribute more than other niches to the realisation of a sustainable agro-food system and therefore should receive special attention. Two actions are crucial for this. First, the general objective (i.e. the realisation of a sustainable agro-food system) must be translated into specific principles and goals ('steering the search process' function). Next, the potential sustainability gain of each niche must be investigated.
- Analyse to what extent the different innovation system functions are present and whether they are sufficiently developed. These functions can be further developed via two paths. First, a broad transition network for the agro-food system can play an important role in developing a number of functions that typically cannot be brought about by small niches (e.g. 'creation of legitimacy' and 'mobilisation of resources').

Existing networks are probably not broad enough in focus (e.g. Flanders Food) or in actor diversity (e.g. Platform Agriculture Research), but can make an important contribution to this greater network. Secondly, smaller networks can also be functional around a specific focus, provided the government plays a proactive role in strengthening the impact of these networks.

- Establish links with other innovation systems and networks that are more open to innovative niches and where some niches may therefore find it easier to overcome resistance and gain access to resources (e.g. DuWoBo (Sustainable Living and Building) where there may, for example, be an interest in food teams). To allow a critical mass to be achieved (e.g. in research capacity), it will probably be necessary to also establish links with innovation networks abroad. An excellent opportunity in this context is the European Innovation Partnership on Agricultural Productivity and Sustainability that is in the process of being founded.
- Last but not least, mobilise entrepreneurs and involve them in the development of the different functions. Here, too, existing networks in the different chains and sub-sectors can be used as starting point.

Table 4: Functions of technological innovation systems

System functions	Meaning
F1 Experimenting by entrepreneurs	Entrepreneurs are essential in an innovation system because they can convert the potential of new knowledge and insights into concrete actions.
F2 Knowledge development	Innovation begins with new knowledge, meaning that learning processes should be at the core of innovation processes.
F3 Knowledge diffusion in networks	Innovation also requires that all relevant actors exchange the necessary information, so that policy, research and development can be geared to each other.
F4 Steering the search process	Since resources are limited, a selection needs to be made taking into account societal norms, needs and preferences. The government plays a prominent role in developing the vision and objectives, but always in interaction with all relevant actors.
F5 Creation of markets	Because new technologies or practices often find it difficult to compete with existing ones, they need to be protected temporarily, e.g. through temporary tax incentives, minimum consumption quotas, etc. Eventually, however, they will only break through if they create sufficient economic value.
F6 Mobilisation of resources	To develop knowledge, resources need to be invested in financial and human capital.
F7 Creation of legitimacy, overcoming the resistance to change	A new technology or practice needs to be accepted by the regime or it needs to replace that regime. That is why catalysing coalitions need to be set up so as to enable niches to be put on the policy agenda, lobbying for resources, etc.

Source: based on Hekkert et al. (2007)

Both the creation of a transition network by analogy with Plan C (Sustainable Materials Management) and DuWoBo (Sustainable Living and Building) and the reinforcement of smaller networks seem to be appropriate means to fulfil the different functions in an inclusive manner. Both approaches can also complement each other. A broad network does not yet exist, but can certainly be set up based on existing networks that address sub-aspects of the innovation system around agriculture and food. The setting up of several of such broad networks for the agro-food system is probably not to be recommended, because of the unnecessary fragmentation of resources and above all because it would result in the loss of opportunities to generate new ideas and create synergies. Support from overarching initiatives such as Flanders in Action (ViA) and the Flemish Strategy for Sustainable Development (VSDO), and from the Policy Research Centre on Transitions for Sustainable Development (TRADO) can be an important catalyst for sharing good practices and establishing links between innovation networks.

notes

[1] http://thefarmery.com

[2] http://nl.wikipedia.org/wiki/Hitte-eilandeffect

[3] In 2008 renamed to International Center for Research in Organic Food Systems (ICROFS).

[4] http://www.ifoam.org/about_ifoam/principles/index.html

[5] http://www.valess.nl/

[6] http://www.slowfood.com/

[7] http://www.vilt.be/Culinaire_themas_overspoelen_televisielandschap

[8] http://www.fao.org/FOCUS/E/obesity/obes1.htm

[9] http://en.wikipedia.org/wiki/Nutrigenomics

[10] www.agrocycle.be

[11] http://www.sirris.be/newsItem.aspx?id=3972&LangType=2067

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The readers have critically reviewed the draft text of this report and given advice on its factual content. This role does not imply that the readers fully agree with the contents of the final text.

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Abbreviations

AMS	Division for Agricultural Policy Analysis of the Department of Agriculture and Fisheries
GDP	gross domestic product
BMI	body mass index
C2C	Cradle-to-Cradle
DARCOF	Danish Research Centre for Organic Farming
DuWoBo	sustainable living and building
EC-LNV	Expertise Centre Agriculture, Nature and Fisheries
EEA	European Environment Agency
EIL	Air Emissions Inventory (VMM)
EU	European Union
EVA	Ethical Vegetarian Alternative
FAO	Food and Agricultural Organisation of the United Nations
FEVIA	Food Industry Federation
FOD	Federal Government Service
GMO	genetically modified organism
IFOAM	International Federation of Organic Agriculture Movements
ILO	International Labour Organisation
ILVO	Institute for Agricultural and Fisheries Research
INBO	Research Institute for Nature and Forest
IPCC	Intergovernmental Panel on Climate Change
IWT	Agency for Innovation by Science and Technology
KU Leuven	Catholic University Leuven
LARA	Agriculture Report (Flanders)
LMN	agricultural monitoring network
MAP	Manure action plan
MIRA	Flanders Environment Report
MIT	Massachusetts Institute of Technology
MLP	Multi-Level Perspective
MOW	Department for Mobility and Public Works
NARA	Nature report (Flanders)
OECD	Organisation for Economic Cooperation and Development
PCB	polychlorobiphenyl
PJ	petajoule
POD	Federal public planning service
QRM	Quick Response Manufacturing
SIETINET	Horticulture technology and innovation network
SVR	Flemish Government Study Service
TRADO	Policy Research Centre on Transitions for Sustainable Development
UGent	University of Ghent
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VELT	Association for Ecological Living and Gardening
ViA	Flanders in Action
VIB	Flemish Institute for Biotechnology
VITO	Flemish Institute for Technological Research
VMM	Flemish Environment Agency
VSDO	Flemish Strategy for Sustainable Development
WBCSD	World Business Council for Sustainable Development
WCED	World Commission on Environment and Development
WEI	Water Exploitation Index
WL	Hydraulic Research Laboratory
WWF	World Wildlife Fund

Colophon

Transition to a sustainable agro-food system in Flanders: a system analysis

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Transition to a sustainable agro-food system in Flanders: a system analysis

Flanders, like many other regions, is facing major societal challenges: climate change, scarcity of fossil fuels and raw materials, limited availability of space, financial and economic crises, etc. Different policy initiatives such as Flanders in Action, Pact 2020 and the Flemish Strategy for Sustainable Development explicitly state that transitions towards sustainability are needed to tackle these challenges.

The agro-food system, like all societal systems, needs to address these sustainability challenges. In summary, the system faces the daunting task of feeding a growing world population with a production system that respects the carrying capacity of the earth and its people.

This report critically reviews the current organisation of our food production and consumption via a system analysis. This led to the identification of a number of hotspots in the system where frictions and problems have arisen due to various social developments or the operation of the system itself. The report is, however, more than a problem analysis: it also describes a series of innovations, bundled into four clusters: urban agriculture, organic agriculture, eating differently and new production paradigms. These innovations provide a source of inspiration for putting the agro-food system on the road to greater sustainability.

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