

SYSTEM BALANCE
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— **3** Food System

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INTRODUCTION

Food is a basic need and is also of great social and cultural significance. Food supply has therefore always been of strategic importance for societies. A sufficiently large autonomous food production, low food prices and a fair income for farmers were important objectives of the European Common Agricultural Policy (CAP) that was created after the Second World War. Under impulse of the CAP and the gradual liberalisation from the end of the twentieth century, the Western European and therefore also the Flemish food production and supply evolved into a large and complex system. An extensive, internationalised network, sometimes over long distances, of suppliers, farmers, food companies, carriers, merchants and catering actors guarantees, the whole year through, a wide and varied offer of affordable food, not only for local consumers but also for exports. Agriculture-related products accounted for around 10 % of total Belgian imports and exports in 2013. The Flemish share in Belgian agricultural trade is estimated at around 80 %, showing that also the Flemish agro-business complex is particularly open¹. A high degree of specialisation in the food chains allows labour, capital and expensive resources to be dealt with in an efficient manner. This allows to remain competitive in a global market of bulk products and also provides opportunities to reduce a number of environmental impacts per unit of output.

Not only agricultural policy and the economic actors within the food chains shape and maintain the food system, also the practices of other policy areas, consumers, credit providers, education, research, and interest groups all play an important role. Thus, the high expectations of consumers, such as a permanent wide offer at low prices, call for an extensive and cost-efficient production and distribution structure, whilst credit providers usually apply a financing model that induces investments, production increases and large-scale operations².

While the current food system is successful in terms of sufficient and affordable food supply, it is nevertheless reaching its limits. Food-related disorders such as obesity and cardiovascular diseases have increased significantly, land is becoming increasingly scarce, and the profitability of agricultural sectors is under pressure. There is also tension on the environmental level. The high consumption of animal products causes a great burden on the environment, also outside Flanders, and the intensive agriculture is highly dependent on external inputs such as fertilisers, water, imported animal feed, pesticides, veterinary medicines and fossil fuels. Also the other sectors in the food chain, such as food industry and retail, are greatly dependent on the use of, among other things, energy and water. And although the environmental impact per output unit of these sectors has considerably decreased in Flanders, the total environmental impact of agriculture remains high, especially at the local level, due to the high production volumes.

This chapter zooms in on two of the environmental challenges facing the Flemish food system, notably climate change due to greenhouse gas emissions, and eutrophication due to nitrogen losses. The chapter starts with a description of a number of major driving forces behind the environmental pressure from the food system. It then considers the greenhouse gas emissions and nitrogen losses on the consumption and production side, and concludes with three broad solution directions, which, in combination with each other, can provide inspiration for the transition to a more sustainable food system. While these solution directions are approached primarily from an environmental perspective, they can also address a number of other societal challenges facing the food system.

SOCIETAL DEVELOPMENTS AND ACTIVITIES

What does our consumption pattern look like?

———— Consumer enjoys a wide range of food products at low prices

Today's food system provides us with a wide and varied range of food products the whole year through. Consumers enjoy a high degree of purchasing comfort thanks to a vast network of points of sale, and low food prices. The share of food in the total family budget in Belgium fell from 50 % just after the Second World War to less than 15 % in 2014³. To this should be added the expenditure for eating out (5 % in 2014)⁴.

However, the current dominant model of food production has also numerous adverse effects on humans, animals, nature and environment, here and elsewhere in the world, and a significant portion of the damage and the costs is not reflected in the price of our food. Moreover, the numerous links in many food chains have increasingly alienated consumers from the production of their food. This reduces the feeling of co-responsibility towards farmers and the ecosystems in which the food is produced⁵.

———— Meat consumption is high

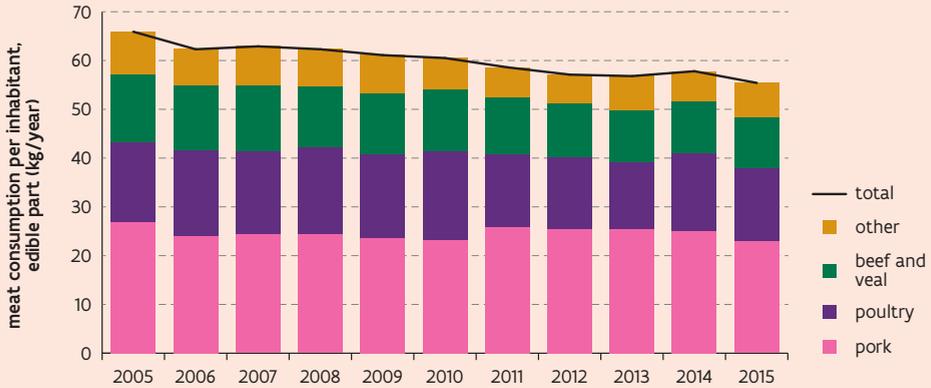
Increasing income and lower food prices have led to an increase in the consumption of animal products worldwide⁶. Although it is difficult to unambiguously compare the environmental impact of individual products, it is clear that the production of meat, dairy products and eggs leads to an increase in greenhouse gas emissions and nitrogen losses, and to higher land and water consumption as compared with vegetable products⁷.

In 2011, animal products accounted for about 60 % of the proteins in Belgian food⁸. The largest portion came from meat and milk (products) (each almost a quarter of the total protein intake). By comparison: the world average share of animal proteins in the total protein intake is 40 %⁸. According to the Food Consumption Survey, in 2014 the average Belgian citizen ate 145 g meat, fish, eggs and vegetable substitutes per day. According to the recommendations of the Flemish Institute for Health Promotion and Disease Prevention (VIGeZ), a daily intake of 100 g of these food products is sufficient to fulfil the protein need of the body (from the age of 12). Especially the meat consumption is too high: in 2014 the average Belgian citizen ate 111 g meat per day, whereas VIGeZ recommends to eat no more than 100 g of meat maximum four times a week. That amounts to an average of 57 g/day. 89 % of the population exceeded this recommended maximum quantity. The study concludes that Belgians do not yet make the best choices regarding food products that contain biologically high-quality proteins⁹.

———— ... but decreasing?

In the meantime, the consumption of animal products does appear to exhibit a downward trend. According to the supply balances of Statistics Belgium, meat consumption in Belgium decreased by 16 % between 2005 and 2015. This is a decrease by on average 1.1 kg per inhabitant per year (**Figure 3.1**). A significant decrease is recorded for beef in particular. Also the consumption of eggs decreased, whereas the consumption of milk products remained relatively stable. A decrease in meat consumption was, however, not observed in the Food Consumption Survey. This study, which is based on surveys instead of macroeconomic calculations, did not find any significant difference between the meat consumption in 2014 and that in 2004⁹.

Figure 3.1 Evolution of meat consumption (Belgium, 2005-2015)



Calculated based on production, imports and exports: extraction factors (kg meat per kg carcass weight) according to Global Footprint Network. National Footprint Accounts 2008 edition. The average daily meat consumption in 2014 (158 g/day) is higher than that reported in the Food Consumption Survey (111 g/day)⁹. This is not illogical because the Food Consumption Survey reports the quantities of meat as they are consumed, i.e. possibly prepared, and because the calculations of Statistics Belgium do not take into account losses in retail and in households. The Netherlands Environmental Assessment Agency estimates these losses at 20 %¹¹.

Source: Algemene Directie Statistiek - Statistics Belgium

Figure 3.2 Evolution of the livestock population by animal category (Flanders, 1990-2015)



* provisional figures

Source: MIRA based on Algemene Directie Statistiek - Statistics Belgium

A decrease in meat consumption appears, in any case, to be in line with the results of a survey held among 1,000 Flemish inhabitants, commissioned by EVA, a not-for-profit organisation. This survey shows that the number of Flemish consumers that occasionally choose not to eat meat or fish doubled in three years' time, from 5 % in 2013 to over 10 % in 2016. Around one in six of the Flemish population eats vegetarian at least three times a week. The main reasons why the respondents eat less meat are health, followed by concern about the environment and the climate, animal welfare, and the pleasure of discovering new tastes. Barriers are lack of interest, followed by fear of the taste and of the price tag¹².

What patterns are visible in agricultural production?

———— Trend towards increasingly fewer yet bigger Flemish farms continues

The early European Common Agriculture Policy enabled the modernisation and the increase in efficiency of the agricultural sector. As a result, agricultural products increasingly became bulk products. Through price support, farmers were assured of a fair income. At the end of the twentieth century, a liberalisation process was started and the price support policy phased out. Farmers more and more began to directly compete with each other on the world market. For bulk products, price is the most distinctive characteristic, which is why cost leadership – producing the same product as much as possible in the cheapest possible way – is the dominant strategy for competitiveness in the European, and also the Flemish, agricultural sector. This strategy leads to a continuous process of specialisation, upscaling and intensification, based on technology and high use of external inputs such as fertilisers, water, imported animal feed, pesticides, veterinary medicines and fossil fuels⁵.

The typical evolution towards fewer but bigger farms is also noticeable in Flanders. In 2015 there were almost three times fewer farms than in 1980, whereas the average size of farms almost tripled¹⁰. In the specialised animal husbandry sector, which in 2015 represented over half of the farms³, the average size of the livestock per farm increased considerably: in 2015 an average Flemish cattle and pig farm had 60 % and 80 % more animals respectively than in 2000¹⁰. The evolution of the total livestock population presents a more nuanced picture, with differences between animal categories. From 1990 to 2015, the number of cattle and pigs decreased by 23 % and 6.5 % respectively and the number of poultry by 24 % (**Figure 3.2**). In 2015, Flanders had around 1.3 million cattle, 6 million pigs and 32.1 million poultry. Explanations for the decrease in the livestock population between 1990 and 2008 are efficiency improvements (dairy cattle), unfavourable market trends (beef) and in general also the inhibitory effect of increasingly stringent manure legislation on the rearing of animals. The pig and poultry populations again increased from 2009, under impulse of the expansion facilities after proven manure processing provided for in the third Manure Action Plan (MAP3). After 2012, the pig population decreased again. From 2014 there is again an increase in the cattle population. The complete abolition of the milk quota effective from April 1 2015 and the high milk price at that time probably played a role in this.

The total agricultural area used in Flanders for the cultivation of agricultural crops, including horticultural crops and temporary fallow, has decreased slightly over the last 15 years (-4 % compared to 2000). There were shifts between crops over the years. Permanent grassland, for example, often had to make way for more profitable crops: between 1990 and 2015 the area of permanent grassland decreased by 14 % to the benefit of temporary grassland, maize and industrial crops. Approximately two-thirds of the Flemish agricultural area is reserved for livestock farming (grassland and arable farming for animal feed production).

Intensive farming is not equally efficient in all respects

In specialised intensive farming, costs are kept low by treating expensive production factors such as labour, land and animal feed, as efficiently as possible. This is reflected in high labour productivity and a high yield per hectare or per kilogram animal feed. This yield increase caused a decrease in the land use per unit of output. Also for greenhouse gases, for example, intensive agriculture produces lower emissions per unit of output. In developing countries, for example, the production of one kilogram of milk from grazing cattle causes greenhouse gas emissions of 2.7 kg CO₂-eq. For mixed systems in Europe, based on grassland and animal feed, this is only 1.7 kg CO₂-eq per kg of milk¹³. Despite the relatively high eco-efficiency for some parameters, the total environmental pressure from Flemish agriculture is considerable, certainly at the local level. This is due to the high production volumes in relation to the small surface area of Flanders, and to the nature of the production (much livestock production).

Moreover, the emphasis on increasing labour and land productivity may incite farmers to make excessive use of proportionately cheaper inputs such as fertilisers, pesticides and energy⁷ or subsidised resources such as machinery and stables. Also for impacts that are not sufficiently regulated and/or do not carry an explicit price tag, such as local biodiversity and animal welfare, farmers lack incentives to produce more effectively¹⁴.

Specialised and intensive production is also physically and economically vulnerable. Large numbers and densities of animals and crops, for example, result in greater disease susceptibility, promoting the use of veterinary medicines and pesticides. Economic factors include high vulnerability to volatile input prices, uncertain product prices on liberalised world markets, and the disappearance of large export markets due to geopolitical problems. This economic vulnerability is visible in the reduced and volatile margins of Flemish agriculture. Boerenbond calculated that direct costs of 100 euros generated a turnover of 146 euros in 2006. In 2016 this turnover was only 122 euros¹⁵.

Low margins provide less room for more sustainable production

Low margins are not only a threat to the viability of a farm, but also reduce the opportunities for farmers to invest in innovations that contribute to more sustainable operations. Margins depend on total costs and sales prices. Partly as a result of more stringent requirements with regard to public health, environment and animal welfare, and the rising prices of numerous inputs, agriculture is facing increasing costs. These costs can often not be simply passed on to the buyers in the food chain. A first major cause of this weak negotiation position of farmers is the fact that the system induces them to increase their production. In the dominant model, which is aimed at production at the lowest possible cost, farmers are under pressure to invest in the latest technologies and to use them to the maximum, resulting in an increasing production^{16, 17}. Even farmers who cannot keep up with the technological treadmill, try to continue with their (obsolete) production resources for as long as possible. As a result, the collective production exceeds what is strictly profitable. In combination with the low price elasticity of the demand for food, this leads to a downward pressure on prices.

In addition, market concentration in certain sectors of the food chain creates an unequal bargaining power, thus contributing to a downward pressure on prices that farmers receive for their products⁷. In Belgium, the food retail sector in particular is highly concentrated: three major players together hold a market share of almost 70 %¹⁸.

ENVIRONMENTAL DISRUPTIONS

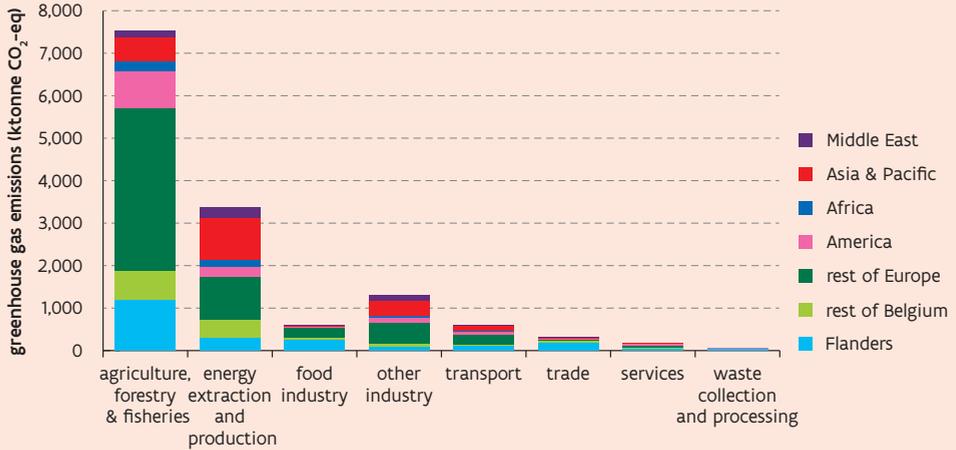
Greenhouse gas emissions

———— Carbon footprint of food consumption originates mainly outside of Flanders

The carbon footprint of Flemish households are the greenhouse gas emissions linked to the goods and services purchased by households. It takes into account not only the emissions that occur during the use of these products, but also the emissions that occur as a result of their production and distribution. The production and distribution of food products purchased by Flemish households, excluding food products in catering, in 2010 caused greenhouse gas emissions of 2.2 tonnes CO₂-eq per inhabitant (**Figure 3.3**) and thus accounts for about one-sixth of the total carbon footprint of Flemish households. By comparison: to limit the average global temperature rise to 2 °C, global greenhouse gas emissions would need to be reduced to an average of 2 tonnes CO₂-eq per capita per year by 2050. Over half of the greenhouse gas emissions linked to Flemish food consumption originate during the production of meat, dairy products and fish.

Today's regional policy objectives for greenhouse gas emissions address only emissions that originate within the territory of a country or region and therefore ignore any responsibility for emissions that are caused outside the territory as a result of consumption. These emissions are, however, significant: over two-thirds of the greenhouse gas emissions linked to the total Flemish consumption originate outside Flanders²⁰. For the production of food products consumed by households, this is 85 %, of which 9 % in Wallonia and Brussels, and 42 % in the rest of Europe (**Figure 3.3**). These consumption-related emissions outside Flanders are more than a third higher than the greenhouse gas emissions from agriculture and the food industry in Flanders itself (**Figure 3.5**). From a global perspective, the reduction in greenhouse gas emissions within the worldwide production chain of food products consumed in Flanders is therefore at least as important as a reduction in the territorial greenhouse gas emissions from the Flemish food production. This is a shared responsibility, the more so because the 'costs' in terms of greenhouse gas emissions and the 'benefits' in terms of gross domestic product (GDP) are not equally distributed: 41 % of the added value linked to Flemish food consumption is created in Flanders, and therefore contributes to the Flemish GDP (**Figure 3.4**), although only 15 % of the greenhouse gas emissions is generated here.

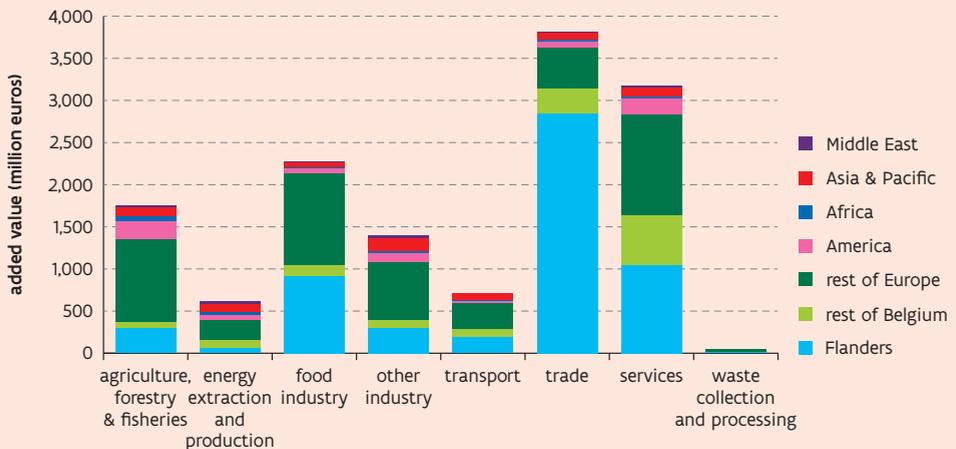
Figure 3.3 Greenhouse gas emissions caused by the production and distribution of food products purchased by Flemish households (carbon footprint of food), broken down by emitting sector and by geographical origin (2010)



Excluding emissions linked to storage and preparation of food at home, and excluding emissions linked to purchases in catering.

Source: Vercaulsteren et al. (2017) commissioned by MIRA²⁰

Figure 3.4 Added value created by the production and distribution of food products purchased by Flemish households, broken down by sector and by geographical origin (2010)



Source: Vercaulsteren et al. (2017) commissioned by MIRA²⁰

—— Agriculture and energy sector make largest contribution to carbon footprint of food consumption

More than half of the greenhouse gas emissions linked to the consumption of food products occurs in agriculture, forestry and fisheries, and one quarter during energy extraction and production (**Figure 3.3**). Three sub-sectors account for almost two-thirds of the emissions: animal husbandry (31 %), electricity production (17 %) and arable farming (16 %). More than three-quarters of animal husbandry emissions are generated within Europe. For electricity production this is almost two-thirds. In Flanders, the largest contributions are made by animal husbandry (6 %), electricity production and food industry (2 % each), and horticulture (1.4 %).

The distribution of the added value linked to the foodstuffs bought by Flemish households, yields a different picture (**Figure 3.4**). Two-thirds of this added value is created in trade, the services sector and the food industry, whereas the aggregate share of these sectors in greenhouse gas emissions is less than 10 %. In the Flemish chain, too, the largest added value is created in these sectors.

—— Emissions from biological processes are the biggest challenge for Flemish agriculture

Agriculture and food industry have a combined share of 11 % in total Flemish greenhouse gas emissions, or 8,224 ktonnes CO₂-eq in 2014, three-quarters of which originate from agriculture (**Figure 3.5**). More than two-thirds of these 8,224 ktonnes is linked to production for export²⁰.

Agriculture and food industry have very different emission profiles. Agriculture is an outsider compared to other sectors because biological, non-energy processes are the major source of greenhouse gas emissions. Not CO₂ (emissions due to the use of fossil fuels for heating, propulsion, use of tractors, etc.), but methane (CH₄) and nitrous oxide (N₂O) originating from digestion in ruminants (CH₄), production and storage of manure (CH₄ and N₂O) and soils (N₂O) are the major emissions here. Emissions from the food industry, by contrast, are purely of energy origin.

Already serious efforts have been made to reduce the greenhouse gas emissions from agriculture and the food industry. Between 1990 and 2008 this resulted in an absolute emissions reduction of 28 %, to be attributed to digestive processes (-18 %), manure storage and use (-13 %), soil processes (-35 %) and energy consumption (-37 %). From 2009, however, the emissions have stagnated, for non-energy greenhouse gases in particular. This was caused by a slight increase in the livestock population from 2009. Variations in the average winter temperature such as the cold winters of 2010 and 2013 and the mild winter of 2014 could explain the fluctuations in the energy greenhouse gas emissions.

Figure 3.5 Evolution of greenhouse gas emissions from agriculture (arable farming, horticulture and animal husbandry) and food industry, broken down by emission source (Flanders, 1990-2014)

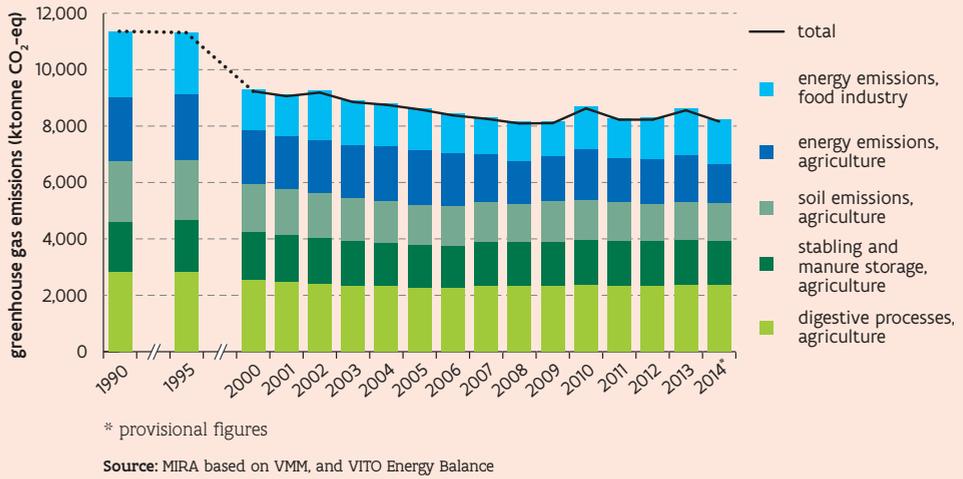
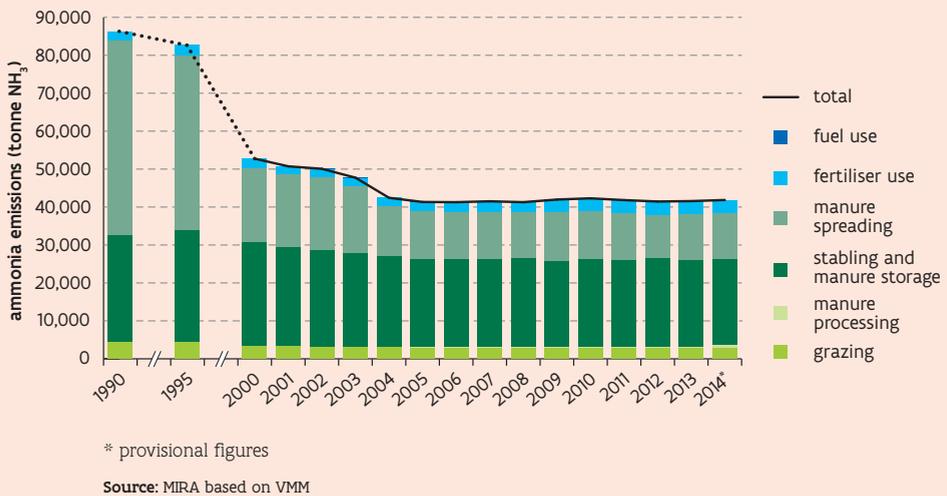


Figure 3.6 Evolution of ammonia emissions (NH₃) from agriculture (arable farming, horticulture and animal husbandry), broken down by emission source (Flanders, 1990-2014)



———— Agriculture experiences effects of climate change

The agricultural and food sector contributes to climate change, but at the same time experiences its effects. What is certain is that climate change will create additional uncertainty and complexity in the medium and long term (50-100 years). 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. Potential effects in the field of animal production are higher wind chill temperatures, leading to production losses, new diseases, lower energy demand for heating and higher energy demand for cooling²¹. Expectations on a larger geographical scale include changes in food quality, increase in (as yet unknown) diseases, heat stress in cattle, drought stress in plants, and strong variations in yield and associated price volatility²².

———— ... but can also contribute their buffering

Preserving or increasing the area of permanent grassland in Flanders may be relevant in the fight against climate change. In fact, a significant amount of carbon can be stored under grassland. Carbon build-up will be greater if the grassland is kept in the same plot over a long period of time and if the turf is renewed only if necessary, preferably by means of superficial soil tillage. A literature study conducted by ILVO on behalf of Boerenbond reports an average carbon storage of 0.5-1.0 tonne C ha⁻¹ year⁻¹ for the conversion of arable land to grassland²³. The grass was kept undisturbed on the same plot for a period of 10 years or longer. Moderately intensive grassland management whereby the grass stalks and roots are given sufficient opportunity to develop, leads to the highest carbon build-up. During the conversion from grassland to arable land, carbon is lost and this loss proceeds at least twice as fast as the carbon build-up during the conversion from arable land to grassland²³. In 2015, grassland accounted for about one-third of the Flemish agricultural area, of which 23 % (50,000 ha) was designated as temporary grassland and 77 % (169,000 ha) as permanent grassland¹⁰. The area of permanent grassland has been declining since 1990 (-55,944 ha or -26 %) to the benefit of temporary grassland, maize and industrial crops.

Nitrogen losses in agriculture

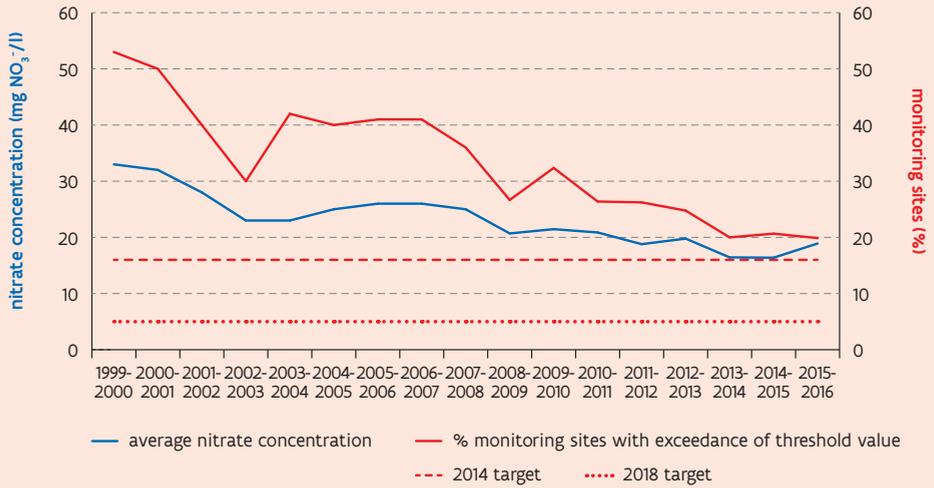
———— Agriculture is responsible for half of the nitrogen losses to the environment

Food production is a major cause of nitrogen losses to the environment. A calculation of the nitrogen flows in Flanders²⁴ shows that agriculture accounts for half of the total nitrogen losses²⁵, via volatilisation of ammonia from manure and stables, leaching of nitrate from soils, volatilisation of nitrous oxide due to rumen fermentation, and denitrification in the soil. Households, trade & services and transport together account for around one-third of the total nitrogen losses. These are primarily emissions of nitrogen oxides that are produced during the burning of fossil fuels.

———— Despite tightened manure policy, ammonia emissions stagnate

In 2014, agriculture accounted for 94 % of the total ammonia emissions in Flanders. Almost two-thirds of these emissions originate from livestock farming, mainly as a result of stabling and manure storage and to a lesser extent grazing and manure processing. The remaining emissions come from the use of fertilisers and animal manure on the land (**Figure 3.6**). Pig farming accounts for over half of the emissions from stabling and manure storage, cattle farming for about one-third.

Figure 3.7 Evolution of average nitrate concentration and percentage of monitoring sites with exceedance of the threshold value, located in surface water agricultural area (Flanders, 1999-2016)



The MAP4 targets (2014 target) and MAP5 targets (2018 target) are indicated by a red dotted line.

Source: MIRA based on VMM

In the 1990s, the agriculture sector achieved a large reduction in ammonia emissions. Reduction in livestock, lower nitrogen content of the cattle feed, low-emission application of animal manure on fields and meadows, construction of low-emission stables, and increasing manure processing reduced ammonia emissions also after 2000 (**Figure 3.6**). During the last decade, however, these emissions have stagnated, because a slight increase in the livestock no longer sets off the positive effect of low-emission stables and manure processing.

In addition to ammonia emissions, nitrogen losses to air also occur in the form of nitrogen oxides. The shares of agriculture and the food industry in Flemish nitrogen oxide emissions (9 and 1.4 % respectively) are much smaller than those for ammonia. The major sources of nitrogen oxides in agriculture are the use of manure and fossil fuels. In the food industry, fuel use is the only source.

———— Nitrate concentration in surface and groundwater of agricultural area decreases too slowly

Too high nitrate concentration in surface and groundwater can pose a threat to drinking water production and may lead to excessive algae growth. Manure policy from the beginning of the 1990s and its further tightening, resulted in a reduction in the average nitrate concentration of surface water in agricultural area by 42 % in winter year 2015-2016 with respect to 1999-2000 (**Figure 3.7**). Also the number of monitoring sites where the threshold value of 50 mg nitrate per litre (MAP4, 2011-2015) is exceeded, has more than halved. In the last two winters, however, little further improvement is visible. The target of MAP4 (maximum 16 % standard exceedances in 2014) has not been reached to date²⁶. The target of the fifth Manure Action Plan (MAP5, 2015-2018), i.e. 5 % standard exceedances in 2018, is not expected to be reached either without additional efforts. Moreover, there are substantial local differences: the situation does not improve everywhere and to the same extent. Especially regions with concentrations of intensive specialised animal husbandry (such as, for example, South-West Flanders (pig farming) and the Northern Campines (poultry and beef cattle) remain problematic.

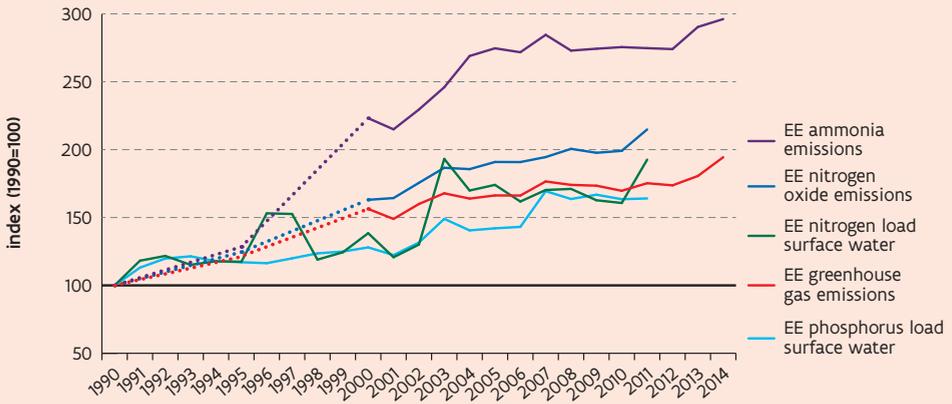
For nitrate concentration of groundwater in agricultural areas, a similar story applies. Despite a gradual decrease in the percentage of monitoring sites with exceedances, the standard is not reached in nearly one-third of the sampled wells. Here, too, exceedances are greatly influenced by local factors such as crop-specific limits on fertiliser use.

———— Nitrogen losses are harmful to nature

Ammonia and nitrogen oxide emissions give rise to nitrogen deposition on the soil. This can disturb the biodiversity because nitrophilic plants suppress less nitrophilic plants. The impact of nitrogen deposition on Flemish biodiversity is great: model calculations show that in 2013 the critical load for eutrophication was exceeded on 83 % of the surface of terrestrial ecosystems. This critical load is the deposition per surface unit for a specific ecosystem above which, based on available knowledge, a decrease in biodiversity occurs in the long term. Nitrogen deposition in Flanders is mainly caused by emissions that occur outside Flemish territory and by agriculture (mainly animal husbandry), with contributions of 47 % and 39 % respectively, in 2013.

Also the sharp decrease in nitrogen deposition since the 1990s has levelled off in recent years. The share of agriculture in this evolution is difficult to determine because around half of the nitrogen depositions in Flanders originate from cross-border emissions. What is clear, however, is that local emission sources lead to a very unequal distribution of nitrogen deposition across Flanders. Furthermore, ammonia, which mainly originates from agriculture, precipitates faster and therefore closer to the source than

Figure 3.8 Eco-efficiency (EE) of agriculture for a number of environmental parameters (Flanders, 1990-2014)



Eco-efficiency (EE) is defined here as the ratio between the end production value at constant prices (2005=100) and the environmental indicator (emission of greenhouse gases, ammonia, nitrogen oxides, nitrogen and phosphorus loading). Trend lines between 1990-1995 and 1995-2000 were visualised through linear interpolation.

Source: MIRA based on AMS, LNE and VMM

nitrogen oxides, which originate from transport and industry, among other sources. The nitrogen deposition is highest in agriculture-intensive areas in West Flanders, the north of Antwerp and, to a lesser extent, the north of East Flanders. Also in the north of Limburg, deposition has increased, due to the vicinity of Dutch Limburg and the German Ruhr region with high emissions from industry. This uneven distribution poses a barrier to achieving the conservation objectives in some Natura 2000 areas. In 2013, the critical nitrogen deposition was exceeded in 51 % of the Natura 2000 areas in Flanders²⁷.

SOLUTION DIRECTIONS

Environmental challenges require structural innovations within the entire food system

The current food system tackles environmental challenges mainly by improving the eco-efficiency of production processes. Based on predominantly technical innovation, the use of resources and the amount of emissions and residual flows per unit of output is reduced. This approach has certainly been successful: in the 1990s, the eco-efficiency of Flemish agriculture increased markedly and substantial absolute reductions were achieved for most emissions.

Over the last decade, however, the eco-efficiency has stagnated for a number of key parameters (**Figure 3.8**) and the total environmental pressure from Flemish agriculture remains considerable, especially at the local level. This shows that optimising production alone will not suffice to achieve the great reductions that are needed within the framework of the nature and environmental quality objectives, for example Natura 2000, the Nitrate Directive and Water Framework Directive. In addition, certain eco-efficiency improvements require a high investment cost that is becoming more difficult to bear for farmers in the current business model.

Moreover, the environmental pressure from the food system comprises not only the environmental pressure from food production in Flanders, but also the environmental pressure that is linked to the food consumed in Flanders. The footprint of Flemish food consumption on the environment is high, and the largest portion of it is generated by activities outside of Flanders^{20, 28}. A reduction in the environmental pressure from Flemish food production has little impact on this.

The nature, scope, geographical range and urgency of the environmental challenges therefore require more structural innovations throughout the entire food system, in which an essential role is to be played not only by the production chain but also by all other actors within the system (commerce, consumers, public authorities, knowledge institutions, investors, education, interest groups, civil society organisations, etc.).

Working on all fronts simultaneously

By analogy with the Netherlands Environmental Assessment Agency¹⁴, we suggest three broad solution directions for an ecologically more sustainable food system: eating differently, producing and earning differently, and marketing, sharing/distributing and connecting differently. To achieve a sufficiently great environmental gain, while at the same time minimising shifting to other regions or from one environmental compartment to another, as well as any undesired socio-economic effects, we have to work on three fronts simultaneously.

It is, for example, not enough to address only the environmental impact of local production, as this involves a risk of shifting. If, for instance, less local meat production is not accompanied by eating less meat, more meat will be imported. This import could possibly be produced under less stringent environment and social standards. Conversely, more environmentally friendly consumption patterns do not necessarily imply a reduction in environmental impact of local production, as long as the food system incentivises farmers to increase their production. Thus, the decreasing meat consumption in Belgium has thus far not been reflected in a decrease in meat production and the associated local environmental impact, because exports have increased²⁹. The same effect is observed in food waste: reduced demand as a result of less food waste by the Flemish consumer will in the current system be offset by an increase in exports.

Moreover, the solution directions are dependent on each other. A breakthrough in the production of more sustainable food will only be possible if demand is high enough and if the consumer is prepared to pay a price that covers the actual costs of a sustainable food production.

Solution direction 1: Eating differently

———— Lower consumption of animal products

Eating fewer animal products has the largest potential to improve the ecological sustainability of the food system³⁰. A nutrition pattern where meat, dairy products and eggs are (partly) replaced by environment-friendly alternative protein sources provides significant environmental benefits, including a much smaller ecological footprint, less and improved direct and indirect land use, lower water consumption and fewer greenhouse gas and nitrogen emissions^{14, 31, 32}. Thus, a halving of the consumption of meat and dairy products in Europe – assuming unchanged exports – can lead to a reduction in nitrogen losses by 40 %, lower greenhouse gas emissions (-25 to 40 %) and lower land use (-23 %)³³.

———— Wasting less food prevents unnecessary environmental pressure

Less waste of edible food by consumers and in the distribution sector prevents unnecessary use of raw materials, other resources and agricultural land and unnecessary emissions during food production^{31, 34}. Each Flemish consumer, on average, throws away between 18 and 26 kg of food per year, which corresponds to 4 to 6 % of the total quantity of purchased food³⁵ and approximately 4 % of the carbon footprint of the purchased food²⁰. Assuming an average daily food consumption of 1.2 kg, beverages not included, 264,000 to 381,000 people can be fed with this wasted food³⁵.

———— Alternative protein sources can replace animal products

In addition to known alternatives, namely vegetable protein sources such as soya and other legumes, there are products that have only recently come into existence, such as cultured meat, or that are starting to emerge, such as insects, algae and seaweeds and novel protein foods, a term that designates various protein sources such as by-products of the starch and oil industry, by-products of ethanol production and proteins from existing crops and from new protein sources that have not been used before³⁴. The Netherlands Food Centre assessed a number of alternative protein sources for criteria of sustainability, nutrients and food safety. Legumes appear to be the most obvious healthy and sustainable meat substitutes. Seaweeds, algae and insects could also prove to be valuable alternatives, but their suitability has to be evaluated on a case-by-case basis³⁶. For the large-scale application of novel protein foods, much research remains to be done on such aspects as optimal reuse of secondary flows and competition in the area of land use for other crops or applications (for example biofuel). To play their role as sustainable meat substitutes, it must be examined whether there is a technical potential

for them in Flanders, whether they can be developed and produced profitably, and whether they are ecologically sustainable³⁷. The future for cultured meat is unclear. Barriers in the short term include the high cost price, technological issues, and lack of clarity in the area of consumer acceptance, for example with regard to the different texture³⁴. It should be added, however, that efforts are being stepped up to address these problems, as became apparent recently from the second international, scientific congress on cultured meat. Entrepreneurs and consumers are also beginning to show interest³⁸.

———— Latching on to new trends

Consumers are increasingly concerned about issues like health, environmental problems, climate change and animal welfare^{3, 5}. This translates, for example, in the significant increase in the number of Flemish consumers that occasionally choose not to eat meat or fish (from 5 % in 2013 to over 10 % in 2016)¹². These trends can be used to embed the new eating pattern into an eating culture that is oriented more towards things like frugality, seasonality, knowing what you eat, good food and personally getting to know the farmer as producer³⁹.

There is, however, often a large gap between what consumers think and do³. Nutrition practices such as buying food, are routines that are embedded in a wider spatial, economic and sociocultural context^{31, 40, 41}. And that is also why they cannot easily be changed. Standards and attitudes^{14, 39} (quality requirements, environmental awareness, etc.), material factors^{31, 42} (price, information on packaging, etc.), time-related factors³¹ (available time, work patterns, etc.) and spatial factors (importance of home meals versus eating out, etc.)³¹ together shape nutritional practices and sometimes also counteract each other. Thus, for example, one may want to eat less meat for health reasons but have insufficient access to healthy alternatives or feel confused due to the amount of product information, notably on food labels³¹. For sustainable nutritional practices to take hold on a large scale and permanently, the food chain and policy need to consistently address all these factors. Existing routines must be broken by offering consumers a new 'choice architecture'^{41, 43}, whereby the alternative is at least as attractive (it should, for example, be quick to prepare or be available outside the home).

Solution direction 2: Producing and earning differently

———— More efficient and more circular production within the boundaries of the environmental space

The largest eco-efficiency improvements in the Flemish food system are to be achieved in the non-OECD regions of provenance of food import¹⁴. However, gains are also to be made in Flemish intensive agriculture. The efficiency of nitrogen and phosphorus conversion throughout the Flemish food chain, for example, is only 12 % and 9 % respectively^{24, 25}. A surplus of these nutrients is therefore contained in residual and waste flows such as animal manure, organic-biological waste and household waste water. Reuse of nitrogen and phosphorus from these flows can reduce emissions to water, air and soil. An example is the integration of aquaculture and hydroponics (aquaponics), resulting in optimal use of nutrients, water, heat and energy⁴⁴. The use of residual flows from agriculture in other sectors is still limited in Flanders⁴⁵, but research is under way^{47, 48}. Residual flows from the food or biofuel industry are already used as an alternative for soya proteins in feed. In Belgium, already more than half of the raw materials for compound feed comes from such flows³.

While there are still opportunities for more efficient and more circular production, such improvements will, as already mentioned, not be sufficient to bring the environmental impact of agriculture quickly enough within the boundaries of the environmental space in Flanders. Consequently, measures will also have to be taken at the level of production volumes, and here the government has a role to play.

Producing more carefully and closing cycles at the local level

The Netherlands Environmental Assessment Agency defines more careful production in agriculture as production that is aimed at improving the quality of the local environment and nature and increasing animal welfare⁴⁴. This may involve, for example, animal husbandry where more space is created for animals, or production models where cycles are closed at the local level wherever possible. In the second case, the Flemish Department of Agriculture and Fisheries distinguishes circular agriculture and multi-actor multifunctional agriculture⁴⁵.

In the circular model, which is closely linked to the concept of agro-ecology, farmers try to close cycles on the farm or at the local level wherever possible. Central here is the combination of vegetable and animal production whereby (residual) products from animal production are used for vegetable production and vice versa. The focus here is on food production. In the multi-actor multifunctional production model, cycles are closed on the level of the nearby (urban) environment. Farmers not only produce food but also fulfil other functions such as recreation or the 'provision' of biodiversity, for which they cooperate with various actors (citizens, NGOs, local authorities, etc.)⁴⁵.

Organic farming, too, is a method of more careful production. Despite the growth figures, Flemish biological agriculture remains a small player in the (European) market⁴⁹. With a share of 0.8 % in the total agricultural area, organic farming in Flanders remains far below the European average (EU-28) of 5.9 % in 2014. There is nevertheless room for faster growth, as the demand for organic products in Flanders significantly exceeds domestic production. Key conditions for accelerated production growth include ensuring the continuity of organic farms and sufficient access to agricultural land.

The environmental benefits of more careful production show a mixed picture. There is often less local environmental impact (for example less leaching of nutrients and pesticides per hectare, and higher local biodiversity), but per unit of output there is often higher land use (for example due to lower productivity of crops or with free-range animals) and some emissions may be higher (for example as a result of the longer lifespan of the animals and therefore the increased need for feed production, or more ammonia emissions with free range than in an indoor system)^{14, 39}.

Business models with higher added value needed for farmers

More sustainable operations often lead to higher costs for farmers and are moreover often accompanied by decreased yields. A key requirement for success is therefore that the environmental performance is reflected in the farmer's income. Possible options in this respect are business models that do not unilaterally focus on low costs, but also, for example, on the unique character and the quality of the products (organic products, regional products, etc.), or on services around the product (diversification through recreation, education, reuse of residual flows, provision of ecosystem services in relation to climate efforts such as carbon storage in grasslands, protection against erosion by planting hedges and trees, or contribution of the sector to the supply of green energy, etc.). As we will see below, the likelihood of success for business models with higher added value depends to a large extent on other actors in the food system.

Environmental impact throughout the food chain must be reduced

Not only agriculture but also other sectors contribute to the environmental impact of the Flemish food system. For example, greenhouse gas emissions from the extraction of fossil fuels and electricity production account for one quarter of the carbon footprint of foods purchased by Flemish households²⁰. These fuels and electricity are used primarily by the food industry and other industrial sectors, and also by trade & services and the transport sector. To this should be added the emissions from the

actual use of fossil fuels by those sectors, which represent almost one-fifth of the carbon footprint. Reducing the energy consumption by these sectors and the switch to environmentally friendly energy sources could therefore have significant effect on the climate impact of food.

Solution direction 3: Marketing, sharing/distributing and connecting differently

———— Environmental and social costs to be incorporated into the price of food

More sustainable operations in agriculture often result in higher costs that need to be offset by higher sales prices or other income. However, due to the current low prices of food from the conventional production chains, the prices for more sustainably produced food cannot be much higher. Too great a price difference in fact reduces the willingness to pay by the consumer. To further upscale more sustainable food production, environmental and social costs will therefore have to be reflected in food prices.

This also gives rise to tension between various societal concerns. On the one hand, higher food prices are needed to make food production more sustainable, but on the other hand, food supply at sufficiently low prices is desirable from a societal perspective because it contributes to stability. However, it should be noted that the share of food in household expenditure has dropped significantly since 1950³.

———— Cooperation within the chain

Higher food prices for consumers do not always translate into higher margins for farmers. Market concentration in retail, for example, makes it difficult for farmers to obtain a good price. Conversely, the dominant position of retail also enables the sector to push agriculture in a more sustainable direction. Vredeseilanden examined which initiatives already exist in Belgium and how the potential can be further developed. A number of supermarkets have already undertaken efforts to make food chains more sustainable and to improve the marketing of sustainable products, for example by relegating less sustainable products to less prominent shelf space or by offering only the sustainable alternative. However, these initiatives often remain modest, not in the least because the financial margins are limited due to the price pressure from consumers. To take this process to the next level, more sustainable partnerships throughout the food chain are necessary, as well as more active steering by and support from the government⁵⁰.

———— Marketing and connecting differently

Farmers can also sell their products directly, through other farmers or in a partnership, to consumers. Examples of such short-chain sales are farm shops, farmers' markets, automatic vending machines, self-picking farms, Community Supported Agriculture (CSA), food subscriptions and food teams. Although the environmental impact of such short chains is not always lower, they can be instrumental in creating more mutual understanding and respect between producer and consumer whereby the latter may be more prepared to pay a fair price. Despite the 1,500 or so points of sale in Flanders, the short chain remains a niche. In 2016, on-farm sales and sales at farmers' markets had a share of 0.8 % in total consumer expenditure on fresh food³.

All noses in the same direction

The transition to a more sustainable food system will have to be achieved through mutually reinforcing changes in the production and distribution chains and in individual consumer behaviour. Paredis et al. (2009) provided a number of levers to promote the transitions to more sustainable systems⁵¹. Firstly, it is important to guide the actions and decisions of individual actors with a broad but supported long-term vision that is incorporated into policy processes such as 'Vision 2050'. The development of such a long-term vision requires a consultation model that involves not only the traditional societal stakeholders, but also civil society, progressive regime and niche actors and all relevant policy areas (agriculture, environment, public health, economy, taxation, etc.).

Secondly, a long-term vision must be translated into regular policy in a stable and consistent manner. Policy integration whereby overarching objectives are embedded into different policy areas or whereby policy areas integrate each other's objectives into their own policy, is an important lever in this respect. In practice, this should be reflected in the choices made, for example, in environmental legislation with respect to food production, in the allocation of budgets for agricultural research, agricultural education, products that are promoted to consumers, advice and educational programmes on healthy food, etc. Certain policy instruments are potentially very powerful levers. Thus, a significant tightening of the European environmental legislation on food production would not only make conventional agriculture more sustainable, but it would also reduce the price difference with the even more sustainable products, thereby increasing the market opportunities for the latter. However, also other policy instruments such as taxes, awareness raising, and education can have a big impact, provided they work in the same direction.

A third lever to accelerate the transition to a more sustainable food system is the creation of space for experimentation, for example via projects whereby innovations can be tested exempt from inhibitory rules, or via subsidy systems, such as projects around innovative rural development as part of the European Common Agricultural Policy (CAP).

Networks, too, are of vital importance to set up and further upscale innovative experiments. There are already many food-related networks, including (inter)sectoral networks such as Flanders Food and the Belgian agrofood supply chain initiative, and networks at the urban level such as in Ghent and Bruges. Just as policy instruments, networks also have a powerful impact when they join forces. In some instances, this is already happening. The Citizens for the Foodture project of Vredeseilanden and Fairtrade Belgium, for example, is supported by Boerenbond, FEVIA, Comeos, Gezinsbond, Test-Aankoop and The Shift. However, the government too can assist in optimising and aligning networks through a long-term vision on a sustainable food system.

The transition to a more sustainable food system does not stand or fall with the government alone. In fact, it acts on structures and practices that are deeply embedded in society, and therefore requires the commitment from all stakeholders involved. The government does, however, have a key role and can, for example, take the initiative to have all noses pointing in the same direction, as on the occasion of the reform of the CAP planned for 2020.

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