Assessing the environmental impact of the food production chain from a Flemish perspective

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In Flanders, certain government agencies have recently felt the need to get a better insight into the environmental impact of regional production and consumption. They have shown their interest in the Flemish EE-IO tables as a tool to determine and support certain policy decisions. Today, one of the topics high on the Flemish policy agenda is the environmental impact related to the production and consumption of food.
The environmental production and consumption of food in Flanders is calculated, both from a territorial perspective as well as a consumption perspective. Through this, a number of questions are answered. The goal is to identify the key sectors in the production chain of food in Flanders and assess the importance of both perspectives to support future policy decisions.

1. Introduction and scope

In Flanders, the Flemish environmental policy plan Environment and Nature 2009-2014 is aimed at i) greening the Flemish economy and ii) reducing environmental impact as a whole. In this framework, a study was commissioned to VITO to investigate the environmental impact of production and consumption. The main focus of this study was to identify the high contributors (producing industries) in the Flemish economy and the most relevant consumption domains. Next to that, the importance and added value of both perspectives (production versus consumption) was discussed.

Within the study, a more detailed analyses was requested for a number of consumption domains, with food being one of them. This paper will present the results and conclusions for this domain only.
The main questions to which this paper is oriented are:

- How important is food production compared to other activities in Flanders' economy?
- In the production chain of food, what are the most important sectors with regard to environmental impact?
- How important is consumption in this?
- What is the role of imported food products compared to regionally produced?

The Flemish environmental input-output model creates the opportunity to answer these questions from an integrated point of view: both economic as environmental information is incorporated and this for several different environmental parameters. All economic activities (sectors) are looked at from a production perspective, as well as all consumption areas from a consumption perspective (Vercalsteren et al., 2012).

As focussing in this paper on food, the economic sectors which are most important are the food producing sectors (NACE 10-11). Of course, when the entire production chain is analysed, other sectors will come into picture as well.
In order to give an integrated answer, taking into account the wide impact of production and consumption, different environmental impacts are calculated: climate change, acidification,

emissions ozone precursors, particulate matter emissions and material consumption. This paper will only focus on climate change.

2. Methodology

The Flemish EE-IO model 2003

The Flemish environmentally extended input-output model for 2003 was developed in commission of the Flemish Public Waste Agency (OVAM), the Flemish Environment Agency (VMM) and the Environment, Nature and Energy department (LNE) (Vercalsteren et al., 2008; Avonds et al, 2008)). Recently, an update of the data was finished for the year 2007.
The IO-model allows to relate economy with ecology, on a scientific base. It inventories all relevant economic and environmental data with regard to production and consumption. This makes it a powerful instrument to support decisions in sustainability policy making of the Flemish region.

The Flemish EE-IO model distinguishes 117 economic sectors and incorporates imports and exports to three regions, i.e. the rest of Belgium, Europe en the rest of the world. There are 9 different food sectors included in the model. The agricultural sector is not further subdivided into subsectors for the 2003 data. This of course reduces the amount of detail in the analysis and results.
The environmental extension tables incorporate emissions to air, emissions to water, emissions to soil, use of energy, use of water, use of materials and waste generation.

In it's basic format, the Flemish EE-IO tables give a picture of which parts of the regional economy key emissions are directly generated and show how the totals of a given domestic environmental pressure are distributed across Flanders economic sectors. Of course, also economic data, like economic output, of each economic sector is available in the model. This information forms the basis for the production or territorial perspective. This actually gives an overview of the total direct emissions released in Flanders, from economic sectors as well as households and government. It gives us the opportunity to identify the environmental 'hotspots' in Flanders production. (Moll et al., 2009)

Because economic data are included and compatible with the environmental data, it is possible to calculate and compare the environmental intensity (environmental pressure per euro of output) of the Flemish economic sectors. The tables can then be manipulated, using the econometric method of environmentally extended input-output analysis. This manipulation provides another perspective, the consumption perspective. This perspective allows to analyse the production chain of products, starting from the consumers. It creates the opportunity to evaluate the impact that arises because of the demand for products e.g. by Flemish households. The emissions of an economic sector are actually re-allocated according to the flow of goods and services the sector sells to other sectors and to final consumers. In this way, embodied emissions are taken into account when looking at final products. For food, this means for example that actually all emissions in the life cycle are taken into account, from farm until store shelf. The embodied emissions are both from the Flemish production chain as well as from the imported production chain. Emissions occurring in Flanders for production of export products are not included.
In the Flemish model, emissions from household consumption (e.g. emissions occurring because of the preparation of food on a gas stove) are allocated to product groups.

3. Results

Using the EE-IOA methodology, the total carbon footprint related to all consumption activities in Flanders in 2003 is 109,5 Mt CO_2-equivalents. Comparing this to the total territorial (production) emissions in Flanders (89,5 Mt CO_2-eq.) according to the EE-IO tables, the number is about 22% higher. The carbon footprint of consumption in Flanders, is caused by direct emissions from households (19,3% i.e. 21,1 Mt CO_2-eq) on one hand and by production of final and intermediate products worldwide for Flemish consumption (remaining 88,4 Mt) on the other.
The total carbon footprint of the food production chain (products from the food producing sectors, agriculture and fishing) for consumption in Flanders accounts for 16% of the total of all consumption activities in Flanders, making it the second most important contributor following the production chain of electricity and gas. Minx et al. (2008) report 16,5% for the UK, while the EIPRO study (Tucker et al., 2006), using average values for Europe, mentions 22-31% share of climate change.

EE-IOA methodology allows to compare the share of carbon footprint related to Flemish production of final food products with imported food products. In monetary terms, Flanders imports 42% of final food products. Figure 1 shows the share in the total climate change of Flemish food and each of the import regions .

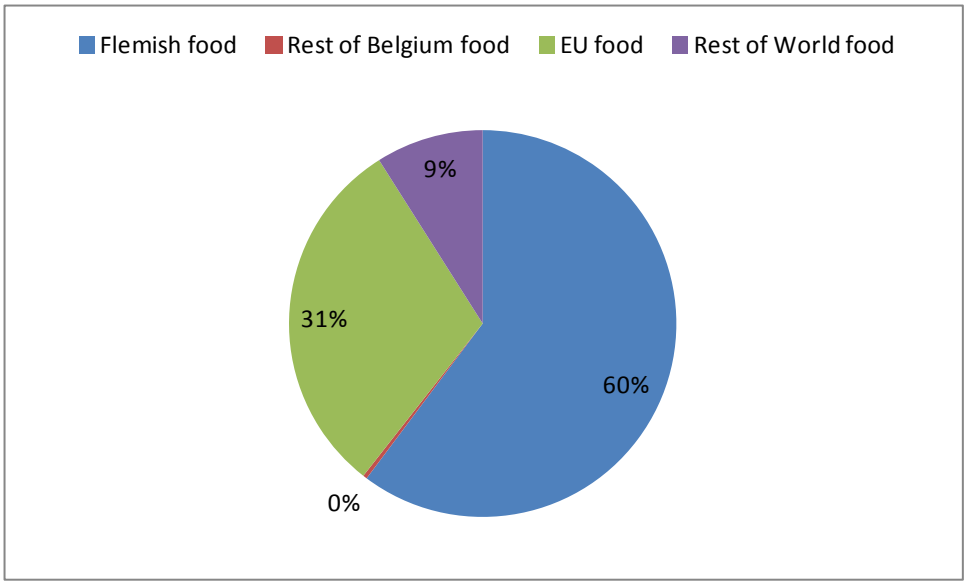

Figure 1: Share of four regions in total climate change of production chain for Flemish consumption of food products

60% of the total carbon footprint from food and drink products are related to the delivery of these products by the Flemish sectors. Impacts outside Flanders through production of intermediates are included in this value as well. The remaining emissions are associated with final food products that are imported for consumption in Flanders.

The role of Flemish household consumption

Flemish consumption covers final demand by households, government, assets and inventories. Household consumption in Flanders is responsible for 75% of total greenhouse gas emissions of Flemish consumption activities. Looking only at emissions occurring during production (thus leaving out direct household emissions), the share of households is 68,5%.

In the Flemish EE-IO tables household consumption is further grouped into different product groups, which again can be combined into consumption domains. One of these domains is “food”, which combines the product groups food products, food preparation & storage and cleaning (dishes etc.). Impacts from production and direct emissions from household consumption were allocated to these product groups. The entire consumption domain is responsible for 25% of total carbon footprint caused by household consumption. Figure 2 shows the importance of each of the product groups.

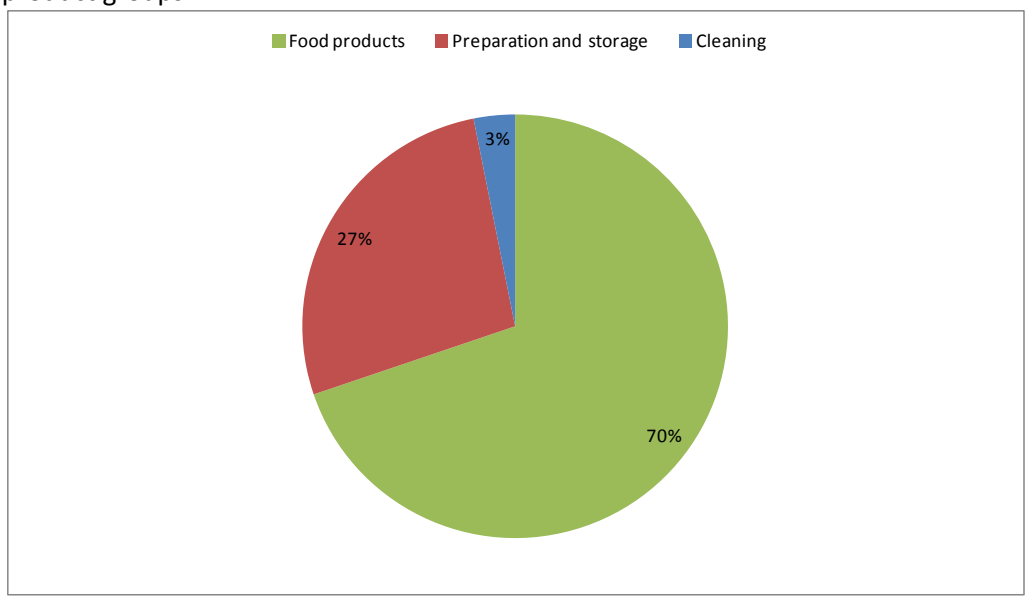

Figure 2: Contribution to climate change of the household consumption of food

It is clear that most of the emissions related to food consumption of Flemish households is related to the food products itself. This is entirely related to the production chain of the food, since direct household emissions are only relevant for the product group of preparation and storage.

A chain analysis allows to identify the most important life cycle phases of food. This is shown in figure 3. Important for the interpretation of these pictures, are the embodied emissions for imported products. Since the Flemish IO-model is not a multi-regional IO-model, the production chains abroad are not to be further specified. This means that when a product (intermediate or final) is imported – from the rest of Belgium, Europe or the rest of the world – the emissions allocated to this product are the emissions of the entire production chain, thus including all embodied emissions. For Flemish production however, the different steps in the production chain are shown separately, indicating both the direct contribution of that step to the total carbon footprint as well as the embodied emissions up ‘till that step.

From figure 3 it shows that food consumption by Flemish households is responsible for 3,4 ton CO_2-equivalents per capita or a total of 20,1 Mt CO_2-equivalents in 2003.

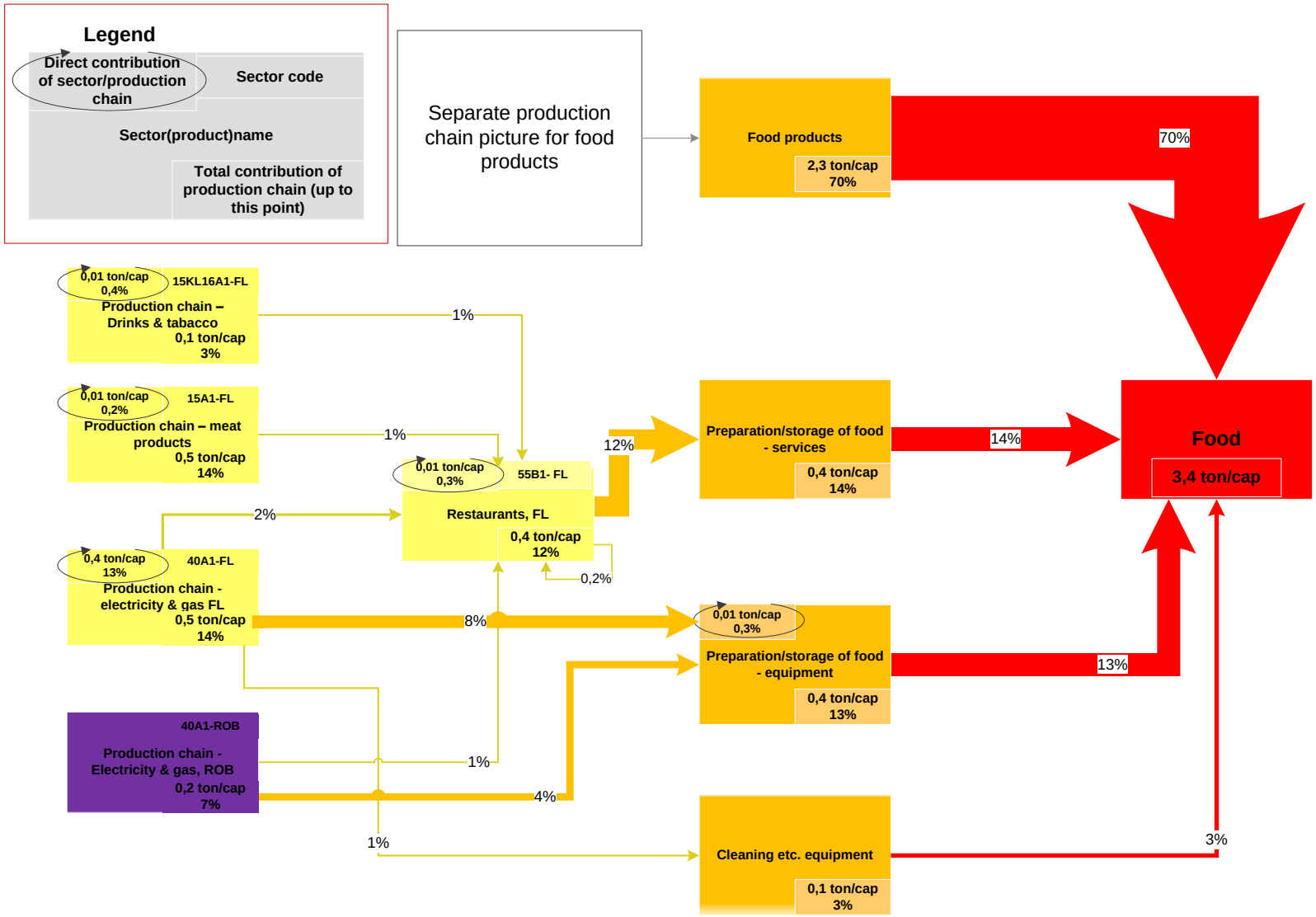

Figure 3: Chain analysis of the carbon footprint related to Flemish household consumption of consumption domain 'food'

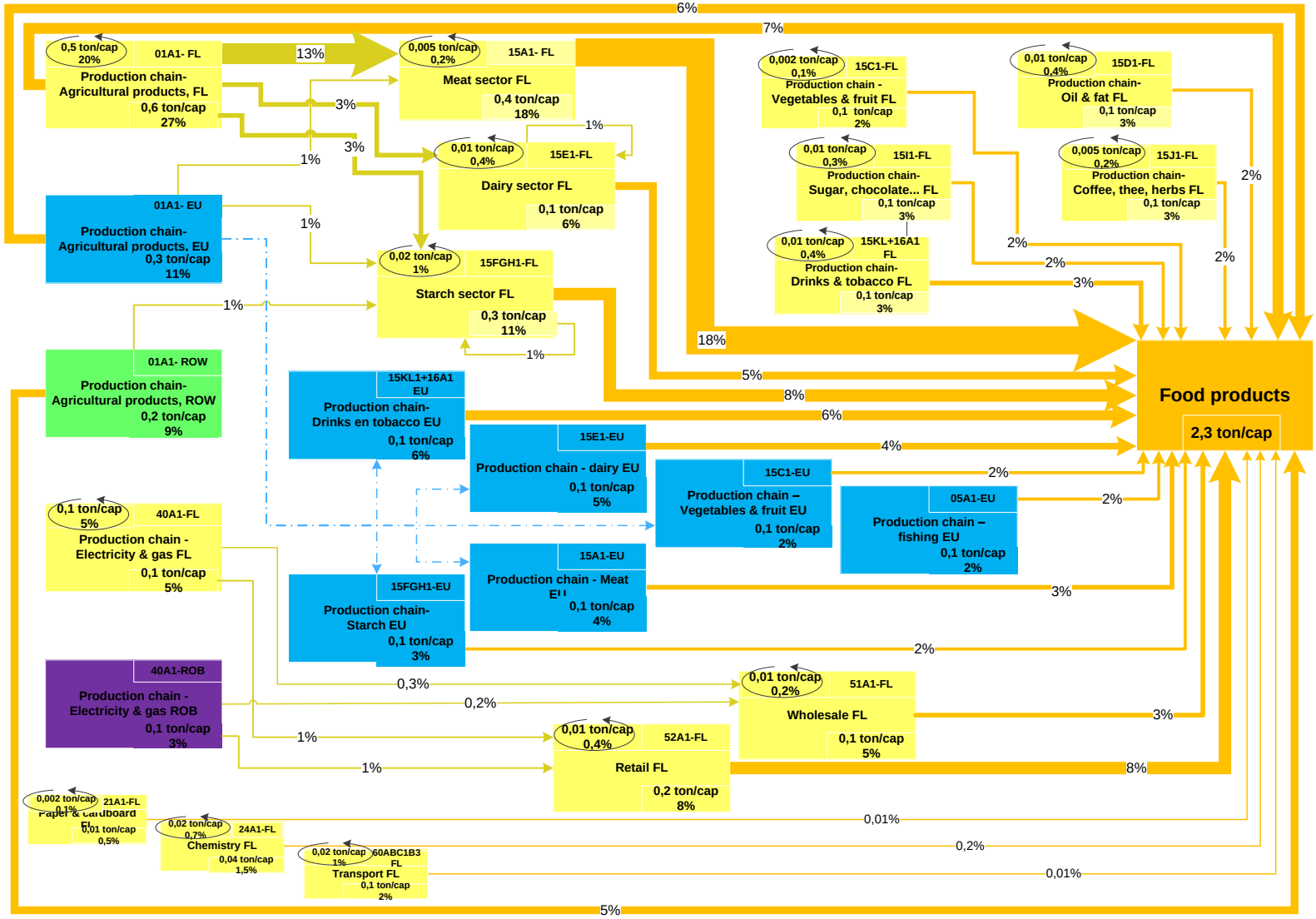

Figure 4: Zoomed-in chain analysis of the carbon footprint of product group 'food products' of Flemish household consumption

Figure 3 shows once more that it's mainly the emissions originating in the production chain of food products that contribute to the total carbon footprint of household consumption of food (70%). For preparation and storage of food as well as the equipment needed for cleaning etc., energy production (electricity and gas) is the main source of emissions in the chain (13% direct emissions from the Flemish energy sector, 7% from the energy production (including embodied emissions) in the rest of Belgium).

Looking at figure 4 which focuses on the production chain of food products, it is clear that most of the carbon footprint is caused by the production of agricultural products (about 47%). When looking only at agriculture in Flanders, the direct emissions of the agricultural sector for food production are about 20% of the total carbon footprint of food. These are mostly methane emissions (49%), followed by N_2O-emissions (29%) and CO_2-emissions (22%). An important remark needs to be stated here: because of the lack of detail in the agricultural sector (only one economic sector, no subsectors) for the 2003 model, the interpretation of these results is distorted when looking at the different food processing sectors. For example, when one euro of agricultural product is bought by the meat processing sector and the starch sector, the embodied impact from agriculture for that euro of product will be the same for both food processing sectors. This of course, reduces the value of these results. The different food processing sectors have only a small direct contribution to the carbon footprint of food.

The contribution of transports in the food supply chain is very limited. This confirms what was previously reported by for example Virtonen et al (2011) and Minx et al (2008). In this regard it is important to note that in Flanders, the food processing sectors and retail often have internal logistics, which probably creates an underestimation of transport when calculating carbon footprints with the Flemish EE-IO model. Also, contrary to popular belief, the contribution of packaging (paper & cardboard sector) to the carbon footprint is very small: only for Flanders, this sector is shown, actually contributing 0,1% directly and 0,5% throughout the production chain of packaging materials. However, when looking at other environmental impacts like waste production, this picture may differ.

4. Discussion

In Flanders, the economy is strongly import-export oriented. From a territorial or production perspective, results give a picture of the most polluting economic sectors in the region. However, since import and export are so important, the consumption perspective might give a very different picture. In this perspective, the focus is on the environmental impact of consumed products in the region. Because the difference can be rather significant, it is important to incorporate both when working out policy measures.

The consumption of food in Flanders – including both non-processed food (agriculture and fishing) and processed food– is responsible for the second largest contribution to the total greenhouse gas emissions generated by Flemish consumption after the energy production chain. Looking at the origin of final food stuffs, the largest share of GHG emissions is generated in Flanders, however imported final products take up about 40% of which the European market is the most important. Not only environmental issues are important here for what policy is concerned, but also ensuring a sufficient food supply for the future since it seems that Flemish consumers are quite dependant on imports.

Traditionally, in Flanders, environmental policy and regulation uses a production perspective as the starting point. There is a large focus on industry, by the use of emission limit values, minimal efficiency requirements and other production related measures. Although this is absolutely necessary, it is clear from the combination of both perspectives, that it is actually consumption that drives industry, drives production and therefore indirectly generates emissions. Moreover, in a globalizing economy, environmental impacts must be looked at cross-boundary to avoid the outsourcing of impacts.
For the case of food specifically, consumption of households is an important factor when trying to reduce greenhouse gas emissions in the production chain (but also waste generation etc.). In fact, one might state that first efficiency in consumption (minimizing food losses) should be stimulated in order to reduce production. Of course, direct emissions of the economic sectors involved in the product chain are to be tackled by implementing the measures and regulations as they are today.

5. Conclusions

Although the results already show some options for environmental policy in Flanders with regard to food production and consumption, some further details are required. This is why a follow-up study was initiated, specifically focussing on the elaboration of the missing results from the study as presented here.

First of all, what is missing, is a further subdivision of the agricultural sector. For the 2003 data, this sector is grouped as one, which reduces the value of analysis results, especially when focussing on hotspots and potential environmental regulation. In the 2007 data (Vercalsteren et al., 2011), therefore, the sector was further subdivided into 3 subsectors, based on available economic statistics and environmental data. Although more detail can still be required, these subsectors might already create some more insights into the specific production chains of, for example, meat compared to vegetables and fruit.

Another issue that should be further investigated is situated on the consumption side. Since households play such an important role, more research is needed on consumption patters, typical diets etc. of the Flemish consumer (Duchin F., 2005). This might create better insights to what topics sensitization should focus on.

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