MTT REPORT 34

Central Baltic INTERREG IV A Programme 2007-2013

# The Baltic environment, food and health: from habits to awareness

## Feasibility Study

Virpi Vorne and Lila Patrikainen (Eds.)

MTT

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# Summary


### Background of the programme and Foodweb-project

"The Baltic environment, food and health: from habits to awareness – FOODWEB" is a part of the Central Baltic IVA Programme 2007- 2013, which funds cross-border cooperation projects with a total of 96 million Euros from the European Regional Development Fund.

The Programme includes three components relating to the origin of partners: Estonia, Finland, Latvia and Sweden. These Programme components are the Central Baltic Programme, the Southern Finland–Estonia Sub-programme and the Archipelago Islands Sub-programme. The Foodweb-project is a part of the Central Baltic Programme and its budget is about 1.5 million Euros. The project focuses on creating attractive and dynamic societies and on improving living conditions and social inclusion.

The partners in the Foodweb-project are MTT Agrifood Research Finland, as the lead partner, the University of Tartu, the science exhibition centre AHHAA, the Finnish Environment Institute and the University of Latvia.

The Central Baltic programme extends to over 180 000 square kilometres of the Baltic Sea catchment area, which is home to over 9.9 million people. This covers approximately 11.7 % of the population of the Baltic Sea drainage basin. 50.6 % of the population of Finland and 85 % of the total population of Latvia live in the central Baltic IV A project area. The project area includes all the inhabitants of Estonia and 42 % of the population of Sweden.

Finland, Estonia and Latvia take part in the Foodweb-project in order to collect up-to-date information for a common database that will encourage sharing of information about food consumption and food related risks, as well as centralising information about the environmental effects of food production on these areas. The information about the food situation in Sweden is also collected and results of hazardous compound analysis and information about the characteristics of these compounds collected in Sweden will also be used in this project.

### About the Baltic Sea

The Baltic Sea is a small and relatively shallow brackish body of water located in northern Europe. It is the second largest brackish water basin in the world and is also considered to be the most polluted. The catchment area of the Sea is large, over 1 600 000 $km^2$, and because the volume of water is small (20 000 $km^3$) due to the shallowness (average depth 55 m), the Sea is very sensitive to pollution.

The salinity of the water changes at different depths, being greatest in the Danish Straits close to the Atlantic, from where the irregular saltwater pulses enter the Baltic Sea. The salinity decreases farther away from the influence of the Atlantic Ocean, being lowest near the Bothnian Bay. Due to the freshwater runoff near the coast, surface salinity increases towards the bottom and decreases when measured near the coastline.

Because of the low salinity, both fresh water and marine species can adapt to life in the Baltic Sea. Low salinity also makes the Baltic's unique ecosystems sensitive to changes resulting from human activity. One of the biggest problems is accelerating eutrophication caused by nutrient runoff. The Sea is also vulnerable to pollution caused by harmful compounds resulting from human activity. Eutrophication also increases hypoxia, oxygen depletion, which already occurs on a regular basis in the Baltic Sea bottom waters.

The food production chain is one the most resource demanding and polluting sectors, and a large user of energy that causes not only eutrophication, but also global warming and marine pollution. The whole food production chain from agriculture to preservation, distribution, preparation and waste management consumes a considerable amount of not only energy, which contributes to total $CO_2$ emissions, but also nutrients and chemicals harmful to the marine environment and its associated species. Such compounds accumulate in the food chain and in particular species. For example, the Baltic Sea herring and large

predatory fish species in the freshwaters exceed the safety limits for harmful chemicals and should not be consumed more often than few times a month. In order to improve the state of the Baltic Sea and maintain the food originating from the Sea as pure as possible, various actions need to be taken.

### *Project objectives*

The main objective of the Foodweb-project is to raise public awareness about the links between food quality and food origin, focusing on the Baltic Sea and its surroundings. Emphasis is placed on the life cycle of food and the biological cycles: the food web and related biogeochemical pathways. The relationship of people, food and environment will be made obvious and interpreted in terms of the impact of the state of the environment on our food and safety and, vice versa, human impact on the environment related to production of food and in treating residues from the food chain. The final aim is mutual understanding and self-efficacy in risk management. The relationships between extensive industrial land use, decreasing potential of ecosystem services in the project area, growing pressure for safer food production areas, food safety in terms of pollutants and related risks, and the challenges of responsibility in risk management set by the public for the food chain, will be the driving forces communicated via various target groups. Consumers can influence the quality of the Baltic watershed through changes in land use and environmental deposition, and they can have an impact on the environmental status of the Sea. Consumers need to be aware of the risks associated with food choices and learn how to minimise them.

In addition to the substantive objectives, the methodical objectives are a) close R&D collaboration throughout the region and regional food supply-demand chains, b) opening of sources of data for the whole food chain partnership and regionally for extensive public use, c) building new tools to combine and interpret environmental impacts and environment-based risks for food consumers, d) making a joint effort to build up food choice models for mutual use and e) identifying a mutual focus on knowledge based facilitation for an exhibition centre. The final methodological aim is a renewed cross-border culture for an environmentally-aware and risk-alert food strategy for the Baltic Sea food shed. The long-lasting impact strived for will be realised by focusing the informational efforts on young families and schools. The project will be strengthened by building partnerships among food chain stakeholders and mutual cooperation throughout the region with help of NGOs.

This is a conceptualisation study for answering the questions 1) What are the volumes of food produced and consumed in the area? 2) Which food material flows are important for food system sustainability and environment-based risks? 3) Which key groups of consumers are at risk? The surveys will be performed through collaborative networks and analysed by MTT, SYKE and the Universities of Tartu and Latvia. For hazardous compounds, the baseline for exposure and pathways will be studied by SYKE based on existing reviews and monitoring data (e.g. HELCOM 2010). The baseline will include total exposure to humans from dietary and non-dietary sources. The possibility to use existing methods for combining risks from contaminants in the decision context will be reviewed. Working hypotheses for databases will be formulated on the basis of the previous feasibility study and a pre-study will be initiated on a) current state recommendations for food, b) key contaminants and their health.

### *Population structure in the area*

The project area covers the southern parts of Finland, the whole of Estonia and in Latvia the capital Riga, as well as Pieriga and Kurzeme regions located on the western coast of the country. The distribution of population in all three countries is concentrated in the main towns, and in Finland and Latvia also along the coastal areas for cultural and agricultural reasons.

The total population of Finland is 5.4 million people and of Latvia 2.2 million. The population of Estonia is the lowest of the partner countries, at approximately 1.3 million people. In Finland and Estonia women represent slightly more than half of the population, but in Latvia women outnumber men by almost 8 %. There is also some variation in household sizes among the countries, ranging between 2.48 and 2.08 people and being smallest in Finland and largest in Latvia. The number of single households exceeds the average account for Europe only in Finland and Estonia, but in Latvia more than 18 % of households are of single women.

The average life expectancy among all European Union countries is 82.4 years for women and 76.4 years for men. There is some variation in life expectancy among project countries, ranging from 83 to 78 years for women and from 68.1 to 76.4 for men. Life expectancy is highest in Finland whereas in Latvia it is one of the lowest in the European Union.

The population is expected to become older in the project area. In Finland and in Estonia the number of people over 80 years has been increasing during the last 40 years, and at the end of 2009 there were over 195 000 persons aged 75 in Finland's project area and almost 105 000 people in Estonia. In the project area of Latvia 7.5 % of the population are over 75. Women represent the clear majority of those over 75 years in all countries. The population of Latvia is decreasing year by year due to emigration and negative natural growth. The number of residents of working age is shrinking, and if this trend continues, in twenty years more than 23 % of the population will be retired. The population of Estonia is also shrinking and the population of Finland increasing. In Finland immigration is a greater cause of population growth than natural increase.

### Food production

In Finland the food industry is the fourth largest branch of industry, in Latvia the second largest and in Estonia it accounts for about one fifth of the total production of processing industry. Meat production, as well as milk and dairy production, are the most important branches of industry in all three countries. In Finland the baking and in Estonia the beverage industries account for a large part of production and in Latvia milk production is the largest production sector ranked by value.

Finland and Latvia are entirely self-sufficient in milk and milk products, as well as in meat and eggs. In Estonia self-sufficiency in milk is about 161 % and the degree in self-sufficiency in meat around 83 %. The degree of self-sufficiency in grain in all project countries varies from year to year depending on the harvest. Due to the northern location of these countries, most fruits and some vegetables are imported.

The main sector of Estonian agriculture is milk production, which is also the most important product from domestic animals in Finland. The selection of dairy products is wide in both countries: the selection varies from non-fat and semi-skimmed products to low-lactose and non-lactose milk products. Some of the products have been differentiated to conform to health trends: in Finland and Estonia customers can choose products that lower blood pressure and blood cholesterol, for example so-termed ‚heart cheese'.

Over 30 % of Finland's 64 000 farms are situated in the project area, where most of them produce cereals, special crops or milk. In Latvia almost 73 900 farms are situated in the project area, which accounts for 65 % of all farms in the country. The majority of farms in Finland produce cultivated cereals whereas most of the farms in Latvia are engaged in crop cultivation, dairy farming and cattle breeding. Every fifth farm in Finland produces milk.

The structure of agriculture has been changing in recent years in the project area. In Finland, Estonia and Latvia the number of farms is decreasing and the size of the farms is increasing, in Estonia and Latvia the total area of agricultural lands have also increased.

### Export and import

In 2010 Finland imported over 2 015 000 tonnes and exported almost 623 000 tonnes of agricultural foodstuffs. The main export products were alcoholic beverages, frozen and fresh fish, pork, milk products, eggs, poultry and malts, whereas most imported foodstuffs included alcoholic beverages, coffee, fish conserves, fresh fish, beef and bakery products.

The import volume of agricultural products in Estonia is slightly larger than the export value, and it has increased in recent years. In 2010 agricultural and food product exports made up 10 % of the total export volume and 11 % of the total import volume. The principal import partners are Latvia, Lithuania, Finland and Sweden, which are also the main export partners, including Russia. The main export production includes milk, fish, meat and beverages.

Nowadays more than one third of food consumed in Latvia is imported, mainly from the Netherlands, Denmark and Lithuania. In Latvia the most imported vegetables and fruits are tomatoes, lettuces, pears, and plums. The most imported animal products are milk powder and canned milk, poultry and cheese. At the same time, the most important food export products are of animal origin, such as meat and meat products, and cheese, but also including cereals. In Latvia food production accounts for 26 % of total export value, and the main export countries are USA, Russia and the Netherlands. For Latvia fish is one of the most important food sector export products after cereals and beverages, and it is also an important Finnish export item.

The trade among Finland, Estonia, Latvia and Sweden is economically significant. Pork is exported from Finland to Estonia and meat products from Estonia to Finland, whereas beef is traded between Finland and Sweden. Cereal products, milk, dairy products and poultry meat are exported from Estonia to Latvia and Finland, and milk and dairy products to Estonia from Latvia and Finland. Fish products are exported from Finland to Estonia and Sweden.

### *Organic farming*

Organic and natural products are gaining more and more in popularity and the demand for organic food is increasing. The consumption of organic food varies among income and age groups and differs between young families and those households with older people.

Currently 5.9 % of farms in Finland are included in the organic farming inspection system, which translates into over 4 000 organic farms. The market share of organic food in Finland is about 1 % of total food sales and one fifth of Finns regularly eat organically produced food. Since 2000, the number of organic farms in Finland has decreased by one fifth.

The organic land area in Estonia is about 122 000 ha, which accounts for 13 % of all agricultural land in use and there are over 1 400 organic producers. There are approximately 4 000 organic operators in Latvia, which includes 4 % of all farms in the country.

The production of organic meat is very low in Finland, and Finns prefer organic milk, bread and vegetables, especially tomatoes. In Finland dairies received 29.4 million litres of organic milk in 2009, whereas in Estonia only a single milk enterprise produces organic milk. In Estonia the number of organic dairy farmers has decreased during recent years and some of the enterprises have switched over to beef farming.

In Finland most of the organic land area produces grass, oats, and green fallow. Also rye, wheat and turnip rape are cultivated organically in Finland. In Estonia almost half of all sheep are organic, as well as 7 % of cattle and 2 % of cows. In Latvia most organic land is devoted to grasslands and pastures, crops and other cultivation.

### *Fish and fisheries*

In the Baltic Sea, fish is caught both from the open sea as from coastal waters. The most significant fish species caught from the open sea are Baltic herring and sprat. In the coastal areas pikeperch, perch and whitefish represent a major part of the total fish catch.

The most fished species differ between countries and fishing areas, but sprat and Baltic herring are commonly fished in Latvia, Estonia and Finland. The most caught species in Latvia and Estonia is the European sprat, which represents over half of the total fish catch. The second most fished species is Baltic herring, followed by Northern prawn in Estonia and by Atlantic cod in Latvia. In Finland the catch of European sprat is slightly smaller than the catch of Baltic herring, which constitutes half of the total fish catch. The total fish catch in Finland is almost entirely comprised of these two species, when the third most fished species is freshwater bream, which represents 1 % of the total fish catch. In Estonia other fished species are European perch and Atlantic cod and in Latvia Atlantic redfish and European smelt. In 2010, 165 million kg of fish were caught in Latvia, of which 79 million kg was from the Baltic Sea. In the same year the catch of Finnish commercial fishermen in the area totalled 122 million kg.

Rainbow trout is farmed for consumption in Finland and in Estonia, and the major part of the fish farming in Finland is within seawaters. In Finland 12 million kg of farmed fish, which was mostly rainbow trout, went for domestic consumption in 2008.

Fish stocks have been declining in the Baltic Sea, and this change can be seen in all project countries. Some fish stocks, especially of cod, are overfished and the catches of migratory species and some coastal species are low. In addition, some fish stocks have slightly increased. During the last ten years there has been an increase in the scad and sardine catch, and a decrease in sprat, cod and Baltic herring.

Fishing is one of the main economic sectors in Latvia, and in the project area there are over 120 companies related to fishing and fish processing. Fish is also one of the Latvia's most important food sector export products: in 2010 it was the most important export product after cereals and beverages.

In recent years the consumption of fish in Estonia has been increasing, even if the importance of local fish products has decreased and consumers grade the quality of local fish and fish products only as acceptable rather than good. In Finland only 9 % of the commercial fishing catch is used for human consumption, the rest is exported or used for fodder. Recreation fishing produced more food for human consumption, 74 % of the total catch.

### *Food consumption*

Food and water are basic human needs, and at the same time food is one of the most important sectors that make a significant impact on the environment. Environmental impacts of food production are related to farming, food processing, food packaging, transportation, retail and distribution, as well as food consumption. Consumption of animal-origin food has a larger impact on climate change than consumption of plant-origin food.

Dietary habits and food choices vary according to gender, age, area and income. Women eat more vegetables, fruits and berries in Finland and in Estonia than men, but in Finland men consume more bread and potatoes. In Estonia potatoes are consumed more among people with lower monthly income. The consumption of food also varies between different areas: for example, people living in eastern Finland eat bread more than those living in other parts of the country. In Latvia rural residents consume more animal-origin food than urban residents, who consume more vegetables, fruit and sweets, whereas fish products are mostly consumed by people with a higher education level and income and who are aged between 25 and 54.

Low-fat milk is the most favoured milk among boys and men in Finland, whereas girls and women prefer skimmed milk. The total consumption of liquid milk products in Finland has decreased, while cheese consumption is increasing. Milk products are widely consumed by Estonians, regardless of age and sex, but 19 % of males and over 25 % of females do not normally drink milk.

Latvians consume cereal products (mostly bread) at a level of over 37 kg, potatoes 88 kg and meat over 80 kg per annum on average. Fish consumption is considerably lower, about 12 kg per annum on average. The most consumed vegetables among Latvians are tomatoes, cabbage and cucumbers, and the most favourite fruits are apples.

In Finland the total meat consumption was 76.2 kg/capita in 2010. Pork was most popular, and it was consumed at 34.9 kg/capita. Nearly equal amounts of beef and poultry meat were consumed, 18.6 kg and 18.2 kg/capita respectively.

When looking at the results from the EFSA food consumption database in Finland, liquids (tap water, milk, coffee and fruit juices) are the most consumed items. In Estonia potatoes and potato products are most consumed and after that liquids (coffee, milk, tea, water and beer). In Latvia tea was most popular, after that ready-to-eat soups, potatoes, potato products and bread. In Estonia there were available data only for adults, in Finland data were missing for adolescents and in Latvia consumption data for elderly people. The data from Estonia were from 1997, so it is possible that consumption has changed over the ten years since then.

### *Current state recommendations on food*

The National Institute for Health and Welfare has been following the dietary habits and nutrient intake of the adult Finnish population for almost 30 years. Currently the major food-related health risks in the Finnish population are obesity, adult-onset diabetes and dental caries. Some nutrition recommendations have been provided to improve the eating habits of the population, and to guide different groups of people towards healthier dietary habits.

One of the aims in Estonia is to increase the consumption of vegetables and fruits and similarly to the Nordic Nutrition Recommendations and state recommendations on food in Finland, take into account the importance of physical activity.

According to Estonian food recommendations, bread should be the basic food and at least 4-7 portions should be eaten every day. Bread and black bread together with milk and milk products are the most common food products consumed by school-aged children every day, and rye bread should be preferred over white bread. The recommendations also include nutrition and physical activity advice for the elderly, recommendations on food for children and recommendations on nutrition and food consumption for pregnant and lactating women. The same has also been done in Finland and Latvia, where pregnant women are advised to avoid certain foodstuffs, for example pike, and to limit the consumption of large Baltic Sea herring and salmon due to the concentrations of potentially toxic chemical compounds in these fish species.

In Finland and Estonia it is recommended to increase the consumption of fish because of the healthy acids, fats and vitamins fish contains. In Estonia fish is recommended to be eaten at least 3 times a week, in Finland at least twice a week and in Latvia cultivated fish or fish caught from internal waters can be eaten as an everyday food. In Finland it is recommended to vary fish species in the diet, and in Latvia there are special recommendations about the consumption of fish for pregnant and lactating women and children; they should not consume more than one portion (140 g) of fish and fish products twice a week. Smoked, salted, dried and pickled fish should not be consumed more than once a month, fish liver and other sub-products or canned cod liver should be eaten more rarely. Pregnant women are also recommended not to consume raw fish and non-cooked fish products.

In Latvia it is recommended not to use fish or fish products in food for infants and small children until they reach 2 years of age. Breastfeeding should continue for as long as possible so that the child receives mother's milk at least until the age of one. According to the Food Health Pyramid in Latvia, half of the daily energy intake should come from cereal products and potatoes, 30 % from fruit and vegetables, and 15 % from different animal-origin products, such as milk, eggs, fish, and meat. The permitted amount of sweets and fats should be 5 %.

In Estonia it is recommended that meat be avoided during 3-4 days a week. Low fat lean meat, bird meat and fish should be eaten more often instead of fatty meat products, which should be consumed less frequently also in Finland. In both countries the consumption of vegetables, fruits, berries, potatoes and whole-wheat products should be increased and the use of salt, sugar and hard fats decreased.

### *Hazardous compounds*

In the HELCOM 2010 assessment the status of hazardous compounds was assessed and classified for 144 sites in the Baltic Sea. An integrated assessment and classification of "hazardous compounds status" was produced and used to evaluate whether the overall goal of "a Baltic Sea with life undisturbed by hazardous compounds" had been achieved. The quantification of the "hazardous compounds status" was based on a Contamination Ratio (CR), which is the ratio of the current status and a threshold level or quality criterion, which is used as an approximation for an environmental target for that particular substance or biological effect. The CRs of all compounds or indicators within an ecological objective are integrated, yielding a status classification ("high", "good", "moderate", "poor" and "bad") of that particular ecological objective.

All open sea areas of the Baltic Sea were classified as "disturbed by hazardous compounds", receiving a classification status of "moderate", "poor" or "bad". The only exception was the northwestern Kattegat, which received a status classification of "good". Open waters in the Northern Baltic Proper, Western and Eastern Gotland Basins, Gulfs of Finland and Gdansk received the worst status classifications (bad or poor), while the open sea areas in the Gulfs of Bothnia and Riga, Arkona and Bornholm Basins and Danish open waters were mainly classified as being of "moderate" status. Only six out of the 104 coastal assessment units were classified as being "areas not disturbed by hazardous compounds", receiving a status classification of good or high. The coastal areas that received the highest status classifications were located around the Åland islands, in the Kaliningrad coastal area, on the Lithuanian coast, in the Kattegat and on the Finnish side of the Bothnian Bay. There was some tendency for the units with the poorest status to be located either near big cities or ports (Tallinn, Klaipeda) or to be estuarine areas (Kymijoki estuary in the Gulf of Finland), Kvädöfjörden in the Western Gotland Basin) or coastal sites (the Kiel bay area). The waters near big coastal cities were mostly classified as being of “moderate” hazardous compounds status (e.g. St. Petersburg, Helsinki, Stockholm, Riga, Gdansk and Copenhagen).

### *Nutrient load and emissions*

Agriculture and the food chain are largely responsible for eutrophication and pollution of waterways. Food consumption represents a significant part of the environmental load of households and, in addition, food can contain hazardous compounds resulting, for example, from farming and livestock production and traces of harmful chemicals, like fertilisers. The share of agriculture in certain chemical emissions to the Baltic Sea in Finland, as well as of nitrogen and phosphorus leaching, has been estimated to be over 90 %. In Latvia it is estimated that more than 70 % of the total nitrogen and more than 40 % of the total phosphorus inland load is caused by various human activities, such as waste water discharge or runoff from agricultural land and forests.

In 2008 a total of 580 600 tonnes of nitrogen and 25 300 tonnes of phosphorus entered the Baltic Sea through waterways and more than half of both nutrients originated from diffuse sources. In 2008, 100 000 tonnes of nitrogen and 5200 tonnes of phosphorus leached into the Baltic Sea from Finland, making Finland responsible for 17 % of the total nitrogen load and 21 % of the total phosphorus load. Estonia’s nitrogen load was 46 230 tonnes, accounting for 8 % of the total load, with the phosphorus load being 1 370 tonnes. This was 5 % of the total load entering the Sea. Latvia’s share of the total nitrogen load was 90 000 tonnes, 15 % of the total load, and the phosphorus load was 3 000 tonnes (12 %). Both N and P fluxes vary significantly from year to year depending mainly on hydrological conditions.

Increase in nutrient and chemical concentrations causes several problems to the Sea. For example, eutrophication results in algal blooms, which can be harmful to numerous species. Water turbidity decreases the recreational value of the Sea and increased vegetation makes commercial fishing difficult by soiling the equipment, particularly the nets. Eutrophication also increases hypoxia, which is already a problem of sea bottoms. Also several harmful leached compounds accumulate in the marine food chain and exceed the maximum allowable limits in some fish species from the southern coast of Finland, making the frequent consumption of certain fish species unhealthy.

One of the actions aimed at improving the state of the Baltic Sea is the HELCOM Baltic Sea Action Plan. Its aim is to achieve good ecological status in the Baltic marine environment by 2021 by decreasing the amount of phosphorus and nitrogen entering the waters. The annual phosphorus load should be decreased by 150 tonnes in Finland, 220 tonnes in Estonia and 300 tonnes in Latvia, and the nitrogen load by a corresponding 1 200 tonnes, 900 tonnes and 2 560 tonnes.

The eutrophication intensity varies among different foodstuffs: beef has the highest eutrophication intensity of all meats, about three times higher than that of pork, and seven times that of poultry. The eutrophication intensity of milk is relatively low. Nevertheless, the values associated with beef and milk are partly bound together, since a significant share of beef comes from milking cows. The eutrophication impacts of plants also vary among species: grain has the highest intensity of the plant-based raw materials.

The modelling shows that eutrophication can be reduced by about 7 % by changing the food consumption habits towards a recommended direction, and currently private food consumption is not far from being in accord with recommendations. The major shift, about 7 % units from protein to carbohydrates, was reached in the scenario by applying a reduction to all protein foods, and an increment to all carbohydrate foods. This is because the foods containing animal proteins have greater eutrophication potential than carbohydrate foods, and shifting from the use of protein foods to carbohydrate foods should influence the state of eutrophication.

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# Introduction

„The Baltic environment, food and health: from habits to awareness – FOODWEB' project contributes to the Central Baltic IVA Programme 2007-2013 *(1)*. A European territorial co-operation programme funds cross-border projects in the central Baltic Sea area, comprising parts of Estonia, Finland (incl. Åland), Latvia and Sweden (Figure 1 *(2)*). The Programme aims to fund projects to a total of 96 MEUR from the European Regional Development Fund before the end of 2013, with a focus on the environment, economic growth as well as development of attractive and dynamic societies.

The Central Baltic IV A programme area covers 180 000 square kilometres, which is 5 % of the total land area of the European Union. The total Baltic Sea catchment area is home to over 85 million people. At the same time, the 9 715 000 inhabitants of this area make up only about 2 % of the population in the EU. The population density throughout the area is rather small, at an average of 50 inhabitants per square kilometre. There are, however, large differences in population density within the area. The capitals of all four participating countries and Åland, along with several of the largest towns, are situated in the Central Baltic programme area. The Swedish and Finnish regions are some of the most densely populated in the respective countries. In contrast, there are largely rural, very sparsely inhabited areas in Estonia, Latvia and the Åland archipelago.

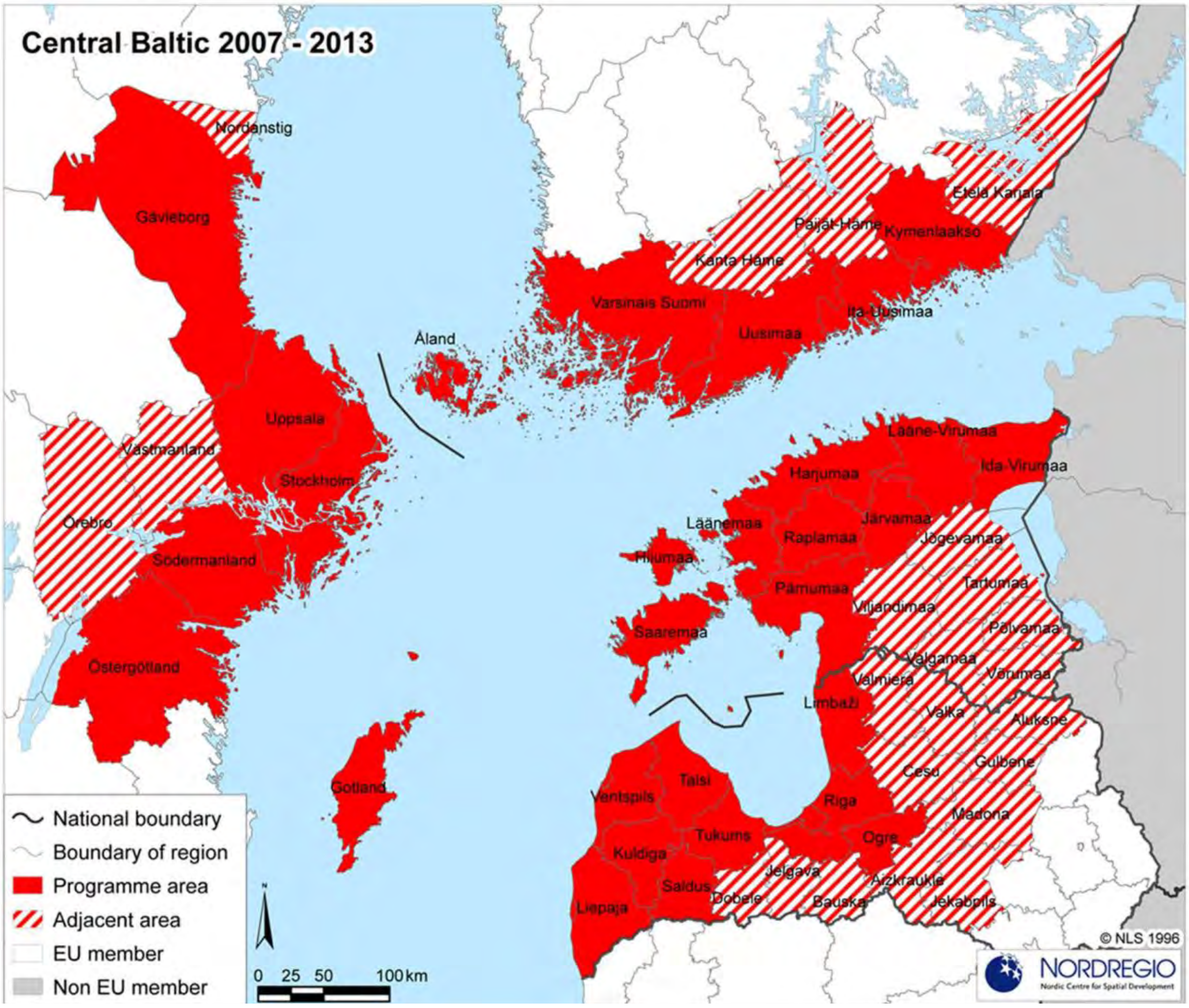



Figure 1. The Central Baltic Programme area. Finland, Estonia and Latvia take part in the Foodweb-project.

FOODWEB' is a project that aims to raise public awareness about the links between food quality and its origin, focusing on the Baltic Sea and its surroundings. Cultivation of food for humans and related production activities can impact negatively on the Baltic Sea, and aquatic food products from the Baltic Sea may cause problems to humans as a result of toxins in the marine environment. This is a circular problem in the Baltic ecosystem.

The aim of the project is to improve consumer knowledge of risks linked to the origin of food, and attempt to enhance consumer awareness of their impact on the status of the Baltic Sea. Consumers can influence the quality of the Baltic watershed through changes in land use and environmental deposition. The Baltic Sea has a large drainage area, four times larger than the surface area of the Sea itself. Consumers can have an impact on the environmental status of the Sea by requiring economic activities to minimise toxic deposits in the watershed. A topical example concerns minimising the dioxin content of Baltic Sea fish. Consumers have to be made aware of the risks associated with food choices and learn how to minimise them.

Information on nutrients, environmental indicators and regional risk indices will be compiled into a database and Web pages. This information will be used to help visualise environment-based risks associated with food choices, specifically regarding the Baltic Sea. In addition, the project will arrange training and distribute research information through exhibitions held at the AHHAA exhibition centre. We will collaborate with consumer advice NGOs in the Baltic Sea area and will train key groups of home advisors to become our advocates and disseminators of information throughout society. Information will be also distributed through the school system and training networks.

The food plate will be used as one example of a functional unit and will represent safe and sustainable choices of food items. We will compose a food plate according to the recommendations for energy and nutrient intake. The nutrient requirements will not be compromised, but environmental impacts of food and risks associated with the plate will be optimised. The FOODWEB project was funded from the Central Baltic INTERREG IV A programme, with a budget of about 1.5 million euros. The working model will be designed first for Finland, Estonia and Latvia, but later it can be applied to other Baltic areas included in the Baltic food shed.

The partners in the research consortium are MTT Agrifood Research Finland, the lead partner, and the Finnish Environment Institute, the Universities of Tartu and Latvia and the science exhibition centre AHHAA at Tartu. Hazardous compounds are taken into account from Sweden, collaborating with The Swedish Museum of Natural History.

### *Objectives of Foodweb-project*

Much has been done in order to improve the state of the Baltic Sea, but there remains a considerable amount to do before the targets are reached. The purpose of this project is to collect information and make it more accessible to consumers and more easily understood. Consumers will have access to information on the consequences of their actions, and they will be able to base their decisions on their own values and on reliable information.

Environmentally aware consumers demand safe food of high quality produced with minimal impacts on the environment, and in this respect the consumption and production of organically produced food is increasing. People are eager to know where and how their food has been produced, and what the associated environmental impacts are. The willingness to know about one's own possibilities to make changes has increased, and this is reflected in consumption habits; people are more aware of the impacts of their own choices, and new information about these issues is needed now more than ever before. In future conscious consumers will consider both ecological and ethical implications when selecting food products.

Even when the people know the environmental effects of their actions, habits are not easy to change. There is a lot of information available about food, healthy eating and associated environmental impacts, but people rarely consider these factors when shopping for groceries. One of the biggest challenges of the project is to break established habits and increase awareness. This goal can be reached by offering information in an easy-to-understand and well-arranged form and by helping consumers base their opinions not only their habits but also on new, reliable information about the health effects of their food choices. The aim is to redirect consumption habits towards a more sustainable direction and to improve the state of the Baltic Sea, which will ultimately lead to improvement in the quality of food originating from the Baltic food shed.

The focus of the project is the Baltic Sea and its surroundings, firstly concentrating on three countries, Finland, Estonia and Latvia. The project develops collaboration among partner countries in order to create a cross-border food strategy for the Baltic Sea food shed and to initiate mutual understanding and self-efficacy in management of the risks. The strategy created will enable sustainable consumption of natural resources and also lead towards the production of cleaner and healthier food in all countries. Through increased awareness it is hoped to heighten the interest of citizens about the state of the Baltic Sea and also encourage improvements in its state through mutual cooperation among all partner countries. The interest in the Baltic Sea varies among the countries, and some nations are not yet as conscious and concerned as others. The goal is to raise the awareness about food and the environmental effects of the entire production chain in all the countries concerned and to similar levels.

Values will be assigned to the environmental impact of certain foodstuffs and the volume of resources needed in their production. This will help consumers to recognise, analyse and interpret the environmental impacts and environment-based risks of their diet. The nutritional value of their diet will also be calculated in order to give people all the information they require. Consumers are also offered reliable tools to evaluate the healthiness and quality of the food they eat. Information about food production impacts on the environment, as well as environmental impacts on the food, will be evaluated and the information will be published in a public database. The project will also publish lunch plate models with ideal nutritional values to show how to choose healthy and also environmentally-friendly lunches of maximum nutritional value and with minimal environmental impacts. Information found during this project will be shared with the public through an Internet database. There will also be an exhibition set up in the science centre AHHAA in Tartu.

The project will gather not only information about food consumption habits and national nutritional recommendations in general, but also recommendations on food consumption in certain areas and for certain groups of people. This information will also be shared with the public through the database and through exhibitions.

The long-lasting impact will reached through directing efforts towards young families and schools by creating a collective learning model for children and by sharing information with the parents of young families. Partnerships will be created between countries, food chain stakeholders and NGOs. The working model created during this project will be built initially for three partner countries, but later it can be applied to other Baltic areas included in the Baltic food shed.

### *Objectives of feasibility Study*

The main goal of the feasibility study is to investigate background data which is used as a foundation in the following steps of the Foodweb-project. Detailed material flow analysis for Finland, Estonia and Latvia was done to estimate eutrophication load of the food chain. The eutrophication potential values of specific foodstuffs are needed for the database in which information about food items, hazardous compounds and environmental impacts are entered. This study also forms the basis for the awareness study.

This feasibility study provides answers to the following questions:

1) What are volumes of food produced and consumed in the area?

2) Which are the most important food material flows for food system sustainability and environment-based risks?

3) Which key groups of consumers are at risk?

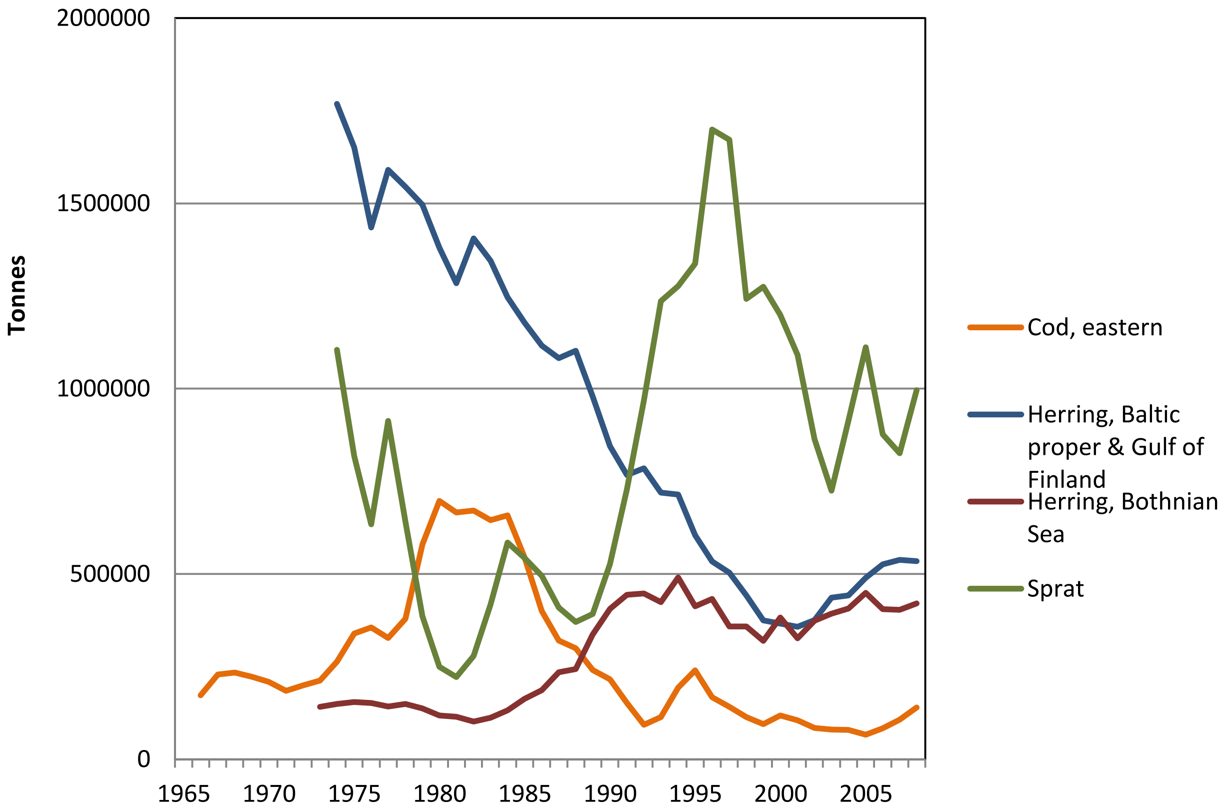
# 1. Background

The water in the Baltic Sea is brackish, its average salinity being lower than 10 PSU (1 % salinity equals 10 PSU) compared with the global oceanic average salinity of 35 PSU. Surface salinity is greatest in the Danish Straits close to the Atlantic and decreases as one travels towards the Bothnian Bay (Figure 2). Due to freshwater runoff surface salinity increases towards the bottom in most Baltic basins but the salinity difference between surface and bottom decreases from the Danish straits towards the Bay of Bothnia. The salt Atlantic water in the Baltic deep basins is renewed only through irregular oceanographic events termed salinity pulses, created by extraordinarily strong and long-lasting winds pressing surface waters through the Danish Straits from the Atlantic. The latest notable salinity pulse occurred in 2003 *(3)*.


Figure 2. Average surface salinities (PSU) in the Baltic Sea, *Picture: Hermanni Backer, HELCOM.*

The water in the Baltic consists roughly of two layers: surface and bottom waters. Salinity changes abruptly at a depth of 50-80 m from the fresher surface waters to the saltier deepwater. This depth of rapid change in salinity is termed a halocline and it is a permanent phenomenon in the Baltic Sea. Due to the constant density difference between surface and bottom waters in the Baltic, the less dense surface waters are not easily mixed with the denser deepwater. Deepwater oxygen is thus minimally replenished from atmospheric oxygen diffusing to the surface waters and requires saltwater pulses from the Atlantic for replenishment. Hypoxia - low levels of oxygen in bottom waters - occurs regularly in the Baltic Sea. The total area of sea bottom covered with hypoxic waters, with oxygen concentrations less than 2 mg/l, in the Baltic has averaged 49 000 $km^2$ over the last 40 years. The ultimate cause of hypoxia is excess nutrient loading from human activities, which cause algal blooms. The blooms sink to the bottom and use oxygen to decompose at a rate faster than it can be added back into the system through the physical processes of mixing. The lack of oxygen (anoxia) kills bottom-living organisms and creates dead zones. Eutrophication is also seen on beaches, seashores and fishnets, which become slimy. The vulnerable species of the Baltic Sea also suffer from eutrophication. Eutrophication, on the other hand, causes increased production of fish biomass, but also changes in fish community structure and function in the Baltic Sea (Figure 3).

The ecosystems of the Baltic Sea are unique, due to the low salinity. Both saltwater and freshwater species can adapt and thrive here. But this also makes the Baltic ecosystems sensitive to changes brought about through human actions. Eutrophication is currently one of the greatest problems, but also harmful compounds derived from human activity reach the Baltic Sea from many different sources. The Baltic Sea has been exposed to extensive use of chemicals since the beginning of industrialisation and its marine environment has a long history of contamination. Thus the Baltic Sea has often been referred to as the most polluted sea in the world. Oil spills release large amounts of hydrocarbons into the Sea and radioactive fallout reaches the Baltic via either airborne routes or is carried by sea currents. Heavy metals, such as cadmium, lead and mercury, are directly harmful to the environment. A large variety of different compounds exceed the threshold levels set by different organisations and countries. These compounds include persistent organic pollutants (POPs), such as PCBs, dioxins, DDT/DDE, heavy metals (cadmium, lead), and organometallic compounds, such as TBT. Many of these accumulate in the marine food chain and may cause problems for wildlife and humans when consumed for human food. The same compounds represent an extensive regional risk if circulating in the food system.



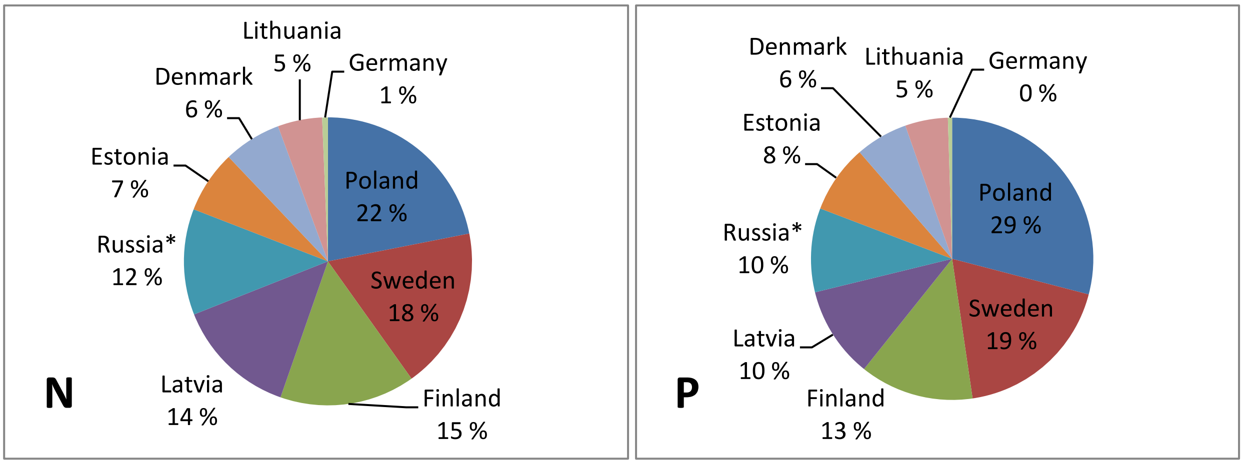

Source: Finnish Game and Fisheries Research Institute, ICES (www.biodiversity.fi).

Figure 3. Variation of fish stocks in the Baltic Sea from 1965 to 2008.

Agriculture is responsible for a large share of the leached nutrients in the aquatic environment. High area-specific nitrogen and phosphorus loads are related to high rates of agricultural activity, including large-scale intensive livestock farming as well as the intensive use of fertilisers in specialised conventional farming systems.

In 2008 the total waterborne input of nitrogen to the Baltic Sea was 580 630 tonnes of which approximately 25 % entered as atmospheric deposition on the Baltic Sea and 75 % as waterborne inputs (i.e. via rivers or as direct discharges). The total input of phosphorus into the Baltic Sea in 2008 was 25 299 tonnes and entered the Baltic Sea mainly as waterborne input with the contribution of atmospheric deposition being only 1-5 % of the total. The main source of nutrient loads in the Baltic Sea is agriculture.

The proportions of average annual nitrogen and phosphorus inputs into the Baltic Sea by HELCOM countries in 2008 are presented in Figure 4 *(4)*. The main contributors of nitrogen were Poland (22 %), Sweden (18 %), and Finland (15 %). The largest loads of phosphorus originated from Poland (29 %), Finland (19 %), and Sweden (13 %). The main contributing countries to the total waterborne inputs were Poland, Russia, Sweden and Finland. These figures include inputs from all anthropogenic sources as well as the natural background load. Appendix 1 presents the source apportionment of Tot-P and Tot-N loads by country in 2006 according to HELCOM 2011 *(5)*.




Source: HELCOM 2010 *(4)*.

Figure 4. The percentages of total loads of nitrogen (Tot-N) and phosphorus (Tot-P) to the Baltic Sea (tonnes) by Helcom country in 2008 (Russia 2007 data).

The HELCOM Baltic Sea Action Plan (BSAP) target is to achieve a good ecological status of the Baltic marine environment by 2021. To achieve this, emission reduction measures must be carried out by 2016 at the latest by every country. The amount of phosphorus must be reduced by 150 tonnes in Finland, 220 tonnes in Estonia and 300 tonnes in Latvia and the amount of nitrogen by 1 200 tonnes, 900 tonnes and 2 560 tonnes, respectively *(6)*.

According of the Council Directive 91/676/EEC *(7)*, concerning the protection of waters against pollution caused by nitrates from agricultural sources (Nitrates Directive), the Member States have designated the Nitrate Vulnerable Zones. The most important nitrate leaching risk factor is intensity of farming (share of arable land and land use). The risk of nitrate pollution is greatest when levels of available nitrate, especially in the soil surface, are high and in increasing flow conditions. Extreme weather conditions in summer and winter, due to future climate change, might increase the nutrient concentration in agricultural runoff and increase the role of diffuse pollution. To protect water and soil from diffuse source pollution, 12.7 % of Latvian, 7.5 % of Estonia and 100 % of Finnish territory under intensive agricultural production has been defined as a nitrate-vulnerable zone. Various restrictions have been imposed on agricultural production in this area: buffer zones, limitations on the application of fertilisers, requirements governing manure storage, soil treatment methods, etc.

The food sector is one the three most resource demanding and polluting sectors and is a large user of energy. Greenhouse gas emission, which has increased markedly due to immense energy use, has resulted in global warming, perhaps the most serious problem that humankind faces today. Food production, preservation and distribution consume a considerable amount of energy, which contributes to total $CO_2$ emission. Nowadays consumers demand safe food of high quality that has been produced with minimal adverse impacts on the environment. There is increased awareness that the environmentally conscious consumer of the future will consider ecological and ethical criteria in selecting food products. It is thus essential to evaluate the environmental impact and the utilisation of resources in food production and distribution systems for sustainable consumption.

The focus of the project is on the Baltic Sea and its surroundings. The project clarifies and interprets the relationship of people, food and environment in terms of how the state of the environment impacts on our food and safety, but also how human activities impact on the environment. Through research collaboration the partners will open up data sources for public use. The project will result in new tools to combine and interpret environmental impacts and environment-based risks to food consumers.

# 2. Methods

The methods are chosen to meet the challenges of linking environmental sustainability issues with the daily food choices of consumers, with particular reference to the Baltic Sea. Improving sustainability requires a thorough understanding of the relationships between the food we eat and all those activities that affect the Baltic Sea environment.

By using a visual method, the food plate model, we will build up a concrete and comprehensible interface for the consumers that demonstrates the sustainability aspects associated with their food choices. The main method that will be used to link food plate models with environmental sustainability measures is life cycle assessment (LCA). Material flow analysis (MFA) will be used as a complementary tool to expand the variety of the individual plate components, and to generate information on the potential risk elements in the food chains. MFA results will also be used to describe and explain the environmental impacts of the food chains of the regions under study.

## 2.1. The food plate model

The food plate model is commonly used in Europe for informing consumers how to plan their meals in a healthy and tasty way. Plate models are applicable to all population groups, from children to elderly people, and from normally healthy people to people that need special diets. The model plate is divided into three parts: one half of the plate is filled with non-starchy vegetables, one quarter with a serving of protein, i.e. meat or meat substitute, and one quarter with a serving of a carbohydrate source, such as potatoes, pasta or beans. The meal is completed by adding a serving of milk and a serving of bread and fruits as side dishes. An essential part of plate the model is a visualisation of the meal (Figure 5). The model is beneficial for learning, since it concretely demonstrates the connection between dietary theory and practice, makes it easier to remember and understand through the visual message, and helps present nutrition counselling as a positive issue *(8)*.

Figure 5. The food plate model.

*Source: Valtion ravitsemusneuvottelukunta, National Nutrition Council.*

The exemplified food plates are used to raise the awareness of the environmental impact of various food choices, and to assist in planning meals that are both healthy and environmentally agreeable. The meals composed according to the food plate model provide a varied and tasty diet. The plate model is used to explore which kinds of meal compositions are environmentally benign, and which may contain harmful compounds or represent some other kinds of health risks. With visualising risks and benefits as a part of daily life, consumers will assimilate the given information better. The example lunches all represent a nutritional total corresponding to the recommended for 1/3 of the energy and the nutrient intake through daily food consumption.

## 2.2. Life cycle analysis (LCA)

Life cycle analysis (LCA) is a technique used to assess environmental impacts associated with the stages of a product's life cycle, through raw materials production, processing, manufacturing, energy inputs and use of the product to recycling or waste disposal. To conduct an LCA, a flow model of the technical system is constructed using data on the inputs and outputs of the interlinked processes to produce a specific, desired final output. Typically, inputs comprise raw materials, intermediate products, fuels and energy. Outputs include products, by-products, wastes and emissions to air, water and soil. The flow model is illustrated with a flow chart that includes the activities that constitute the supply chain. The flow chart gives a picture of the system boundaries. Usually, it also serves as a user interface to the model construction, system solution, and the results. The input and output data needed for the activities within the system boundary are collected to construct the model. Indicators, which describe the environmental impacts, are obtained by means of characterisation from the solution of the system for a specific boundary condition, which in LCA terms is termed the functional unit of the system. Such indicators include carbon dioxide equivalent ($CO_2$-eq, carbon footprint), eutrophication of aquatic environment ($PO_4$-eq, acidification and tropospheric ozone formation. LCA coupled with other approaches, such as water footprints, risk indices and indices of environmental and overall sustainability, provides even more comprehensive information to environmentally aware consumers, producers and policy makers for selecting and developing sustainable products and production processes.

**Carbon dioxide equivalent** describes the potential for global warming of a given amount of a greenhouse gas. The primary greenhouse gases are carbon dioxide $CO_2$, methane $CH_4$ and nitrous oxide $N_2O$. When calculating the $CO_2$-equivalent, the amounts of $CH_4$ and $N_2O$ are multiplied by coefficients 25 and 298 respectively.

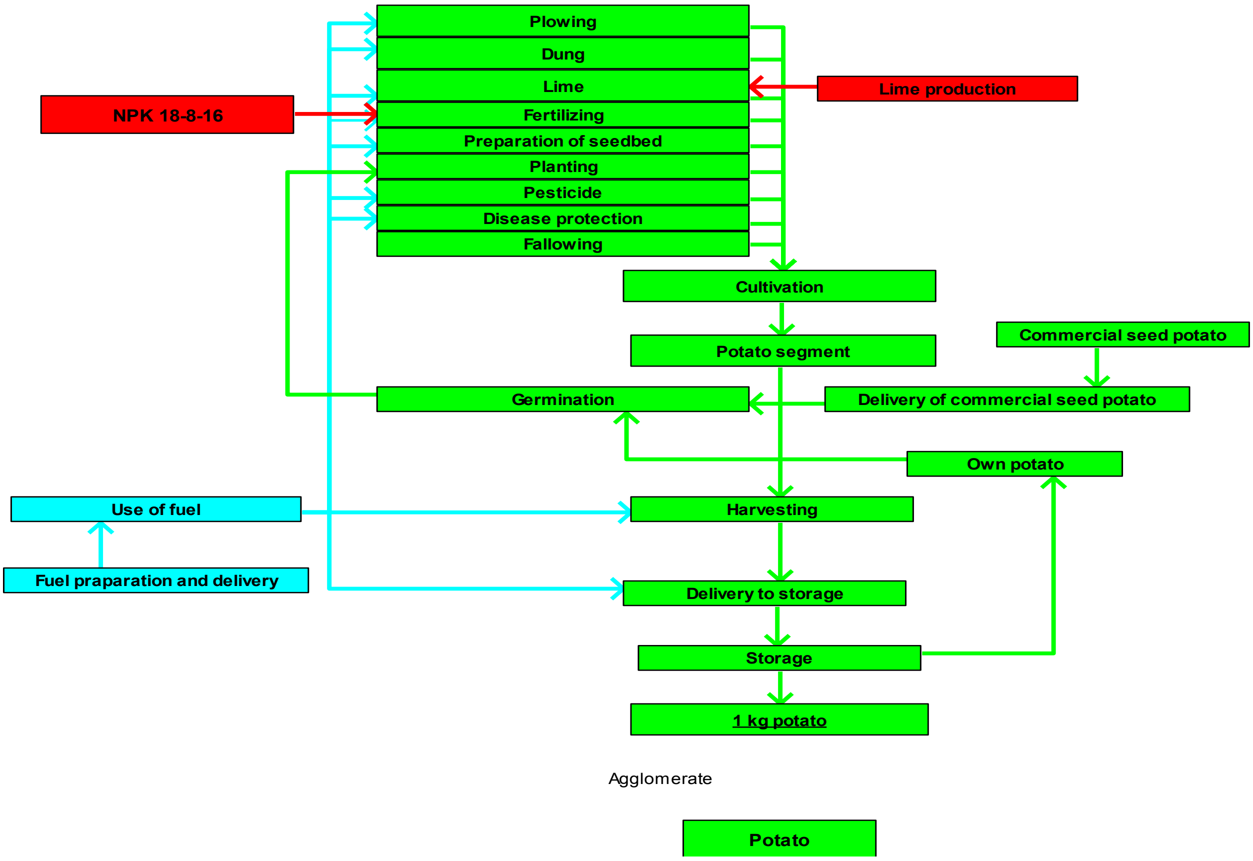
Phosphate and nitrogen are known as the most important nutrients causing **eutrophication.** Eutrophication potential is described by phosphate equivalents ($PO_4$-eq). Fertiliser runoffs from plant cultivation are the main sources of nutrient emissions in the food chain. When calculating $PO_4$-eq, N (water), P (water), $NH_4^+$ (water), $NH_3$ (air) and $NO_x$ (air) releases are taken into account by multiplying by the equivalent coefficients of 0.42, 3.06, 0.18375, 0.04025 and 0.01495 respectively.

**Acidification** occurs when the capacity of the ecosystem to neutralise acidifying loads declines. Acidifying loads are chemical compounds that fall as particles and gases (dry deposition) or with rain and snow (wet deposition). An ecosystem may lose its neutralising capacity completely if acidifying loads continuously exceed the tolerance levels. Acid depositions also damage buildings and other corrodible objects in the man-made environment. Acidification is caused by oxides of sulphur and nitrogen ($SO_2$ and $NO_x$), and ammonia ($NH_3$). Acidification potential is expressed as AE –equivalents. Characterisation coefficients vary geographically because the state of the tolerance exceeding (accumulated exceedance, AE) is very different in different regions.

Tropospheric (ground-level) ozone is linked to smog, which causes serious human health problems in many cities. Ozone ($O_3$), which is a natural component of the troposphere, becomes a pollutant at abnormally high concentrations. It is involved as a reactant and a product in the formation of photochemical smog by a chemical reaction between sunlight, nitrogen oxides (NOx) and volatile organic compounds (VOC). Smog is harmful also for animals and plants. An exposure to abnormally high concentrations of ozone is phytotoxic, and thus affects, for instance, the yields of crops. The potential for tropospheric ozone formation is expressed in person-ppm-hour exposure-equivalents.

### *LCA model for raw materials production*

As an illustration of an LCA model for raw material production Figure 6 shows an LCA flow chart for potato production on a farm. The flow chart includes several activities (modules) e.g., ploughing, sowing, harvesting and storage. Input data describe the amounts of the commodities used, e.g. fertilisers, lime, seeds, pesticides, fuels, and energy, and output data the amounts of the materials produced, i.e. potato, greenhouse gas emissions, acidifying emissions, VOC emissions and the runoffs of nitrogen and phosphorus etc. The flow chart can be aggregated into a single module, sub-system agglomerate, which contains all inputs into and all outputs out of the system presented by the flow chart.

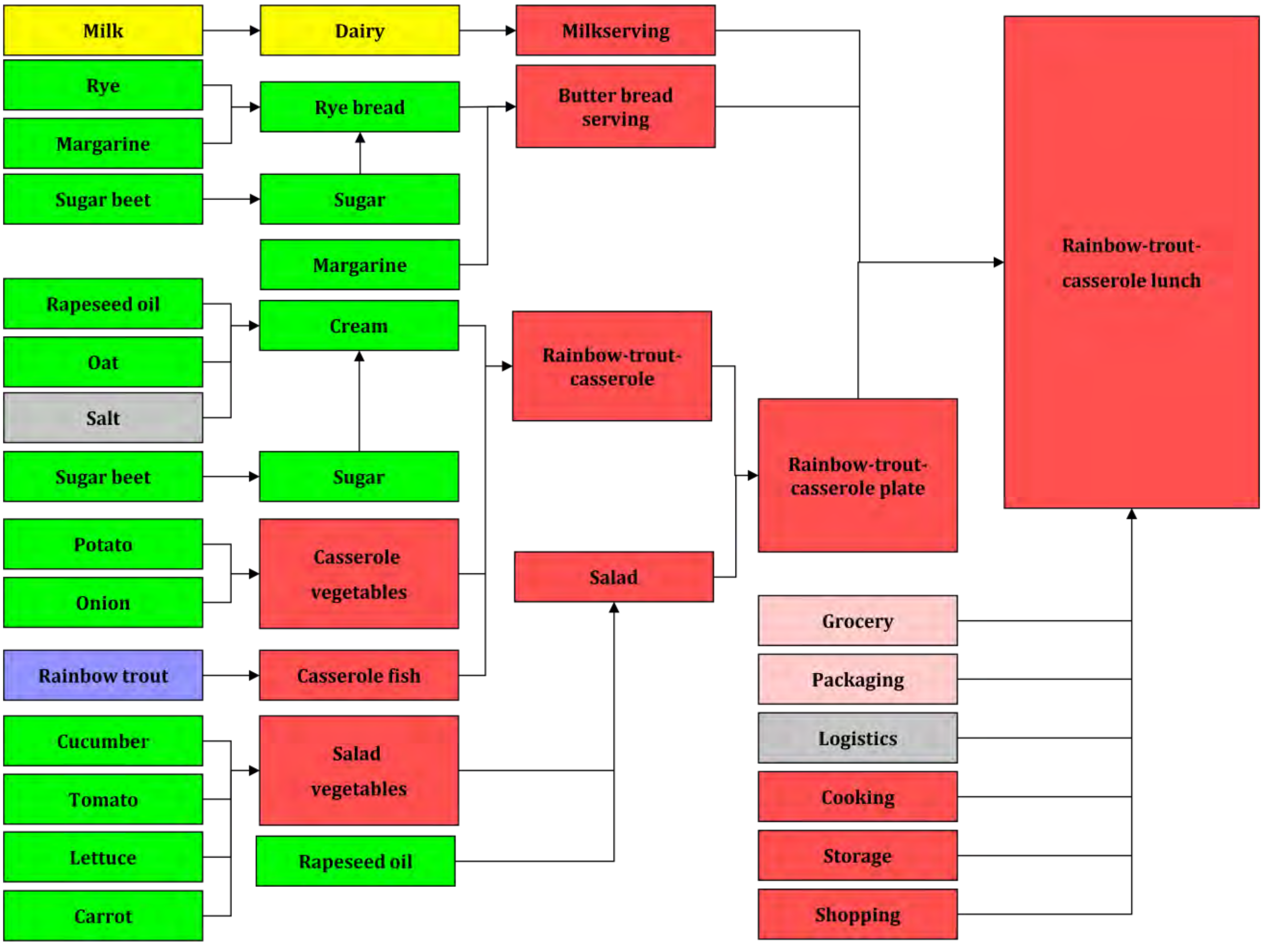



Colours: green = plant production stage, blue= fuel, red= agro-chemicals production.

Figure 6. LCA flow chart for potato production. Potato-agglomerate includes the whole model as a single module.

### *LCA model for food plates*

Figure 7 shows an LCA flow chart for a lunch of rainbow trout casserole. It consists of the actual lunch plate with rainbow trout casserole and vegetable salad, and the buttered bread and milk servings that accompany it. The salad dressing is rapeseed oil and the bread is buttered with margarine. Raw materials are linked to the model as agglomerates, as are packaging, grocery, logistics, as well as shopping, storage and cooking at home. The main input data include the amounts of natural raw-material supplies and primary energies. The main output data consist of the amounts of greenhouse gas emissions as well as of nitrogen and phosphorus emissions to water. The lunch plates are adjusted according to national nutrition recommendations as discussed above. In this study, numerous different lunches will be modelled.

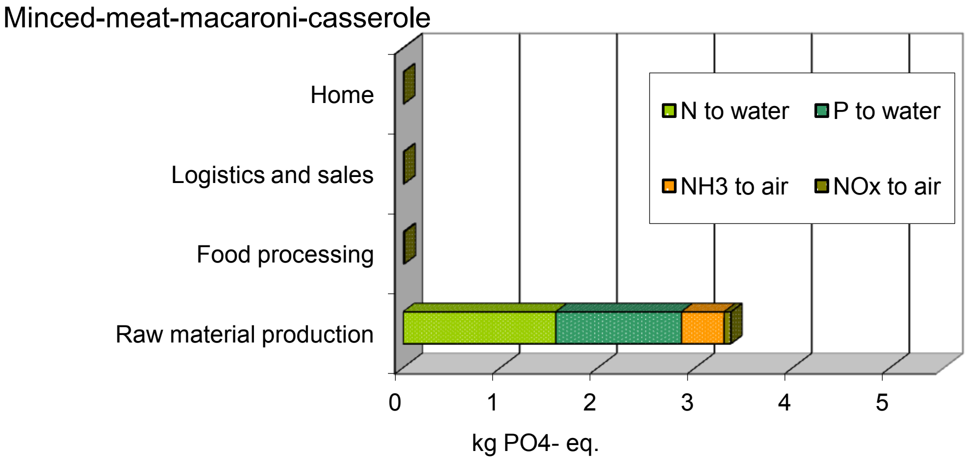



Colours: green = plant products, yellow=milk, blue= fish, pink= sales, gray= other products and services, red= home.

Figure 7. LCA flow chart for a lunch of rainbow-trout-casserole.

### *Findings of a Finnish Food Plate LCA study (ConsEnv)*

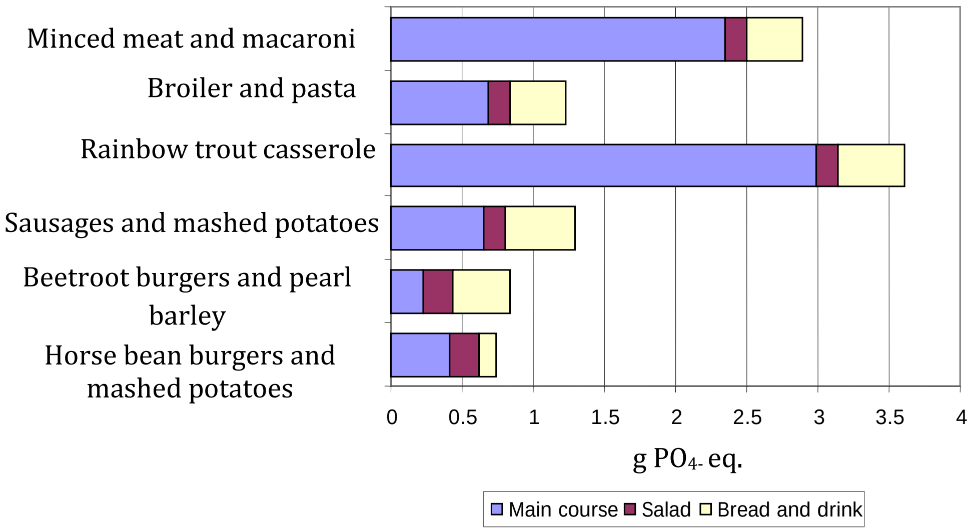
Eutrophication is currently one of the major problems of the Baltic Sea (FoodBalt-project). The following figures provide perspective on the eutrophication impacts dishes may have. Figure 8 illustrates the formation of the eutrophication impact of a lunch at different phases of the chain, from raw material to the final food preparation at home. Over 90 % of the eutrophication impact stems from the raw material production. According to the findings of the ConsEnv–project (Environmental impacts of consumer choice and communicating them to consumers, examples of environmental impacts of foodstuffs and housing) *(9)*, the dependency between climate change and eutrophication impacts, under Finnish production conditions, is strong. Thus, by the choice of food items one can simultaneously decrease both major impacts.




Source: Saarinen et al. 2011 *(9)*.

Figure 8. Eutrophication impact of different food processing phases.

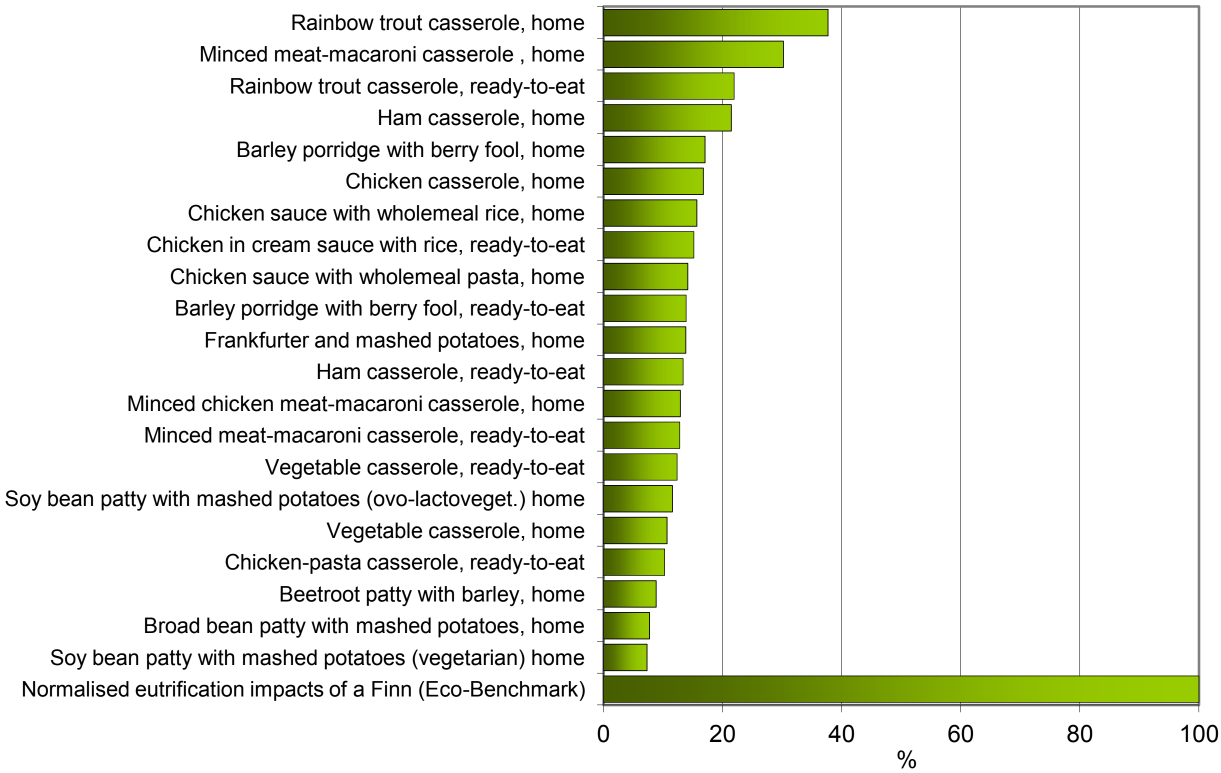
Figure 9 shows an example of how various food portions can be compared with each other. The reason for the high impact of rainbow trout casserole is that rainbow trout is a farmed fish.




Source: Saarinen et al. 2011 *(9)*.

Figure 9. Eutrophication impacts of some dishes, g $PO_4$ eq.

[Figure 10](#) presents an example of how environmental impact of a food portion can be compared with daily environmental impact of an average Finn. The share of food ranges between 7-40 % and is lowest when vegetable lunch plates are preferred.




Source: Saarinen et al. 2011 *(9)*, Method from Eco Benchmark project *(10)*.

Figure 10. Eutrophication impact of the case lunch plates in relation to the normalised daily eutrophication impact of an average Finn.

## 2.3. Material flow approach (MFA)

Materials flow analysis (MFA) is a systematic approach used to explore how materials appear in economic systems, and how they affect the environment. The essential goal of this approach is increased understanding of the interactions between the economic and natural systems. The principal instrument used to seek this goal is a model of the internal relationships of the economic system and its interrelations with the environment.

MFA is a rapidly expanding field of sustainability assessment and has been applied to a broad range of issues, from flows of individual compounds to economy-wide total material flow accounting. It is typical for MFA that, unlike with LCA discussed above, focus is on materials rather than products. MFA is practicable when entire economic systems are considered with feedbacks from the industries, such as flows of by-products.

The MFA approach can support the LCA approach in this study in two principal aspects. Firstly, it represents a feasible method to generate information on the specific risk compounds in the food chains. Secondly, MFA has been applied to national economies, and has produced information on the environmental impacts of food commodities that can be used to fill gaps in the LCA data when building the sustainability information tool for consumers. MFA results can also be used to describe and explain the environmental impacts of the entire food chain.

Economy-wide material flow analysis will become a standard and comprehensive statistical exercise in the EU by 2013. The Eurostat guide *(11)* describes the general framework and methods for compiling these MFAs. Economy-wide MFA has been carried out for many countries in the EU, but data availability is not adequate for all countries to allow comprehensive compilation.

Economy-wide MFA describes quantitatively the materials and energy entering and leaving an economy. An economy is regarded as a system that is surrounded by the global environment, and interacts with it by flows of materials and energy (Figure 11). In this respect the economy is analogous to natural ecosystems. This conceptual resemblance with living ecosystems is reflected also in the characteristic terminology of MFA, as “industrial metabolism”, “societal metabolism” or “industrial ecosystem”. The environment constitutes the natural environment and other economies.

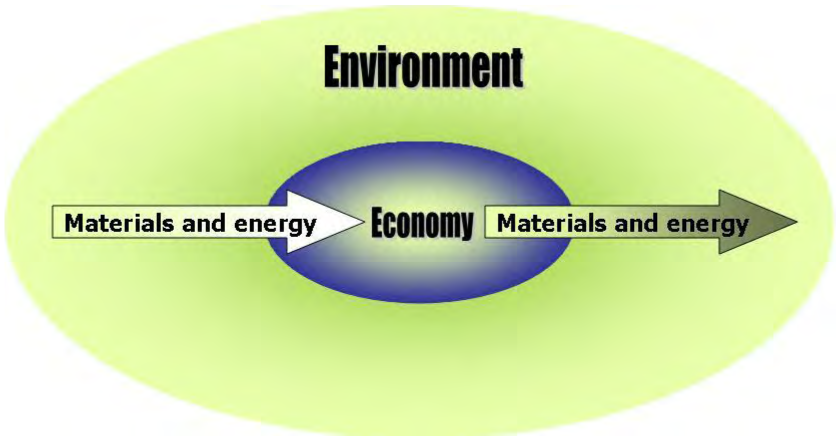



Figure 11. Conceptual economy-environment system.

The principles of the conservation of mass and energy represent the physical foundation of MFA and are expressed by balances:

total inputs = total outputs + accumulation

Balances are drawn over a specific period of time, normally a year, corresponding to the normal rhythm of national accounting. Flows covered by MFA include materials and energy (from natural environment and from other economies as imports) into and through the economy, accumulation into the economy (e.g. to infrastructure and durable goods), as well as outputs to other economies (exports) and the emissions and wastes into the natural environment. So-called unused domestic extraction (UDE) is in most cases taken into account in modern MFA studies. These flows, also called hidden flows, are generated by raw-material extraction, but do not enter the economy for further processing. Consequently, UDE flows have no economic value. Examples of UDE flows are side-stone from mining and harvest residues from agriculture.

### *Data sources used in MFA studies*

MFA studies have used many kinds of data and data sources, depending on the goal, scope and selected approach of the study, as well as the availability of the data. MFA is often coupled with existing economic accounting systems, which readily offers access to comprehensive data on most of the MFA system variables, like industry-wise input-output economic and physical data, respective data on export, domestic end-use and imports, industry-wise emissions and waste data, etc.

The main indicators of material flow analyses are (Figure 12): input indicators - Domestic Extraction Used (DEU), Direct Material Input (DMI) and Total Material Requirement (TMR); consumption indicators - Domestic Material Consumption (DMC) and Total Material Consumption (TMC); balance indicators - Net Addition to Stock (NAS) and Physical Trade Balance (PTB); output indicators - Domestic Processed Output (DPO) and Total Domestic Output (TDO) and efficiency indicators - GDP per DMI, GDP per DMC and GDP per TMR *(12)*.

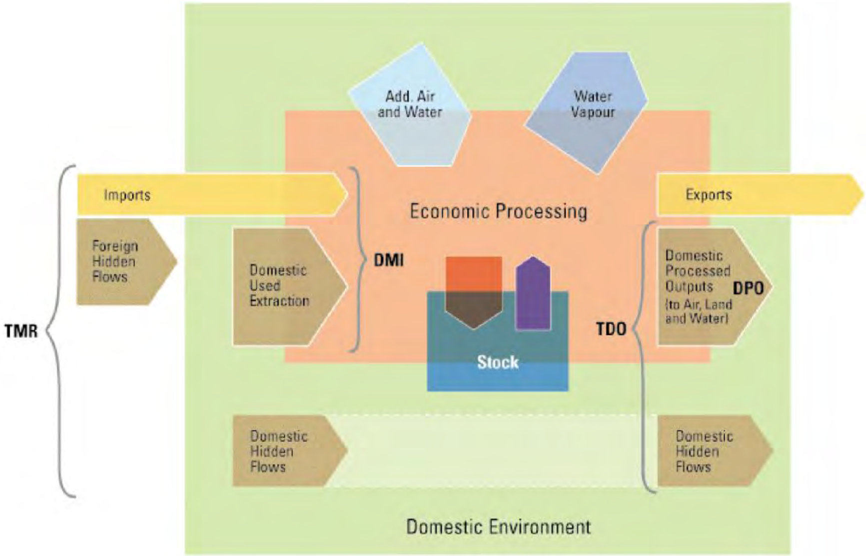



Figure 12. Specified economy-environment –system. (Source: Matthews et al. 2000).

Direct Material Input (DMI) measures the input of materials used in the economy, that is, all materials of economic value, and that are used in domestic production activities. This includes materials contained in imported goods, and resources used in the production of exports.

Direct material Input (DMI) = Imports + Domestic Extraction Used (DEU)

Domestic material consumption (DMC) measures the total amount of materials directly used by an economy and is defined as the annual quantity of raw materials extracted from the domestic territory, plus all physical imports minus all physical exports.

Domestic material consumption (DMC) = DMI - Exports

Domestic unused materials extractions and indirect material requirements associated with imports together with DMI constitute the TMR. The *unused* domestic extraction relates closely to the *used* domestic extraction. Unused means that this material is extracted at the same time as the used material, but is not further processed in the economic production system and is shifted aside in the form of e.g. mining waste, tailings, biotic residuals from harvest etc.

Total Material Requirement (TMR) = DMI + Unused Domestic Extraction + Indirect Flows Associated with Imports

In addition to the above gross material indicators, modern MFAs produce environmental impact indicators (see for instance Seppälä et. al. 2011, *(13)*), which allow an explicit and essential view to ecological sustainability. However, the differences in the goals and scopes, and resources of MFA studies reflect the environmental aspects addressed. Some aspects are commonly addressed, others less frequently. Those aspects commonly addressed in the novel MFAs include climate change, use of non-renewable primary energy, aquatic eutrophication, acidification and formation of tropospheric ozone. Some studies also address land-use. Obviously, many environmental aspects, possibly important for the sustainability of the food chains, such as eco-toxicity, human health impacts, and biodiversity, remain as yet unaddressed in MFA. Some of these cannot be addressed because relevant data are not available, and others because relevant methods are not yet practicable.

# 3. Data available

The project area covers the Finnish provinces of Uusimaa, Varsinais-Suomi, Häme, Åland and Southeastern Finland, and the whole of Estonia and Latvia are included, except for the Vidzeme and Zemgale regions. The average population density ranges from 31 to 51 persons per square kilometre. In Latvia, Estonia and in Finland´s project area, about 3 million hectares, 22 % of the total land area and 47-68% of all agricultural land, is cultivated.

The main sources of Finnish data are Statistics Finland and the Information Centre of the Ministry of Agriculture and Forestry (TIKE). Regional statistics are presented from ELY-centres (Centre for Economic Development, Transport and the Environment) or TE-centres (Employment and Economic Development Centres). In Estonia, the main sources of information are Statistics Estonia and the Estonian Agricultural Registers and Information Board. Most Latvian data were gathered from the Central Statistical Bureau of Latvia and FVS, the Food and Veterinary Service. Regional information has been used when it has been available, otherwise the data are from the whole country. Most of the data are presented according to Central Baltic IVA programme areas, divided to programme area and adjacent area as shown in Figure 1. The definition project area is stated as the sum of programme and adjacent area.

## 3.1. Finland

### 3.1.1. Population structure in the area

At the end of 2010, Finland's official total population was 5 375 276, of whom 2 638 416 were men and 2 736 860 women *(14)*. The population in the Finnish project area was 2 717 911 and 81 % of the people were living in the programme area (Table 1). The population distribution was predominantly concentrated in the main towns and coastal areas.

Table 1. Area and population by region in Finland.

| Region | Land area km² 1.1.2011 | Population 31.12.2010 | Males % 31.12.2009 | Females % 31.12.2009 | Children under 3 years old (%) 31.12.2009 |
|---|---|---|---|---|---|
| Uusimaa [1)] | 9 097 | 1 532 309 | 48.3 | 51.7 | 3.6 |
| Varsinais-Suomi | 10 662 | 465 183 | 48.5 | 51.5 | 3.1 |
| Kanta-Häme | 5 200 | 174 555 | 48.8 | 51.2 | 3.3 |
| Päijät-Häme | 5 125 | 201 772 | 48.4 | 51.6 | 3.0 |
| Kymenlaakso | 5 148 | 182 382 | 49.2 | 50.8 | 2.7 |
| South Karelia | 5 613 | 133 703 | 49.5 | 50.5 | 2.6 |
| Åland | 1 552 | 28 007 | 49.8 | 50.2 | 3.1 |
| Whole country | 303 892 | 5 375 276 | 49.1 | 50.9 | |
| Programme area | 26 458 | 2 207 881 | 49.0 | 51.0 | 3.4 |
| Adjacent area | 15 938 | 510 030 | 48.9 | 51.1 | 3.0 |
| Project area | 42 396 | 2 717 911 | 48.9 | 51.1 | 3.4 |

[1)] According to the regional division of 1 January 2011 (Itä-Uusimaa and Uusimaa were united).
Source: Official Statistics of Finland (OSF), Statistics Finland.

The average size of a Finnish household was 2.08 people. Those living alone accounted for 40.7 %. The average life expectancy for women was 83 years and for men 76 years *(14)*.

The population is projected to become older in Finland and the trend is also seen in the Finnish project area (Table 2). According to Statistics Finland, data on population structure, there were 195 243 persons over 75 years of age in the project area at the end of 2009. The clear majority of those aged 75 and over were women (65 %), as the number of men was 67 469 and that of women 127 774. In the whole country the number of persons aged 80 and over has grown five-fold over the last 40 years *(14)*.

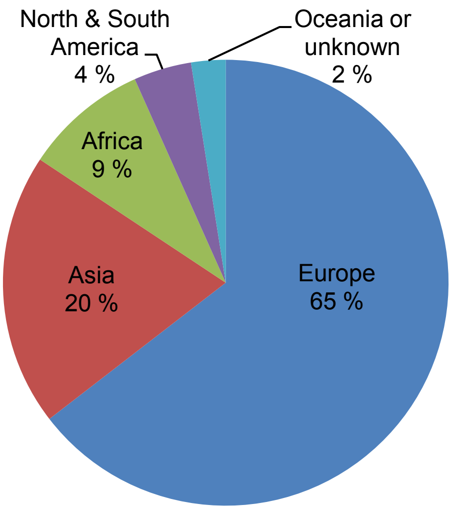
Table 2. Population projection by age and region for 2010–2030 in Finland.

| Finland | Year 2010 | 2020 | 2030 | Finnish Project area | Year 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|
| Population (1000) | 5 378 | 5 636 | 5 850 | Population (1000) | 2 721 | 2 906 | 3 058 |
| Age 0-14 (%) | 16.5 | 16.6 | 16.1 | Age 0-14 (%) | 16.3 | 16.2 | 15.7 |
| Age 15-64 (%) | 65.9 | 60.5 | 57.8 | Age 15-64 (%) | 67.3 | 62.3 | 59.7 |
| Age 64- (%) | 17.6 | 22.9 | 26.1 | Age 64- (%) | 16.4 | 21.5 | 24.6 |

Source: Official Statistics of Finland (OSF), Statistics Finland, Population projection 2009–2060.

A total of 248 135 foreign nationals lived in Finland at the end of 2010 (Figure 13). According to the 2008 statistics, Finland had the seventh lowest proportion of foreign citizens in total population among the EU27 countries. The proportion of foreign nationals in the whole country was 2.9 % at the end of 2009. For the programme area the figure was 4.6 % and in the adjacent area it was 2.1 %, being 4.1 % for the whole project area. The majority of those living in the project area and who were born abroad were European (64 %). Next came those born in Asia (21 %), Africa (10 %) and America (4 %). Most nationals born in Europe were from Estonia (29 %), the Russian Federation (27 %) and Sweden (7 %), and nationals born in Asia were from China (16 %), Thailand (12 %), Iraq (12 %) and India (11 %). Most of those from Africa were born in Somalia (19 %), those from America were born in the United States (43 %), Brazil (12 %) and Canada (11 %), and those from Oceania were born in Australia (82 %) *(14)*.

In Finland, at present, migration contributes more to population growth than natural increase. In 2010 60 980 children were born in Finland. 50 % of those were born in the project area (25 292 in the programme area and 4 935 in the adjacent area). The relative share of mothers born abroad among all mothers of children born in Finland has been growing steadily. 9 % of the mothers of the children born in 2010 were born abroad, while the respective share in 1990 was only 2 % *(14)*.




Source: Official Statistics of Finland (OSF), Statistics Finland.

Figure 13. Persons born abroad living in Finland at the end of 2010 by continent of birth.

### 3.1.2. Food production

#### *Characteristics of the domestic food chain*

In Finland food production is the fourth largest branch of industry, after the metal and engineering, forest and chemical industries. Its main branches are meat processing, baking and dairy products. Finland is entirely self-sufficient in milk and milk products, as well as in meat and eggs. The degree of self-sufficiency in grain varies from year to year depending on the harvest. Self-sufficiency in the main greenhouse-grown products was estimated to be about 64 % in 1997, while that of outdoor vegetables was 88 %. Self-sufficiency in potatoes was over 140 % in 1997. The domestic food industry produces about 85 % of the food consumed in Finland. In addition, 85 % of the raw material used by the Finnish food industry is domestic.

The structure of Finnish agriculture has changed in recent years. The number of farms has decreased by more than 3 % a year, and in livestock production by as much as 7 %. In 2009 the number of active farms was 64 175. Over 30 % of farms are situated in the project area. The majority of Finnish farms produce milk or cultivate cereals. Every fifth farm produces milk and most of these farms are located in eastern and northern Finland. More than half of the farms produce cereals, and the majority of these farms are in southern Finland.

There are several operators in food chains: farms produce grain for human consumption and for animal feed and horticulture and livestock production fulfil the need for vegetables, milk, meat and eggs. Raw materials and food are transported from farms to food processing and packaging facilities. Imports supplement supply when domestic production is not sufficient, fruits being the most imported foodstuff. Food was processed at 1800 different sites in 2008. There are few public data available about the raw material volumes used by the food industry for the various kinds of food products, but the gross value of food production was 10.4 billion euros and the value added was 2.4 billion euros in 2009.

In addition to households, food services, i.e. restaurants and catering companies, are major consumers of Finnish food products. Wholesale trade in foodstuffs was undertaken by 1 200 stores and retail trade by 6 600 stores in 2008. At the same time there were over 12 000 restaurants, cafeterias, catering sites and canteens in Finland *(15)*.

In 2009 the production of field crops totalled 1 260 million kg, meat 383 million kg, milk 2 264 million kg and eggs 54 million kg. 13 million kg of fish for food was produced (Table 3).

Table 3. Quantity of production and consumption in the food chain in 2009 for Finland.

| | |
|---|---|
| **Field Crop Production** | |
| Bread grain (million kg) | 929 |
| Feed grain (million kg) | 3331 |
| **Cereals used by industry** | |
| Used for food (million kg) | 423 |
| Used for feed (million kg) | 565 |
| **Livestock production** | |
| Meat (million kg) | 383 |
| Milk (million l) | 2264 |
| Eggs (million kg) | 54 |
| **Production of food fish** | |
| Live fish (million kg) | 13 |
| **Horticultural Production** | |
| Vegetables, open cultivation (million kg) | 179 |
| Greenhouse vegetables (million kg) | 72 |
| Potted vegetables (millions) | 74 |
| **Consumption, kg/capita/year** | |
| Meat | 74 |
| Fish (2008 data) | 16 |
| Milk, liquid products | 184 |
| Cereals | 80 |
| Vegetables | 71 |
| Fruits and berries | 79 |

Source: TIKE. From farm to fork 2010 *(15)*.

### *Export and import of foodstuff*

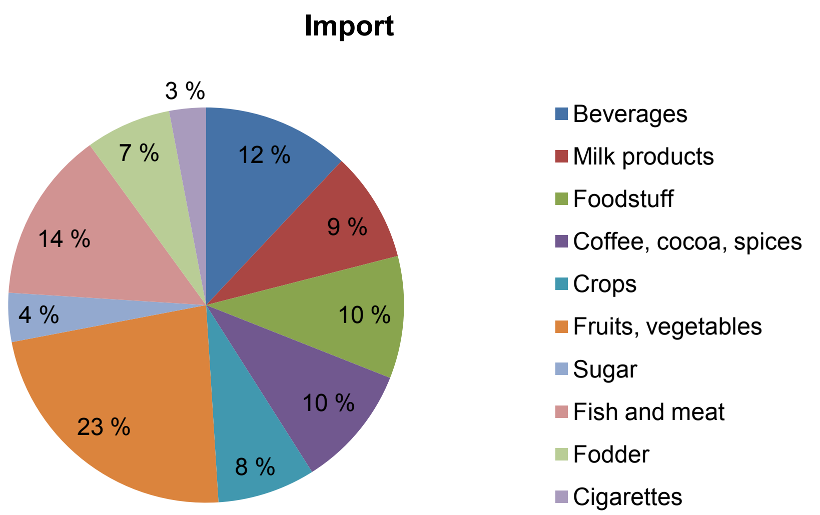
Finland was a net exporter of barley and oat in 2009. For wheat and rye, the imports exceeded exports, i.e. Finland was a net importer *(16)*. For potato the material balance of foreign trade was practically nil. Again, the net import of sugar, tomato and fruits was dominant. Finland was a net exporter of pork and poultry meat, and a net importer of beef and mutton. Net imports of key food raw materials are given in Table 4.

According to the statistics of the Finnish Customs, in 2010 Finland imported 2 015 300 tonnes of agricultural and 740 451 tonnes of industrial foodstuffs. In the same year Finland exported 651 730 tonnes of industrial and 622 699 tonnes of agricultural foodstuffs. The main export products were alcohol beverages, frozen and fresh fish, pork, milk products, eggs, poultry, malts, oat, barley and wheat flour, whereas the most imported foodstuffs were alcoholic beverages, coffee, other drinks, fish conserves and fresh fish, beef, fruits, oil seeds, sugar, bakery products and vegetables. Fodder was also imported. The value of exported foodstuffs was 468 million euros and the value of imported foodstuffs 1 286 million euro in 2010. The destinations of exported foodstuffs were most often Russia, Sweden and Estonia. The main countries from which foodstuffs were imported were Germany, Sweden, Netherlands, Denmark and France. The structure of food imports by products is shown in Figure 14 and of exports in Figure 15.

Table 4. Net imports of food raw materials into Finland in 2009 as a percentage of domestic use. Negative value indicates net export.

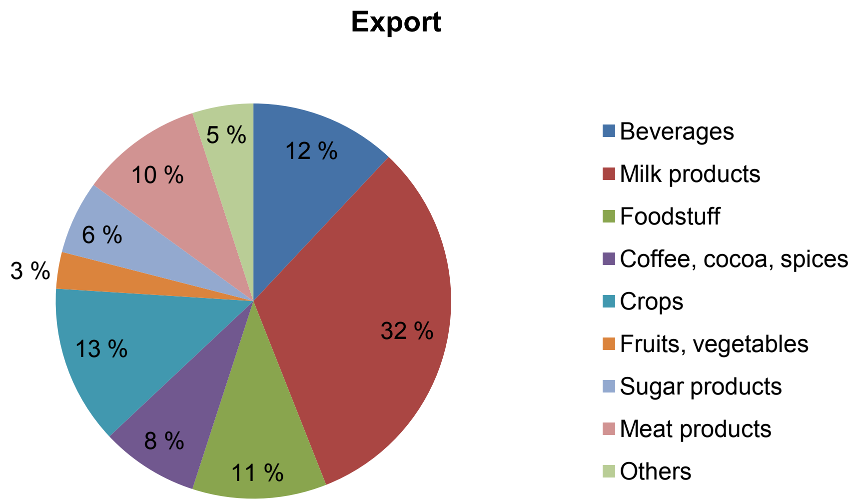
| Raw material | Net import as % domestic use |
|---|---|
| Wheat | 10 |
| Rye | 58 |
| Barley | -8 |
| Oats | -43 |
| Rice | 100 |
| Potatoes, fresh | 0 |
| Sugar | 65 |
| Peas | 26 |
| Turnip rape | 50 |
| Sunflower | 100 |
| Soybeans | 100 |
| Tomatoes, fresh | 38 |
| Other fresh vegetables | 26 |
| Citrus fruit, fresh | 100 |
| Other fresh fruit | 96 |
| Berries | 26 |
| Beef and veal | 15 |
| Pork | -12 |
| Mutton | 77 |
| Poultry meat | -3 |

Source: TIKE 2009 *(16)*.




Source: Customs Finland 2010 *(17)*.

Figure 14. Structure of Finnish imports in 2009.




Source: Customs Finland 2010 (17).

Figure 15. Structure of Finnish exports in 2009.

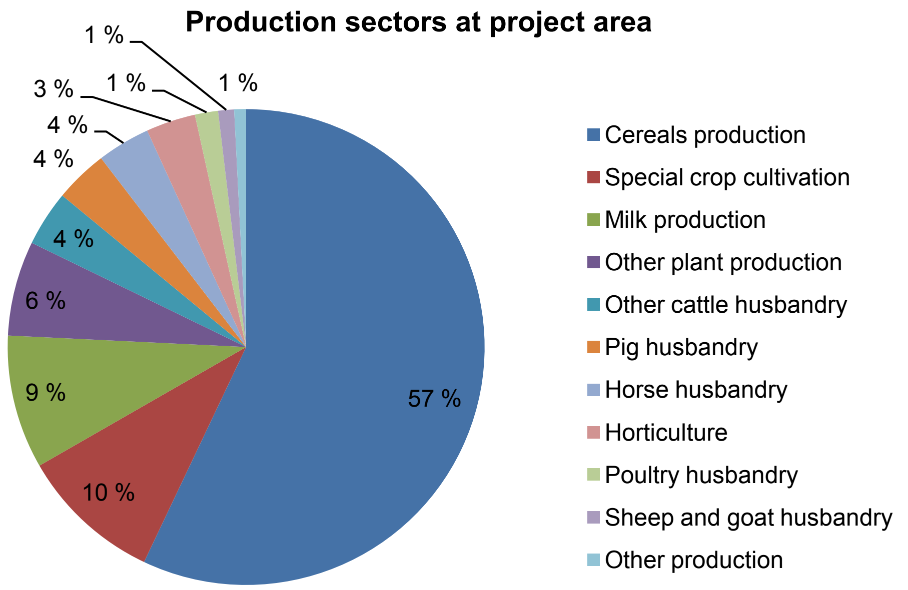
### *Crops production*

In the project area the most farms produce cereals (57 %), special crops (10 %) or milk (9 %) (Figure 16). The majority grow wheat (151 640 ha), barley (148 214 ha) and oats (133 334 ha). The average arable area of cereal farms is 34.04 hectares *(18)*. The yields of the main crops in 2010 are presented in Table 5. Rye and wheat are cultivated as bread grain, barley and oats mainly for fodder. Barley is also cultivated for brewing, beer and for enzyme malts. Contract cultivation has a long tradition and a strong position in Finland. However, normally, some 50 to 60 % of rye flour - very susceptible to the vagaries of the weather - is imported.

There are significant rye product exporters in Finland. Vaasan & Vaasan Oy, with its Finn Crisp products, is the world's largest rye crisp manufacturer and the second largest rye cracker manufacturer. Finnish rye products are also sold by other bakeries established in the Baltic States, Poland and Russia. Oat grain is exported to more than 15 countries and the market is expanding. The trend is to export processed products instead of bulk grain. All barley farmed in Finland is spring barley and the varieties used are internationally known. Barley malt is a significant Finnish export product, which is mainly exported to neighbouring countries.

The largest food producers according to www.ruokatieto.fi are:

Valio Oy (milk products)
Lännen Tehtaat Oyj (frozen vegetables, vegetable oils, fish products, trade of cereals)
Raisio Oyj (oils, fats, mill products, feed)
HK Ruokatalo Oy (meat products)
Atria Oyj (meat products)
Fazer-konserni (bakery, sweets, chocolate)
Vaasan Oy (bakery)
Oy Hartwall Ab (beverages)
Saarioinen Oy (meat products, convenience food, canned food)
Oy Gustav Paulig Ab (coffee, spices)
Oy Sinebrychoff Ab (beverages)




Source: Official Statistics of Finland (OSF), Tike, Farm structure.

Figure 16. Number of farms by production sector 2010 in the project area in Finland.

### *Vegetable production*

Finnish vegetables are available all year round. The main products, cucumbers, tomatoes and lettuce, are cultivated in greenhouses, and potatoes and storable vegetables are available throughout the seasons. The yield of the most important greenhouse vegetables was about 70 million kg in 2009. The most important vegetables are also available as organic produce. However, the yield of organically produced vegetables and berries represents only about 2 % of total production. Cultivation of fruit is rather limited. Strawberry is an important cultivated berry and in 2009 its yield was 11.6 million kg *(18)*. Finland is self-sufficient in potatoes, but most vegetables and fresh fruit are imported.

### *Milk production*

In Finland milk is the most important product from domestic animals. There is a large selection of dairy products in Finland. Milk products have been differentiated in Finland to conform to health trends. There is a large selection of non-fat, semi-skimmed, low lactose and non-lactose milk products available, and there are also products that lower blood pressure and blood cholesterol.

According to TIKE statistics *(18)* milk production for the whole of Finland in 2009 was 2 223 million litres, the number of milk producers was 11 680 and the amount of milk produced in the project area was 16.7 % of whole country's production, 372.1 million litres . In the project area there were 1 855 milk producers and the amount of milk produced represented 15.9 % of total Finnish milk production (Table 6).

In 2010, 2 268 million litres of milk were produced, which is some four million litres more than the year before. Dairies received 2 222 million litres, of which some 30 million litres were organically produced milk. There were 284 280 dairy cows in December 2010, which is about the same number as the year before. The average production rate for the dairy cows rose by a little less than one percent, to 7 900 litres per cow in 2010.

Table 5. Yield of the main crops in Finland and in the project area.

| | Finland, whole country | | | Project area | | |
|---|---|---|---|---|---|---|
| | Area | Yield | | Area | Yield | |
| | 1 000 ha | kg/ha | million kg | 1 000 ha | kg/ha | million kg |
| Winter wheat | 22.3 | 3 970 | 88.5 | 18.3 | 3 662 | 73.2 |
| Spring wheat | 188.9 | 3 370 | 635.9 | 133.3 | 3 200 | 428.5 |
| Wheat total | 211.2 | 3 430 | 724.4 | 151.6 | 3 324 | 501.6 |
| Rye | 25.2 | 2 720 | 68.5 | 13.6 | 2 538 | 37.2 |
| Bread grain, total | 236.4 | 3 350 | 792.9 | 165.3 | 3 238 | 538.9 |
| Feed barley | 338.8 | 3 240 | 1 096.2 | 84.3 | 2 966 | 253.2 |
| Malting barley | 78.6 | 3 100 | 244 | 63.9 | 2 895 | 190.9 |
| Barley total | 417.4 | 3 210 | 1 340.2 | 148.2 | 2 962 | 444.0 |
| Oats | 278.3 | 2 910 | 809.7 | 94.6 | 2 846 | 266.7 |
| Mixed crops, cereals | 8.7 | 2 420 | 21.1 | 1.1 | 2 720 | 2.4 |
| Legumes + cereal | 10.6 | 2 390 | 25.4 | 2.4 | 1 988 | 4.5 |
| Other grain | 2.7 | | | 0.8 | | |
| Grain total | 951.5 | 3 140 | 2 989.3 | 411.6 | 3 030 | 1 256.9 |
| Turnip rape | 141.5 | 1 120 | 158.6 | 78.9 | 988 | 80.1 |
| Rape | 16.2 | 1 230 | 19.9 | 14.2 | 1 274 | 16.6 |
| Rape and turnip rape, total | 157.7 | 1 130 | 178.5 | 93.1 | 1 044 | 96.6 |
| Linseed | 2.6 | 1 040 | 2.7 | 1.4 | 983 | 1.3 |
| Caraway | 12.8 | 660 | 8.5 | 3.8 | 617 | 2.2 |
| Food potatoes | 10.8 | 26 910 | 290.9 | 2.0 | 20 118 | 41.9 |
| Early potatoes | 1.1 | 11 270 | 11.9 | 0.9 | 11 335 | 9.7 |
| Processed food potatoes | 3.6 | 28 630 | 103.6 | 1.2 | 26 923 | 29.3 |
| Starch potatoes | 6.3 | 27 640 | 174.1 | 0.2 | 27 935 | 5.7 |
| Other potatoes | 3.4 | 23 320 | 78.6 | 0.5 | 18 910 | 9.8 |
| Potatoes total | 25.2 | 26 210 | 659.1 | 4.8 | 20 066 | 96.6 |
| Sugar beet | 14.6 | 37 120 | 542.1 | 8.7 | 35 670 | 319.7 |
| Peas | 6.1 | 2 190 | 13.4 | 4.6 | 1 808 | 9.6 |
| Broad bean | 9.4 | 1 720 | 16.3 | 6.9 | 1 450 | 10.9 |
| Timothy seed | 6.7 | 390 | 2.6 | 3.1 | 380 | 1.1 |
| Hay | 106.1 | 3 600 | 382.4 | 34.1 | 3 776 | 134.2 |
| Green fodder | 13.6 | 8 820 | 120.3 | 2.5 | 7 008 | 16.9 |
| Silage, fresh | 58.7 | 18 070 | 1 060.4 | 10.8 | 14 920 | 158.5 |
| Prewilted silage | 392.9 | 17 870 | 7 020.8 | 53.5 | 15 202 | 831.7 |
| Silage, total | 451.6 | 17 890 | 8 081.3 | 64.3 | 14 666 | 990.1 |
| Whole crop cereals for silage | 8.1 | 7 100 | 57.5 | 1.0 | 7 825 | 4.6 |
| Cereals harvested green, total | 57.5 | 4 180 | 240.0 | 10.2 | 3 275 | 34.4 |

Source: Tike (Information Centre of the Ministry of Agriculture and Forestry in Finland *(18, 19)*.

**Livestock production**

In Finland the total number of livestock has remained quite stable for many years. For example, there have been about 1 million cattle, about 1.3 million pigs and about 10 million poultry for the past ten years. However, the number of farms has rapidly decreased while farm sizes have increased. For example, in 2001 the average number of cattle per farm was 38 while in 2009 this had increased to 56. At the same time the number of farms in Finland halved from 26 000 to 13 000.

There are large piggeries and henhouses in the project area, especially in Varsinais-Suomi and Satakunta. 38 % of Finland´s pigs and 56 % of its poultry were raised in these two regions in 2009. In 2009 the average piggery size was 610 pigs/farm and henhouse size 6 884 birds/farm. In addition, a single farm could raise approximately 47 752 broilers *(15)*.

The main meat production in Finland includes beef and pork, chicken and turkey, and reindeer from the northern part of Finland as a speciality food. There are several co-operative companies and family businesses with long traditions in meat production in Finland. Finland is a pioneer in reducing salt content in meat products and the need for appreciating consumer health issues.

Table 6. Meat and milk production in the project area.

*Pork, beef and mutton production by ELY Centre, 2010 (million kg)*
*Milk production by ELY Centre in quota period 2009/10 (1 000 l)*
*Number of milkproducers by ELY Centre in quota period 2009/10 (number)*

| ELY Centre | Pork production 2010 | Beef production 2010 | Mutton production 2010 | Milk production 2009/10 | Number of milk producers 2009/10 |
|---|---|---|---|---|---|
| Uudenmaan | 5.3 | 1.8 | 0.03 | 64 988 | 281 |
| Varsinais-Suomen | 54.0 | 3.2 | 0.07 | 64 937 | 316 |
| Hämeen | 15.6 | 3.9 | 0.02 | 118 239 | 602 |
| Kaakkois-Suomen | 5.1 | 2.9 | 0.03 | 110 027 | 603 |
| Ahvenanmaa - Åland | ... | 0.6 | 0.12 | 13 914 | 53 |
| *Whole Country* | 203.1 | 82.1 | 0.72 | 2 223 068 | 11 680 |
| **Project area** | **79.9** | **12.4** | **0.26** | **372 106** | **1 855** |

ELY Centres (Economic Development, Transport and the Environment).
Source: Tike, Meat/Milk production by area.

Approximately 10 % of Finnish meat production is exported. Pork is exported to Russia, Estonia and Japan, among other countries, and beef is traded with Sweden (Table 7) *(18)*. The largest meat industry companies have expanded their production outside Finland to the Baltic States, Poland, Sweden and Russia.

There are no data available for poultry meat production in the project area, but in 2009, 95 million kg of poultry meat was produced in Finland.

Table 7. Finnish meat consumption and trade, 2009.

| Meat | Consumption (M kg) | Exports (M kg) | Imports (M kg) |
|---|---|---|---|
| Pork | 184 | 45 | 24 |
| Beef and veal | 95 | 1 | 15 |
| Poultry meat | 93 | 15 | 12 |
| Mutton | 3 | 0 | 2 |
| Meat total | 378 | 62 | 56 |

Source: TIKE. From farm to fork 2010 *(15)*.

### Egg production

Egg production in Finland grew to record levels from 2000 to 2010, reaching some 61 million kg**.** More eggs than this were previously produced in 1998 when the production was some 64 million kg *(20)*.

A total of 73 % of the eggs were produced in henhouses with battery cages or enriched cages, 24 % in barn-type henhouses and 3 % in organic production henhouses. Of the eggs received by the packaging plants, 93 % were class A and 7 % class B. Due to the climate conditions, there are only indoor henhouses in Finland. Speciality eggs are produced in Finland, such as omega eggs containing alpha-linolenic acid, eggs for baking and so-called extra fresh eggs. The Finns have discovered also cage-free or free-range and organic eggs.

### Fish catches

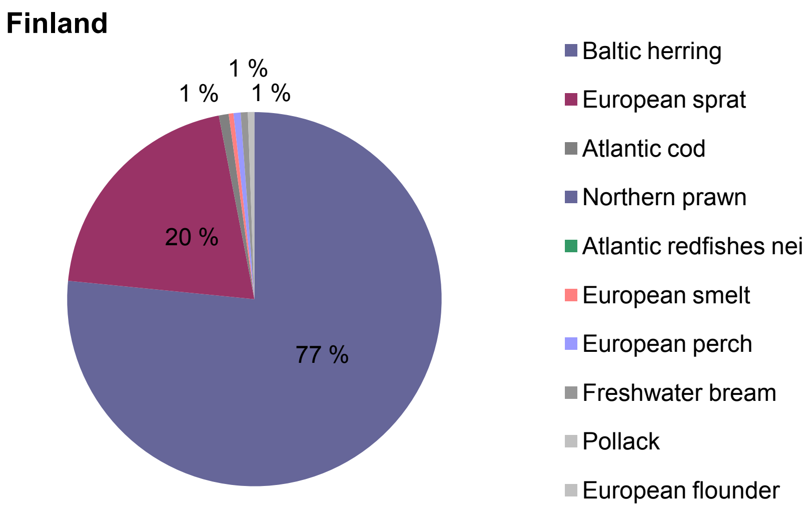
During recent decades fish stocks have been steadily declining. In 2010, the catch by Finnish commercial fishermen in the sea totalled 122 million kg (Table 8). Only about 9 % of this catch was used for human consumption, the rest was exported or used for fodder.

Table 8. Professional marine fish catch from the Baltic Sea 1980-2010, 1000 kg.

| | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|---|---|
| Baltic herring | 74 852 | 88 702 | 66 078 | 94 612 | 80 697 | 66 457 | 92 400 |
| Sprat | 2 137 | 364 | 162 | 4 104 | 23 134 | 17 883 | 24 602 |
| Cod | 2 317 | 3 793 | 1 668 | 1 852 | 1 817 | 283 | 1 028 |
| Bream | 256 | 226 | 134 | 100 | 110 | 134 | 741 |
| Perch | 505 | 259 | 398 | 663 | 782 | 860 | 741 |
| European whitefish | 986 | 771 | 1312 | 1 161 | 1 176 | 765 | 647 |
| Smelt | 323 | 300 | 543 | 981 | 340 | 193 | 497 |
| Pikeperch | 241 | 166 | 276 | 532 | 450 | 440 | 351 |
| Roach | 238 | 110 | 68 | 113 | 151 | 217 | 227 |
| Pike | 280 | 190 | 184 | 174 | 250 | 216 | 217 |
| Salmon | 550 | 815 | 2 058 | 1 160 | 591 | 461 | 215 |
| Vendace | 385 | 82 | 108 | 92 | 96 | 151 | 132 |
| Other | 202 | 81 | 121 | 171 | 95 | 76 | 98 |
| Burbot | 161 | 91 | 159 | 97 | 112 | 42 | 63 |
| Sea trout | 43 | 70 | 331 | 128 | 113 | 66 | 54 |
| Ide | 30 | 17 | 9 | 19 | 28 | 23 | 29 |
| Flounder | 52 | 37 | 59 | 89 | 81 | 27 | 28 |
| Rainbow trout | .. | .. | 41 | 47 | 18 | 17 | 7 |
| **Total** | **83 558** | **96 074** | **73 709** | **106 095** | **110 041** | **88 313** | **122 078** |

Source: ICES 2011, ICES Areas 27-29 and 32.

Baltic herring constitutes >3/4 of the catch at sea (Figure 17). In addition to Baltic herring, the most significant fish species caught from the open sea is sprat. Pikeperch, perch and whitefish are also caught in the coastal areas. Fish stocks, especially of cod, are overfished, and the catches of migratory species and some coastal species are low *(21)*. Finland is committed to follow the fishing quota regulations set by the Ministry of Agriculture and Forestry, and in 2010 the maximum allowed catches of Baltic herring and cod were caught *(22)*. In the underlying figure, the data presented are not corrected for non-reported landings where they may have occurred.




Source: ICES 2011, ICES Areas 27-29 and 32.

Figure 17. Fish catch Statistics from project area 2010, Finland.

In 2008, there were 321 commercial inland fishermen in Finland, 65 of them operating in the project area. Measured by both catch volume and value, the main catch species was vendace for the whole country. However, in the project area, and especially in Varsinais-Suomi, the relative value of the signal crayfish catch was significant. In the project area, the total fish catch was 759 000 kg and 153 000 crayfish were caught. The most caught fish species were vendace, roach, bream, pikeperch and European whitefish (Table 9) *(23)*.

Table 9. Fish catch from the inland waters, 2008 (whole country).

| **Species** | **Catch 1000 kg** | **Species** | **Catch 1000 kg** |
|---|---|---|---|
| Vendace | 2 496 | Signal crayfish | 153* |
| Roach | 495 | Roe, vendace | 10 |
| Bream | 157 | Other roe | 1 |
| Smelt | 148 | | |
| Perch | 142 | | |
| Pike-pearch | 113 | | |
| Whitefish | 106 | | |
| Pike | 97 | | |
| Burbot | 25 | | |
| Trout | 9 | | |
| Arctic char | 3 | | |
| Lake trout | 1 | | |
| Other species | 120 | | |
| **Fish, total** | | | **3 912** |

Source: RKTL 2010. Commercial inland fishery 2008.

About 12 million kg of rainbow trout was farmed in Finland in 2010, mainly for domestic consumption. Other farmed fish species are whitefish, Arctic char and sturgeon. The major part of the fish farming is within seawaters. Recreational fishing produced more food for human consumption, 31 million kg, which makes up 74 % of the total catch. The most important catch species from recreational fishing were pike and perch.

In 2008, 95 million kg of fish and fish products were imported and 80 million kg exported. Measured by export value, the most important fish and fish product export countries are Russia, Sweden, Estonia and Japan. The most important export products are frozen Baltic herring and sprat. Roe and roe products are also exported from Finland. The most important export countries for roe are Japan, Russia, Sweden and Estonia *(23)*.

Finnish Food Safety Authority Evira recommends that fish should be eaten twice a week, varying the species. According to the Tike report *(18)*, 174 million kg of fish products were consumed in Finland in 2008, but the share of food consumption of total consumption was only 79 million kg. According to RKTL data for 2009, consumption of domestic fish was 4.5 kg/capita/year and of exported fish 11.5 kg/capita/year.

### 3.1.3. Organic farming

In 2009, there were 64 175 farms in Finland, approximately 1 600 fewer than in the previous year. Since 2000, the number of farms has decreased by one fifth. The number of farms covered by the organic farming inspection system was 3 967, which represents 5.9 % of all farms. Organic farms were slightly larger (41 ha on average) than traditional farms (36 ha) so that 7.2 % of the total arable area was under organic production. However, there is great local variation in land use, for example in Åland the proportion of land used for organic production is 20.2 %.

48.7 % of the certified organic area was used for cultivating grass, 15.7 % for cultivating oats and 12.7 % was green fallow. Rye, wheat, turnip rape, pea, berries and fruits, potato and caraway were also commonly grown on organic farms. Greenhouse vegetables, green herbs, vegetables grown in the open, legumes and cereals, buckwheat, broad beans, flax and other vegetables also contributed a small proportion to the cultured area. Dairies received 30 million litres of organic milk in 2010. The production of organic meat is very low.

The crop of organically produced pre-wilted silage was 371.3 million kg, feed grain 58.7 million kg, oats 39.5 million kg, but compared to traditional farming, their proportions of total production were relatively low, less than 3.5 %. The relatively biggest yields were from rye (14.1 %), mixed grains (24.6 %) and peas (11.9 %) (Table 10) *(18)*. In order to increase the share of organic farming, the new government decided in 2011 to support it with a development programme that includes financial support and education.

Approximately one fifth of Finns eat organically produced food regularly of often. Finns prefer organic milk, bread and vegetables, especially tomatoes. About 4 % of egg production is organic, and the share is increasing annually. The market share of organic food is approximately 1 % of total food sales. Typical customers are elderly, wealthy people. Families with children ate organically produced food less than on average, although there are also active consumers among families with small children.

Table 10. Organic production, 2006-2009 (million kg).

| Crop | 2006 | 2007 | 2008 | 2009 | % from total production 2009 |
|---|---|---|---|---|---|
| Cereals, total | 68.7 | 80.9 | 75.5 | 76.2 | 1.8 |
| Bread grain, total | 15.8 | 18.2 | 16.3 | 17.5 | 1.9 |
| Wheat | 8.9 | 9.7 | 10.2 | 11.6 | 1.3 |
| Winter wheat [1)] | 0.5 | 1.5 | 1.4 | 1.5 | 2.4 |
| Spring wheat | 8.4 | 8.2 | 8.8 | 10.1 | 1.2 |
| Rye | 6.9 | 8.5 | 6.1 | 5.9 | 14.1 |
| Feed grain, total | 52.9 | 62.7 | 59.2 | 58.7 | 1.8 |
| Barley | 10.9 | 8.8 | 6.6 | 8.0 | 0.4 |
| Oats | 33.5 | 41.0 | 41.8 | 39.5 | 3.5 |
| Mixed crops | 8.5 | 12.9 | 10.8 | 11.2 | 24.6 |
| Cereals | 5.8 | 6.6 | 3.3 | 4.0 | |
| Legumes + cereal | 2.7 | 6.3 | 7.5 | 7.1 | |
| Turnip rape | 1.4 | 1.3 | 1.3 | 2.1 | 1.7 |
| Potatoes | 4.4 | 3.7 | 4.8 | 2.2 | 0.3 |
| Peas | 1.7 | 1.2 | 0.6 | 1.3 | 11.9 |
| Broad bean | | | | 2.0 | |
| Hay | | 14.2 | 16.2 | 10.0 | 3.4 |
| Silage, prewilted | | 271.9 | 261.1 | 371.3 | 4.7 |
| Cereals harvested green | | | 22.4 | 28.7 | |

[1)] Contains spelt

Source: TIKE 2010 *(18)*.

From July 2010 the EU organic logo is obligatory for all organic pre-packaged food products within the European Union. It is also possible to use the logo on a voluntary basis for non pre-packaged organic goods produced within the EU or any organic products imported from third countries.

The Finnish sun-design organic logo can be applied alongside the Euro-leaf logo (Figure 18). The sun logo is Finland's official logo for organic products which guarantees that 95 per cent of a product's ingredients have been organically produced. The right to apply the sun-design logo is granted by the Finnish Food Safety Authority Evira.

Source: Kuluttajavirasto 2011 *(24)*.

Figure 18. The EU organic farming logo and Finnish organic sun label.

### 3.1.4. Food consumption

As food consumption forms a significant part of the environmental load of households, the sustainability implications of what we eat is becoming a topical issue.

Dietary habits and food choices vary by gender, age and area. Women eat more vegetables, fruits and berries, but less bread and potatoes than men. The group eating fresh vegetables least frequently is the one composed of the youngest men, while the youngest of both genders eat potatoes and fruits less frequently than others. People living in eastern Finland eat bread, and rye bread in particular, more than those living in other parts of Finland.

Pork, the fat content of which has decreased markedly, is still the most common type of meat consumed, but the consumption of poultry has increased substantially since the early 1980s. The consumption of meat is about four times higher than that of fish. According to Tike, total meat consumption was 76.2 kg/capita in 2010. Pork meat was most popular; its consumption was 34.9 kg/capita. Nearly equal amounts of beef and poultry meat were consumed, 18.6 kg and 18.2 kg/capita, respectively *(25)*.

Low-fat milk (1.5-1.9 % fat) is the most favoured milk among boys and men. Skimmed milk (< 0.5 % fat) is currently the type of milk preferred by girls and women. The total consumption of liquid milk products has decreased, while cheese consumption is increasing.

The type of fat used on bread has also changed appreciably since the mid 1980s, butter having been mainly replaced by soft vegetable margarine and butter-oil mixtures. In the late 1970s about 60 % of Finns reported using mostly butter on bread while in 1998 the proportion dropped to only 5 %. Furthermore, the popularity of vegetable oils has increased particularly among young adults. It is the most common fat used in cooking *(26)*.

According to FINDIET 2007 survey *(26)*, an adult working age Finnish person had, on average, six eating occasions per day. Among the working age adults most of the daily energy was derived from the main meals (62 % in men and 60 % in women). Thus snacks contributed more than one-third to the daily energy intake. The 65- to 74-year-olds consumed more porridge and low-fat spreads than the 25- to 64-year-olds, who in turn consumed more yoghurt, hard cheeses and sweets. There were no major differences observed in the nutrient intake between working age adults and the older adults. Overall, women's diets contained a significantly higher proportion of fruit and vegetables than men´s.

The percentage contribution of fat to the total energy intake was 33 % in men and 31 % in women. The respective percentages for saturated fatty acids in men and women were 13 % and 12 %. Most of the saturated fat consumed was so-called hidden fat, derived from milk products, meat products, bakery products etc. Salt intake was higher than recommended whilst the intake of folate and vitamin D fell below the recommended levels. Women's diets were higher in protein, dietary fiber and sucrose compared to men's. The main sources of vitamin D were fish, dietary fats and milk products, and that of folate, cereal products, vegetables, fruit and berries.

Among the 1-6-year-old children, the consumption of fresh vegetables, fruit and berries was low, along with the consumption of fish dishes and the use of fat spreads. Cereal and milk products and meat dishes on the other hand were consumed in large amounts. The consumption of sugar-containing juices, chocolates and sweets increased from the age of 2 years. 1-year-olds were given large amounts of industrial baby foods. The overall quality of the children's diets started to decline after the age of one year when the children started to partake in family meals *(27)*.

The intake of sucrose and saturated fatty acids, among toddlers and pre-schoolers (2- to 6-year-olds), was higher than levels suggested by the Finnish Nutrition Recommendations, while the intake of polyunsaturated fatty acids fell below recommended levels. The majority of the children between the ages of 1 and 6 years had inadequate intakes of vitamin D. The intakes of vitamin E and iron also fell below the recommended levels *(27)*.

The dietary habits of adults have headed in a positive direction overall. However, in certain areas, there remains room for improvement. For instance, although the quality of the fats consumed has continued to improve, and the intake of salt has decreased, the recommended levels of intake are still not met. Similarly, the intakes of folate and vitamin D continue to fall below the recommended levels. There is further a need to increase fibre intake and to cut down on the intake of sucrose. In 2010, 32 % of men and

50 % of women reported eating fresh vegetables daily. Thirty-seven percent of men reported drinking skimmed milk, and the corresponding rate among women was 47 % *(28)*. A diet comprised of more whole grain cereals, fish, vegetables, fruit, and berries, and fewer foods containing high levels of sucrose and saturated fats, would help achieve the goal of national food recommendations.

Table 11 presents the average food consumption values according to The EFSA Comprehensive European Food Consumption Database. The data have been built on existing information from Finland, including FINDIET 2007, DIPP 2003-2006 and STRIP 2000 data *(29)*. The EFSA is using the following age classes:

1. Infants: up to and including 11 months
2. Toddlers: from 12 up to and including 35 months of age
3. Other children: from 36 months up to and including 9 years of age
4. Adolescents: from 10 up to and including 17 years of age
5. Adults: from 18 up to and including 64 years of age
6. Elderly: from 65 up to and including 74 years of age
7. Very elderly: from 75 years of age and older

When looking at the results from the EFSA food consumption database in Finland, liquids (tap water, milk, coffee and fruit juices) are the most consumed items. According to EFSA the use of their food consumption data for direct country-to-country comparisons is not advisable, however, because the data has been collected using different methodologies. Data from Food Balance Sheets may be useful when examining differences in amount of food supply patterns. These results are presented in Appendix 2.

Table 11. Average food consumption (g/day) according to age classes.

| Food | Adults | Elderly | Other children | Toddlers |
|---|---|---|---|---|
| Tap water | 900.0 | 854.6 | 218.1 | 487.5 |
| Liquid milk | 284.0 | 289.0 | 447.7 | 292.9 |
| Coffee (Beverage) | 486.4 | 393.6 | 1.3 | 0.1 |
| Fruit juice | 163.8 | 101.0 | 129.6 | 18.1 |
| Fermented milk products | 113.6 | 114.6 | 82.6 | 71.8 |
| Potatoes and potatoes products | 85.7 | 89.9 | 68.2 | 73.8 |
| Grain milling products | 122.7 | 123.6 | 30.2 | 45.1 |
| Tea (Infusion) | 126.4 | 124.8 | 11.8 | 0.1 |
| Soft drinks | 55.7 | 14.5 | 89.2 | 1.7 |
| Fruiting vegetables | 61.7 | 49.5 | 29.5 | 17.1 |
| Infant formulae. liquid | 0.0 | 0.0 | 0.0 | 179.9 |
| Pome fruits | 42.4 | 52.0 | 21.2 | 14.3 |
| Citrus fruits | 62.9 | 50.3 | 13.6 | 2.1 |
| Livestock meat | 38.2 | 33.9 | 18.9 | 26.1 |
| Beer and beer-like beverage | 105.5 | 25.5 | 1.3 | 0.0 |
| Berries and small fruits | 28.6 | 49.0 | 14.5 | 16.7 |
| Miscellaneous fruits | 24.7 | 17.2 | 19.4 | 24.1 |
| Sausages | 28.5 | 18.1 | 24.5 | 3.3 |
| Breakfast cereals | 10.3 | 17.0 | 32.0 | 4.1 |
| Cheese | 36.9 | 23.2 | 15.0 | 5.0 |
| Root vegetables | 20.1 | 22.1 | 13.3 | 24.6 |
| Poultry | 30.3 | 21.5 | 13.3 | 10.8 |
| Fish meat | 24.7 | 35.5 | 8.9 | 6.2 |
| Mixed fruit juice | 0.0 | 0.0 | 37.1 | 7.8 |
| Fine bakery wares | 0.0 | 0.0 | 36.1 | 1.3 |
| Ices and desserts | 6.4 | 3.4 | 30.6 | 2.1 |
| Bread and rolls | 2.2 | 1.8 | 33.2 | 1.1 |
| Bottled water | 38.8 | 27.3 | 1.7 | 0.1 |
| Margarine and similar products | 18.7 | 20.2 | 9.0 | 1.9 |
| Ready to eat soups | 0.0 | 0.0 | 29.0 | 0.0 |
| Sugars | 14.7 | 16.9 | 6.7 | 9.8 |
| Pasta (Raw) | 8.1 | 3.3 | 16.7 | 3.2 |
| Cereal-based dishes | 0.0 | 0.0 | 23.9 | 0.0 |
| Eggs. fresh | 16.1 | 14.6 | 7.1 | 2.7 |
| Meat-based meals | 0.0 | 0.0 | 22.2 | 0.0 |
| Vegetable products | 13.7 | 12.9 | 6.0 | 4.8 |
| Grains for human consumption | 9.8 | 7.3 | 9.9 | 4.0 |
| Preserved meat | 15.1 | 14.9 | 4.5 | 0.9 |
| Cream and cream products | 11.7 | 11.1 | 6.7 | 3.6 |
| Confectionery (non-chocolate) | 7.9 | 2.1 | 13.0 | 0.7 |
| Brassica vegetables | 11.0 | 11.5 | 3.9 | 5.4 |
| Bulb vegetables | 11.3 | 9.6 | 3.4 | 5.0 |
| Mixed meat | 10.0 | 6.5 | 5.4 | 3.2 |
| Wine | 16.9 | 12.5 | 0.0 | 0.0 |
| Savoury sauces | 0.0 | 0.0 | 13.8 | 0.0 |
| Cocoa beverage | 0.0 | 0.0 | 13.5 | 0.0 |

(Source: EFSA database: acute food consumption statistics – reported in grams/day – L2-all days g/day (In EFSA database the data for Finland originates from the studies FINDIET 2007, DIPP 2003-2006, STRIP 2000)).

### 3.1.5. Food trends

#### *Long term trends (1966-2008)*

There are clear differences in the quantities of foods acquired for home consumption from 1966 to 2006. The differences are evident both among groups of foods and within them. Consumption of milk has fallen by half, i.e. by about 100 litres per annum, but it has been replaced by growth in the consumption of cheese and yoghurts. Among grain products, the annual consumption of flour and flakes has fallen from 57 kg to 15 kg. It has not been compensated for by acquisition of bread, which has remained at about 35 kg per annum. The annual consumption of fruit has doubled, and that of potatoes more than halved. The annual consumption of sugar has fallen to a third of the earlier figures, while consumption of soft drinks has tripled. Foods are also acquired in more ready-to-eat forms than previously. The acquisition of preserved and prepared foods has grown during the period investigated from 6 kg to 29 kg *(30)*. There is also a clear change in drinking habits, especially among women whose alcohol consumption was 6 times higher in 2008 than in 1968. Currently Finns also prefer mild alcohol drinks such as beer rather than spirits *(31)*.

#### *Current trends*

- Natural, tasty and pure food is preferred over highly processed food
- Local ingredients are preferred
- Demand for organic food is greater than production
- Popularity of ethnic food continues
- Light products are out of fashion
- Consumption of non-fat milk has decreased, whole milk has gained in popularity
- Increased consumption of milk products with high protein content
- A low-carbohydrate diet has become more and more popular
- Awareness of food additives and their possible health effects has increased

## 3.2. Estonia

### 3.2.1. Population structure in the area

At the end of 2010, Estonia's official total population was 1 340 194 of whom 617 757 were men and 722 437 women (Table 12) *(32)*. The project area covers the whole of Estonia. The distribution of the population is predominantly concentrated around the main towns. Almost 30 % of the population lives in the capital, Tallinn, which is located in northern Estonia by the Gulf of Finland.

Table 12. Area and population by region in Estonia.

| Region | Land area km$^2$ 1.1.2011 | Population 1.1.2011 | Males % 1.1.2011 | Females % 1.1.2011 | Children under 3 years old (%) 1.1.2011 |
|---|---|---|---|---|---|
| Harju county | 4 333 | 528 468 | 46.1 | 53.9 | 5.5 |
| Hiiu county | 1 023 | 10 000 | 47.7 | 52.3 | 3.4 |
| Ida-Viru county | 3 364 | 167 542 | 44.6 | 55.4 | 3.5 |
| Järva county | 2 460 | 35 963 | 46.5 | 53.5 | 4.1 |
| Lääne county | 2 383 | 27 283 | 46.4 | 53.6 | 3.7 |
| Lääne-Viru county | 3 628 | 66 861 | 46.2 | 53.8 | 4.2 |
| Pärnu county | 4 807 | 88 327 | 46.4 | 53.6 | 4.5 |
| Rapla county | 2 980 | 36 652 | 47.7 | 52.3 | 4.6 |
| Saare county | 2 922 | 34 577 | 46.8 | 53.2 | 4.1 |
| Jõgeva county | 2 604 | 36 550 | 46.9 | 53.1 | 3.5 |
| Põlva county | 2 165 | 30 778 | 47.5 | 52.5 | 3.9 |
| Tartu county | 2 993 | 150 535 | 45.8 | 54.2 | 5.4 |
| Valga county | 2 044 | 33 889 | 46.4 | 53.6 | 3.8 |
| Viljandi county | 3 422 | 55 275 | 46.7 | 53.3 | 3.9 |
| Võru county | 2 305 | 37 494 | 46.9 | 53.1 | 3.8 |
| Whole country | 45 227 | 1 340 194 | 46.1 | 53.9 | 4.7 |

Source: Statistics Estonia. Population.

The average size of an Estonian household is 2.3 people *(32)*. Those living alone make up 37 % of the households. The average life expectancy for women is 80 years and for men 70 years. The difference in life expectancy between men and women is one of the highest in the EU *(32)*. In the year 2010 the number of births was higher than the number of deaths for over 20 years. The reason was not the rise in the number of births but the decline in the number of deaths.

The population is projected to become older in Estonia *(32)*. According to Statistics Estonia, there were 104 618 persons aged 75 and over in Estonia at the end of 2010. The clear majority of those aged 75 and over were women (72 %). The number of women aged 75 and older was 75 748, as the number of men was 28 870. In the whole country the number of people aged 80 and over has doubled over the last 40 years *(32)*. Population structure by age and gender at the end of 2010 is presented in Table 13 and in Table 14.

Table 13. Population projection by age and region for 2010–2050 in Estonia.

| Estonia | Year 2010 | 2020 | 2030 |
|---|---|---|---|
| Population (1000) | 1 331 | 1 277 | 1 189 |
| Age 0-14 (%) | 15.1 | 18.1 | 17.2 |
| Age 15-64 (%) | 67.9 | 63.6 | 62.4 |
| Age 65- (%) | 17.0 | 18.3 | 20.4 |

Source: Statistics Estonia. Population prognosis and age distribution in Estonia.

Table 14. Population structure in project area by age grouping at year-end 2010 in Estonia.

| Estonia 2010 | < 1 | 1-2 | 3-9 | 10-17 | 18-64 | 65-74 | 75- |
|---|---|---|---|---|---|---|---|
| Total | 1.2 | 2.4 | 7.2 | 7.6 | 64.6 | 9.2 | 7.8 |
| Males | 1.3 | 2.6 | 8.1 | 8.5 | 67.4 | 7.5 | 4.7 |
| Females | 1.1 | 2.1 | 6.5 | 6.8 | 62.3 | 10.7 | 10.5 |

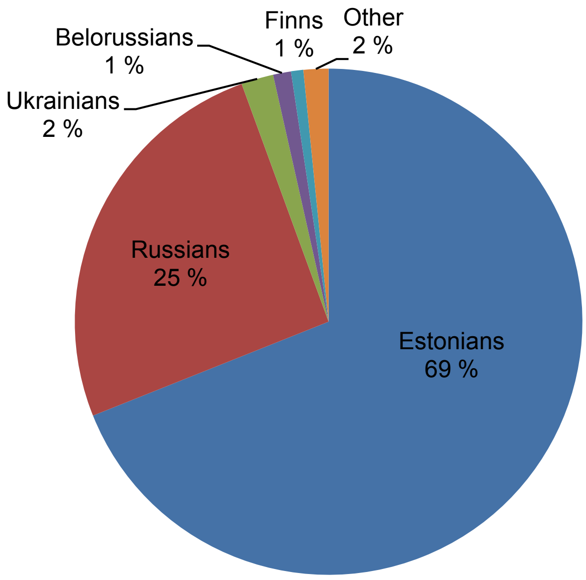
Source: Statistics Estonia. Population structure.

According to Statistics Estonia information about foreign nationals is gathered by nationality not by citizenship. A total of 417 729 foreign nationals lived in Estonia at the end of 2010. In 1989 there were only 61.5 % Estonians (by nationality) living in Estonia. The level of foreign nationals in the whole country at the end of 2010 was 31.2 %, so that the numbers of people with Estonian nationality have grown 7.3 % in 22 years.

In 2010, by nationality, those living in Estonia comprised 68.8 % Estonians, 25.6 % Russians, 2.1 % Ukrainians, 1.2 % Belorussians and 2.4 % other nationalities (Finnish, Armenian, Lithuanian, Polish, Latvian and German (Figure 19). Among men there were 430 431 who had Estonian nationality and 491 967 women: 69.7 % of the men were Estonian and 68.1 % of the women.

According to the European Migration Network, 84 % of Estonians have Estonian citizenship, 8 % have undefined citizenship, 7 % have Russian citizenship and 1% have other (mostly citizenship of EU countries) *(33)*. According to the population census in 2000, 90.9 % of Estonian citizens were born in Estonia and 8.8 % were born in a foreign country (0.3 % did not know their country of birth) *(32)*.

In Estonia the emigration rate is higher than the immigration rate. Migration in Estonia has grown year by year. Most immigrants come from Finland, Russia, Ukraine and the United Kingdom. Those were also the countries where people emigrated to, in addition to Germany, Ireland and the US. 60 % of the immigrants were men. It is not possible to add Asia and Africa to this list because there is not sufficient information *(32)*.




Source: Statistics Estonia. Population by ethnic nationality.

Figure 19. Breakdown of nationalities in Estonia in 2010.

In 2000-2009 the Estonian population shrank by 1.3 % due to emigration. According to Statistics Estonia, in 2010, 5 294 persons emigrated from Estonia and 2 810 persons immigrated to Estonia *(32)*.

In 2010 15 825 children were born in Estonia, 11 866 of which were Estonians by nationality and 3 959 of other nationalities. 75 % of the mothers who gave birth were Estonian by nationality, 22 % were Russian, 1 % Ukrainian and 2 % were of other nationalities (Belorussian, Finnish, Armenian, Lithuanian, Latvian, German and Polish). In 2000 70 % of the mothers were Estonian by nationality, 25 % were Russian, 2 % Ukrainian and 3 % of other nationalities. Statistics on where the mothers were born (in which country) are not available.

### 3.2.2. Food production

The food industry is important in Estonia in that it represents about one fifth from the total production of the processing industry. In 2008, 375 enterprises were engaged in the food industry, which contributes almost 2 % of Estonian gross domestic product and 8 % of industrial product exports. Most of the production volume in 2009 came from milk (25 %), meat (20 %) and beverages (17 %) *(34)*.

Self-sufficiency in milk was 161 % in 2009. The degree in self-sufficiency in meat in 2009 was around 83 %. Self-sufficiency in pork was 92 %, in beef 83 % and in poultry 51 %. The degree of self-sufficiency in grain varies from year to year depending on the harvest: in 2004/2005 it was around 90 % and in 2008/2009 122 % *(35)*. Self-sufficiency in vegetables in 2009 was 57 % and in fruit 8 %. Self-sufficiency in potatoes was around 100 % in 2000, but in 2009 it was 82 % *(34)*.

Preliminary data released from the 2010 Agricultural Census reveal that the current number of agricultural holdings is roughly a third of the total recorded in 2001. Estonia has 19 700 holdings of at least one hectare of agricultural area or which produce agricultural products mainly for sale. According to Statistics Estonia this large decrease in the number of holdings does not mean the disappearance of agricultural activity on that land. On the contrary, for total agricultural land an 8 % increase was recorded. The Final Census data will be published in December 2011 *(32)*.

In 2007 there were 23 336 agricultural holdings in Estonia. The average farm size in Estonia was about twice that of the EU25 average. The average size of farms was 29.9 ha in 2005 *(36)*. According to a country profile of rural characteristics report, 45 % of farms engage in crop production, 21 % in dairy farming and 31 % in mixed production (crop and livestock production).

Agricultural crops were grown in Estonia on 602 044 hectares in 2010. Slightly less than half of this area (46 %) was under cereals, the rest of the land was under fodder crops (35 %), industrial crops (17 %) and potato, vegetables and legumes (2 %). 44.7 % of the cereals was represented by wheat, 39.2 % by barley, 11.4 % by oats and 4.7 % by rye *(32)*.

The biggest shares in exports in 2010 were milk (28 %), fish (24 %), meat (11 %) and beverages (12 %) *(37)*. In 2010, agricultural and food products export made up 10 % of the whole export volume and 11 % of the whole import volume. Almost one fifth of products are exported to Russia (mainly frozen fish and baby food). Also a lot of products are exported to Finland (dairy products), Latvia and Lithuania *(37)*.

The biggest number of enterprises was engaged in bakery (100 enterprises), meat (53 enterprises) and fish industries (49 enterprises). The largest food production enterprises according to the Estonian 2010 annual economic report are:

- AS Rakvere Lihakombinaat (meat products)
- Atria kontsern (AS Wõro Kommerts, AS Vastse-Kuuste Lihatööstus) (meat products)
- AS Tallegg (eggs, poultry)
- AS Leibur (bakery)
- Fazer Eesti AS (bakery, sweets)
- AS Eesti Pagar (bakery)
- Valio Eesti AS (dairy)
- E-piim (dairy)
- AS Saku Õlletehas (beverages)
- AS A.Le Coq (beverages)
- AS Paljassaare Kalatööstus (fish products)

Some of the bigger producers are subsidiaries of Finnish companies like Fazer Eesti AS (bakery, sweets, chocolate) and Valio Eesti AS (milk products).

Table 15. Yield of the main crops in Estonia in 2010.

| Estonia, whole country | | | |
|---|---|---|---|
| | Area 1000 ha | Yield kg/ha | million kg |
| Rye | 12.6 | 1 983 | 25.0 |
| Winter wheat | 50.6 | 2 934 | 148.5 |
| Winter barley | 1.0 | 2 210 | 2.2 |
| Triticale | 4.0 | 2 234 | 8.9 |
| Spring wheat | 68.8 | 2 604 | 179.2 |
| Barley | 103.8 | 2 433 | 252.5 |
| Oats | 30.4 | 1 790 | 54.4 |
| Mixed grain | 3.8 | 1 964 | 7.5 |
| Buckwheat | 0.3 | 452 | 0.1 |
| Legumes | 7.3 | 1 713 | 12.5 |
| Linseed | 0.2 | 1 274 | 0.3 |
| Spring swede rape | 85.9 | 24 499 | 2 104.5 |
| Winter rape | 12.3 | 22 941 | 282.2 |
| Cabbage | 0.7 | 38 804 | 27.2 |
| Cucumber | 0.2 | 9 055 | 1.8 |
| Beetroot | 0.3 | 1 571 | 0.5 |
| Carrot | 0.6 | 684 | 0.4 |
| Onion | 0.2 | 7 490 | 1.5 |
| Garlic | 0.1 | 17 456 | 1.7 |
| Peas | 0.1 | 5 460 | 0.5 |
| Turnip | 0.2 | 20 379 | 4.1 |
| Potato | 9.4 | 17 456 | 164.1 |
| Fodder root | 0.1 | 5 460 | 0.5 |
| Corn | 1.6 | 20 379 | 32.6 |

Source: Statistics Estonia. Crop production.

Total harvest of cereals has remained under a 1000 million tonnes and average yield under 3000 kg/ha. Barley and wheat are the most grown cereals (Table 15).

In 2010 602 000 hectares were under agricultural crops. The area of cultivation has grown at the expense of technical crops (rape) in recent years. The consumption of potatoes has decreased year by year due to decrease in their use as forage.

Most important importers of Estonian cereal products in 2010 were Russia (21.6 %), Latvia (18.2 %), Finland (17.5 %) and Lithuania (12.7 %) and most cereal products from Estonia go to Latvia (14.0 %), Finland (12.9 %), Lithuania (12.7 %), Germany (9.9 %) and the Netherlands (8.3 %) *(38)*.

Agricultural products were exported in 2010 in the sum of 835.3 million euros, which is ~9.5 % of Estonian total export and import volume was 1022 million euros, which accounted for 11.1 % of the total import of Estonia in 2010. More information about export and import are represented in Figure 20.


Source: Statistics Estonia, Ministry of Agriculture.

Figure 20. Structure of export and import in 2010.

The flagship of Estonian agriculture is milk production where nowadays the selection of dairy products is quite wide. There is a selection of non-fat, low fat and more and more low lactose and non-lactose products. There are also products that lower blood pressure (for example so-called heart cheese). During recent years, Estonian milk producers have been successful in improving their production indicators and increasing milk quality. There is also an EU funded project called "School milk". The aim on the project is to get more kindergarten and school children to drink milk. At the end of 2010 997 schools with 208 569 children were involved in this project *(39)*.

According to Statistics Estonia, 676 million kg of milk was produced in Estonia in 2010. The milk sold to industry represents 89 % of the total milk production. Milk processing enterprises purchased 603 900 tonnes of milk. There were 39 milk and dairy products enterprises in Estonia in 2010, most of which are located in Harju County (around the capital). The main milk products were flavoured yoghurt and cottage cheese. Almost half of the cheese produced in Estonia is exported and an increasing amount of bought-in milk is used for cheese production.

The main importers of Estonian milk and dairy products in 2010 were Russia (37.8 %), Latvia (15.3 %), Finland (14.3 %) and Lithuania (12.7 %). Milk product export to the EU was 60.7 % of total exports. Most imported milk and dairy products are from Germany (23.6 %), Latvia (17.8 %), Poland (15.7 %), Lithuania (15.1 %) and Finland (12.2 %) *(40)*.

Table 16. Amount of meat and milk production in Estonia (million kg).

| Production 2010 | Pork | Beef | Mutton | Poultry | Milk | Number of milk producers |
|---|---|---|---|---|---|---|
| **Whole Estonia** | 45.8 | 12.9 | 0.7 | 16 | 676 | 39 |

Source: Statistics Estonia. Meat and milk production.

The main meat production in Estonia includes beef, pork, lamb, goat and poultry. Domestic raw materials were used in the Estonian meat industry up to 52 million kg and 54 % of meat used in the industry was of domestic origin. Over time, the Estonian consumer has preferred domestic meat. Meat and meat products in Estonian supermarkets are mostly the products of the Estonian meat industry. People prefer pork, the production of which amounted to 45.8 million kg in 2010 (Table 16). The main meat products according to Statistics Estonia were frankfurters and cooked sausages.

The number of sheep and goats in 2010 was double that compared to 2004. This has resulted from support for ewe breeding and support for organic sheep breeding. In 2010, the significance of poultry in meat production was around 20 %. 16 million kg of poultry was produced (Table 17).

The main importers of Estonian meat and meat products in 2010 were Denmark (20.6 %), Finland (17.5 %), Lithuania (13.0 %) and Germany (12.3 %). Beef and sausage product exports grew the most. Meat and meat products are imported from Denmark (20.6 %), Finland (17.5 %), Lithuania (13.0 %) and Germany (12.3 %) *(41)*.

Table 17. Estonian meat production, consumption and trade, 2010.

| Meat | Million kg |
|---|---|
| Pork | |
| total production | 45.8 |
| consumption | 42.3 |
| exports | 19.4 |
| imports | 30.6 |
| Beef | |
| total production | 14.2 |
| consumption | 15.3 |
| exports | 2.8 |
| imports | 5.6 |
| Poultry | |
| total production | 16.0 |
| consumption | 29.8 |
| exports | 7.1 |
| imports | 21.6 |
| Mutton | |
| total production | 0.7 |
| consumption | 0.7 |
| exports | 0.1 |
| imports | 0.1 |
| Meat total | |
| total production | 79.0 |
| consumption | 93.9 |
| exports | 31.5 |
| imports | 63.7 |

Source: Statistics Estonia. Supply balance for meat *(42)*.

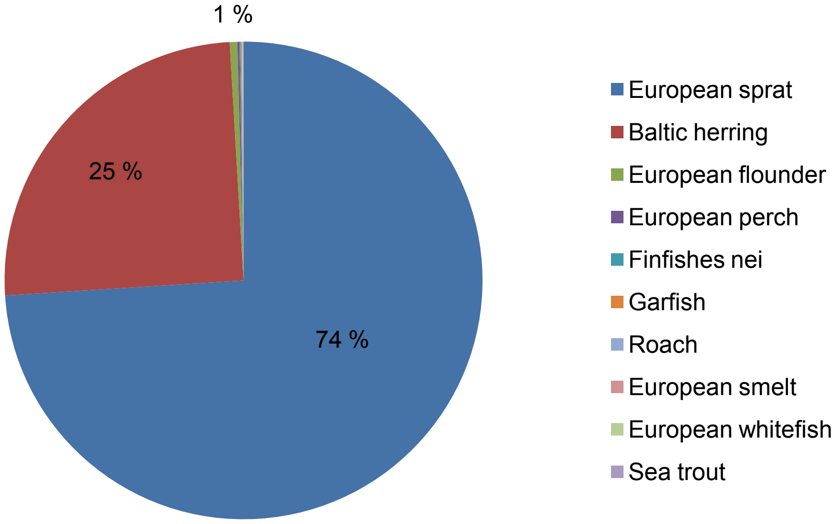
In 2010, Estonia produced 181.9 million eggs The Estonian Veterinary and Food Board has information on those producers that have more than 350 laying hens. According to that information 11 enterprises have 600 893 laying hens, 97 % of which live in henhouses with cages, 2 % in henroost henhouses and around 0.5 % in cage-free henhouses or are kept organically. Special eggs are produced in Estonia, such as omega eggs and eggs that balance blood cholesterol level.

In the Baltic Sea, fish is caught both from the open sea and near the coast. According to Statistics Estonia, the most popular fish in 2009, in the case of deep-sea fishing in Estonia, were the European sprat, Baltic herring and Atlantic cod Table 18 and Figure 21. In the case of coastal fishing, they were Baltic herring, European perch, smelt, flounder, silver bream/roach, garfish, pikeperch, European whitefish, Baltic vimba, sea trout and northern pike. Sprat and Baltic herring are most important economically and represent those species mainly used as raw material in the Estonian fish industry *(43)*.

Table 18. Fish catch from the Baltic Sea.

| Fish caught, 1000 kg | 1995 | 2005 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Baltic herring | 43 481 | 22 098 | 31 838 | 33 164 | 28 862 |
| European sprat | 13 051 | 55 285 | 48 602 | 47 298 | 47 862 |
| Atlantic cod | 1 049 | 589 | 973 | 821 | 796 |
| Commercial fishing, total* | 317 | 554 | 814 | 971 | 765 |
| Recreational fishing, total | | 93 | 88 | 93 | 97 |
| Manufacture of fish products [1)] | 100 | 86 | 67 | 77 | 67 |

Source: Statistics Estonia. The Baltic Sea fish catch.
*commercial fishing in total in Estonia.
[1)]Manufacturing of fish products (canned fish included).




Source: Eurostat/ICES database on catch statistics - ICES 2010 Copenhagen.

Figure 21. Fish catch Statistics 2009, Estonia.

According to Statistics Estonia, 81 % of the farmed fish in 2009 was rainbow trout (789.6 tonnes). Other farmed fish species included carp and eel. The main fish products are canned fish and fish preserves. 75 % of Estonian fisheries production goes for export. Canned fish is also a major export commodity. In 2008, more than 7 million kg of canned fish was produced. According to the Estonian Tax and Customs Board, in 2009 the main countries importing fish products from Estonia (mainly frozen fish and canned fish) were Ukraine and Russia. The biggest importers of Estonian fish products in 2004-2008 were Ukraine, Russia, Denmark and Switzerland. Most exported fish products are frozen fish. The largest volumes of fish products entering Estonia are imported from Russia, Denmark, Norway and Finland. In 2010 there were 90 fish establishments in Estonia.

Professional fishermen are also active on Estonian inland waters. Inland fishing mostly takes place on Lake Peipsi and Võrtsjärv (Table 19). Fish that were most caught in 2009 from inland waters were European perch, bream, pikeperch, silver bream, roach, northern pike, lamprey, burbot and eel.

Table 19. Fish catch from Estonian inland waters, 2009.

| Species | Catch 1000 kg |
|---|---|
| European perch | 820 |
| Freshwater bream | 782 |
| Pike-perch | 723 |
| Silver bream / roach | 211 |
| Northern pike | 102 |
| Lampreys | 59 |
| Burbot | 30 |
| European eel | 16 |
| Houting | 3 |
| Ide | 1 |
| European cisco | 1 |
| Other fish | 81 |
| Fish total | 2 829 |

Source: Statistics Estonia, Fish catch from inland waters.

Self-sufficiency in vegetables and fruit in Estonia is lower than the climatic conditions would allow. There is an overabundance in the harvest period and shortages in the winter-spring season. In 2009 there were only 18 enterprises that were active in the fruit and vegetables sector. From 2009 there was an EU funded project called "School fruit and vegetables", and by the end of 2010 346 schools with 40 053 children were involved in this project *(44)*.

### 3.2.3. Organic farming

Estonian organic farming started in 1989 with the foundation of the Estonian Biodynamic Association. The Association used IFOAM (International Federation of Organic Agriculture Movements) standards to work out the very first Estonian organic agriculture standards and began to use the trademark „ÖKO" and also started to monitor the producers *(45)*.

In 2010 organic land (121 815 ha) represented about 13 % of all agricultural land in use, with 1 356 organic producers. The area of organic farmland has expanded from year to year, to reach an average area of 90 hectares. Organic farms are three times larger than traditional farms (29.9 ha). Six of Estonia's largest organic farms are over 1000 hectares in area. The largest number of organic producers is in Võru County, but the most extensive organic land is in Saaremaa. Organic farming is also widespread in Tartu, Viljandi, Pärnu and Lääne Counties *(45)*.

Almost two thirds of organic producers are engaged in animal breeding. In 2009 42 % of all sheep in Estonia were organic, 7 % of cattle were organic and also over 2 % of milking cows *(35)*. 75 % of the organic meat was beef and 23 % mutton. Other livestock are little kept in organic farming: pigs and poultry mostly for self-consumption and only a few producers market organic eggs. Rabbit farming is starting to gain in popularity and the number of organic hives has also increased continuously *(45)*.

Only 1 of the 39 milk enterprises produced organic milk and the number of organic dairy farmers has decreased during recent years and some of the enterprises have switched over to beef farming.

Organic producers have started to show more interest in cereal production. The cultivation area of organic cereal, which in 2009 was 16 279 hectares, has increased more than three times within six years. The harvest of organically grown cereals, mostly oats, was 17.1 million (Table 20).

In 2010 it was possible to buy 109 different organic potato and vegetable products in the supermarkets. Most of the organic fruits are apples and 62 % of the organic berries were sea buckthorn.

Organic and natural products are gaining more and more in popularity. The number of people who knowingly follow the principles of a healthy diet is continuously rising in Estonia. This trend has increased the demand for organic food. The public is mostly interested in the places where organic food can be bought and the means of recognising it in supermarkets. Consumers demand for organic food outstrips current supplies.

Organic food and animal feed is labelled with the Estonian or EU organic logo. In addition (or instead of) the label the organic product can bear the Estonian terms „ökoloogiline“(often used in the form of the prefix „öko-“) and „mahe“, which are both legally acceptable terms in Estonian for „organic“ *(46)*.

Figure 22. Estonian organic logo.

Table 20. Organic production and total agricultural production, Estonia 2009.

| | 1000 kg | % |
|---|---|---|
| Milk | 671 000 | 100 |
| Organic milk | 10 662 | 1.6 |
| Cereals | 873 500 | 100 |
| Organic cereals | 17 121 | 2 |
| Oats | 8 975 | 10.4 |
| Barley | 2 720 | 0.7 |
| Meat | 76 000 | 100 |
| Organic meat | 987 | 1.3 |
| Beef | 743 | 5.2 |
| Mutton | 230 | 28.8 |
| Pork | 11 | 0.02 |
| Poultry | 1 | 0 |
| Fruits and berries | 9 773 | 100 |
| Organic fruits and berries | 527 | 5.4 |
| Potatoes | 139 100 | 100 |
| Organic potatoes | 1 654 | 1.2 |
| Vegetables | 70 600 | 100 |
| Organic vegetables | 277 | 0.4 |
| | **Thousand** | **%** |
| Eggs | 173 300 | 100 |
| Organic eggs | 523 | 0.3 |

Source: Estonian Institute of Economic Research. Local organic farming products and food products market in Estonia in 2009.

### 3.2.4. Food consumption

Food consumption data in Estonia are (1) actual or (2) frequency based. The latest actual data are available for 1997, when *The study on nutrition of the Estonian (adult) population* was performed (Table 21 *(47)*). Frequency-based surveys are more common (the latest from 2010), and focus on monitoring particular food consumption trends for example vegetables, fruits, bread, fish, fats, milk and salt.

In 1997 potatoes were the most consumed daily food. For both, men and women, the age group of 25-34 consumed most vegetables per day. Fresh root vegetables are consumed mostly on 1-2 or 3-5 days in week and women eat somewhat fresher root vegetables than men. Children aged 11-15 years tend to eat vegetables at the same frequency as adults – on 2-4 days a week. The consumption of vegetables increased in 2009, but those with a lower monthly income ate more potatoes.

Men and women eat fruits and berries mostly on 1-2 days in week, but women tend to eat more fruits and berries than men. The age group consuming fresh fruits and berries at the highest frequency is 25-34 for women and 55-64 for men. The majority of 11-15 year old children eat fruits on 2-4 days a week. Among 11 years old boys and girls there are more who eat fruits more than once every day than among 13 and 15 year old children.

The most widely consumed foods by Estonians are milk products, the majority of which are bought from shops. Usually regular shop milk is preferred, and unprocessed farm milk, whole shop milk or low fat shop milk is consumed rarely. 19 % of males and 25.2 % of females do not usually drink milk. School-aged children consume milk and milk products frequently: 36.6 % of the boys and 30.4 % of the girls drank milk more than once every day. 43.9 % of boys and 33.7 % of girls eat milk products more than once every day. Milk and milk products are mostly eaten by school-aged children on 2-4 or 5-6 days a week.

In 2010 men ate slightly more black bread than women and most of the men ate 3-5 slices per day, while women ate mostly 1-2 slices per day. 25.4 % of men and 42.9 % of women do not eat white bread, but those that do, normally eat more than 2 slices/buns a day. School-aged children normally eat black and white bread 2-4 days a week. Girls tend to prefer black bread somewhat more than white bread. White bread and black bread together with milk and milk products are the most common food products consumed by school-aged children on a daily basis *(48)*.

During recent years fish consumption has increased a little, but since 2007 the importance of local fish products has decreased. School-aged children eat fish mostly once or less than once in a week. Boys eat somewhat more fish than girls. Fishermen eat fish or fish products as a main dish at least once a week, and on average 2.4 times a week. The fish most consumed are Baltic herring and sprat. Of the fish products was herring eaten most *(49)*.

90 % of Estonian adults use mostly vegetable oil for food preparation. Butter and low fat (60 %) margarine are most widely consumed of the fats used with bread. A large share of women do not use fats on bread. The usage of additive fats has been decreasing since 2003. Table salt is used mostly, few (until 17.5 %) use low sodium salt or iodised salt *(50)*.

Table 21. Average food consumption (g/day) for adults in Estonia.

| Food | g/day |
|---|---|
| Potatoes and potato products | 203.0 |
| Coffee (Beverage) | 202.0 |
| Liquid milk | 185.4 |
| Tea (Infusion) | 132.6 |
| Drinking water (water without any additives except carbon dioxide; includes water ice for consumption) (unspecified) | 123.3 |
| Beer and beer-like beverages | 120.0 |
| Bread and rolls | 107.1 |
| Fruiting vegetables | 86.0 |
| Fruit juice | 78.4 |
| Livestock meat | 57.4 |
| Fermented milk products | 57.1 |
| Seasoning or extracts | 52.5 |
| Sausages | 44.7 |
| Root vegetables | 40.5 |
| Soft drinks | 39.8 |
| Brassica vegetables | 36.3 |
| Pome fruits | 32.7 |
| Bottled water | 30.6 |
| Eggs, fresh | 27.3 |
| Cheese | 26.3 |
| Grain milling products | 25.5 |
| Cream and cream products | 20.8 |
| Berries and small fruits | 19.9 |
| Fish meat | 19.8 |
| Spirits | 17.3 |
| Mixed meat | 17.0 |
| Grains for human consumption | 16.6 |
| Poultry | 16.3 |
| Sugars | 16.0 |
| Preserved meat | 15.5 |
| Ices and desserts | 14.0 |
| Wine | 13.7 |
| Bulb vegetables | 11.9 |
| Vegetable oil | 11.9 |
| Pasta (Raw) | 11.4 |
| Animal fat | 10.5 |
| Miscellaneous fruits | 9.7 |
| Legumes, beans, green, without pods | 9.0 |
| Jam, marmalade and other fruit preserves | 8.1 |
| Vegetable juice | 6.6 |
| Breakfast cereals | 6.5 |
| Margarine and similar products | 6.3 |
| Legumes, beans, dried | 5.9 |
| Stone fruits | 4.9 |

(Source: EFSA database: acute food consumption statistics – reported in grams/day – L2-all days g/day (In EFSA database the data for Estonia originates from the study made in 1997)).

## 3.3. Latvia

### 3.3.1. Population structure in the area

The official total population in Latvia was 2 229 641 at the end of 2010, of whom 1 029 391 were male and 1 200 250 female. The population living within the central Baltic IV A Project area was 1 894 628, which constitutes 85 % of the total population of Latvia. The project area covers 50 012 km$^2$, equivalent to 77 % of the total territory of Latvia.

The preliminary results of the 2011 population census show that the total population decreased by 15 %, i.e., 1.9 million since 2010. The programme area comprises Riga, Pieriga region, Kurzeme region, and the adjacent Vidzeme and Zemgale regions. The project area includes the programme area and the adjacent area. In the project area, there are 97 local municipalities (counties) in Latvia.

The population is concentrated in the capital Riga and other coastal cities and areas. The urbanisation level in Latvia is 67.52 %. The data show that women outnumber men by almost 8 % and in Riga by 11 %.

Children until the age of 4 constitute, on average, 5 % of the total population. Of this age group, the highest percentage of children resides in the Pieriga region, whereas in the adjacent area it is lower (Table 22). 65.7 % of residents are of working age, more than 17 % are pensioners and almost 17 % children.

Table 22. Population structure in project area and total in Latvia.

| Region | Land area km$^2$ 31.12.2010 | Population 31.12.2010 | Males % 31.12.2010 | Females % 31.12.2010 | Children under 4 years old (%) 31.12.2010 |
|---|---|---|---|---|---|
| Riga | 304 | 700 107 | 44 | 56 | 5.2 |
| Pieriga | 10 133 | 389 660 | 47 | 53 | 5.8 |
| Kurzeme | 13 596 | 296 529 | 47 | 53 | 4.9 |
| Latvia total | 64 562 | 2 229 641 | 46 | 54 | 5.0 |
| Programme area | 24 033 | 1 386 296 | 46 | 54 | 5.1 |
| Adjacent area | 25 979 | 508 332 | 47 | 53 | 4.6 |
| Project area | 50 012 | 1 894 628 | 46 | 54 | 5.3 |

Source: Central Statistical Bureau 2011.

The average size of a household in Latvia is 2.48 persons *(51)*. Those living alone account for 27.5 % of the total, which is less than the average in Europe (30.3 %). 18.3 % are single women households and households with two adults account for 27.2 % *(52)*.

The average life expectancy for women is 78 years and for men 68.1 years: one of the lowest values among European Union countries. The average life expectancy in the European Union is 76.4 years for men and 82.4 years for women *(53)*.

The demographic data for Latvia show problematic trends: the population is decreasing year by year. There is a negative migration rate and natural growth. 1991 was the last year with a positive natural growth, whereas the migration rate has been negative every year since 1990 - emigration is higher than immigration.

Most immigrants come from European Union countries (neighbouring countries – Estonia, Lithuania, Germany and Sweden) and Russia; people emigrate to European Union countries – 76 % of the total, and to Russia. More than 59.5 % of permanent residents are Latvian; the second largest nationality is Russian with 27.4 %.

According to the Eurostat population projection, the Latvian population will continue to decrease. This will have a significant impact on the state economy because the number of residents of working age will shrink. According to the Eurostat population projection, in 2030 there will be 63.8 % residents of working age and more than 23 % of pensioners (Table 23 and Table 24).

Table 23. Population projection by age for 2010–2030 in Latvia.

| | 2010 | 2020 | 2030 |
|---|---|---|---|
| Population | 2 248 374 | 2 141 315 | 2 021 890 |
| Age 0-14 (%) | 13.8 | 15.0 | 13.1 |
| Age 15-64 (%) | 68.9 | 66.0 | 63.8 |
| Age 64- (%) | 17.4 | 19.0 | 23.1 |

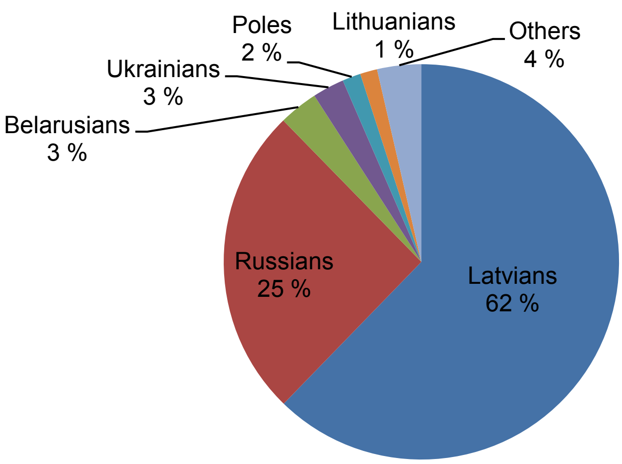
Source: EUROSTAT database Population projection.

Table 24. Population structure (%) in Latvian project area by age grouping at year-end 2010.

| 2010 | | < 1 | 1-2 | 3-9 | 10-17 | 18-64 | 65-74 | 75- |
|---|---|---|---|---|---|---|---|---|
| Project area | Total | 0.9 | 2.1 | 6.7 | 7.2 | 65.7 | 9.8 | 7.5 |
| Programme area | | 0.9 | 2.2 | 6.8 | 6.9 | 65.9 | 9.8 | 7.5 |
| Adjacent area | | 0.8 | 1.9 | 6.6 | 8.2 | 65.3 | 9.8 | 7.4 |
| Project area | Males | 1.0 | 2.3 | 7.4 | 8.0 | 68.9 | 7.8 | 4.4 |
| Programme area | | 1.1 | 2.4 | 7.6 | 7.7 | 68.8 | 7.8 | 4.5 |
| Adjacent area | | 0.9 | 2.1 | 7.1 | 8.8 | 69.2 | 7.9 | 4.1 |
| Project area | Females | 0.8 | 1.9 | 6.1 | 6.6 | 63.0 | 11.5 | 10.1 |
| Programme area | | 0.8 | 2.0 | 6.1 | 6.2 | 63.5 | 11.4 | 10.0 |
| Adjacent area | | 0.7 | 1.8 | 6.1 | 7.6 | 61.9 | 11.6 | 10.3 |

Source: CSB database.

62.2 % of the residents in the project area are Latvians, 25.4 % Russian, 3.2 % Belarusian. The areas with the highest proportion of Latvians are the Vidzeme adjacent area, with 85.3 % Latvians, and Kurzeme with 74.2 %. Fewer Latvians in the Foodweb project area live in Riga – 42.5 %, where the second largest nationality is Russian, with 40.7 % (Figure 23). 82.56% of the total population are citizens, 15. 27% non-citizens and 2.16 % foreigners *(51)*.




Source: CSB database.

Figure 23. Latvian population structure at year-end 2010.

### 3.3.2. Food production

The food industry is the second largest industrial sector in Latvia after energy, gas, heating supply and air conditioning. It is the most important manufacturing industry, accounting for 20.3 % (2010) of the total industry added value. Agriculture and fishing in 2010 accounted for 4 % of the total *(54)*.

The largest food production sectors ranked by value are meat and meat product production, processing and canning, followed by dairy production and processing and cheese production *(55)*. Latvia is entirely self–sufficient in milk and dairy products, as well as in eggs and meat.

Food imports have increased during recent years. According to Dr. oec. L. Melece's study *(56)*, import dependency in the period from 2004 to 2007 increased by 9 %. More than one third (34 %) of food consumed in 2007 was imported. Although the food industry is the sector that is traditionally oriented towards the internal market, the statistical data indicate that the recent years have seen a decrease in local utilisation of the local produce and an increase in food export ratio as of the total amount of produce. This points to unsustainable development of the food chain.

The largest part of imported food and agricultural products come from the Netherlands, Denmark and Lithuania. Vegetables and fruit are the most imported food products and the import dependency is more than 50 % *(56)*, the most imported animal products are milk powder and canned milk – 80 %, poultry (47 %), cheese (47 %) *(54)*.

At the same time, the most important food export products are of animal origin, such as meat and meat products, cheese, and cereals, but wheat and mixed wheat and rye are also exported. The most important food export destinations are the USA, Russia, the Netherlands *(54)*.

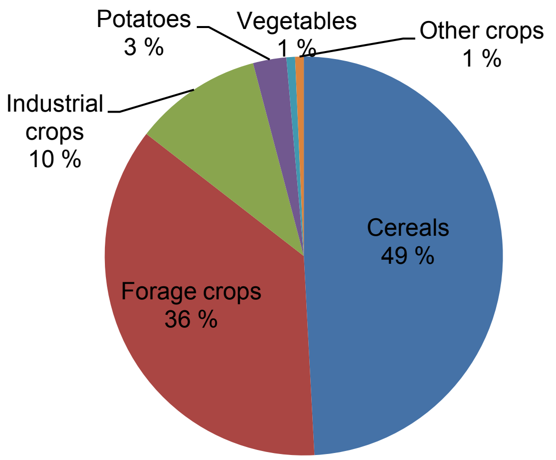
In 2010, agricultural, food and fish products were the second main export sector in Latvia. In 2010, the export of these products accounted for 17.6 % of the total export value in Latvia – LVL 818 million. In 2007, a total of 73 891 farms were active in the project territory, which represents 65 % of the total number of farms in Latvia.

Statistics show a trend in Latvia of transition from small farms to larger ones. Over recent years the number of farms has been decreasing, and the area of agricultural land per a single farm has been growing. The larger farms boast the highest yield capacity.

#### *General characteristics of agriculture*

The agricultural land in Latvia covers 1.8 million ha, of which 65 % is arable land, 34.6 % meadows and pastures, and 0.4 % permanent crops. According to the Central Statistical Bureau data, in 2007 agricultural land covered 1.3 million ha or 13 160 $km^2$, which comprises 26 % of the project area.

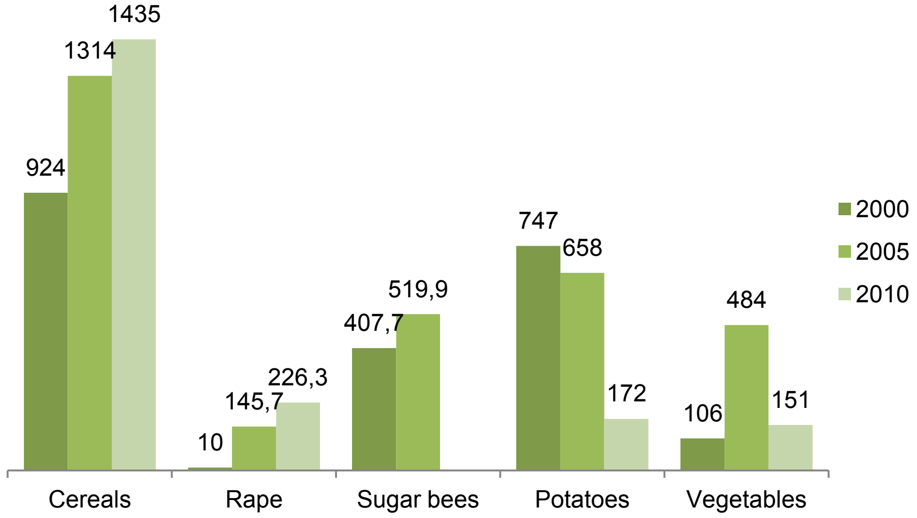
The main crops in Latvia are cereals, rape, potatoes, vegetables, flax and linseed (Figure 24). Sugar beet cultivation was terminated in 2007 and two sugar production factories were closed down.




Source: CSB database.

Figure 24. Agricultural sowing area structure for Latvia in 2010.

Over the recent years, however, rape cultivation has increased, with a 20-time growth since the year 2000. Rape is in Latvia mainly used for energy production needs (biogas and biofuel), and only a very small amount is used for producing oil. The potato and vegetable produce has also been decreasing recently, whereas the crop yield has been on a rise (Figure 25).




Source: CSB database.

Figure 25. Harvested production of main crops in Latvia 2000–2010 (million kg).

A comparison of statistical data shows that over recent years the average yield has decreased for cereal products but increased for open field vegetables.

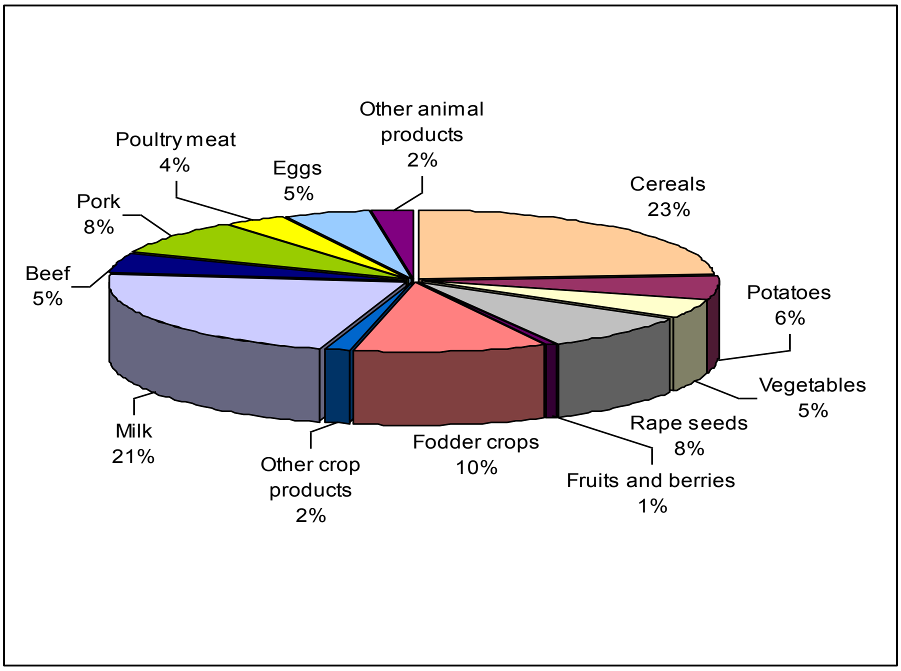
From the total produce, a very small amount is used for food; the table shows that it is on average less than one fifth. Part of this produce is useless, and part is used for seed, fodder, industrial processing, etc. (Table 25).

Table 25. Yield of main crops in Latvia in 2010 (open field).

| | Area (1000 ha) | Yield (kg/ha) | Production (M kg) | Used for human consumption (M kg) |
|---|---|---|---|---|
| **Cereals** | 541.5 | 2 650 | 1 435.5 | 276.3 |
| Winter wheat | 225.8 | 3 500 | 790.5 | 198.6 |
| Spring wheat | 81.8 | 2 430 | 198.8 | |
| Winter rye | 34.6 | 2 030 | 70.2 | 47.5 |
| Winter barley | 15.4 | 2 880 | 44.5 | 11.1 |
| Spring barley | 91.1 | 2 020 | 184.0 | |
| Oats | 63.3 | 1 590 | 100.6 | 15.0 |
| Buckwheat | 8.2 | 670 | 5.2 | |
| Triticale | 12.1 | 2 190 | 26.4 | |
| Mixed cereals | 3.6 | 1 720 | 6.2 | 4.1 |
| Mixed cereals and legumes | 5.6 | 1 560 | 8.8 | |
| **Legumes** | 2.7 | 1 980 | 5.4 | 5.4 |
| **Potatoes** | 30.1 | 16 100 | 484.3 | 277.7 |
| **Vegetables** | 8.1 | 17 200 | 138.8 | |
| Cabbage | 2.5 | 24 300 | 61.3 | |
| Leeks | 0.05 | 4 960 | 0.25 | |
| Lettuce | 0.02 | 3 650 | 0.06 | |
| Spring onions | 0.06 | 3 330 | 0.22 | |
| Cucumbers | 0.24 | 6 590 | 1.59 | |
| Tomatoes | 0.01 | 3 430 | 0.03 | |
| Beetroots | 0.99 | 16 400 | 16.3 | |
| Carrots | 1.80 | 19 100 | 34.3 | 3.8 |
| Onions | 1.07 | 15 300 | 16.2 | |
| Garlic | 0.04 | 2 880 | 0.12 | |
| Horseradish | 0.16 | 1 510 | 0.24 | |
| Gourds and marrows | 0.17 | 18 100 | 3.1 | |
| **Other** | 0.93 | 5 240 | 4.9 | |
| **Strawberries** | 0.47 | 1 300 | 0.6 | |

Source: CSB 2011.

In 2010, crop farming contributed 54.8 % of the total final production value of agricultural goods at base prices, with livestock farming providing 45.2 % *(57)*. The largest produced value (at base price) in 2010 was represented by cereal products (23 %), followed by dairy products (21 %) and meat products (17 %) (Figure 26).




Source: Ministry of Agriculture 2009.

Figure 26. Structure of final agricultural output in 2010 for Latvia (at base price).

### Main food production sectors in the project area

The main agricultural regions are situated in the adjacent area of Vidzeme and Zemgale, which are the areas with the most nutrient-rich soils. Many important dairy product industries are situated in the Vidzeme region, whereas the Zemgale region has more farms specialising in vegetable and cereal growing. The Kurzeme region, which is located in the coastal zone, is mainly characterised by the fishing industry.

In 2010, almost 90 % of the total key food items produced in Latvia were produced in the project area, with vegetables and eggs accounting for up to 95 % of the total produce in the project area. According to the Central Statistical Bureau, in 2010 a total of 257.5 million kg cereals, 404 million kg potatoes, 131.6 million kg vegetables, 67 million kg meat products, 676.8 million kg milk, and 675 million eggs were produced in the Foodweb project area.

### Crop production

Cultivation of grain has in Latvia long been one of the most important agricultural production sectors. Grain cultivation constituted 47-51 % in the overall field structure in the period from 2000 to 2010. Grain cultivation is the principal crop sector for food production; directly as bread and flour among other products and indirectly as fodder products. Cereal products are a key source of feed in livestock breeding.

On average, when there has been a good yield, Latvia has been self–sufficient in cereals over the years *(56)*. In times of deficit, the required amount of crops was imported from Estonia and Lithuania. Rice is being imported, buckwheat somewhat less. The key rice import countries are Thailand, Pakistan, and European Union countries, and half of the pasta is imported from the Czech Republic and Lithuania. Self sufficiency in cereals and cereal products is 80 – 90 % *(56)*.

### Vegetable and fruit production

Due to the climate and weather, self–sufficiency in vegetables and fruit during the whole year is impossible. In recent years, the vegetable imports have been growing, with more than 30 % of vegetables now being imported. The main country from which fruit is imported is the Netherlands.

Dependency on fruit import amounts to 60 – 80 %; it is affected by local apple harvest and self-consumption. The largest amount of fruit is imported from the Netherlands, Spain, Italy, and Germany. The most imported vegetables and fruits are tomatoes (87 %), salads (82 %), pears (95 %), and plums (90 %) *(58)*.

In 2010, cabbage had the largest total yield percentage in open field vegetable areas with 31 %, carrots – 22 %. Other vegetables accounted for 47 % of the total yield of open air vegetables. Most widespread vegetables in covered areas (greenhouses) are tomatoes and cucumbers. In 2010, a total of 12.16 million kg of vegetables were produced in greenhouses, of which 43 % were tomatoes, 53 % cucumbers, the rest – salads and other vegetables. Fruit tree and berry fields occupy 7 324 ha, the largest areas being taken up by apple-trees and pear-trees, red currants and black currants *(54)*.

### Animal-origin food production

According to the Food and Veterinary Service (FVS), 350 companies were engaged in the production of food of animal origin – meat, eggs, dairy products, fish products and gelatine – and operate within the project territory. The majority of these companies (112) are related to fishing, 66 are concerned with meat and meat products, and 64 are dairy production companies *(59)*.

Comparing dairy and meat production indices with the statistics of 20 years ago, milk production has decreased by more than half and meat production by more than two thirds. After 2000, the production of these items stabilised, and on average 80 million kg of meat and 830 million kg of milk are produced annually. Recent years have seen an increase in egg production, by 40 % since 2000 *(54)*.

Meat products are mostly produced in the Pieriga region, which accounts for 33 % of the total production, most milk is produced in the Vidzeme region, and most eggs in the Zemgale region (70 % of total production) *(54)*.

### Meat production

According to the Latvian Central Statistical Bureau data of 2010, Latvia produced 79.9 million kg of meat (carcass weight). In Soviet times, meat production was the third largest food production sector, but the amount of meat produced has significantly decreased, although remains the second most important food sector (ranked by value).

According to FVS data, 66 meat production companies are registered in the project area. The largest proportion of produced meat is pork (47 %) followed by poultry meat (28 %), beef and veal (24 %) *(51)*.

According to agricultural data from 2009, farms contain a total of 378 200 cattle (of these, dairy cows account for 165 500, pigs 376 500, sheep and goats 83 900, and poultry 4.8 million *(51)*.

Self-sufficiency in meat products in Latvia is 65 % *(56)*. Most imported meat is processed into meat products. In 2010, the total meat product imports was 79 500 kg, and exports 37 500 kg. Pork imports were highest (45.9 million kg). Although pork represents the largest meat sector in Latvia, the local production does not meet demand. A total of 37.2 million kg of pork was produced in Latvia in 2010, which is even less than is imported (45.9 million kg). Pork also has the highest export volumes of all meat products. A similar situation occurs with poultry, 3.5 million kg being produced locally and 29.7 million kg being imported.

### Egg production

In 2010, almost 90 % of all key food products generated in Latvia were produced in the project area, with vegetables and eggs accounting for 95 % of the total produce in the project area.

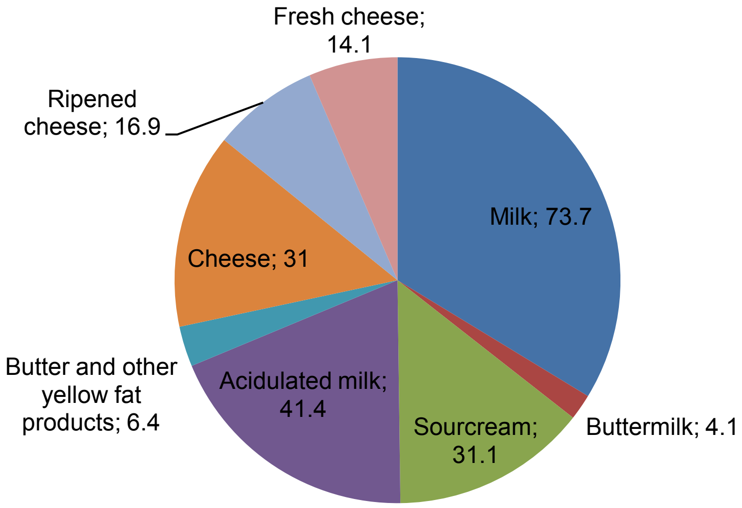
According to FVS data of 2011, there are 13 egg production, processing and packaging companies in Latvia, of which 12 are in the project territory, and as much as 95 % of all egg production is produced in the project area. Latvia produces almost all of the eggs it consumes, only 4 % are imported. In 2010, a total of 715 million eggs were produced, of which 115.6 million were exported.

### Dairy products

Dairy farming is one of the key sectors in Latvia contributing 21 % to the total agricultural production value (Ministry of Agriculture). According to FVS data, 64 milk-processing companies are registered in the project area, with one third of them (21) in the Vidzeme region (adjacent area).

Self–sufficiency in milk products is 80 – 90 %. The most imported milk products are sour milk products from Poland and Germany, as well as cheese from Lithuania and the "old" European Union countries. This is a particularly negative trend, as earlier Latvia was one of the main milk product exporting countries *(56)*.

Of milk products produced in 2010, milk accounted for 73.7 million kg, acidulated milk for 41.4 million kg, and cheese for 31 million kg (Figure 27). Latvia produces cow milk and goat milk food products. Goat milk products constitute not more than 4 % of all dairy products.




Source: CSB data.

Figure 27. Dairy products in Latvia in 2010 (million kg).

### Fish catch and production

Historically fishing has been one of the main economic sectors. In recent years, fish imports grew, despite the fact that Latvia is situated on the coast and 33 % of consumed fish is imported. According to FVS data, 122 companies related to fishing and fish processing are registered in the project area, of which 35 are in Riga.

Fish products include frozen fish, frozen fish fillet, smoked and salted fish to canned fish. In 2010, 43.7 million kg of fish products were exported to 45 countries (LVL 38.5 million in value).

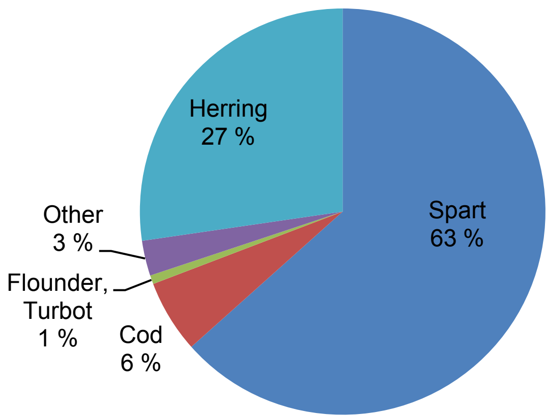
Fish is one of the most important food sector export products: in 2010 it was the most important export product after cereals and beverages.

The amount of fish caught in the Baltic Sea and the Gulf of Riga has decreased in recent years. The biggest fish catches between 2000 and 2010 were in 2005 – 93.1 million kg. On average, 81.29 million kg of fish were caught in this period. During the same time the volume of fish caught in the Atlantic Ocean has increased.

In 2009, a total of 162.6 million kg of fish was caught. The catch in 2009 was made up of 51 % from the Ocean (82 888 tonnes), 48.5 % from the Baltic Sea and the Gulf of Riga (78 913 tonnes), 0.2 % from inland waters and 0.3 % from fish farms.

The amount of fish caught in the Baltic Sea and the Gulf of Riga has decreased in recent years, most were caught in 2005 during recent times; 93.1 million kg. On average, 81.29 million kg of fish were caught between 2000 and 2010.

In the Baltic Sea, in 2009 sprats were the most caught fish, 49.9 million kg, which accounted for 63.4 % of the total Latvian catch in the Baltic Sea and the Gulf of Riga (Figure 28) *(60)*.




Source: Riekstins, Joffe et al. 2010 *(60)*.

Figure 28. Latvian fish catch in the Baltic Sea and the Gulf of Riga, 2009.

**Fish processing**

There are 101 fish processing companies in Latvia with 7000 employees. In 2009, a total of 165 741 tonnes of fish products were produced, of which 61.8 % were fresh and frozen fillet, 23.2 % prepared and canned fish, 10.3 % fresh, chilled and frozen, and 4.7 % dried, salted and smoked.

In 2009, a total of 76 797 tonnes of fish production (canned fish excluded) were exported, mainly to Belarus, Mauritania, Denmark and Ukraine. At the same time, there were 35 723 tonnes of fish imported, the main countries being Norway, Lithuania, Sweden and Estonia.

In 2009, a total of 38 878 tonnes of canned fish were exported, mainly to Russia (36 %), Estonia (13 %), but including Germany and Lithuania *(60)*.

### 3.3.3. Organic farming

According to Ministry of Agriculture data, in 2009, 3 977 organic farms were registered, with a slight decrease in numbers since 2006. Latvia has a total of 160 175 ha of organically managed agricultural lands, of which 72.8 % are grasslands and pastures, followed by crops with 18.7 % and other cultures.

In 2010, the amount of organic production as a proportion of the total agricultural production in Latvia was 2.9 % for cereals, 3.8 % for potatoes, 0.1 % for other vegetables, 3 % for meat, 6 % for milk, and 20.9 % for honey *(61)*.

In 2009, compared with the previous 2 years, the area of organic agricultural crops, such as potatoes and vegetables, decreased, whereas the fruit and legume production area slightly increased.

According to Ministry of Agriculture data for 2009, a total of 3 977 organic operators were registered, which is almost 4 % of all farms. The figure has increased more than 5 times during 5 years; in 2003, there were 556 registered organic operators. For comparison, there are twice as many organic farms in Latvia as in Lithuania and the Netherlands.

Over recent years the economic downslide has affected the development of organic farming. Until 2008, organic farming was on the increase, with the amount of production and number of organic farms rising. In 2009, there was a slight decrease both in the number of organic farms and the amount of total produce (Table 26).

Table 26. Organic farming in Latvia in 2006 – 2009.

| | 2006 | 2008 | 2009 |
|---|---|---|---|
| **Organically managed agricultural land (1000 ha)** | 150 | 162 | 161 |
| **Number of organic farms** | 4 105 | 4 179 | 3 977 |
| **Livestock breeding production** | | | |
| Meat (million kg) | 3.1 | 2.3 | 2.7 |
| Milk (million l) | 62.1 | 45.2 | 66.4 |
| Chicken eggs (1000 pcs) | 1 561.1 | 1 171.0 | 448.1 |
| Honey (1000 kg) | 201.7 | 130.3 | 111.8 |
| **Crop production** | | | |
| Cereals (million kg) | 41.6 | 47.3 | 45.2 |
| Legumes (million kg) | 0.33 | 0.64 | 0.77 |
| Potatoes (million kg) | 23.6 | 18.7 | 17.8 |
| Technical cultures | 0.6 | 0.5 | 0.3 |
| Open field vegetables | 2.6 | 1.3 | 2.0 |
| Fruit and berries | 2.7 | 1.4 | 1.7 |

Source: Ministry of Agriculture.

Latvia has its own organic label – a green shamrock within a yellow horseshoe. The trademark „Latvijas Ekoprodukts" (Latvian Eco Product) belongs to the society "Latvijas Bioloģiskās lauksaimniecības asociācija" (Latvian Organic Farming Association, LBLA).

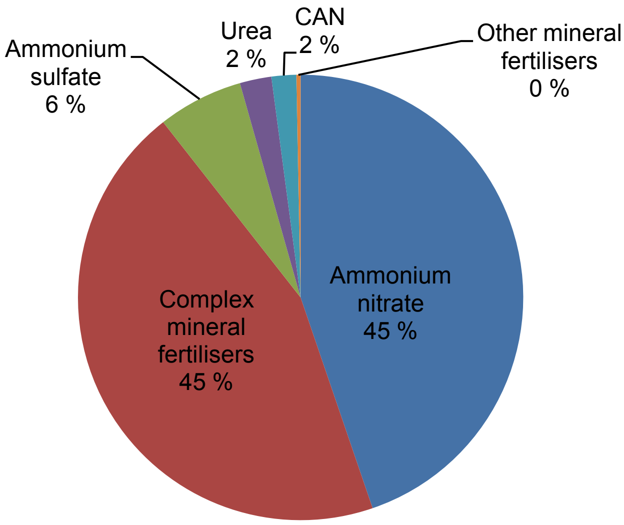
### *Use of fertilisers on agricultural crops*

In 2010, 34 % of the cultivated agricultural area was treated with mineral fertilisers. Expressed as 100 % of nutrients, 92.2 million kg of minerals were used, of which 58.9 million kg were nitrogen, 15.5 million kg phosphorus and 17.8 million kg potassium. 1 178.8 thousand ha (65 %) were not treated and were mainly meadows, pastures and perennial grasses.

In 2010, 55 % of the total sown area of agricultural crops was treated with mineral fertilisers (in 2009 – 50 %) of which 78 % supported cereals (in 2009 – 73 %) and 89 % industrial crops (in 2009 – 71 %).

During the past three years, the use of nitrogen per hectare of sown land has increased by 10 kg or by 23 %, use of phosphorus has remained stable at 14 kg, and the use of potassium has slightly fallen from 17 kg to 16 kg.

Such a trend was caused by the more widespread use of straight nitrogen mineral fertilisers because their prices were noticeably lower than the prices of complex mineral fertilisers (Figure 29) *(62)*.




Source: Central Statistical Bureau of Latvia 2011 *(63)*.

Figure 29. Mineral fertilisers used in Latvia in 2010 by fertiliser type (physical trends).

### 3.3.4. Food consumption

Household environmental behaviour patterns account for a large number of environmental problems. Food and water are basic human needs and at the same time represent one of the most important sectors that makes a significant impact on the environment. Environmental impacts stemming from food consumption factors are related to farming practices, food processing and packaging, transportation, retail and distribution, as well as to consumption practices – i.e. consumer shopping habits and diets through, among other things, daily food intake, imported food levels, and meat and dairy product consumption.

Research on household impact on the climate shows that food consumption of Latvian residents is responsible for 25 % of household-generated GHG. 55 % of the ecological footprint of an average Latvian resident is generated by food consumption *(64, 65)*.

The ecological footprint is 5.6 ha/per capita in Latvia *(66)*, but this value is based on 2007 data, a period of economic growth in Latvia. Presently, taking into account the impact of the economic recession, the ecological footprint is likely to have decreased.

Food consumption is affected by a number of different factors, such as:

- Social demography: sex, e.g., women require a lower amount of energy; age (children and pensioners eat less); education;
- Income level and occupation;
- Lifestyle, interests, social (impact of the surrounding public), attitudinal factors.

Food consumption in Latvia has been analysed using statistics from FAOSTAT *(67)*, and CSB and gathering information from the scientific literature and reports on food consumption issues in Latvia.

#### *Nutrient intake of Latvian residents*

The data on the average energy intake in Latvia differ for men and women. In the Food and Veterinary Service study, in which the diary method was used, the data show that the average energy intake from food for women per day is 1 596 kcal, whereas for men it is 2 234 kcal *(59)*. The FVS study shows that residents in Latvia consume a slightly increased amount of protein, which is mainly due to slightly increased consumption of food of animal origin compared with the recommended levels *(59)*. Consumption of animal-origin food also has a larger impact on climate change *(65)*.

According to the Central Statistical Bureau data, an average resident consumes over 80 kg of meat products per year, mostly pork (18 kg), sausage and smoked products (23 kg). Fish consumption is considerably lower at 12 kg per year on average. One egg every other day is consumed on average. Of milk products, the leading items are whole milk (39 kg per year) and sour cream (12 kg per year). Cereal products dominate the resident food basket of which the most consumed item are bread, both wheat and rye (over 37 kg per year) and potatoes (88.5 kg per year on average).

The most consumed vegetables are tomato (11.2 kg), cabbage (9.2 kg) and cucumber (8.9 kg), and the favourite fruit is apple (17.4 kg) *(68)*. Comparing rural and urban food consumption, rural residents consume more food of animal origin than urban residents, who, in turn, consume more vegetables, fruits and sweets. Table 27 provides food consumption values according to the EFSA Food Comprehensive Database. The dietary survey was done in 2008 for 7-66 year olds.

Table 27. Average food consumption (g/day) for age groups 7 to 66 year old.

| Food name | Adolescents | Adults | Other children |
|---|---|---|---|
| Tea (Infusion) | 221.6 | 198.5 | 179.2 |
| Ready to eat soups | 120.8 | 146.6 | 124.3 |
| Potatoes and potatoes products | 126.1 | 128.9 | 94.4 |
| Bread and rolls | 117.6 | 145.8 | 74.7 |
| Coffee (Beverage) | 52.4 | 256.8 | 15.3 |
| Soft drinks | 96.3 | 49.5 | 80.1 |
| Liquid milk | 69.3 | 42.5 | 93.3 |
| Fruit juice | 79.7 | 42.6 | 58.2 |
| Fine bakery wares | 62.0 | 51.8 | 56.4 |
| Fruiting vegetables | 47.8 | 74.1 | 41.2 |
| Tap water | 54.4 | 57.5 | 41.5 |
| Fermented milk products | 51.9 | 50.0 | 45.7 |
| Prepared salads | 44.7 | 64.4 | 32.7 |
| Bottled water | 49.4 | 57.3 | 32.5 |
| Livestock meat | 42.6 | 63.4 | 29.5 |
| Pome fruits | 45.7 | 40.7 | 29.6 |
| Sausages | 41.2 | 39.9 | 30.8 |
| Berries and small fruits | 26.2 | 25.9 | 32.3 |
| Ices and desserts | 25.4 | 12.4 | 29.0 |
| Beer and beer-like beverage | 2.6 | 59.8 | 0.5 |
| Cheese | 20.4 | 28.3 | 12.9 |
| Breakfast cereals | 16.1 | 14.0 | 30.0 |
| Poultry | 16.6 | 23.6 | 13.8 |
| Other fruit products (excluding beverages) | 17.5 | 12.1 | 22.6 |
| Cereal-based dishes | 18.9 | 16.5 | 11.2 |
| Savoury sauces | 17.0 | 15.6 | 13.4 |
| Cocoa beverage | 16.5 | 3.5 | 25.6 |
| Miscellaneous fruits | 16.0 | 11.3 | 16.0 |
| Cream and cream products | 13.3 | 18.4 | 11.5 |
| Grain milling products | 10.8 | 11.0 | 11.6 |
| Rice-based meals | 10.2 | 15.0 | 7.0 |
| Egg-based meal (e.g.. omelette) | 8.2 | 15.4 | 7.9 |
| Chocolate (Cocoa) products | 13.1 | 6.8 | 11.5 |
| Sugars | 9.9 | 12.6 | 8.4 |
| Fish meat | 4.8 | 16.3 | 4.9 |
| Meat-based meals | 7.3 | 11.2 | 6.7 |
| Stone fruits | 8.8 | 8.2 | 5.9 |
| Eggs, fresh | 7.8 | 9.1 | 5.6 |
| Vegetable-based meals | 7.1 | 7.8 | 7.1 |
| Snack food | 11.3 | 3.2 | 6.8 |
| Vegetable juice | 7.7 | 11.0 | 2.4 |
| Animal fat | 6.7 | 7.3 | 4.9 |
| Grains for human consumption | 6.2 | 7.0 | 4.7 |
| Potato based dishes | 5.3 | 6.7 | 3.2 |
| Jam. marmalade and other fruit preserves | 5.1 | 4.1 | 5.6 |

(Source: EFSA database: acute food consumption statistics – reported in grams/day – L2-all days g/day (In EFSA database the data for Latvia is from EFSA_TEST 2008)).

### *Factors affecting resident choice*

**Economic considerations**

According to the resident poll carried out by the Market and Public Opinion Research Centre, the resident choice of specific food products is mostly affected by the price, food quality and food campaign offers.

The role of economic considerations in food product choice is confirmed in another sociological poll on the impact of the economic crisis on food consumption habits. Almost 30 % of residents indicated that they changed their food consumption habits. 35 % said they started to eat less (39 % of women and 26 % of men).

The price, however, is not always the decisive factor. Concerning the use of genetically modified raw material, for example, the majority indicated that they would refuse to buy a product containing GMOs irrespective of price.

20 % of all respondents indicated that they try to purchase ecological food even if it is more expensive and more difficult *(69)*.

**Health, attitude and information level factors**

As for local production, data show that approximately half of all residents consider locally produced products to be tastier (55 %), ecologically cleaner (51 %) and of higher quality (43 %), but also more expensive (46 %) compared with imported products.

On the issue of food, the majority of residents are concerned about preservatives (60 %), food additives (59 %) and GMO content (54 %). Around 1/5 of the residents pay attention to salt (21 %), saturated fat (20 %) and calorific (17 %) content *(69)*.

**Food purchase location**

The poll results show that an average of 70 % of residents purchase food products in supermarkets. Only 16 % mainly purchase them in smaller shops, 7 % in the market, 2 % mostly produce themselves, and 1 % buys directly from farmers. The data indicate that Latvia has over recent years increasingly been pursuing the path of a capitalist consumer society, as over two thirds purchase their food in supermarkets, which was not the case ten years ago *(69)*.

In the Latvian countryside there is still a strong tradition to cultivate gardens to partly provide home-grown food products, vegetables and fruits, although most food products are purchased from supermarkets. The data from the marketing and public opinion research centre poll of 2009 *(70)* show that the majority of households in Latvia (70 %) still make stewed fruit and jams and store fresh fruit and vegetables in cellars or other appropriate storage places. In this respect, a positive impact of the economic crisis is evident. The 2009 poll reveals that residents started to make better thought out purchases, eat more home-cooked food, and consume more home-grown products, either their own or from people they knew *(71)*.

**Outdoor eating habits**

Over recent years, residents have dined out in public catering spots much more rarely. The 2011 poll shows currently these represent only 30 % of residents, when a year ago they were 40 % and in 2007 and at the beginning of 2008 around a half of all residents used public catering services.

**Household budget expenditure on food**

Food purchases are also the items that represent the largest percentage of money from the total household budget. In 2009 it was 26.7 %, or LVL 52.04/ month (CSB), which is twice as much as the average EU value of 12.7 % (EUROSTAT). In absolute numbers, however, Latvian residents spend half as much as the average EU resident.

With regard to decision-making on food purchases, 65 % of respondents indicated in the poll that mother was the main decision-maker; whereas 16 % said it was father *(56)*.

# 4. Food material flows for food system sustainability

From the socio-economic sustainability point of view, materials extracted from the environment are vitally important since they provide the basic physical necessities of life: food, water, clothing, and shelter. Materials also contribute to the standard of living and the quality of life through consumption goods. For food chains, the key flows in this respect are the food raw materials, their domestic production and consumption as well as their import and export. However, also extraction of the raw materials for energy, fertilisers and lime should be considered, even though not all of these are as critical from the ecological carrying capacity aspect as the food raw materials themselves.

Through environmental interventions, by extraction, primary production and processing, food material chains are linked to the ecosystem services necessary for human long-term wellbeing. Atmospheric emissions, for instance, reduce the availability of clean air and the primary production capacity of arable and forest lands, aquatic emissions reduce the availability of clean water and fish, and solid wastes, production facilities and infrastructure the availability of land. How and to what extent material flows bring about environmental interventions is thus a vitally important issue to be considered when ecologically sustainable development is sought. In the case of food chains, critical interventions include land use and emissions to air and water.

Emissions of alien compounds, including chemicals, pathogens and radioactive compounds affect the sustainability of the food chains and are not present in the clean natural raw materials. Examples are plants that take up heavy metals from polluted soils, fish that get them from polluted waters and waters that get them from industrial emissions, traffic and waste management. Emissions are of critical importance for food chains because they represent health risks for consumers. In other kinds of product chains the risks from emission are primarily technical and not a sustainability issue in the same sense as for food chains.

An overview of the environmental interventions of food material flows on the food chains is presented below. We omit the extraction of raw materials and land use issues, which are quantitatively described in previous chapters. The overview was compiled by participant countries and is based on the available data. Consequently, the availability of data varies according to country and the level of detail and the coverage of the overviews vary. The emission issue is addressed in chapter 7 on environment-based risks.

The focus is on the eutrophication impact, but also other interventions are discussed briefly. Eutrophication is a major problem in the Baltic Sea. It is a state where high nutrient concentrations stimulate the growth of algae, which leads to imbalanced functioning of the system. Nitrogen and phosphorus loads are the main cause of the eutrophication in the Baltic Sea. About 75 % of the nitrogen load and 95 % of the phosphorus load enter the Baltic Sea via rivers and 25 % of the nitrogen load enters as atmospheric deposition. Diffuse losses, mainly from agriculture, forestry and scattered dwellings, contribute 58 % of the waterborne nitrogen and 49 % of phosphorus inputs into the Baltic Sea. Agriculture is a significant producer of the airborne nitrogen load, due to ammonia emissions, of which about 90 % originate from agriculture *(72)*.

According to a novel HELCOM assessment *(73)* the total nitrogen load into the Baltic Sea was 637 891 tonnes and total phosphorus load 28 378 tonnes in 2008. 57 % of the nitrogen load stemmed from socio-economic activities in the Baltic Sea realm. The phosphorus load was 65 %. And the natural background supplied 19 % of the nitrogen and 16 % of the phosphorus load. The contribution of the transboundary load was 8 % for the nitrogen and 9 % for the phosphorus. The origin was unspecified for 16 % of the nitrogen and 10 % of the phosphorus load.

About 78 % of the nitrogen and 69 % of the phosphorus load that originated from socio-economic activities fell as diffuse loads from agriculture, forestry, scattered dwelling and atmospheric deposition. The corresponding contributions of point sources were 22 % and 31 % for nitrogen and for phosphorus. The average contribution of agriculture to the diffuse load was 80 %.

The apparent eutrophication potential totalled 354 750 tonnes of $PO_4$ eq. The estimate is based on the characteristic potentials of nitrogen and phosphorus currently used in life cycle assessments, i.e. 0.42 kg $PO_4$ eq / kg for nitrogen and 3.06 kg $PO_4$ eq / kg for phosphorus. Eutrophication potential generated by the socio-economic activities of the Baltic Sea region was 210 384 tonnes of $PO_4$ eq. Of this 76 % originated from diffuse sources, corresponding to 159 948 tonnes of $PO_4$ eq. The average contribution of agriculture to the eutrophication potential of diffuse loads was 80 %.

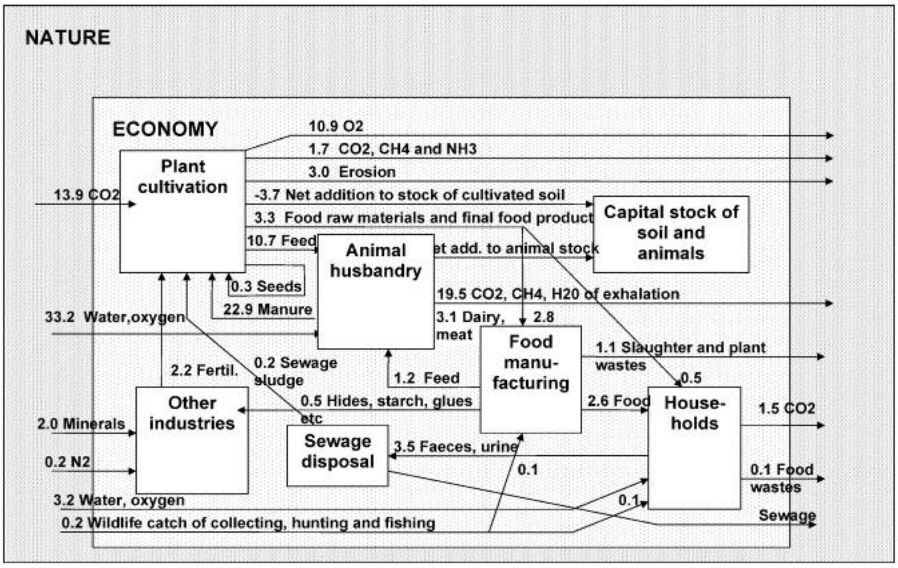
The nitrogen load appears to dominate the eutrophication potential of the Baltic Sea. Its contribution to the potential of the socio-economic activities was 73 %, which is 2.7 times that for the phosphorus load. In the contribution of agriculture the domination appears slightly higher, about 3.2 times that of phosphorus load. This suggests that the importance of nitrogen emissions may be underestimated in the current sustainability discussion concerning the Baltic Sea in the context of food chains.

The profiles of the nitrogen and phosphorus loads for each Baltic Sea country are given in Appendix 1. The extent of loads seems to correspond well to the sizes of the economies located in the Baltic Sea catchment area for each country, except for Latvia and Lithuania, where the contributions of transboundary flows are considerable. Of the project participant countries, Finland has the largest and Estonia the smallest estimates for the loads of both nutrients.

## 4.1. Developments in the realm of the food chain

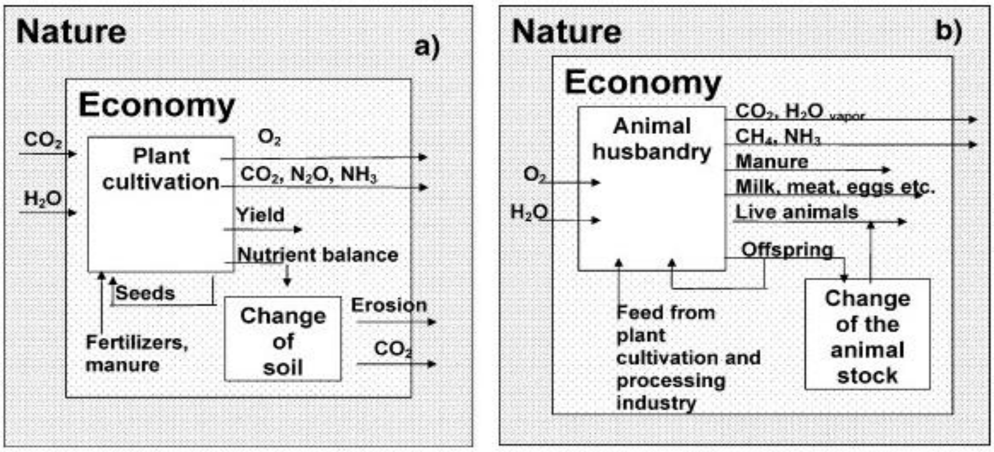
### *Finland*

Risku-Norja (2011) *(74)* used a material flow approach (MFA) to study ecological sustainability of primary production. The MFA-method was applied first to plant and animal production in agriculture and secondly to the domestic food chain in Finland. The two approaches were used in order to capture the effects on the environment of dietary changes as well as changes in production patterns. The system boundaries of the two approaches are shown in Figure 30 and Figure 31 below. Figure 30 also indicates the main material flows within the system as well as the flows crossing the system boundaries of the Finnish food chain.




Values thousand metric thousand kilograms (Risku-Norja et al. 2011 *(74)*).

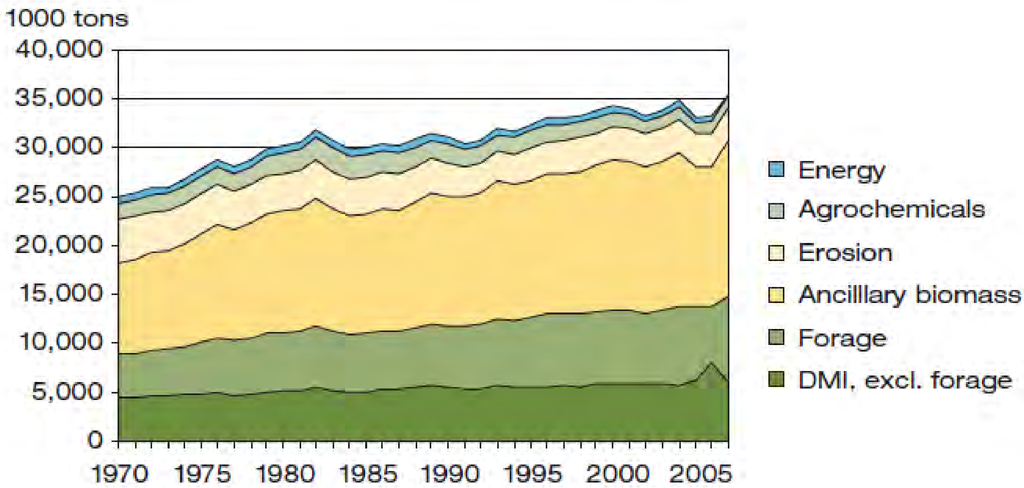
Figure 30. The system boundaries and summary of the material flows of the domestic food chain of Finland in 1995.




Source: Risku-Norja et al. 2011 *(74)*.

Figure 31. The system boundaries of agriculture: a) plant cultivation, b) livestock husbandry.

According to Risku-Norja, the total material requirement (TMR) of agriculture in Finland was 35 million tonnes in 2006. Direct flows are those of exploitable yield and comprise 13-14 million tonnes. Hidden flows were considerable, 60 %, consisting mainly of eroded lands and ancillary biomass, but also agrochemicals and energy used. Development of the total material requirement is shown in Figure 32 *(74)*.

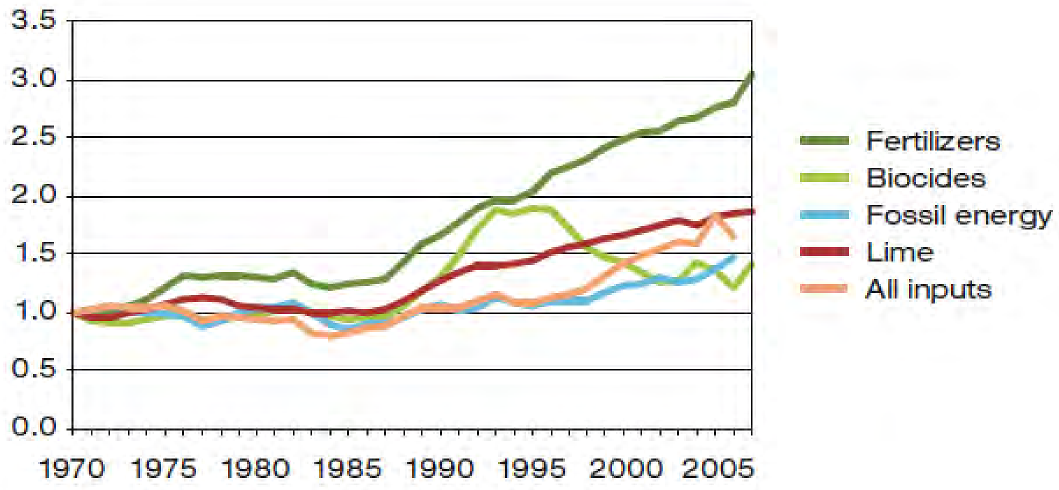



5-year running averages until 2004, thence annual figures. Data source: Information Centre of the Ministry of Agriculture and Forestry. Risku-Norja et al. 2011 *(74)*.

Figure 32. Development of the total material requirement (TMR) of agriculture during 1970-2006 for Finland, 1000 tonnes.

TMR is not considered a good indicator of environmental impact of agriculture because it cannot inform sufficiently about the actual environmental impacts, such as those on watersheds and biodiversity. For environmental impacts, actual volumes are essential *(74)*. Nevertheless, Risku-Norja (2011) *(74)* found biocides, fossil energy, fertilisers and lime, which influence $CO_2$-emmissions, to be the most important material flows for food system sustainability in Finland. Erosion and ancillary biomass were considered less important, since they are only calculated parameters. However, at the regional level erosion can predict the level of nutrient load on the watershed.

Development of the eco-efficiency of plant production in terms of the ratio of the yield to the volume of each of these inputs annually is shown in Figure 33. Eco-efficiency has increased most with respect to fertilisers and lime inputs. With respect to fossil energy and biocide inputs the development has been slower, but still positive.




Data sources: Information Centre of Agriculture and Forestry, Kemira Agro Ltd/Yara, the Lime Association and the Plant production Inspection Centre, Statistics Finland. Risku-Norja et al. 2011 *(74)*.

Figure 33. Development of eco-efficiency of Finnish agriculture in 1970-2007 expressed as the ratio of total yield to the use of biocides, fertilisers and lime for soil improvement, and fossil energy consumption relative to base level in 1970.

Table 28 to Table 30 provide additional details of total annual biocide sales, fertiliser purchase and energy use in some of the industries related to the Finnish food chain. The increase in the eco-efficiency of fertiliser application is noteworthy because it reflects the intensities of the nitrogen and phosphorus runoffs as indicated in Figure 34 for grain production in Finland. The general trend in runoff intensities has been a decrease, but the variation between different plants is considerable, and in some cases the trends appear to be increasing, for example for rapeseed production over the first decade. Variation indicates the importance of the holistic management of plant production, in which soil management, fertiliser application and plant protection all play an essential role.

Table 28. Sale of plant protection products in Finland, calculated in terms of active agents, 2004-2009 (1000 kg).

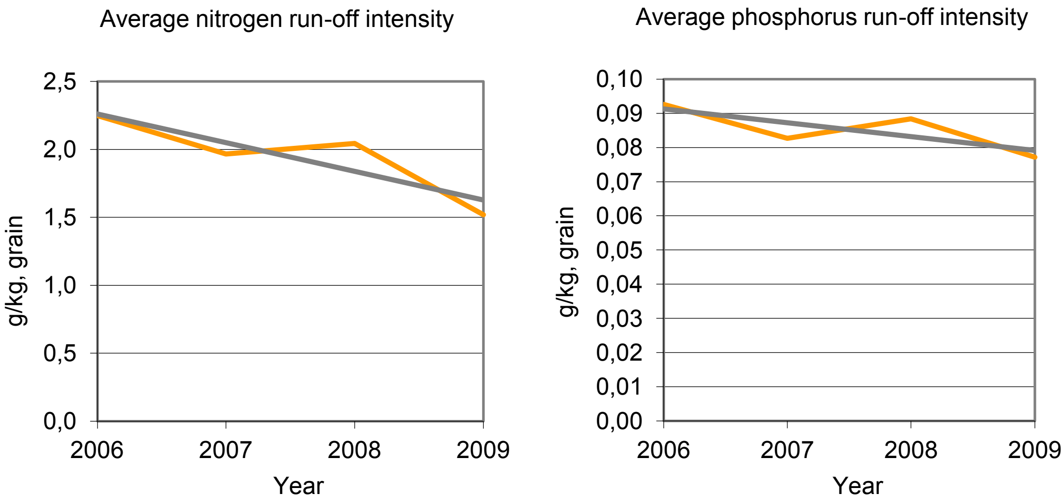
| Pesticide group | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| Fungicides | 237 | 255 | 261 | 187 | 158 | 225 |
| Insecticides | 36 | 47 | 40 | 35 | 35 | 35 |
| Herbicides in agriculture | 1 174 | 1 077 | 1 274 | 1 191 | 1 357 | 1 355 |
| Herbicides in forestry | 260 | 429 | 581 | 977 | 1 054 | 808 |
| Growth regulators | 42 | 52 | 70 | 66 | 72 | 79 |

Source. TIKE *(18)*.

Table 29. Consumption of fertilisers in Finland 2008/2009.

| Fertiliser | Amount in million kg |
|---|---|
| Nitrogen (N) | 136.0 |
| Phosphorus (P) | 10.8 |
| Potassium (K) | 32.9 |

Source: TIKE *(18)*.




Source: Association of ProAgria Centres.

Figure 34. Development of the runoff intensities for nitrogen and phosphorus in grain production in Finland 2006-2009. The data are compiled using the runoff sub-model of the Finnish food chain model. Straight lines indicate the development trends.

Table 30. Energy use in Finland in terajoules (TJ).

| Industry (TOL 2008) | Fuels TJ | Electricity TJ | Heat TJ |
|---|---|---|---|
| Manufacture of food products | 3 455 | 4 395 | 4 186 |
| Manufacture of beverages | 676 | 619 | 876 |

Source: Statistics Finland, Energy use in manufacturing *(75)*.

Generated volume of waste in Finland in 2004 is presented in Table 31.

Table 31. Waste generated in Finland (2004).

| Economic sector | Generated volume 1000 kg |
|---|---|
| Agriculture, forestry and fishing | 857 |
| Mining and quarrying | 23 819 |
| Manufacturing | 15 714 |
| Energy production | 1 573 |
| Construction | 20 843 |
| Services | 1 822 |
| Households | 1 164 |
| Total (about) | 65 792 |

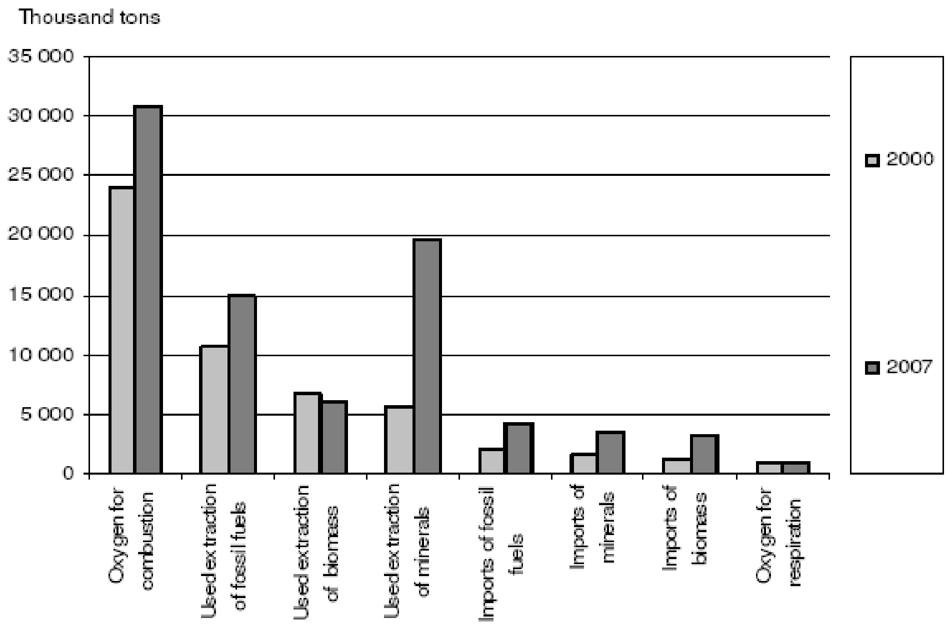
Source: Finland´s Natural Resources and the Environment 2006 *(76)*.

### *Estonia*

#### Material flow balance accounts

The following discussion is based on the direct material flow balance drawn for Estonia in 2010 by Statistics Estonia *(77)*. The balance indicated that the total direct material flow was about 70 % bigger in 2007 than in 2000. Material flows into and out of the Estonian economy have also increased in the time span from 2000 to 2007.

In Figure 35 the bigger items in the input side of direct material flow balance for 2000 and 2007 are compared. The figure indicates that the increase of material flow has occurred mainly due to increase in excavation of minerals and of fossil fuels. Oxygen for combustion has increased as well, as a follow-up to the increased use of fossil fuels.

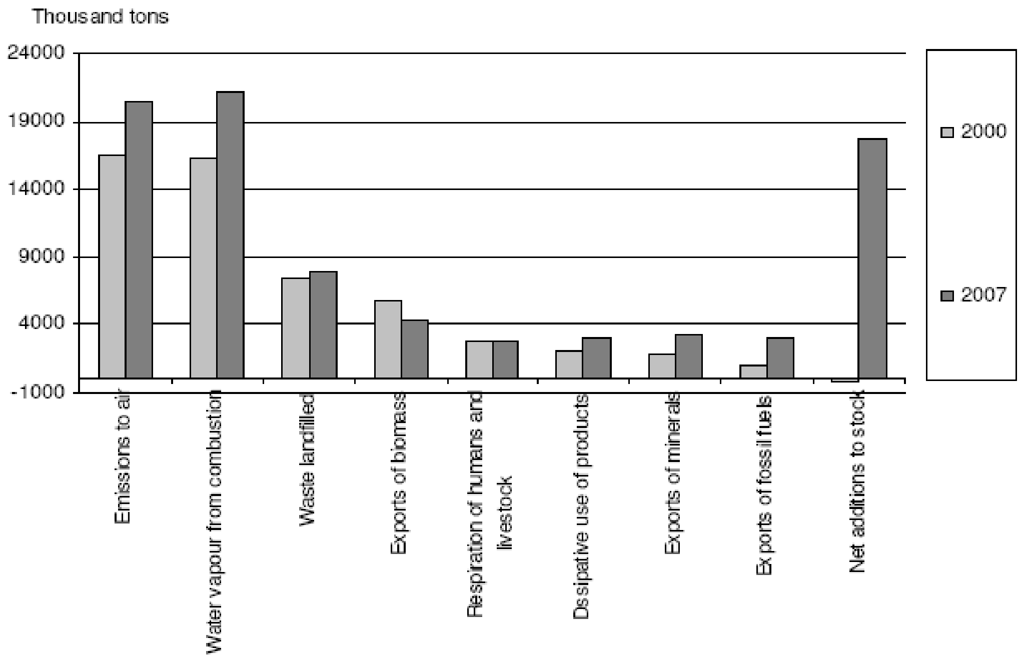



Source: Statistics Estonia, 2010.

Figure 35. Input side of direct material flow balance for 2000 and 2007.

Figure 36 summarises the main items on the output side of the direct material flow balance for 2000 and 2007. It indicates that the increase of material output flow has occurred to large extent due to the increase in the net additions to stocks. Atmospheric emissions are another item that has contributed considerably to the growth of the output.

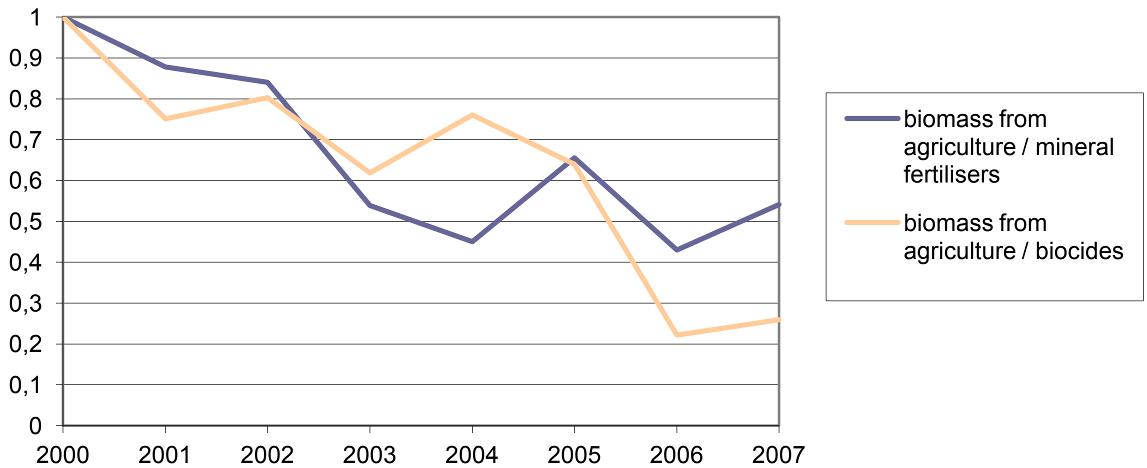
The increase in stocks consists to large extent of new buildings and infrastructure, which is reflected in the input side as an increase in the extraction of domestic construction materials. Another important issue is the increased domestic extraction of oil shale for electricity production and the consequent increase in the energy-related atmospheric emissions.




Source: Statistics Estonia, 2010.

Figure 36. Output side of direct material flow balance for 2000 and 2007.

The development of the eco-efficiency of food production in terms of the ratios of biomass yield to mineral fertiliser and biocide application is shown in Figure 37. It appears that eco-efficiency in these respects has considerably shrunken over the first decade of the millennium. This is especially noteworthy because the intensity of mineral fertiliser application has radically increased. To some extent the trend may be explained by the shift from dairy cows to beef cattle, which may have reduced the availability of manure for crop fields.

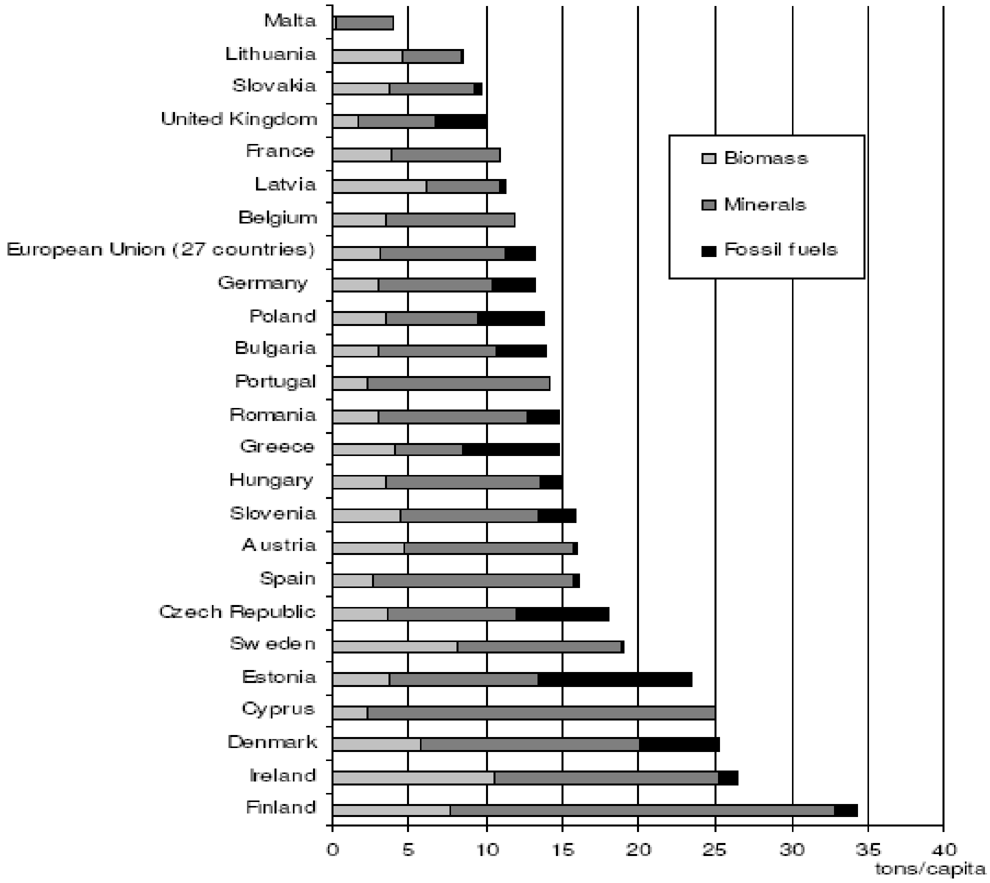



Source: Grüner and Oras (2010) and from the Statistical database of Statics Estonia on the Environment *(77)*.

Figure 37. Development of agricultural biomass yield, fertiliser application and the ratios between mineral fertiliser application and biocide application to the agricultural biomass yield in Estonia. Year 2000=1.

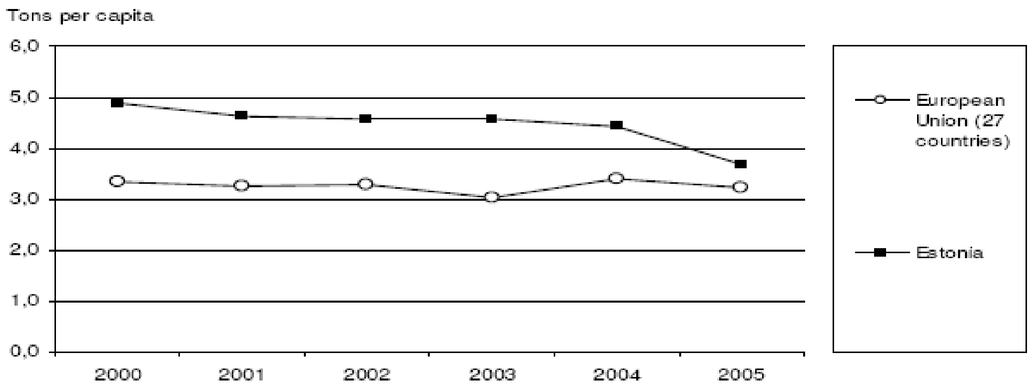
### The profile of the domestic extraction

Domestic extraction makes up most of the direct material input during the considered time period. Imports increased from 19 % in 2000 to 23 % in 2007. Nevertheless, the Estonian domestic extraction per capita was one of the biggest among the 27 EU Member States in 2005 (Figure 38). In particular, the total extraction of biomass was much higher than the average within the "EU 27" (Figure 39). It stayed considerably higher than average until recent years, during which the domestic extraction of biomass declined. To some extent the decline is due to the reduction in forest biomass extraction, which makes up 60-70 % of the total biomass extracted. However, biomass from agriculture has also decreased by about 24 % from the beginning of the 2000s (Figure 40). Domestic extraction of fossil fuel per capita has remained at a comparatively stable level during the last decade (Figure 41).



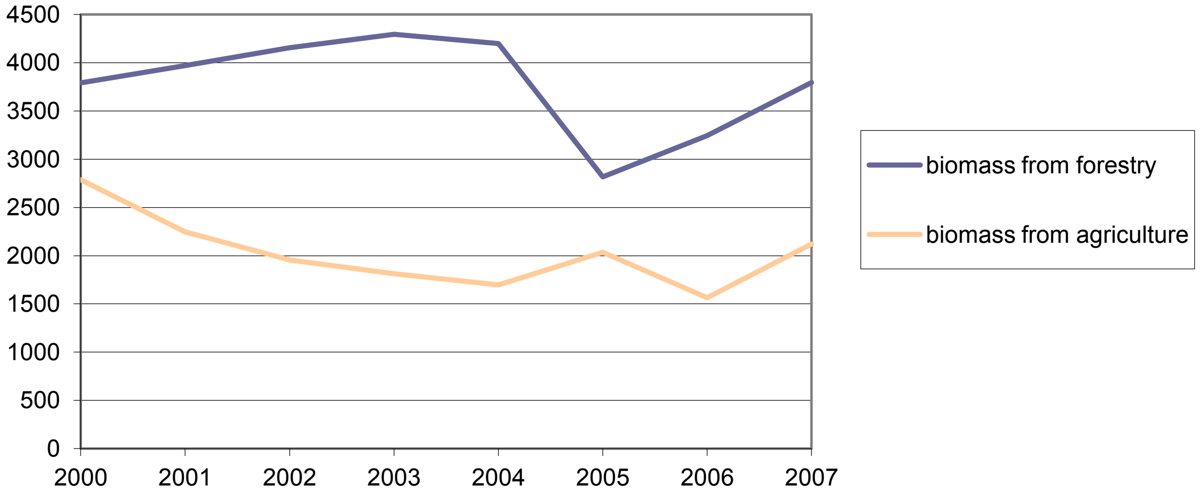

Source: Estonia- Statistics Estonia; the other countries - Eurostat

Figure 38. European domestic extraction, 2005, tonnes per capita.



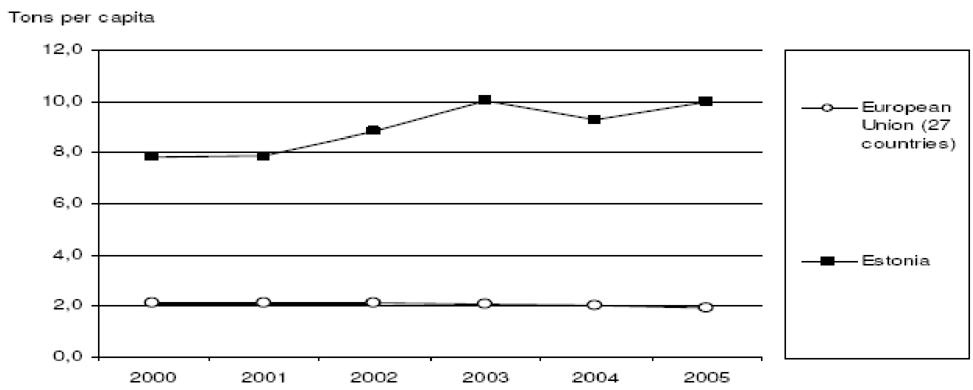

Source: Estonia- Statistics Estonia; the other countries - Eurostat

Figure 39. Estonian domestic extraction of biomass, tonnes per capita.




Source: Statistics Estonia, 2010.

Figure 40. Development of domestic biomass extraction in Estonia from forestry and agriculture, thousand tonnes.

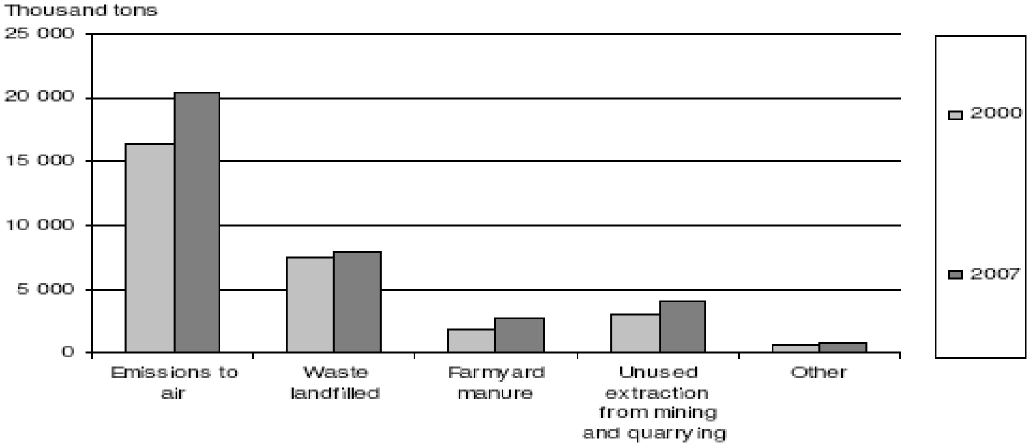



Source: Estonia- Statistics Estonia; the other countries - Eurostat

Figure 41. Domestic extraction of fossil fuels, tonnes per capita.

### Total domestic output

Both the production and consumption activities in Estonia increased considerably during the first decade of the 2000s, which is reflected in the outflow, which increased accordingly. By the end of 2007, total domestic output had increased by 22 % from the beginning of the decade. Figure 42 illustrates the main material flows that contributed to the total domestic output. The emissions to air were the biggest contributors, and their flows also increased from 2000 to 2007.



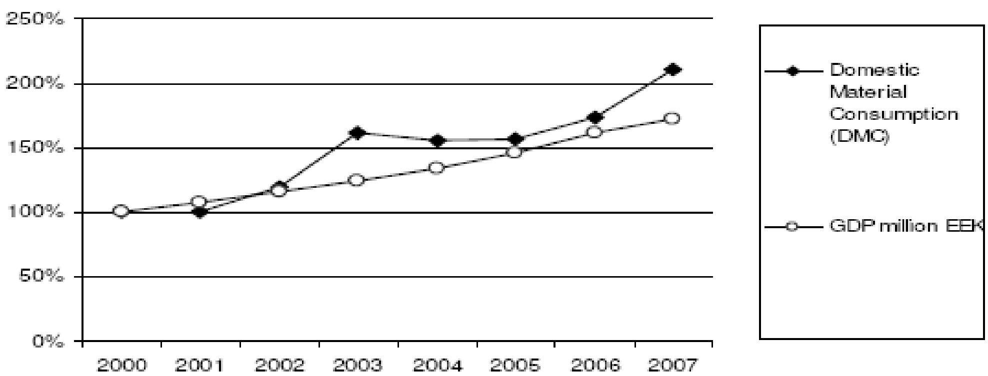

Source: Statistics Estonia, 2010.

Figure 42. The main material flows of TDO in 2000 and 2007, thousand tonnes.

Most of the atmospheric emissions originated from electricity generation based on oil shale burning. Oil shale extraction and electricity production from that generates numerous landfilled wastes and disposal of unused domestic extraction.

### Resource productivity

Resource productivity declined between 2000 and 2007. In 2000 315 euros was produced per single ton of consumed materials, but in 2007 it was only 259 euros. The following Figure 43 illustrates the changes in domestic material consumption and GDP and shows that domestic material consumption increased faster than GDP.

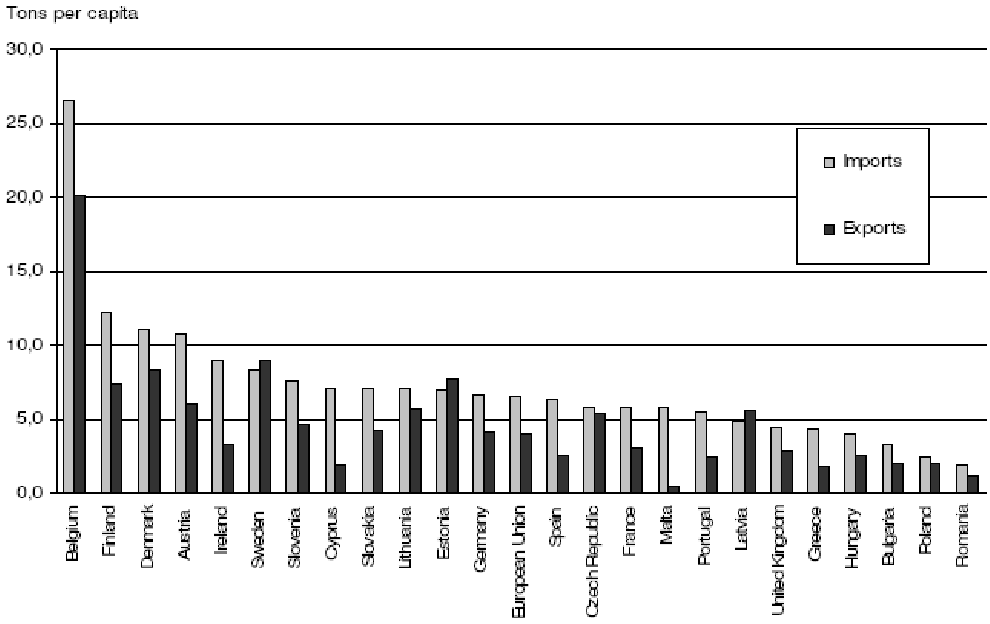



Source: Statistics Estonia, 2010.

Figure 43. Changes in domestic material consumption and GDP in Estonia, 2000=100%.

**Physical trade balance**

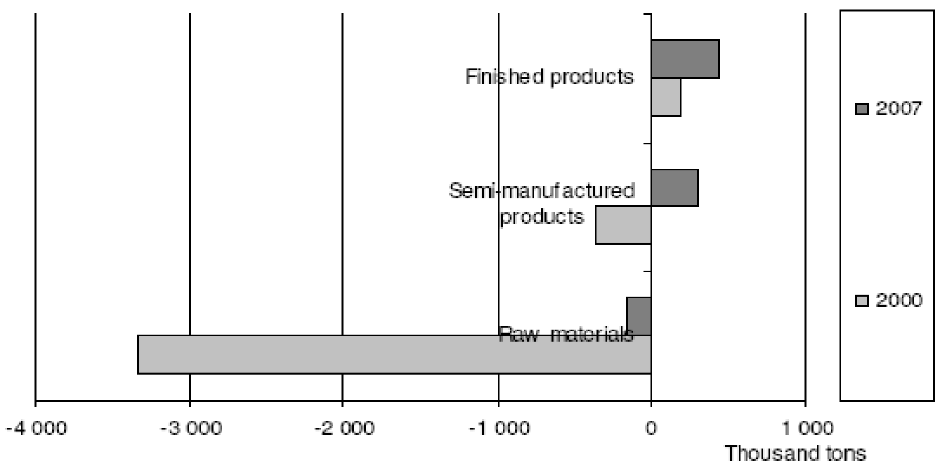
The physical trade balance (PTB), which measures the physical trade surplus or deficit of an economy, is at the average EU level in Estonia (Figure 44).




Source: Estonia- Statistics Estonia; the other countries - Eurostat

Figure 44. Physical imports and exports for Estonia in 2005, ton/capita.

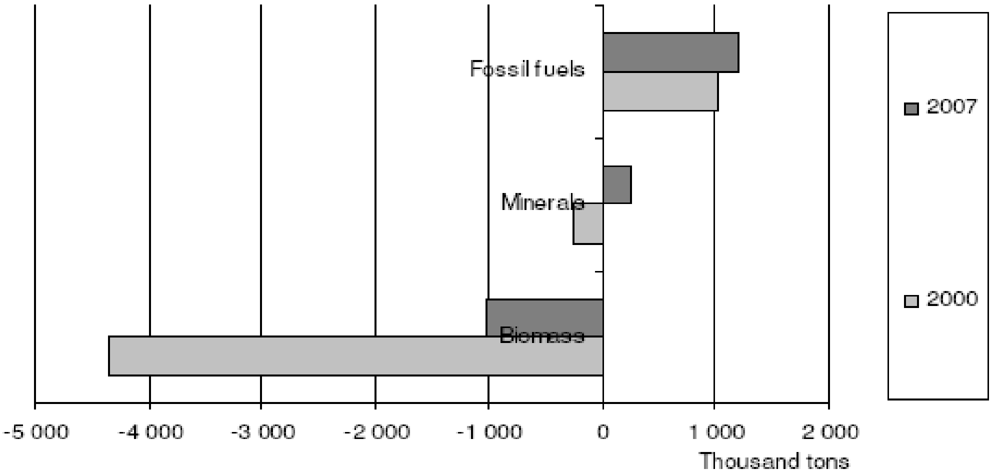
However, in the seven years from 2000 to 2007 the physical trade balance shifted from deficit to surplus. Figure 45 illustrates the changes in physical trade balance of materials with different degrees of processing in 2007 compared with 2000. Figure 45 outlines the main reason for the shift of PTB being the corresponding shift in the PTB for the raw materials. In 2000 about 2.5 times more raw materials were exported than imported, and raw materials made up 63 % of all exported materials. In 2007 the exports and imports of the raw materials were almost in balance. Most of the balance is due to the considerable increase in raw material imports, whereas the export of raw materials decreased only rather slightly over the years.




Source: Statistics Estonia, 2010.

Figure 45. Physical Trade Balance of materials with different processing level for Estonia in 2000 and 2007, thousand tonnes.

Figure 46 shows the changes in the physical trade balance in Estonia for the main material groups between 2000 and 2007. Biomass appears to have had the biggest impact on the shift of PTB. In 2000 four times more biomass was exported than imported. Raw forest biomass made up 83 % of exported biomass. In 2007 the share of biomass was 36 % of the total physical exports and 33 % of the respective imports. The imbalance has considerably decreased, even though the biomass exports still exceeded the imports by about 30 % in 2007. The shift in the balance of the raw forestry biomass made the biggest balancing contribution to the entire balance of the biomass.




Source: Statistics Estonia, 2010.

Figure 46. Physical Trade Balance of main material types in Estonia in 2000 and 2007, thousand tones.

### Synthesis and conclusions

In 2007 the Estonian direct material flow was about 70 % bigger than in 2000. This increase occurred mainly due to the substantial increase in domestic extraction of construction minerals and consequent increase of stock (buildings and infrastructure). The main consequences of the increase of material flow are the increased domestic extraction of oil shale (for increased production of electricity) and the increase in atmospheric emissions.

The Estonian economy depends almost totally on domestic raw material supply (80 %), but the share of imported raw materials has increased to the extent that Estonian domestic extraction per capita is one of the highest in the EU 27. Domestic extraction of fossil fuels is particularly high, exceeding the EU 27 average by 4-5 times, and is growing continuously. Atmospheric emissions constitute the biggest output, and they have also grown most rapidly during the period between 2000 and 2007. It is noteworthy that most of these emissions originate from burning oil shale, but their volume has increased more slowly than that of oil shale extraction, indicating that the emission intensity of oil shale burning has decreased.

The Estonian physical trade balance changed from deficit in 2000 to surplus in 2007. This occurred mainly due to decrease in the export of raw materials from forestry, but also the export of semi-manufactured products also increased. Comparing physical and monetary trade demonstrates that Estonia imports commodities of higher value and exports commodities of lower value. Nevertheless, the difference between values per ton of exported and imported material is falling slightly.

### Environmental load of agriculture

Increased agricultural activity has increased the load agriculture directs to the environment. The average contribution of agriculture to total nitrogen emissions into waters between 2004 and 2007 was 57 % and to total phosphorus emissions 25 % (Table 32). In 2008 nitrogen application through mineral fertilisers was 50 % more than the 2004-2007 average value (Table 33). In 2007 herbicide application was about 2.5 times that of 2005 (Table 34). Source: Estonian Environment Information Centre *(78)*.

Figure 47 indicates herbicide (pesticide) use during 2003-2008 (kg/year) by county. Most eutrophic emissions originated from food raw material production and most mineral fertiliser and herbicide applications were similarly linked. Thus, development of the flow patterns, as well as the intensities of inputs and emission outputs of the food chain, played an essential role in sustainable development, especially with respect to the aquatic environment of the Baltic Sea.

Table 32. N and P emissions into the environment in Estonia (2004–2007 average).

| Source of contamination | Total N | | Total P | |
|---|---|---|---|---|
| | 1000 kg/year | % | 1000 kg/year | % |
| Agricultural source | 17 800 | 57 | 220 | 25 |
| Industrial & household sewage | 1 500 | 5 | 140 | 17 |
| Forests, wetlands, precipitation | 11 800 | 38 | 500 | 58 |
| Total | 31 100 | 100 | 860 | 100 |

Source: Estonian Environment Information Centre *(78)*.

Table 33. Use of mineral fertilisers in Estonia during 2004-2008.

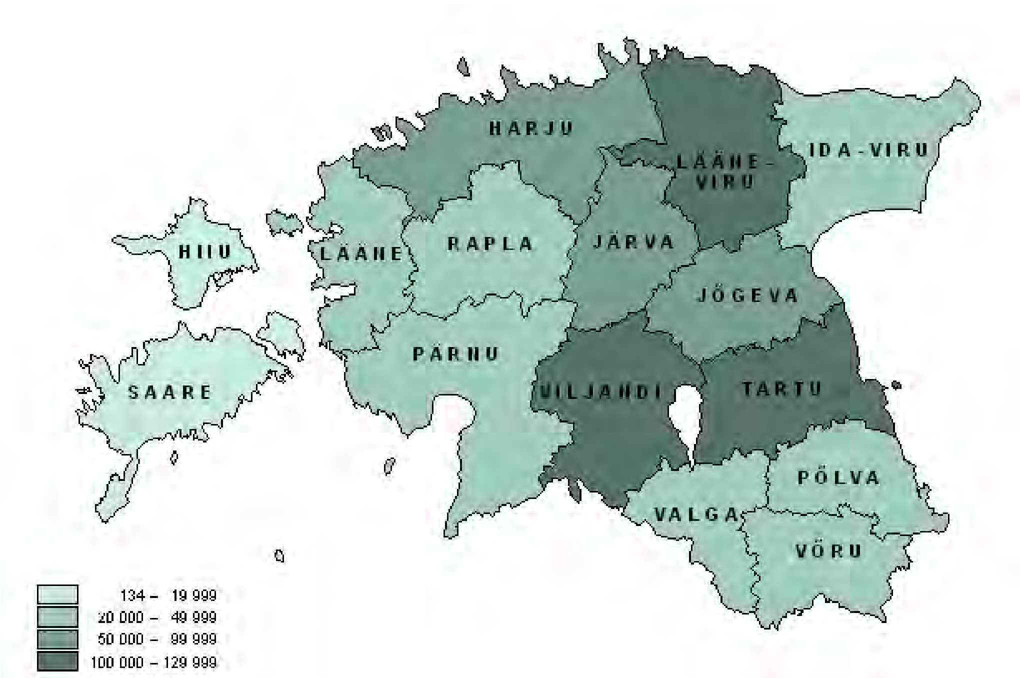
| | 2004-2007 (average), 1000 kg | 2008 1000 kg |
|---|---|---|
| Mineral fertiliser | 43 090 | 59 997 |
| inc. N | 23 412 | 35 455 |

Source: Estonian Environment Information Centre *(78)*.

Table 34. Use of herbicides in Estonia during 2005–2007.

| Year | Herbicides (1000 kg/year) |
|---|---|
| 2005 | 349 |
| 2006 | 775 |
| 2007 | 898 |

Source: Estonian Environment Information Centre *(78)*.




Source: Estonian Environment Information Centre *(78)*.

Figure 47. Use of herbicides (pesticides) in Estonia during 2003-2008 (kg/year) by county.

### *Latvia*

There are several studies and data sets on material flows in Latvia:

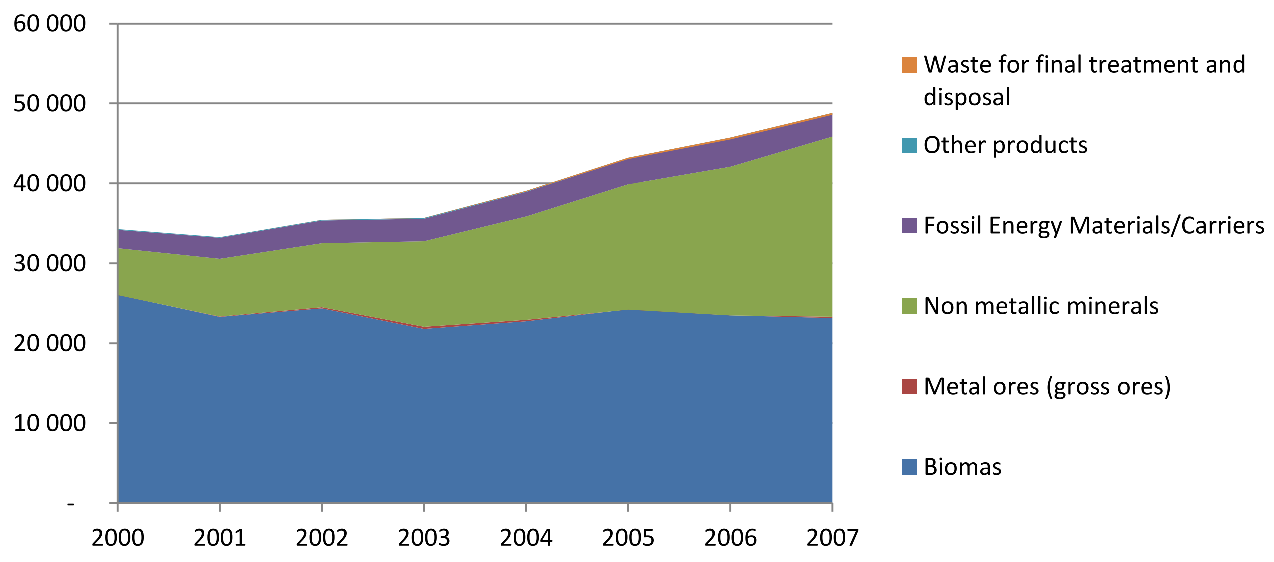
- Schütz, H. (2002) DMI of 13 EU Accession Countries and Norway 1992-1999. Wuppertal Institute – covers DMI for Latvia;
- Sustainable Europe Research Institute, SERI (2010) - covers DME for Latvia from 1992-2007;
- Eurostat data for DME, DMC and material intensity from 1999-2007;
- Latvian Environment Agency (LEA) in has published a Material Flow Accounts for 2002 and 2005.

Results from these studies differ. For example, LEA estimated that domestic extraction use (DEU) in 2002 in Latvia was 22 919 thousand tonnes. SERI for the same year estimated DEU to be 56 002 and Eurostat 38 699 thousand tonnes The biggest difference appears to be in the accounting of biomass and minerals. For international comparison and to secure the longest time-series data we chose the Eurostat dataset for use in this study, if not specified otherwise.

#### Domestic material consumption

Direct material consumption (DMC) estimated by Eurostat for Latvia in 2007 was 48 592 million tonnes From 2000 to 2007 the DMC in Latvia increased by 42 % despite the decrease in biomass consumption but because of the increasing use of non-metallic minerals, which comprise products made in the cement, ceramics, glass and lime sectors. Consumption of these materials more than tripled and can be attributed to the booming construction sector during this period. However, biomass still constitutes the largest component of DMC, followed by fossil fuels (Figure 48). Waste, metal ores and other products don't have significant impact on DMC.

DMC per capita in Latvia in 2007 was 21.3 tonnes, which is close to the EU average.

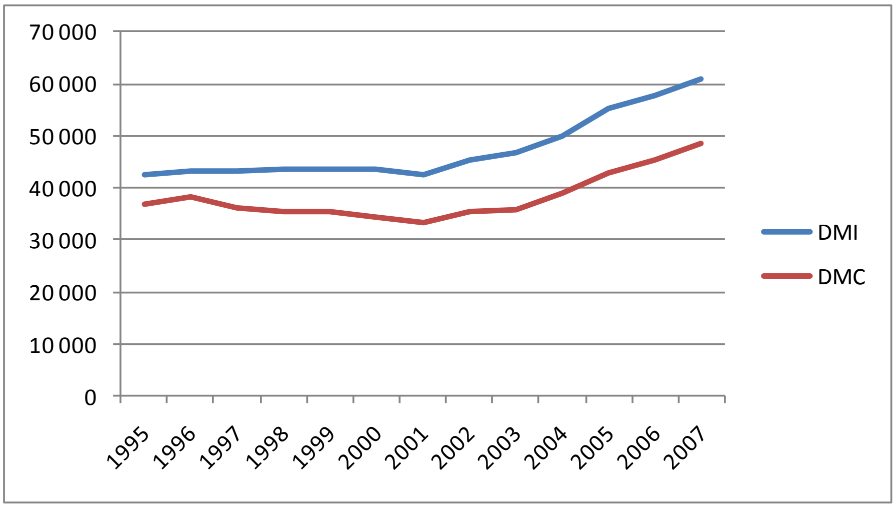



Source: Eurostat database.

Figure 48. Direct material consumption (million kg).

### Direct material input

DMI shows all the materials used in production and consumption (excluding exports). The difference between DMI and DMC is exports. Latvia reduced its DMC (from 1996 to 2001) whereas its DMI was stable over the same period. But from 2001 onwards both DMC and DMI increased (Figure 49). Direct material resource management aimed only at reducing DMC would thus have only limited effect on the reduction of direct material requirement. In contrast to industrialised economies, Latvia increased its absolute DMI via imports due to increased demands for fossil fuels and mineral resources.



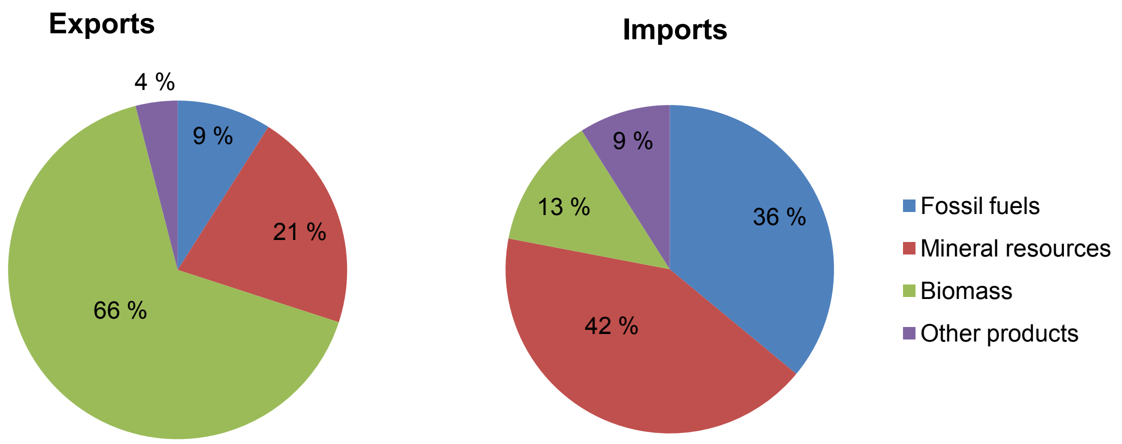

Source: Eurostat.

Figure 49. DMI and DMC for Latvia (million kg).

The size and composition of material inputs depends on the economic structure and on consumption and production patterns. Latvia's DMI is, as for developing countries, largely driven by domestic primary industries, especially construction minerals, fossil fuels, but the forestry industry also deserves special attention.

### Physical trade balance

Material requirements for Latvia's economy are dominated by domestic extraction (DEU), which makes up almost the entire DMC, but Latvia is not self-sufficient; many materials are obtained through international trade and many are re-exported as Latvia lies on the international trade route. Physical trade balance (PTB) is the difference between imports and exports. Most of the EU countries are net importers and only Latvia and Sweden are net exporters. According to the data from Latvia's environmental agency, imports are dominated by mineral resources and fossil fuels, but exports by biomass (mostly wood biomass) (Figure 50).




Source: LEA.

Figure 50. Physical trade balance in Latvia (2005).

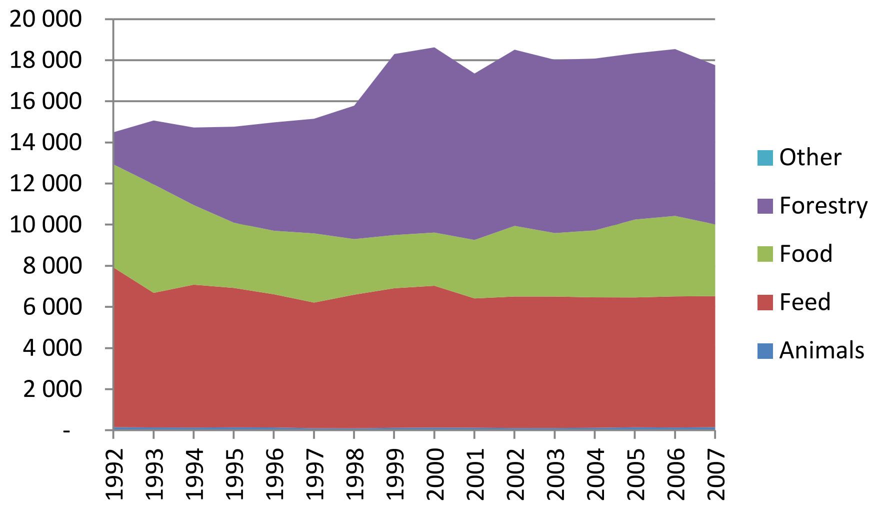
The situation in Latvia is somewhat between a developing and an industrialised economy. It has both the characteristics of a resource exporting (mostly timber) country and also of a trading (re-exporting fossil fuels and wood biomass) country.

#### Domestic material extraction

The DEU includes all biomass, fossil fuels, metals, industrial minerals and construction minerals that are extracted within a national territory and are used in the economy. According to Eurostat, DME was stable in Latvia until 2001, but then increased to 48.7 million tonnes in 2007, which is 29 % higher than in 1995. The following three industrial sectors dominate domestic material extraction:

- Mining and quarrying, except for energy-producing materials (metal ores, minerals, others);
- Agriculture, hunting and forestry;
- Mining and quarrying of energy-producing materials (coal, lignite, peat, crude petroleum, natural gas, uranium, thorium).

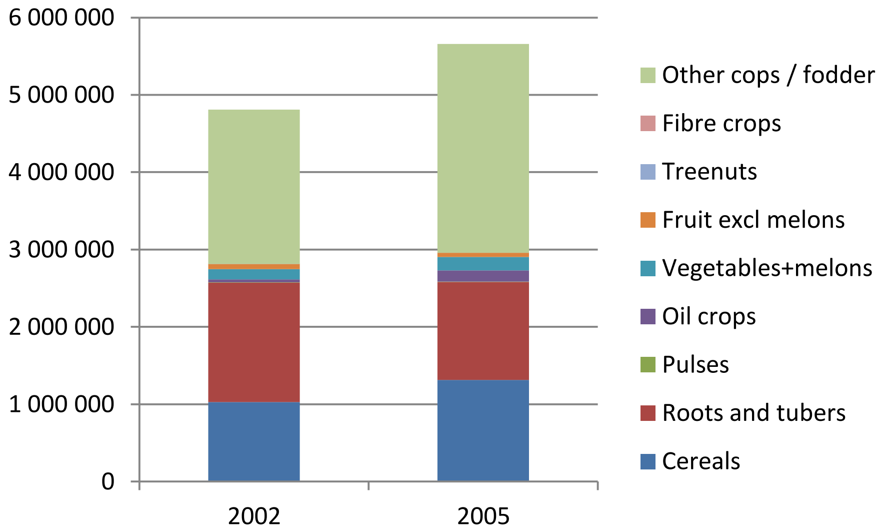
Feed, food and biomass from forestry dominate total biomass DEU. From 1992 to 2007 total DEU of biomass increased by 22 % because of the fivefold increase in forestry extraction (Figure 51), a large part of which is exported. During the same period, feed and food extraction decreased respectively by 18 % and 30 %. Direct unused extraction comprises 6 % of total domestic extraction.




Source: SERI, 2010.

Figure 51. Domestic extraction in Latvia used for biomass (million kg).

Agricultural production is heavily reliant on the availability of natural resources. Increased international competition, globalisation and changes in consumer demand have led to profound structural changes in food production and agriculture in Latvia during recent decades. Similarly, as in other countries, development is towards increased average farm size and increased regional specialisation in production. Moreover, the area of cultivated land decreased from 1.7 million hectares in 1990s to the present day level of 1.1 million hectares. Most agricultural production is used as feed, but cereals and roots also comprise a significant part of the used domestic agricultural extraction (Figure 52). These data also show an increase in domestic agricultural extraction between 2002 and 2005 due to increased fodder and cereals production.




Source: LEA.

Figure 52. Domestic extraction used - agricultural biomass (million kg).

### Domestic processed outputs

It is estimated that more than 70 % of the total nitrogen and more than 40 % of the total phosphorus inland load is caused by various human activities – e.g. waste water discharge or runoff from agricultural land and forests. The agricultural sector generates the largest proportion of nitrogen discharge and the main source of phosphorus is municipal and industrial waste water.

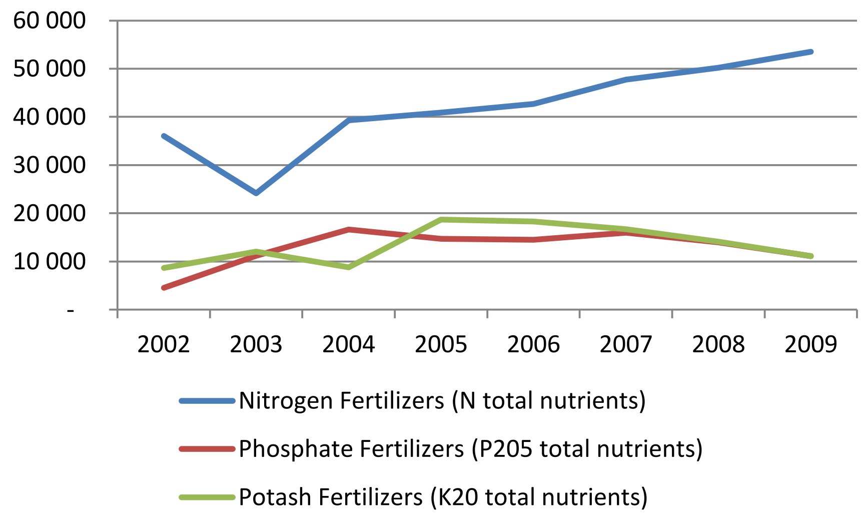
For both nitrogen and phosphorus, runoff tends to increase with the intensity of production. Despite the overall low input levels in the 1990s the average runoff of nitrogen may be as high as 15 kg/ha in the most intensively farmed areas of Latvia. In low intensity areas, the typical figure is 5 kg per ha (data from 1994–98) *(79)*. Any renewed intensification as a result of a general recovery of the agricultural sector is thus likely to increase environmental pressure on water quality.

Nevertheless since the beginning of the 1990s the annual average concentration of nitrogen in rivers has decreased and does not exceed 2 mg/l in Daugava, Gauja and Venta. In Lielupe, the concentration of nitrogen is higher due to intensive agricultural activity in the region. In 2007, the average nitrogen concentration in Lielupe exceeded 6 mg/l. However, despite variability in the overall average nitrogen concentration from year to year, the recent trend indicates a small increase in nitrogen concentrations in all rivers.

In Lielupe, the annual average concentration of total phosphorus has changed significantly compared with other rivers. This is partly explained by climatic and specific hydrological conditions in the catchment area.

To protect water and soil from diffuse source pollution**,** 13 % of Latvia's territory under intensive agricultural production has been defined as a nitrate-vulnerable zone. Various restrictions have been imposed on agricultural production in this area: buffer zones, limitations on the application of fertilisers, requirements governing manure storage, soil treatment methods, etc. In order to reduce diffuse pollution resulting from other human activities or originating from natural processes, protective belts have been established for watercourses and water bodies and in the vicinity of drinking water abstraction sites.

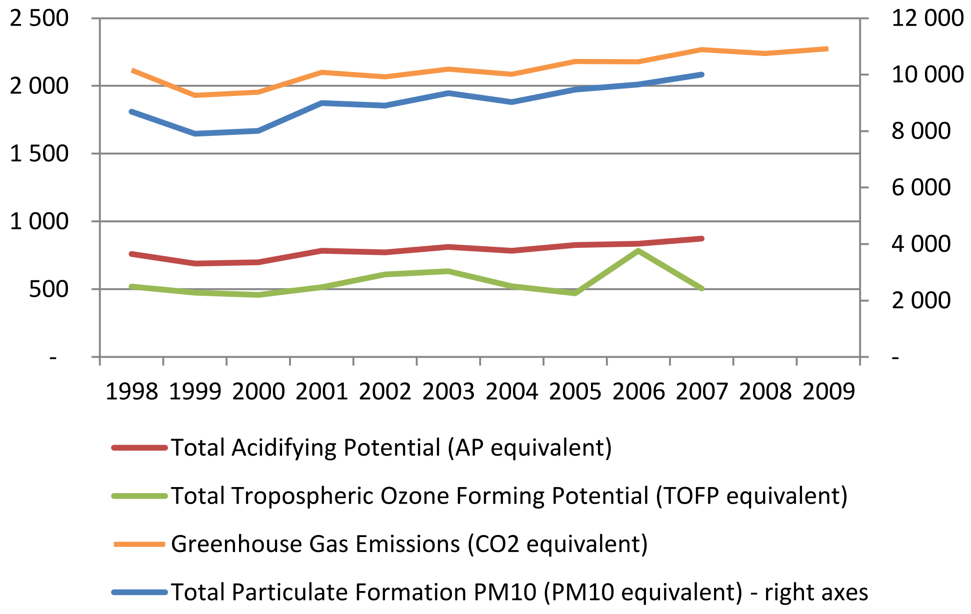
Nitrogen fertiliser use in Latvia has been increasing since 2003, but use of phosphate and potash fertilisers decreased slightly since 2004 (Figure 53).




Source: European environmental agency.

Figure 53. Fertiliser use in Latvia (tonnes).

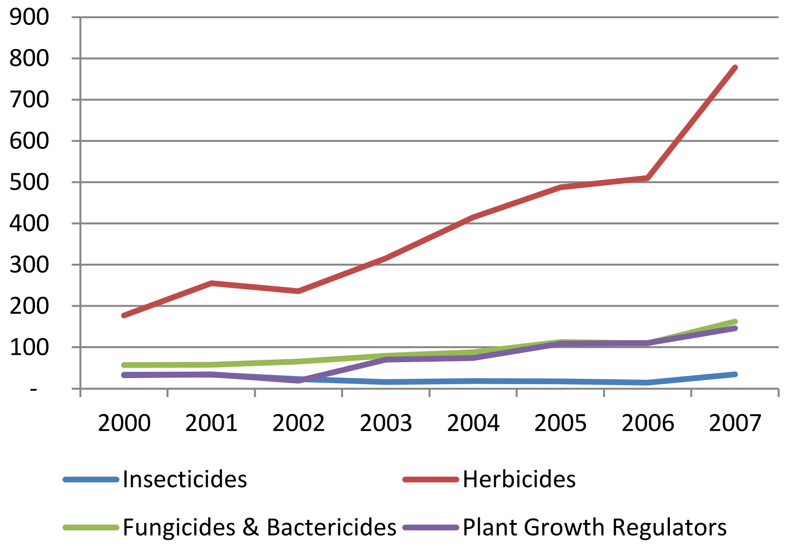
Other environmental pressures caused by agriculture include acidifying and tropospheric ozone forming potential. Total tropospheric ozone forming potential has been fluctuating, but total acidifying potential and PM10 emissions from 1998 to 2007 have increased by 15 %. $CO_{2e}$ emission from agriculture from 2007 to 2009 has increased by 7 % (Figure 54). Almost all $NH_3$ emissions originate from agricultural activity and since 1999 they rose, reaching 15 Gg in 2009.




Source: Eurostat.

Figure 54. Environmental pressures from agriculture in Latvia.

Utilisation of pesticides in Latvia is increasing, especially consumption of herbicides (Figure 55).




Source: FAO Stat.

Figure 55. Consumption of herbicides and insecticides in Latvia.

Estimates from the Bio Intelligence Service study (Monier et al. 2010 *(80)*) suggest that in 2006 185 million kg of food waste were generated in Latvia, the biggest part coming from the food manufacturing and agricultural sectors (Table 35).

Table 35. Total food waste generation in Latvia.

| | Agriculture, hunting and forestry | Manufacturing sectors | Households | Food Service/ Catering | Wholesale and retail | Total |
|---|---|---|---|---|---|---|
| Eurostat data (total tonnes, estimate 2006) | 38 049 | 125 635 | 10 466 | 6 661 | 3 870 | 184 681 |
| kg/capita | 17 | 55 | 5 | 3 | 2 | 82 |
| Scenario development (total tonnes) | | 125 635 | 78 983 | 27 490 | 20 393 | 252 500 |

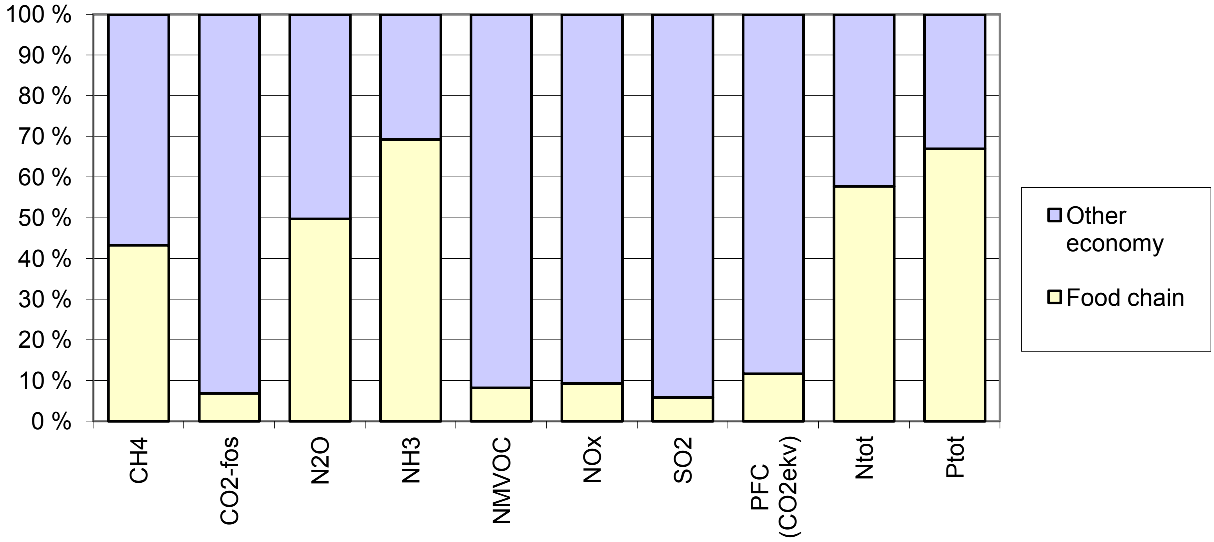
Source: Monier et al. 2010 *(80)*.

## 4.2. Environmental impacts of the food chain

### *The role of the food chain in the environmental impacts of the national economy*

The EIOLCA study on the Finnish food chain (Virtanen et al., 2009 and 2011 *(81, 82)*) which is used as the main reference in the following discussion, was based on data from 2005. The food chain was restricted to those flows that directly contribute to end-use as human food, or are necessary in order to produce such flows. Accordingly, those flows of agricultural products that serve other kinds of end-use are not included. The starch for the paper industry is an example of a flow that is excluded from the food chain. Hence, the agriculture sector of the food chain is slightly smaller than the agriculture sector of the national economy.

According to the EIOLCA study, the food chain accounts for 6 to 70 % of the domestic environmental loads of the whole national economy of Finland (Figure 56).




Source: Virtanen et al. 2009 *(81)*.

Figure 56. The shares of the food chain of domestic emissions for the national economy of Finland.

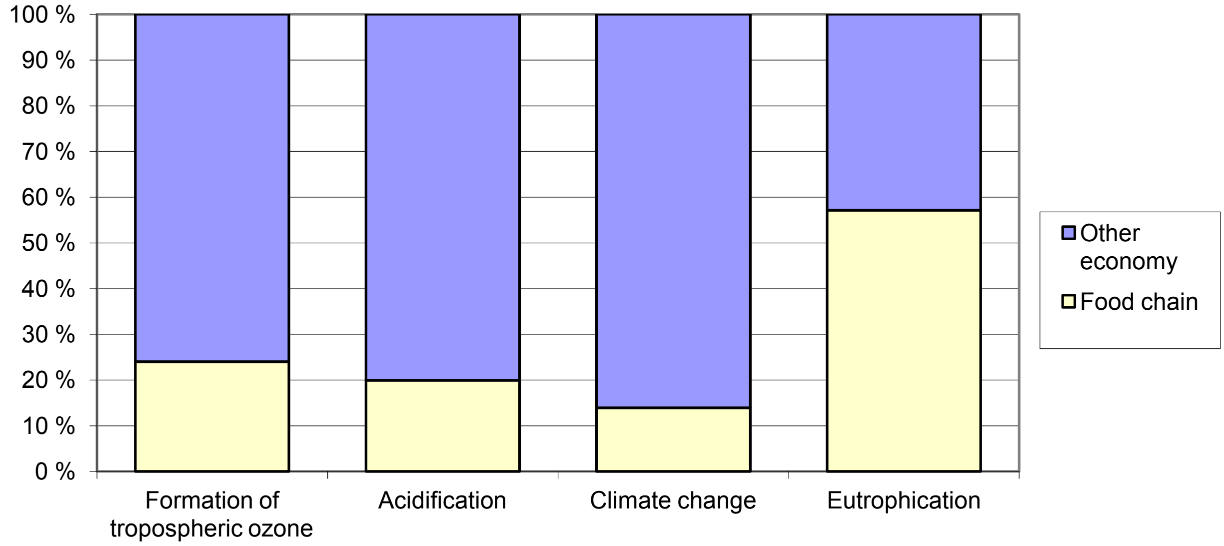
As for the atmospheric emissions, the contribution of the food chain is greatest for $NH_3$ emissions, 69 %, and smallest for $SO_2$ emissions, 6 %. Over 40 % of contributions to the food chain include $N_2O$ (50 %) and $CH_4$ (43 %) emissions. Fossil $CO_2$ emissions in the food chain account for 7 %, NMVOC emissions for 8 %, $NO_x$ emissions for 9 %, and F-gas emissions for 12 % of the respective economy-wide emissions. The food chain dominates the eutrophic water emissions. The share of the food chain in domestic N-leaching is 58 % and that of P-leaching 67 %. Results for the emission inventory are given in Table 36.

Table 36. Results for the emission inventory for the Finnish food chain and for the whole national economy.

| Emission | Domestic production | | | Imports | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Food chain | Other economy | Whole economy | Food chain | Other economy | Whole economy | Food chain | Other economy | Whole economy |
| $CH_4$ | 89 104 | 116 754 | 205 858 | 32 774 | 245 085 | 277 860 | 121 879 | 3 61 839 | 483 718 |
| $CO_2$-fos | 3 670 565 | 49 524 718 | 53 195 283 | 3 394 324 | 38 336 613 | 41 730 936 | 7 064 888 | 87 861 331 | 94 926 219 |
| $N_2O$ | 10 454 | 10 550 | 21 004 | 5 284 | 7 002 | 12 285 | 15 738 | 17 552 | 33 289 |
| $NH_3$ | 23 548 | 10 444 | 33 992 | 8 637 | 9 872 | 18 509 | 32 185 | 20 316 | 52 501 |
| NMVOC | 6 117 | 68 093 | 74 210 | 5 288 | 68 175 | 73 462 | 11 405 | 136 268 | 147 673 |
| NOx | 17 912 | 174 817 | 192 729 | 14 684 | 160 628 | 175 312 | 32 596 | 335 446 | 368 041 |
| $SO_2$ | 4 655 | 74 703 | 79 358 | 9 004 | 164 093 | 173 097 | 13 659 | 238 797 | 252 456 |
| F-gases* | 94 493 | 713 648 | 808 140 | 25 423 | 694 831 | 720 254 | 119 915 | 1 408 479 | 1 528 394 |
| $N_{tot}$ | 34 679 | 25 359 | 60 037 | 28 343 | 22 177 | 50 520 | 63 022 | 47 535 | 110 557 |
| $P_{tot}$ | 2 321 | 1 146 | 3 467 | 607 | 1 151 | 1 758 | 2 928 | 2 297 | 5 225 |

Source: Virtanen et al. 2009 *(81)*. The data is from year 2005. * $CO_2$ eq.

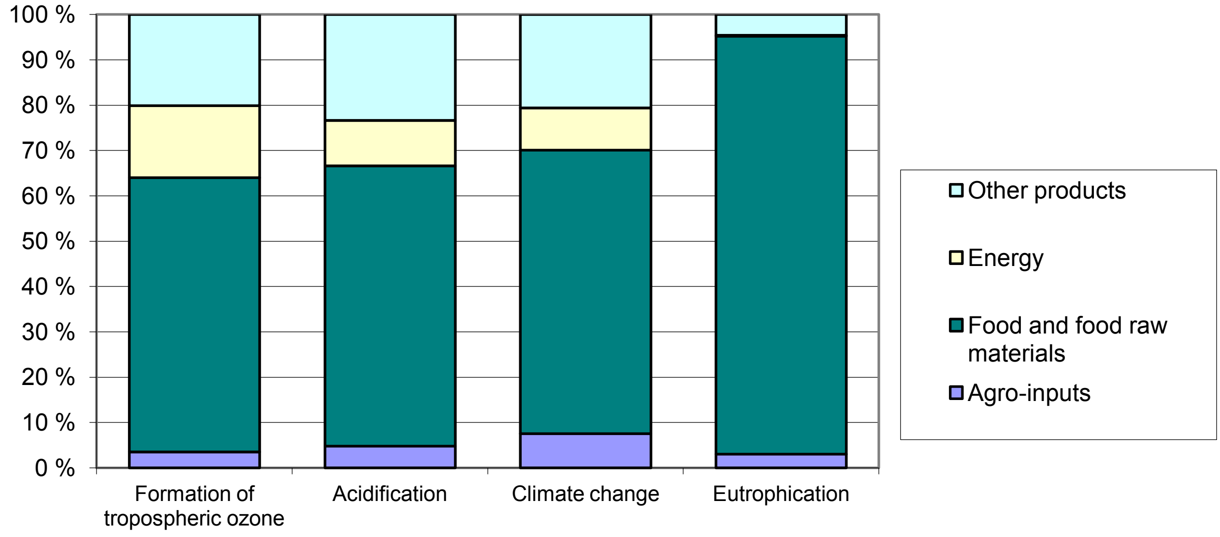
Food chain produces over 50 % of the domestic eutrophication impact of the Finnish economy (Figure 57). It is hence largely responsible for eutrophication of water bodies. Regarding the domestic climate change impact, the food chain is a minor contributor, being responsible for 14 % of the total. Due to relatively high levels of $NH_3$ and $CH_4$ emissions, the food chain is a more dominant contributor to acidification (20 %) and tropospheric ozone formation (24 %) impacts.




Source: Virtanen et al. 2009 *(81)*.

Figure 57. The contributions of the food chain to the domestic environmental impacts of the Finnish economy.

Of the total environmental impacts of the food chain, 32 % to 39 % arise outside Finland from the manufacture and the transport of imported raw materials and products. Most of these external impacts relate to food and raw food materials (Figure 58).

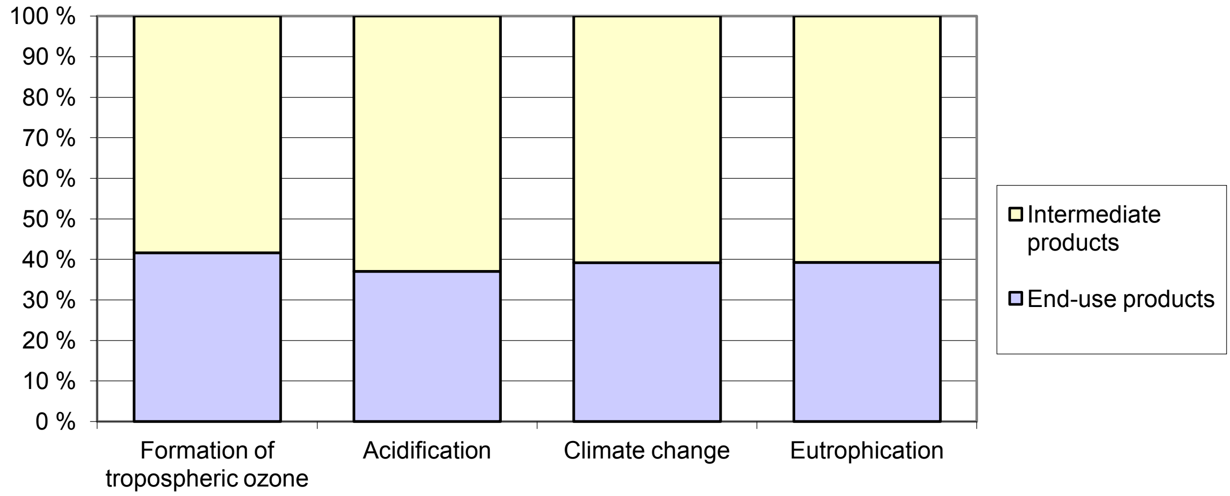



Source: Virtanen et al. 2009 *(81)*.

Figure 58. The shares of different import product groups for the external environmental impacts of the Finnish food chain.

The value of the imports was about the same for both product groups, which means that the impact intensity (impact per euro) of the intermediate imports was about 40 % higher than that of the end-use products.

All total impacts of the food chain include relatively fewer external impacts than those of the other economies and of the entire Finnish economy. Consequently, the contributions of the food chain to the total external impact are smaller than those to the domestic impacts (Figure 59).

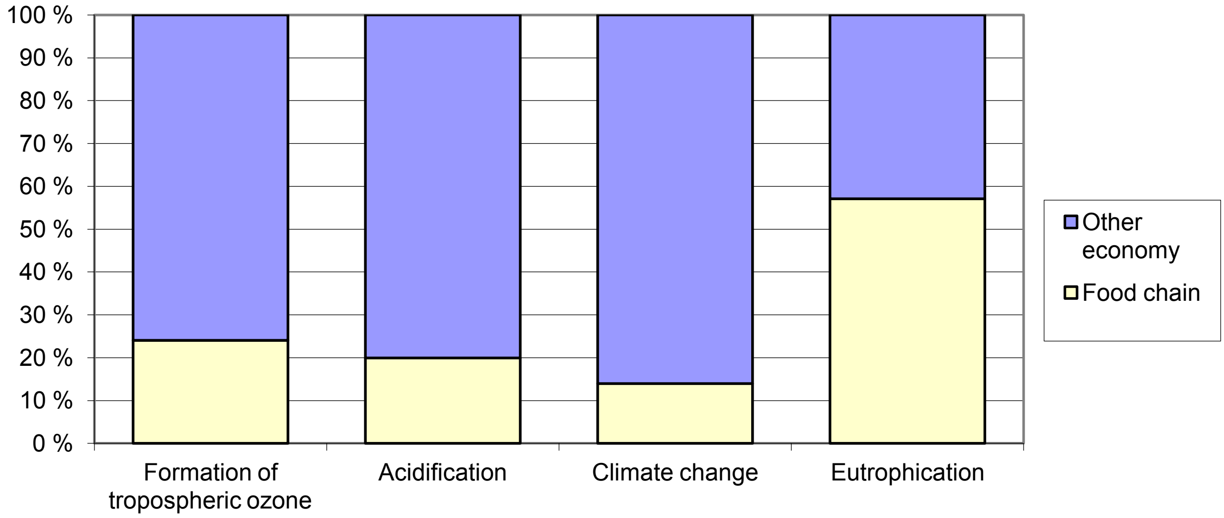



Source: Virtanen et al. 2009 *(81)*.

Figure 59. The shares of different import product groups of the external environmental impacts of the Finnish food chain.

The value of the imports was about the same for both product groups, which means that the impact intensity (impact per euro) of the intermediate imports was about 40 % higher than that of the end-use products.

All total impacts of the food chain include relatively fewer external impacts than those of the other economies and of the entire Finnish economy. Consequently, the contributions of the food chain to the total external impact are smaller than those to the domestic impacts (Figure 60).



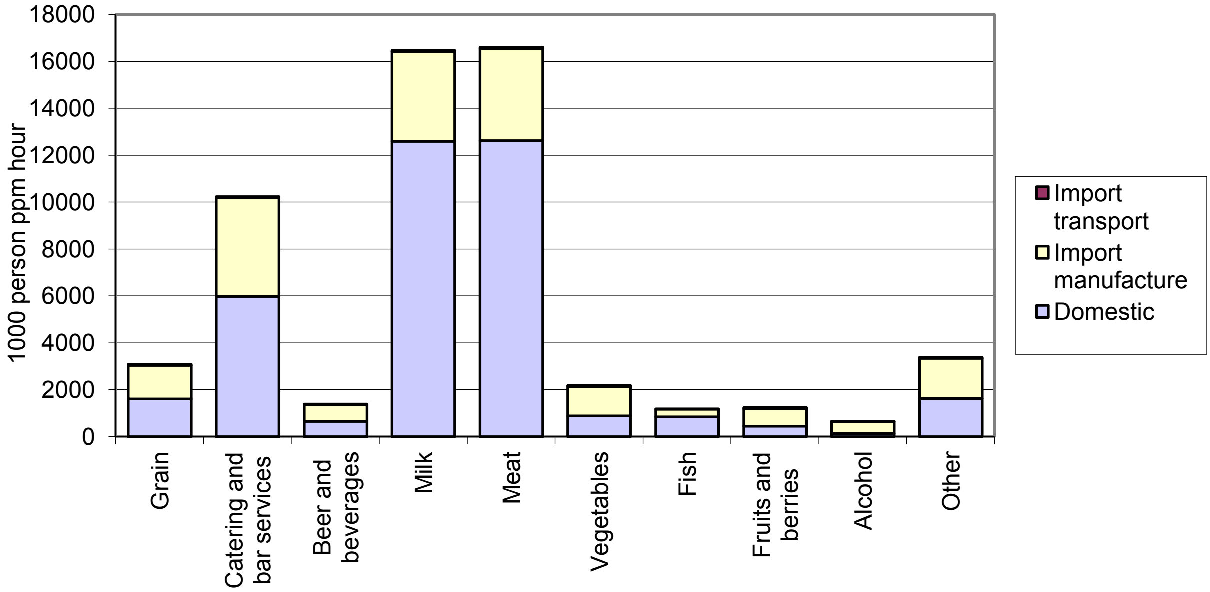

Source: Virtanen et al. 2009 *(81)*.

Figure 60. The contributions of the food chain to the external environmental impacts of the Finnish economy.

Some of the external impacts are targeted at the Baltic Sea region, as it is the origin of some of the imported food and food raw materials. This aspect was not, however, considered quantitatively in the study.

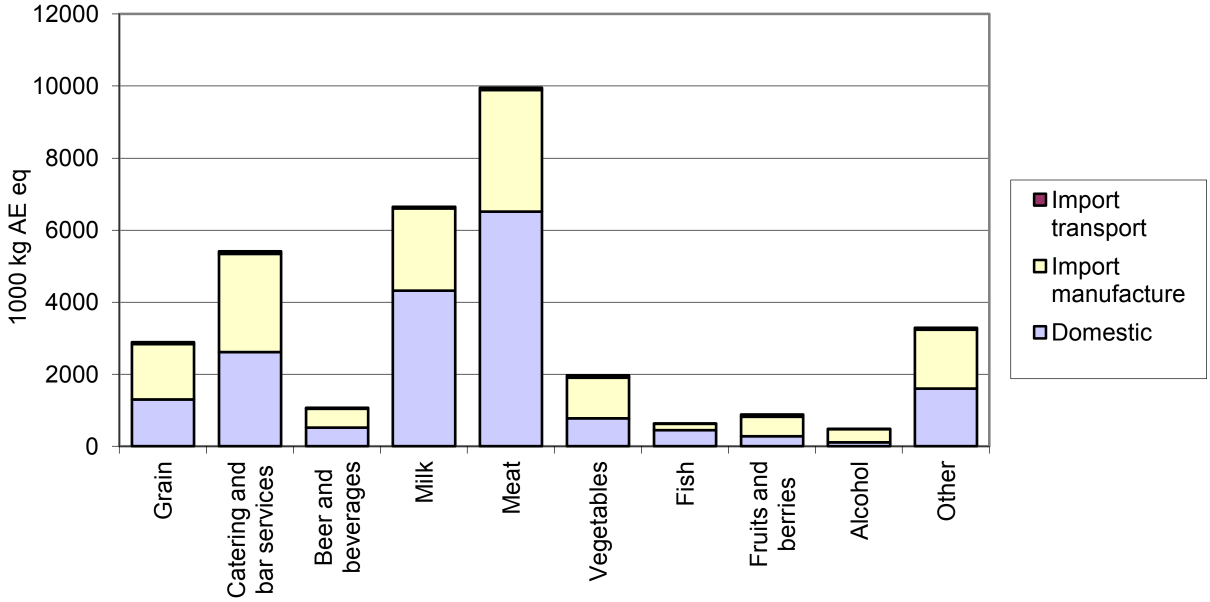
**The role of food products in the environmental impacts of the food chain**

The breakdown of the environmental impacts of the food chain by product groups is shown in Figures 61 to 64. Major contributors are meat and milk products, catering services and grain products. Of the domestic impacts, these four product groups account in total for 88 % of the tropospheric ozone formation impact, 80 % of the acidification impact, 78 % of the climate change impact, and 75 % of the eutrophication impact of the food chain. The respective shares of the total impacts, including the imports, are 3 to 6 % units smaller. In the background of the impacts of the catering services are the food products used to produce the services.



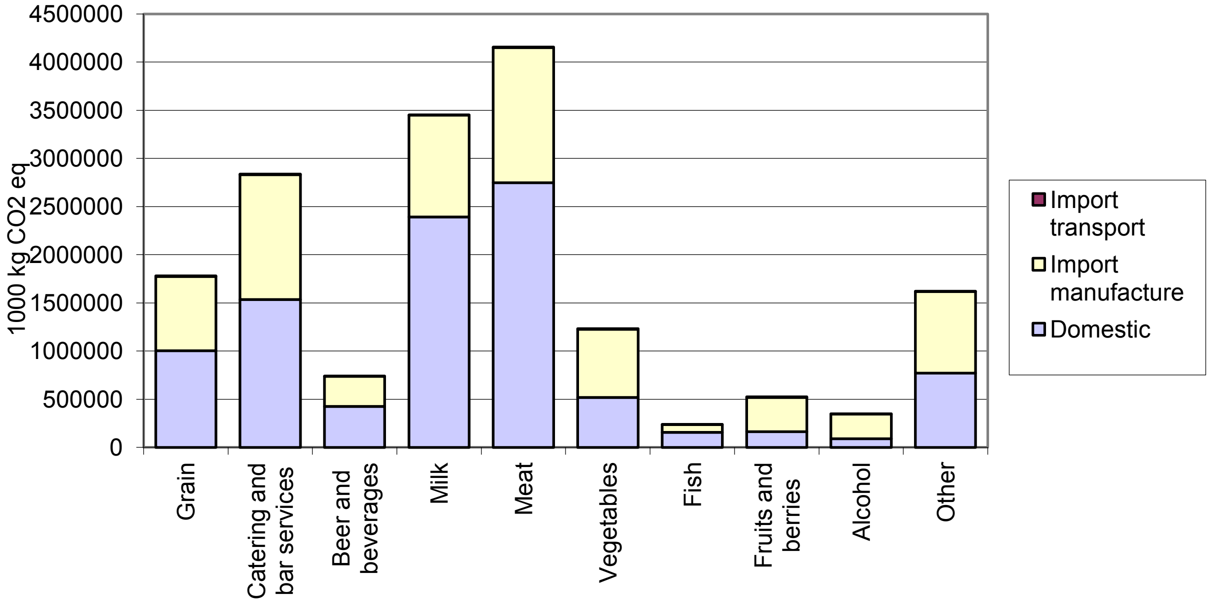

Source: Virtanen et al. 2009 *(81)*.

Figure 61. Breakdown of the tropospheric ozone formation impact of the food chain by product groups for Finland 2005. Stock changes are ignored. Note that the contribution of the transports of the imports is very small and thus indistinguishable.



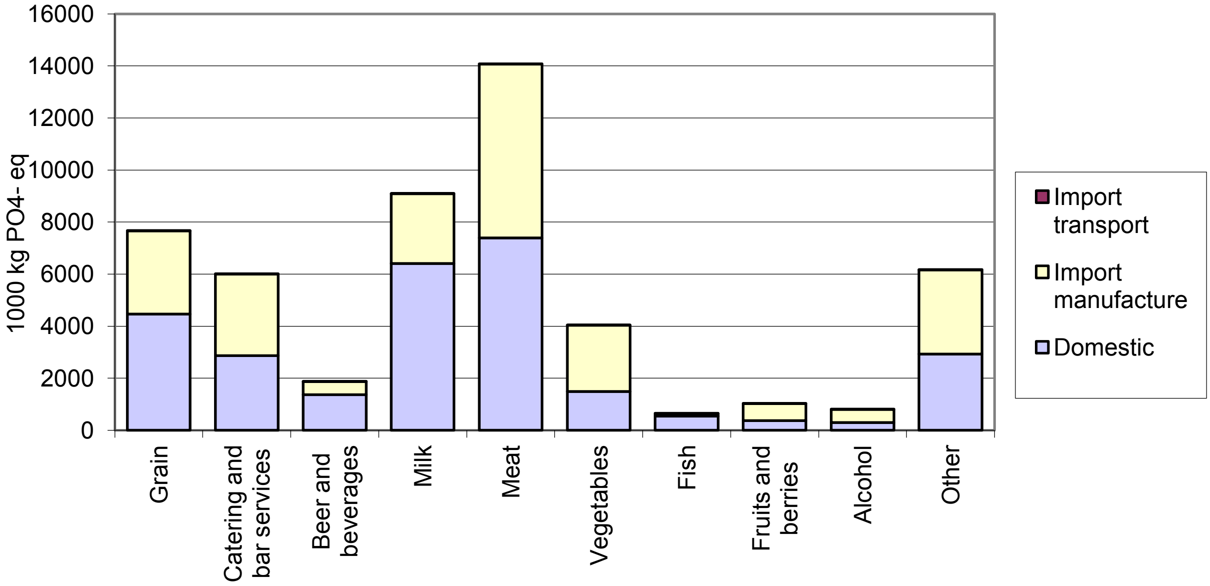

Source: Virtanen et al. 2009 *(81)*.

Figure 62. Breakdown of the acidification impact of the food chain by product groups for Finland, 2005. Stock changes are ignored. Note that the contribution of the transports of the imports is very small and thus indistinguishable.




Source: Virtanen et al. 2009 *(81)*.

Figure 63. Breakdown of the climate change impact of the food chain by product groups for Finland, 2005. Stock changes are ignored. Note that the contribution of the transports of the imports is very small and thus indistinguishable.




Source: Virtanen et al. 2009 *(81)*.

Figure 64. Breakdown of the eutrophication impact of the food chain by product groups for Finland, 2005. Stock changes are ignored. Note that the contribution of the transports of the imports is very small and thus indistinguishable.

**Formation of the eutrophication impact of the food chain**

An average 3 600 tonnes of phosphorus and 78 000 tonnes of nitrogen were leached into the Baltic Sea from Finland annually between 2000 and 2006. Approximately 28 % of the phosphorus and 36 % of the nitrogen load were from natural sources. The runoffs of the food chain were estimated at 2 320 tonnes of phosphorus and 34 680 tonnes of nitrogen in 2005 *(81)*, corresponding to about 80 % of the diffuse phosphorus load, and about 70 % of the diffuse nitrogen load from socio-economic activities.

Raw material production governs the total environmental load of the domestic food chain. Its contribution to the eutrophic emissions is 83 % on average (Table 37). About 95 % of nitrogen and phosphorus leaching stems from raw material production. Ammonia emissions originate almost entirely from raw material production. $NO_x$ emissions are an exception, with only a 37 % share of raw material production.

Table 37. The origins of the domestic eutrophication impact in the food chain, Finland 2005.

| | 1000 kg | Of the chain total (%) | Of the parent total (%) |
|---|---|---|---|
| **Eutrophic emissions total** | **78 461** | **100.0** | |
| of which | | | |
| Raw material production | 65 125 | 83.0 | 83.0 |
| Other activities | 13 336 | 17.0 | 17.0 |
| **Nitrogen and phosphorus total** | **37 000** | **47.2** | |
| of which | | | |
| Raw material production | 34 987 | 44.6 | 94.6 |
| Other activities | 2 013 | 2.6 | 5.4 |
| **$N_{tot}$** | **34 679** | **44.2** | |
| of which | | | |
| Raw material production | 32 779 | 41.8 | 94.5 |
| Other activities | 1 900 | 2.4 | 5.5 |
| **$P_{tot}$** | **2 321** | **3.0** | |
| of which | | | |
| Raw material production | 2 208 | 2.8 | 95.1 |
| Other activities | 114 | 0.1 | 4.9 |
| **Ammonia and nitrogen oxide total** | **41 460** | **52.8** | |
| of which | | | |
| Raw material production | 30 138 | 38.4 | 72.7 |
| Other activities | 11 322 | 14.4 | 27.3 |
| **$NH_3$** | **23 548** | **30.0** | |
| of which | | | |
| Raw material production | 23 467 | 29.9 | 99.7 |
| Other activities | 81 | 0.1 | 0.3 |
| **NOx** | **17 912** | **22.8** | |
| of which | | | |
| Raw material production | 6 671 | 8.5 | 37.2 |
| Other activities | 11 241 | 14.3 | 62.8 |

Source: Virtanen et al. 2009 *(81)*.

Table 38 shows the formation of the domestic eutrophication impact of the food chain. Based on the profile of the eutrophic emissions above, it is clear that raw material production again plays a major role. 94 % of the eutrophication impact stems from raw material production. It is noteworthy that the contribution of nitrogen leaching, 64 %, is twice that of phosphorus leachate. This indicates that the management of the nitrogen flows in raw material production is an important sustainability issue. On the other hand, the contribution of phosphorus to the eutrophication potential is also high at 31 % and should not be underestimated in the management schemes. Gaseous emissions are minor contributors to the eutrophication potential of the food chain.

Table 38. Formation of the domestic eutrophication impact in the food chain, Finland 2005.

| | kg $PO_4$ eq/kg [1)] | 1000 kg $PO_4$ eq | Of the chain total (%) | Of the parent total (%) |
|---|---|---|---|---|
| **Eutrophic emissions total** | | **22 884** | **100.0** | |
| of which | | | | |
| Raw material production | | 21 567 | 94.2 | 94.2 |
| Other activities | | 1 317 | 5.8 | 5.8 |
| **Nitrogen and phosphorus total** | | **21 668** | **94.7** | |
| of which | | | | |
| Raw material production | | 20 523 | 89.7 | 94.7 |
| Other activities | | 1 146 | 5.0 | 5.3 |
| **$N_{tot}$** | **0.42** | 14 565 | **63.6** | |
| of which | | | | |
| Raw material production | 0.42 | 13 767 | 60.2 | 94.5 |
| Other activities | 0.42 | 798 | 3.5 | 5.5 |
| **$P_{tot}$** | **3.06** | **7 103** | **31.0** | |
| of which | | | | |
| Raw material production | 3.06 | 6 755 | 29.5 | 95.1 |
| Other activities | 3.06 | 348 | 1.5 | 4.9 |
| **Ammonia and nitrogen oxide total** | | **1 216** | **5.3** | |
| of which | | | | |
| Raw material production | | 1 044 | 4.6 | 85.9 |
| Other activities | | 171 | 0.7 | 14.1 |
| **$NH_3$** | **0.04025** | **948** | **4.1** | |
| of which | | | | |
| Raw material production | 0.04025 | 945 | 4.1 | 99.7 |
| Other activities | 0.04025 | 3 | 0.0 | 0.3 |
| **NOx** | **0.01495** | **268** | **1.2** | |
| of which | | | | |
| Raw material production | 0.01495 | 100 | 0.4 | 37.2 |
| Other activities | 0.01495 | 168 | 0.7 | 62.8 |

1) specific eutrophication potential.
Source: Virtanen et al. 2009 *(81)*.

The formation of the domestic eutrophication impact of the raw material production is presented in Table 39. The contribution of plant production is given as 38 %, and that of the animal production 60 %. Animal production includes *in situ* feed production on the livestock farms. Plant production includes all grain production for sales. A large part of this, 30 % to 40 %, is cycled back as feed for animal production via industrial feed manufacture.

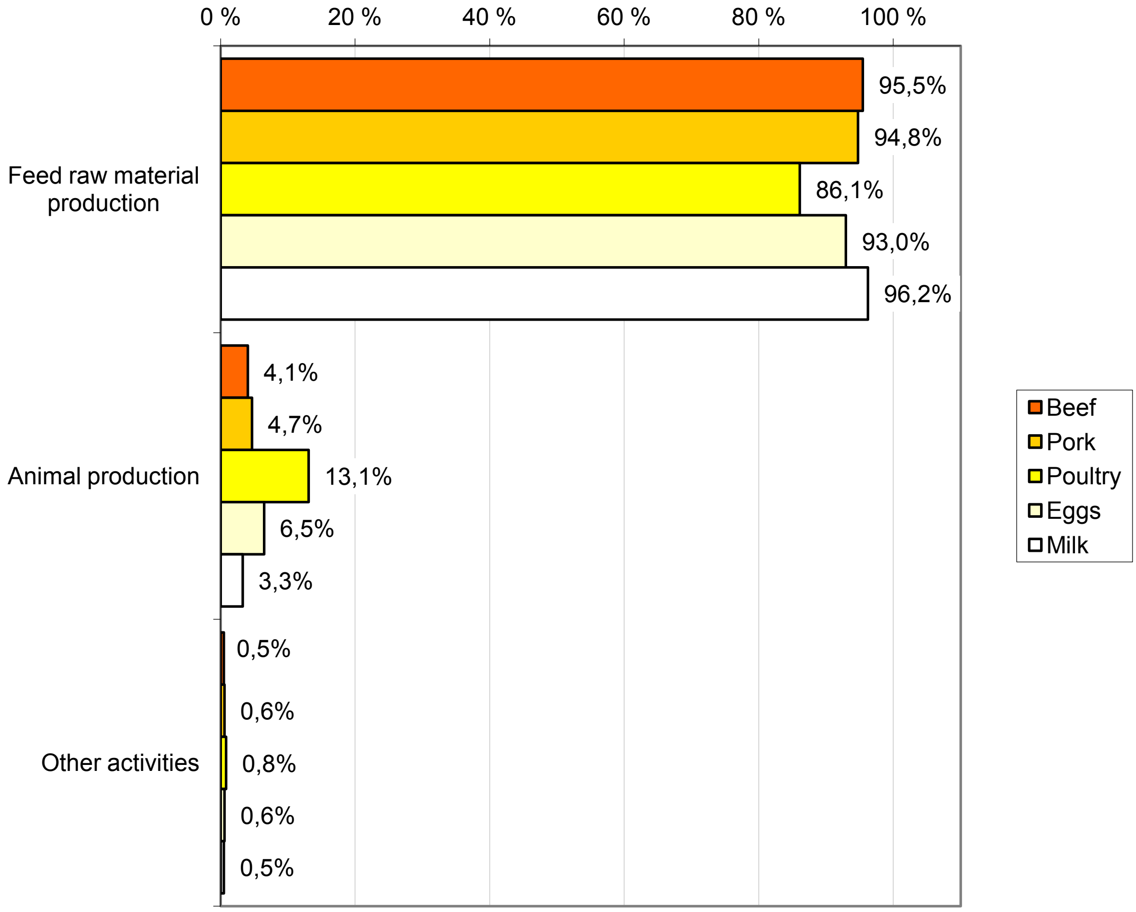
Table 39. Formation of the domestic eutrophication impact of the raw material production, Finland 2005.

| | kg $PO_4$ eq/kg | 1000 kg $PO_4$ eq | Of the phase total (%) | Of the parent total (%) |
|---|---|---|---|---|
| **Eutrophic emissions total** | | **21 567** | **100.0** | |
| of which | | | | |
| Plant production | | 8 264 | 38.3 | 38.3 |
| Animal production | | 12 824 | 59.5 | 59.5 |
| Other activities | | 478 | 2.2 | 2.2 |
| **Nitrogen and phosphorus, water emissions** | | **20 523** | **95.2** | |
| of which | | | | |
| Plant production | | 8 199 | 38.0 | 40.0 |
| Animal production | | 11 907 | 55.2 | 58.0 |
| Other activities | | 416 | 1.9 | 2.0 |
| **$N_{tot}$** | **0.42** | **13 767** | **63.8** | |
| of which | | | | |
| Plant production | 0.42 | 5 588 | 25.9 | 40.6 |
| Animal production | 0.42 | 8 047 | 37.3 | 58.4 |
| Other activities | 0.42 | 133 | 0.6 | 1.0 |
| **$P_{tot}$** | 3.06 | **6 755** | **31.3** | |
| of which | | | | |
| Plant production | 3.06 | 2 612 | 12.1 | 38.7 |
| Animal production | 3.06 | 3 860 | 17.9 | 57.1 |
| Other activities | 3.06 | 283 | 1.3 | 4.2 |
| **Ammonia and nitrogen oxide emissions** | | **1 044** | **4.8** | |
| of which | | | | |
| Plant production | | 65 | 0.3 | 6.2 |
| Animal production | | 917 | 4.3 | 87.8 |
| Other activities | | 62 | 0.3 | 5.9 |
| **$NH_3$** | **0.04025** | **945** | **4.4** | |
| of which | | | | |
| Plant production | 0.04025 | 34 | 0.2 | 3.6 |
| Animal production | 0.04025 | 861 | 91.2 | 91.2 |
| Other activities | 0.04025 | 49 | 5.2 | 5.2 |
| **NOx** | **0.01495** | **100** | **0.5** | |
| of which | | | | |
| Plant production | 0.01495 | | | 30.8 |
| Animal production | 0.01495 | 56 | 5.9 | 56.3 |
| Other activities | 0.01495 | 13 | 1.4 | 12.9 |

Source: Virtanen et al. 2009 *(81)*.

When a corresponding part of the eutrophication potential is transferred from plant production to animal production, the contribution becomes 71 % - 75 % for animal production and 23 % to 26 % for plant production. The share of feed grain varies annually depending on yields, stock changes, exports and imports of feed raw materials.

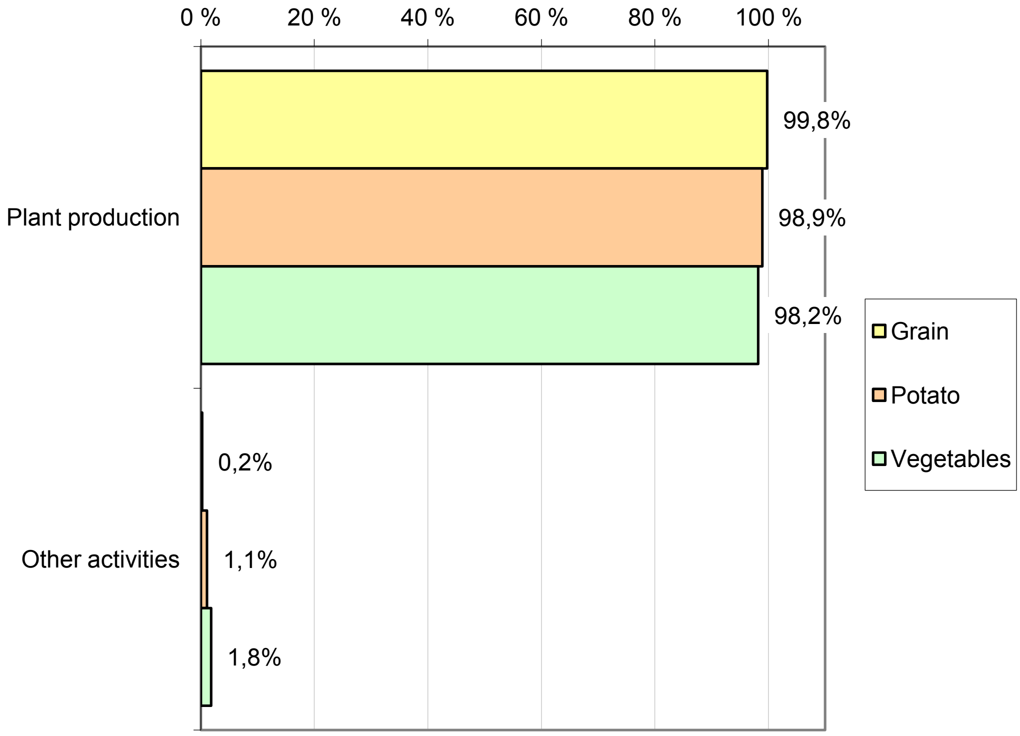
The domestic eutrophication impacts of animal production chains concentrate on feed raw material production (Figure 65). For beef, pork and milk, feed production contributes 95 to 96 % of the total impact. For poultry and eggs the contribution is 86 to 93 %. The contribution of animal production (husbandry) is 4 to 5 % and 7 to 13 % respectively. The main causes of the eutrophication impacts are nitrogen and phosphorus runoffs from feed raw material production and the $NH_3$ emissions from animal production. The slight difference in the contribution of the feed raw material production between beef and pork and poultry, and eggs on the other hand, follows from a bigger share of imported raw materials in the industrial feed production.




Source: Virtanen et al. 2009 *(81)*.

Figure 65. Breakdown of the domestic eutrophication impact of the main animal production chains by activities, 2005. Stock changes are ignored.

The domestic eutrophication impacts of plant production chains originate almost entirely from the plant production (Figure 66). Grain, potato and vegetable chains all have more than 98 % of the eutrophication impact coming from plant production. In the vegetable chain, the 2 % contribution of the other activities stems mainly from the $NO_x$ emissions from power production for greenhouse lighting. The main causes of the eutrophication impacts are nitrogen and phosphorus runoffs from plant production.




Source: Virtanen et al. 2009 *(81)*.

Figure 66. Breakdown of the domestic eutrophication impact of the main plant production chains by activities, 2005. Stock changes are ignored.

### Eutrophication intensities of food raw materials

The factors contributing to total impacts of food raw materials are volume and impact intensity, and the value of their product, which is expressed as impact per unit mass of the raw materials. Eutrophication intensities vary considerably among food raw materials. Table 40 shows eutrophication intensity values for Finnish food raw materials. The values were compiled with the help of the EIOLCA food chain model. It should be noted that mass based intensities do not provide the whole picture of environmental impacts of foodstuffs because food has many other important properties, such as energy and nutritional capacity, which have to be taken into account.

Table 40. Formation of the Finnish eutrophication impact of raw material production in 2005.

| Food raw material | Eutrophication potential g $PO_4$- eq/kg |
|---|---|
| Beef | 51.5 |
| Pork | 15.4 |
| Poultry | 7.1 |
| Eggs | 16.1 |
| Milk | 3.3 |
| Meat (Beef, pork and poultry) | 21.8 |
| Grain | 5.0 |
| Fruits and berries | 3.9 |
| Potato | 0.7 |
| Vegetables | 1.5 |
| Vegetarian average | 4.3 |

Source: Virtanen et al. 2009 *(81)*.

In general plant-based materials have lower eutrophication intensities than animal based ones. On average meat is about five times more eutrophication intensive than plant raw materials. Among the meats, beef has the highest eutrophication intensity, about three times that of pork, and seven times that of poultry. Milk has a relatively low intensity. It should be noted, however, that the values for beef and milk are partly bound together as a considerable share of the beef comes from milk cows. Thus the method used to allocate the eutrophication emissions of milk cows reflects the intensities. In the Finnish model the shares allocated to beef and milk were 18 % and 82 %.

Of the plant-based raw materials grain has the highest intensity, and variation is relatively of the same order as for animal based products. Grains are three times more intensive than vegetables, and seven times more intensive than potato in producing eutrophication impacts.

#### Eutrophication estimates for Estonian and Latvian food raw materials

Eutrophication intensity was estimated for Estonian and Latvian food raw materials using the Finnish EIOLCA model, which was modified for the emission factors of the raw material production sectors. Modification included the effects of the yields from crop production. The total intensity of fertiliser nutrient application was assumed to be at the same level as in Finland. The modification was done in two phases: in the first phase the effects of land-use intensity on nitrogen and phosphorus emissions of plant production were estimated. Land-use intensity is defined as the ratio of field area to yield. The relative land-use intensities with respect to corresponding Finnish production are given in Table 41. The effects of yield to the area runoffs were estimated. According to the runoff models used in the Finnish food chain model, only nitrogen area runoffs depend on the yields. This dependency is mediated by the nitrogen balances. Phosphorus runoffs are considered to be independent of the phosphorus balance of the field, and thus also of the yields. Relative nitrogen area runoffs used in the emission factor modifications are given in Table 42. Phosphorus area runoffs were assumed the same as in Finland, i.e. their relative value is 1.

Table 41. Relative land-use intensities for Estonian and Latvian plant production with respect to the corresponding Finnish production.

| | Cereals | Potato | Grass |
|---|---|---|---|
| Estonia | 1.47 | 1.15 | 1 |
| Latvia | 1.14 | 1.25 | 1 |

Value for Finland=1. Land-use intensity describes the field area needed in order to produce a specific amount, for instance 1 kg of plant raw material.

Table 42. Relative nitrogen and phosphorus area-runoffs for Estonian and Latvian plant production with respect to the corresponding Finnish production.

| | Nitrogen | | | Phosphorus | | |
|---|---|---|---|---|---|---|
| | Cereals | Potato | Grass | Cereals | Potato | Grass |
| Estonia | 0.85 | 1 | 0.90 | 0.77 | 0.51 | 0.72 |
| Latvia | 0.74 | 1 | 0.90 | 0.77 | 0.51 | 0.72 |

Value for Finland=1. Area-runoff describes the mass flow of a nutrient runoff from 1 ha of field.

Nitrogen and phosphorus runoff-intensities are then calculated based on the assumptions and the intensity estimates given above. The relative values for them are given in Table 43.

Table 43. Relative runoff intensities for Estonian and Latvian plant production with respect to the corresponding Finnish production.

| | *Nitrogen runoff* | | | *Phosphorus runoff* | | |
|---|---|---|---|---|---|---|
| | Cereals | Potato | Grass | Cereals | Potato | Grass |
| Estonia | 1.18 | 1.49 | 1.35 | 1.07 | 0.77 | 1.08 |
| Latvia | 0.81 | 1.62 | 1.46 | 0.83 | 0.83 | 1.17 |

Value for Finland=1. Runoff intensity describes the runoff released in order to produce 1 kg of plant raw material.

In the second phase, the effects of the nutrient runoff intensity changes for the animal raw material chains were estimated. For this it was assumed that the feed receipts, and other activities, in addition to plant raw material production, in Estonia and Latvia were the same as in Finland. Relative eutrophication intensities thus obtained are given in Table 44. Absolute values for the eutrophication intensity estimates are given in Table 45. Eutrophication intensity describes the eutrophication impact produced in order to produce a specific amount, for instance 1 kg, of raw material. Estimates are based on the yield data for grain and potato and were compiled using the Finnish Food Chain EIOLCA model *(81)*.

Table 44. Relative eutrophication intensities for Estonian and Latvian plant and animal raw material production with respect to the corresponding Finnish production.

| | Estonia | Latvia |
|---|---|---|
| Beef | 1.20 | 1.17 |
| Pork | 1.14 | 0.82 |
| Poultry | 1.13 | 0.84 |
| Eggs | 1.14 | 0.83 |
| Milk | 1.20 | 1.18 |
| Cereals | 1.15 | 0.82 |
| Potato | 1.06 | 1.16 |

Value for Finland=1.

Table 45. Estimated eutrophication intensities for Estonian and Latvian plant and animal raw material production.

| Raw material | Eutrophication impact intensity, g $PO_4$- eq/kg | |
|---|---|---|
| | Estonia | Latvia |
| Beef | 61.9 | 60.5 |
| Pork | 17.5 | 12.7 |
| Poultry | 8.0 | 6.0 |
| Eggs | 18.3 | 13.3 |
| Milk | 3.9 | 3.9 |
| Cereals | 5.7 | 4.0 |
| Potato | 0.7 | 0.8 |

The corresponding runoff intensities for nitrogen and phosphorus are given in Table 46 and Table 47 below. Even though the estimates are ruff, but they predict the order of magnitude relations of eutrophication intensities between different kinds of raw materials. In Estonia and Latvia the relation between beef and cereals is 11 to 14, which is of the same order of magnitude as in the Finnish production. The overall trend for Estonia is that eutrophication intensity estimates are higher than Finland. For the Latvian cereals the estimate is considerably lower than for the Finnish ones. This reflects through grain fodder to pork, poultry and eggs.

Table 46. Estimated nitrogen runoff intensities for Estonian and Latvian plant and animal raw material production.

| Raw material | Nitrogen runoff intensity, g N/kg | |
|---|---|---|
| | Estonia | Latvia |
| Beef | 98.7 | 94.9 |
| Pork | 30.5 | 21.5 |
| Poultry | 14.3 | 10.5 |
| Eggs | 32.0 | 22.7 |
| Milk | 6.3 | 6.0 |
| Cereals | 9.7 | 6.7 |
| Potato | 1.0 | 1.1 |

Runoff intensity describes the runoff produced in order to produce 1 kg of raw material. Estimates are compiled with a modified EIOLCA model the Finnish Food Chain (KETJUVASTUU).

Table 47. Estimated phosphorus runoff intensities for Estonian and Latvian plant and animal raw material production.

| Raw material | Phosphorus runoff intensity, g N/kg | |
|---|---|---|
| | Estonia | Latvia |
| Beef | 6.7 | 6.7 |
| Pork | 1.5 | 1.2 |
| Poultry | 0.6 | 0.5 |
| Eggs | 1.6 | 1.2 |
| Milk | 0.4 | 0.4 |
| Cereals | 0.5 | 0.4 |
| Potato | 0.1 | 0.1 |

Runoff intensity describes the runoff produced in order to produce 1 kg of raw material. Estimates are compiled with a modified EIOLCA model the Finnish Food Chain (KETJUVASTUU).

#### Effect of diet on the eutrophication impact

The effects of diet were studied with help of the EIOLCA food chain model as part of a project on the coherency assessment of other environmental policies in Finland. The estimate was produced using the scenario method, the basis of which was the consumption of foodstuffs in 2006. The modified scenario was produced by applying a modified end-use to the 2005 model. This was done through comparison of the ratios of food plate components, i.e. vegetables, protein foods and carbohydrate foods, in the 2006 private consumption to the recommended plate, and adjusting the private consumption of foodstuffs so that it met the recommended plate composition. The idea is illustrated in Figure 67. The red triangle for 2006 private consumption is turned into the green triangle for the recommended food plate in the scenario. Nothing else was changed in the model, i.e. no technological or other types of development that would affect the emissions of the production sectors were assumed to take place. Other end-use components, of which the most important are exports and changes in stocks, were kept constant, as were consumption of food in service and industrial sectors, and in catering services.

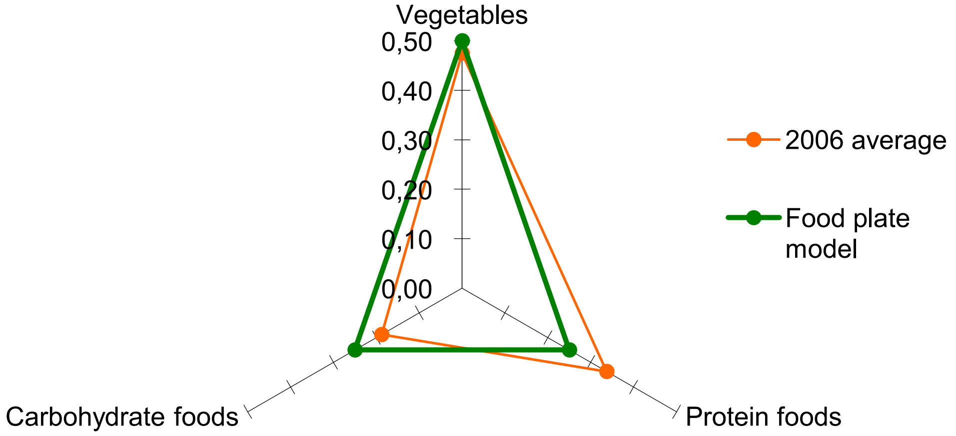



Figure 67. The idea of the diet scenario. The red triangle of 2006 private consumption is turned into the green triangle of recommended food plate.

The modelling results indicated that eutrophication could be reduced by about 7 % if the recommended diet were to have full effect on private food consumption. This is a relatively strong response since private food consumption is quite close already to that recommended. The major shift, about 7 % units from protein to carbohydrates, was accomplished in the scenario by applying a constant relative reduction to all protein foods, and a constant relative increment to all carbohydrate foods. Consequently, the eutrophication intensities, which are the gradients of the changes and are much higher for animal protein foods than for carbohydrate foods, are the main cause of the strong response.

# 5. Environmentally based risks

## 5.1. Sources of hazardous compounds to the Baltic Sea

The traditional classification for pollution sources to point sources, land-based diffuse sources and atmospheric deposition is fully applicable to the Baltic Sea *(83)*. Point sources situated either on the coast or inland in the catchment area have historically contributed with significant amounts of heavy metals and persistent organic pollutants (POPs) to the Baltic Sea surface waters *(84)*. In order to tackle specific point polluters, HELCOM created a list of hot spots of the main point polluters in the Baltic Sea catchment area. The list originally contained 163 hot spots and set measurable targets for them. By the end of 2009, 89 sites had been removed from the list due to reduced discharges or the end of production *(83)*. However, the past pollution load is often deposited in soils and sediments and has yet to disappear from the ecosystem.

There are several contaminant groups which originate mainly from minor industrial sources, agricultural pesticides, pharmaceuticals and fertilisers, household consumer products, sludge, dump sites and waste deposition in land-fills. Long-term emissions from buildings and construction materials have also received more attention lately. Diffuse emissions are often channelled via, for example, storm waters and sewage water effluents. Atmospheric emissions from traffic, shipping, energy production, incineration of wastes and even small-scale household combustion are important sources of hazardous compounds. They end up to the marine environment by being deposited in surface waters. For example, in 2006, almost half of the lead loading and one third of the mercury loading originated from atmospheric deposition *(85, 86)*. For compounds like dioxins, atmospheric deposition may dominate over other sources. It is important to note that part of the atmospheric emissions of hazardous compounds, and ultimately deposition in the Baltic Sea, originate from sources outside the Baltic Sea catchment area and are transported long distances in the atmosphere. For example, 60 % of dioxins deposited in the Baltic Sea are thought to originate from outside the Baltic Sea catchment area *(87)*.

The most hazardous compounds for the ecosystem and human health are those with persistent, bio-accumulative and toxic (PBT) properties. Intensive agriculture, industry and other social and economic activities within the large human population in the catchment area, produce large amounts of different hazardous compounds which are leached into the Baltic Sea and fresh water or emitted into the atmosphere (Figure 68, *(83)*). Due to slow replacement of the Baltic Sea water with Atlantic waters and the long-term water retention, the Baltic Sea remains the final source of many toxins with low degradation rates. The environmental characteristics, such as low temperature and ice during winters, further enhance the bioaccumulation of harmful compounds in the food chain. Consequently, the Baltic Sea biota, including fish for human consumption, may contain hazardous compounds in concentrations many times higher than those in other seas.

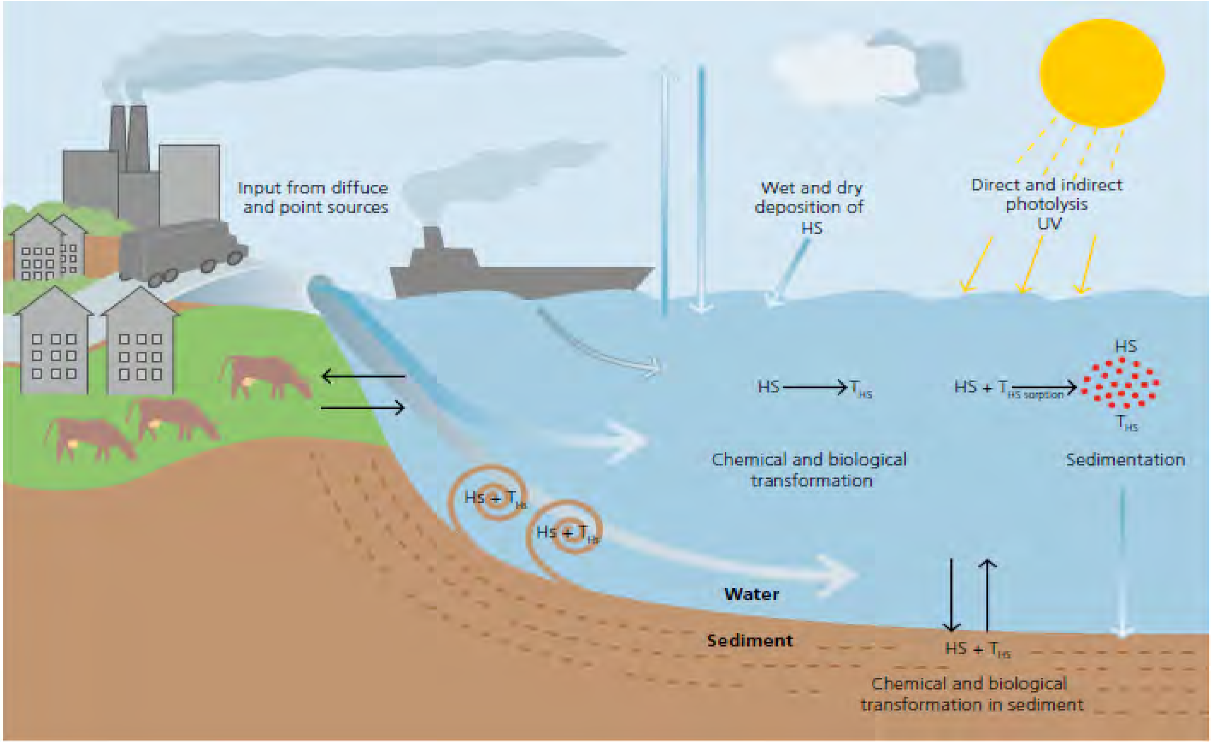



Figure 68. Sources of pollution inputs to the Baltic Sea marine environment (HELCOM 2010).

By adopting the HELCOM Baltic Sea Action Plan (BSAP), the Baltic Sea countries committed themselves to achieving a strategic objective; "Baltic Sea with life undisturbed by hazardous compounds" order to be successful, four ecological objectives were defined:
- Concentrations of hazardous compounds close to natural levels
- All fish safe to eat
- Healthy wildlife
- Radioactivity (radionuclides) at pre-Chernobyl level

The 11 compounds/substance groups identified in BSAP as being of special concern were:
1) Dioxins (PCDD), furans (PCDF) and dioxin-like polychlorinated biphenyls (PCBs)
2) Tributyltin compounds (TBT), triphenyltin compounds (TPhT)
3) Pentabromodiphenyl ether (pentaBDE), octabromodiphenyl ether (octaBDE), decabromodiphenyl ether (decaBDE)
4) Perfluorooctane sulfonate (PFOS), Perfluorooctanoic acid (PFOA)
5) Hexabromocyclododecane (HBCDD)
6) Nonylphenols (NP), nonyphenol ethoxylates (NPE)
7) Octylphenols (OP), octylphenol ethoxylates (OPE)
8) Short-chain chlorinated paraffins (SCCP), medium-chain chlorinated paraffins (MCCP)
9) Endosulfan
10) Mercury
11) Cadmium

Appendix 3 presents the estimated emissions of some hazardous compounds into the environment (kg/year) from Finland, Estonia and Latvia according to COHIBA (Control of Hazardous compounds in the Baltic Sea region) project (http://www.helcom.fi/projects/on_going/en_GB/cohiba/). Atmospheric emissions were mostly taken from the Meteorological Synthesizing Centre–East (http://www.msceast.org/).

### *Environmental status and hazardous compounds*

Knowledge of the levels of hazardous compounds in the Baltic Sea, and of their temporal changes, has increased substantially during recent years. Environmental concentrations and risks associated with several compounds that were used for long periods but have recently been highly regulated are in general well understood. These include many organic toxins (e.g. PCB, DDT, HCB, HCH) and heavy metals (mercury, cadmium, lead, organic tin compounds). Further knowledge of some compounds used widely as flame retardants (PBDE, HBCD) or for their surface-active properties has been increasing. Examples of compounds of unintentional use, for which data are available, include dioxin compounds and polyaromatic hydrocarbons (PAH), which are largely formed during combustion processes and are distributed extensively through atmospheric transport. Current knowledge of the state of the Baltic Sea regarding these compounds has been collected and assessed for the first time as part of the Baltic Sea Action Plan *(83, 88)*.

In the HELCOM 2010 assessment the status of hazardous compounds was assessed and classified for 144 sites in the Baltic Sea. An integrated assessment and classification of “hazardous compounds status” was produced and used to evaluate whether the overall goal of “a Baltic Sea with life undisturbed by hazardous compounds” had been achieved. The quantification of the “hazardous compounds status” was based on a Contamination Ratio (CR), which is the ratio of the current status (measurement of the concentration of a substance or biological effect) and a threshold level or quality criterion, which is used as an approximation for an environmental target for that particular substance or biological effect. The CRs of all compounds or indicators within an ecological objective are integrated, yielding a status classification (“high”, “good”, “moderate”, “poor” and “bad”) of that particular ecological objective.

All open sea areas of the Baltic Sea were classified as “disturbed by hazardous compounds”, receiving a classification status of “moderate”, “poor” or “bad” (Figure 69). The only exception was the northwestern Kattegat, which received a status classification of “good”. Open waters in the Northern Baltic Proper, Western and Eastern Gotland Basins, Gulfs of Finland and Gdansk received the worst status classifications (bad or poor), while the open sea areas in the Gulfs of Bothnia and Riga, Arkona and Bornholm Basins and Danish open waters were mainly classified as being of “moderate” status. Only six out of the 104 coastal assessment units were classified as being “areas not disturbed by hazardous compounds”, receiving a status classification of good or high. The coastal areas that received the highest status classifications were located around the Åland islands, in the Kaliningrad coastal area, on the Lithuanian coast, in the Kattegat and on the Finnish side of the Bothnian Bay. There was some tendency for the units with the poorest status to be located either near big cities or ports (Tallinn, Klaipeda) or to be estuarine areas (Kymijoki estuary in the Gulf of Finland), Kvädöfjörden in the Western Gotland Basin) or coastal sites (the Kiel bay area). The waters near big coastal cities were mostly classified as being of “moderate” hazardous compounds status (e.g. St. Petersburg, Helsinki, Stockholm, Riga, Gdansk and Copenhagen).

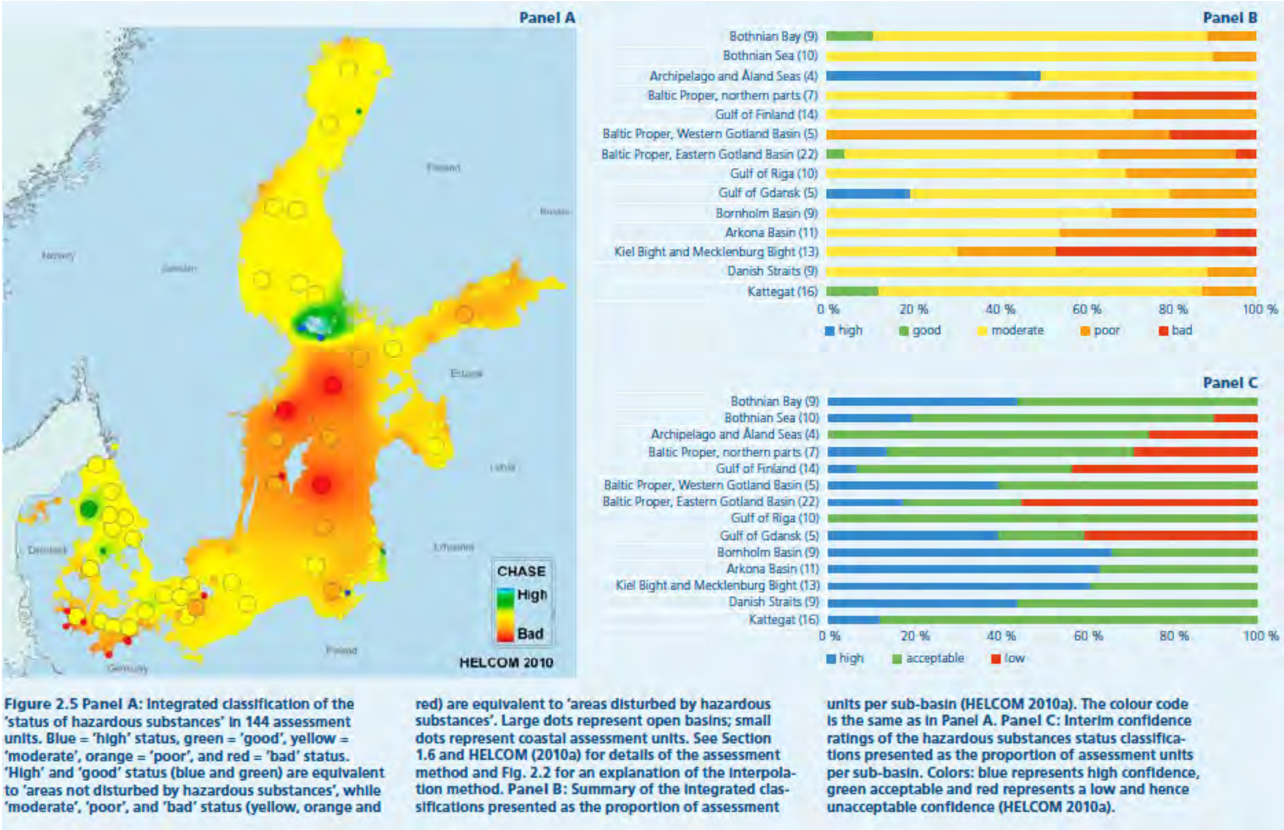



Figure 69. An integrated classification of the Baltic Sea environment based on concentrations of hazardous compounds in biota and their relation to environmental thresholds and human food standards (HELCOM 2010).

An important question is "Which compounds are decisive in determining the status in the integrated classification?" PCBs, lead, mercury, caesium-137, DDT/DDE, TBT, benz(a)anthracene and cadmium were those compounds most commonly recorded among the compounds with the highest Contamination Ratios (CR, i.e. having highest concentrations in relation to target levels). Although several of the assessed compounds accumulate in the food chain the maximum levels in fish for human consumption are rarely exceeded. According to the Finnish Food Safety Authority, Evira *(89)*, levels of dioxin and dioxin-like PCB compounds exceed the maximum stipulated limits in Baltic herring, salmon, sea trout, river lamprey and European flounder along the southern coast of Finland. However, the mean levels of dioxin and PCB, as well as of PBDE (polybrominated diphenyl ethers) compounds, have decreased during the past 7 years.

Fertilisers and waste waters cause eutrophication and high nitrate and phosphate levels in the Baltic Sea have favoured the expansion of cyanobacteria during the past 10-20 years. Cyanobacteria reproduce explosively under certain conditions, resulting in algal blooms that can become harmful to other species if they produce toxins. Nodularine-R is synthesised by *Nodularia spumigena* and is the most common cyanotoxin in the Baltic Sea during the warm season. Currently eutrophication is considered the major environmental problem of the Baltic Sea.

### *Designing site-specific ecotoxic impact factors for life cycle assessment in the central Baltic region*

Life cycle assessment proceeds in several stages: first the objective of the study is well defined (goal and scope), then all emissions are collated (inventory), impacts of emissions are assessed (impact assessment) and finally the results are interpreted (ISO 14044). The goal of impact assessment is to associate individual emission sources with comparable environmental impacts. The impact assessment is usually done using general impact assessment factors, such as global warming potentials of greenhouse gases. For ecotoxic and human toxic impacts however, the local environmental conditions may have a significant effect on the relative importance of compounds. This supports a more site-specific approach to life cycle impact assessment (LCIA). This study was based on regionalising the recent USEtox impact assessment model to represent the environmental conditions of the Central Baltic. The USEtox model is a consensus of seven LCIA models, designed by an UNEP SETAC working group on toxic impacts *(90)*. It is based on the same approach as the E-USES model used for chemical risk assessment that is emissions of chemicals to an evaluative environment. In this study, the evaluative environment was adjusted to better match the local environmental conditions. Comparison of the input parameters was between the default environment and the Central Baltic

#### Comparison of the input parameters between the default environment and the Central Baltic

The parameterisation of the USEtox model was based on the more detailed chemical transport model of the Baltic Sea environment, POPCYCLING Baltic *(91)*. Most parameters were directly obtained from the POPCYCLING model. The fractions for runoff, the average depths of water bodies and erosion rates were however calculated from the mass balances of the model. Since the model did not include groundwater compartments, they were also ignored in the parameterisation. This would have a significant impact on human exposure, but not on freshwater ecotoxicity.

Two alternative parameter sets were made, one where only freshwater impacts were considered and another where the Baltic Sea was also included in the modelled waterbody (Table 48). This inclusion especially influenced the impact of chemicals with longer degradation times, since the residence time of water bodies was considerably increased by the inclusion of open sea areas.

#### Ecotoxic impact factors for selected compounds

Since the life cycle inventory work of the Foodweb project included only pesticides, impact factors were calculated only for the 120 pesticides on the inventory. In order to compare the hazards of different emissions, all pesticides were reported as MCPA equivalents. The normalisation was done by dividing the toxicity of the substance by the toxicity of MCPA using a similar approach to that commonly used in LCIA for both toxic and other compounds (for example, the radiative forcing impact of $N_2O$ is generally reported as $CO_2$ equivalents).

Table 48. Landscape parameters for USEtox model.

| Parameter | Compartment | Unit | USEtox | Central Baltic, inland | Central Baltic, including sea |
|---|---|---|---|---|---|
| Area | land | $km^2$ | 9.01E+06 | 5.84E+05 | 5.84E+05 |
| Area | sea | $km^2$ | 9.87E+05 | 2.58E+05 | 0.00E+00 |
| Area fraction | fresh water | | 3.00E-02 | 5.73E-02 | 4.62E-02 |
| Area fraction | natural soil | | 4.85E-01 | 5.72E-01 | 4.61E-01 |
| Area fraction | agricultural soil | | 4.85E-01 | 3.71E-01 | 2.99E-01 |
| Area fraction | other soil | | 1.00E-20 | 1.00E-20 | 1.00E-20 |
| Temperature | | ˚C | 1.20E+01 | 5.56E+00 | 5.56E+00 |
| Wind speed | | $m\ s^{-1}$ | 3.00E+00 | 5.50E+00 | 5.50E+00 |
| Rain rate | | $mm\ yr^{-1}$ | 7.00E+02 | 6.08E+01 | 6.08E+01 |
| Depth | fresh water | m | 2.50E+00 | 5.00E+00 | 8.48E+00 |
| River flow | region-continent | | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Fraction, runoff | | $s^{-1}$ | 2.50E-01 | 5.84E-01 | 5.84E-01 |
| Fraction, infiltration | | | 2.50E-01 | 1.00E-02 | 1.00E-02 |
| Soil erosion | | $mm\ yr^{-1}$ | 3.00E-02 | 1.30E-02 | 1.30E-02 |

## 5.2. Hazardous compounds in food

Food can contain hazardous compounds from various sources. They partly originate from the environment or farming and partly from food processing such as roasting or fermenting. There are also reports of soluble chemicals from packaging materials such as tin cans or plastics.

In Finland there is still large-scale use of pesticides and herbicides in farming, and in 2007 residues of 135 different compounds, including banned organophosphates and carbamate, were found (mainly from imported fruits) *(92, 93)*. However, only 4-6 % of vegetables exceed the maximum stipulated limits for pesticide residues, but they can still represent a health risk, especially for three-year old children. Nitrate is a commonly used fertiliser and in addition to its eutrophication effect, its metabolite, nitrite, can be toxic for small children. Food itself can also be naturally hazardous. For example, green potatoes and tomatoes synthesise glycoalkaloids, and fresh false morel (*Gyromitra esculenta*) is notorious for its highly poisonous gyromitrine, which breaks down during drying or boiling. Moulds commonly spoil food by producing harmful mycotoxins, which can cause serious health problems to humans.

In Estonia, every year daily food is becoming safer, but the food industry remains threatened from different sources (mostly environmental or industry-based risks) and food can contain hazardous compounds. Interest in food safety and healthy food has increased during last decade and information about hazardous compounds (contaminants, toxins, heavy metals etc.) in food is available from various sources: www.terviseamet.ee, www.vet.agri.ee, www.keskkonnainfo.ee, www.eria.ee. Food safety is regulated through a variety of laws, directives and regulations (EU, Food Act and Regulation (EC) No. 178/2002 of the European Parliament and of the Council) and the aim is to ensure that consumers purchase safe food, and get sufficient, factual information about food.

In Latvia The Food and Veterinary Service report details the key groups of products for which PAH (polycyclic aromatic hydrocarbons) and dioxins are taken in, and the proportion of risk-group products. Concerning hazardous compound intake through food, PAH mostly derives from cereal and cereal products, as well as marine products. Bread and its products constitute the highest proportion of the food basket in Latvia (26 %), followed by cereals and their products (18 %). The study shows that women consume 4.4 ng/kg bw PAH per day, and men 6.6 ng/kg bw. The PAH consumed in the case of the male food basket exceeds the EFSA recommendation by 0.6 *(59)*. The study also indicates that Latvian residents mostly consume dioxins through eating sea fish (32.4 %), including salmon and canned fish (23.2 %), and milk products (11.34 %). In Latvia, according to the study results, young people aged 7-11 with 4.28 pg TEQ/kg body weight per day exceed the permitted dioxin intake (Table 49).

Table 49. Total average dioxin and dioxin-like compound intake in Latvia by food per day.

| Resident group | Dioxin intake pg TEQ/kg body weight per day |
|---|---|
| Male | 2.17 |
| Female | 1.62 |
| Young people aged 12–16 | 2.79 |
| Children aged 7–11 | 4.28 |

Source: FVS 2009.

Main sources of hazardous compounds in food are:

- Environmental pollution
    - PCB, perfluorated compounds (PFC), PBDE, dioxin, furan, heavy metals, radioactive compounds, organometals, alcylphenols, DTT
- Pesticides, herbicides
- Biological toxins and amines
    - Glycoalkaloids, ergotoxin, mycotoxins, gyromitrine, cyanotoxins, biogenic amines such as histamine
- Hazardous compounds from food processing, especially smoking, roasting, drying, fermenting and grilling
    - PAH, acrylamide, 3-monochloropropane -1,2 diole (3-MCPD), heterocyclic aromatic amines (HAA)
- Nitrates from fertilisers
- Packaging
    - Phtalates, bisphenol A, tin, furan

Food additives are widely used in the food industry and are regulated by the European Food Safety Authority EFSA. However, their potential adverse health or environmental effects are not taken into account in this study.

The estimated hazardous compound intake of an average Finn is presented in Table 50.

Table 50. Estimated hazardous compound intake of an average Finn.

| Compound | Intake | Maximum tolerated intake |
|---|---|---|
| **Cadmium** | 0.8 µg/bw kg/week | 2.5 µg/bw kg/week |
| **Mercury** | 6.8 µg/day | 1.6 µg/bw kg/week |
| **Aluminium** | 1.6-13 mg/vrk | 1 mg/bw kg/week |
| **Organic tin** | 0.007 µg/bw kg/day | 14 mg/ bw kg/week |
| **Lead** | 17 µg/day | 70 µg/day (children), 200 µg/day (adults) |
| **Arsenic** | 14.50 µg/day | 0.015 mg/ bw kg/week |
| **Dioxin, furan and dioxine-like PCB-compounds** | 114 pg TEQ/day | 60 pg TEQ/bw kg/day |
| **Dioxin** | 54 pg TEQ/day. | 2 pg TEQ/bw kg/day |
| **PBDE** | 43 ng/day | No legislation |
| **PFAs** | 60 ng/bw kg/day | 1.5 µg/bw kg/day |
| **Glycoalkaloids** | 0.13 mg/bw kg/day | 1.25 mg/bw kg/day |
| **Nitrate** | 82 mg/day | 3.7 mg/bw kg/day |
| **T-2-and HT-2-toxins** | 0.024 µg/bw kg/day | 0.06 µg/ bw kg/day |
| **PAH** | 32.04 µg/day | No legislation |
| **3-MCPD** | 0.079 µg/bw kg/day | 2 µg/bw kg/day |
| **Acrylamid** | 0.3 µg/bw kg/day | No legislation |
| **Bisphenol A:** | children aged 0-1.5 years: 4-5.3 µg/bw kg/day, adults 0.25 µg/bw kg/day | 0.05 mg/bw kg/day |

bw = body weight
Source: The chemical contaminants of foodstuffs and household water (Hallikainen et al. 2010, *(93)*).

Hazardous compounds have been detected from various food products and ingredients in Finland (FI) and in Estonia (EE) (Table 51).

Health risks of hazardous compounds are presented in Table 52.

Table 51. Intake of hazardous compounds from food.

| Foodstuff | Hazardous compound |
|---|---|
| **Tap water** | FI: nitrate, radon-222, cyanotoxins, chlorophenol, tetra- and trichloroethene, aluminium<br>EE: nitrate, Rn, pesticides (herbicides), Al, Fe, Pb, asbestos |
| **Fish and fish products** | FI: lead, mercury, dioxin, PCB, PBDE, PFC, DTT, organic tin, arsenic, biogenic amines, HAA, cyanotoxin<br>EE: PCDD, PCDF, Gd, Pb, Ni, Zn, Hg, Sn, Cu, dioxins, PCB, POP, DDT, Ni, HCA, phenols |
| **Other seafood: mussles, crabs, calamari** | FI: cadmium, PAH, cyanotoxin<br>EE: POS, heavy metals, Cd, PAH, cyanotoxin |
| **Meat and meat products** | FI: lead, mercury, PAH, HAA, furan in canned meat, cesium-137<br>EE: Nitrates, Pb, mercury, PAH, HAA, furan in canned meat, $KNO_2$, $NaNO_2$ (glutamates) |
| **Milk and milk products** | FI ,EE: lead, dioxin, mycotoxins, biogenic amines, furan, PFCs |
| **Soy and soy products** | FI: cadmium, biogenic amines, 3-MCPD, furan<br>EE: biogenic amines, Cd, 3-MCPD, furan, phytates |
| **Fresh root vegetables, vegetables, peas, beans and nuts, fruit and berries** | FI: cadmium, lead, tin, nitrates, glycoalkaloids, biogenic amines, mycotoxins, pesticides, cesium-137, PFC<br>EE: Pb, Sn, nitrates, glycoalkaloids, biogenic amines, mycotoxins, pesticides, cesium-137, PFC, Cd |
| **Canned beans, vegetables, fruits and sauces** | FI, EE: tin, furan, PFC |
| **Baby food** | FI, EE: Furan |
| **Eggs** | FI, EE: dioxin, PCB, PFC |
| **Cereals and cereal products** | FI: cadmium, lead, mycotoxins, acrylamide, pesticides, 3-MCPD, PAH<br>EE: Sn, Gd, mycotoxins, acrylamide, pesticides, 3-MCPD, PAH, Pb |
| **Chocolate** | FI, EE: biogenic amines |
| **Mushrooms** | FI, EE: gyromitrine, Cesium-137 |
| **Baked, roasted or oil cooked cereal and root vegetable products with high carbohydrate content** | FI, EE: acrylamide |
| **Juices and other drinks** | FI, EE: lead, mycotoxins, furan |
| **Coffee, tea, cocoa** | FI, EE: PAH, mycotoxins, furan, acrylamide |
| **Fermented alcohol (wine, cider, beer)** | FI, EE: lead, biogenic amines, 3-MCPD |
| **Greases and oils** | FI, EE: PAH, PBDE |
| **Supplements prepared from sea algae** | FI, EE: cadmium<br>EE: heavy metals |

Source FI: The chemical contaminants of foodstuffs and household water (Hallikainen et al. 2010, *(93)*).
EE: www.terviseamet.ee, www.vet.agri.ee, www.keskkonnainfo.ee, www.eria.ee.

Table 52. Health risks of hazardous compounds.

| Hazardous compound | Health risks |
|---|---|
| **Cadmium** | Damages kidneys |
| **Lead** | Neurotoxicity |
| **Mercury** | Neurotoxicity, especially dangerous for unborn and developing babies |
| **Aluminium** | Neurotoxicity, may result in Alzheimer´s disease –like dementia. |
| **Arsenic** | Carcinogenic |
| **Dioxin and furan** | Carcinogenic, birth defects, endocrinological disorders such as diabetes |
| **PCB** | Serious adverse health effects, including liver cancer and skin disorders |
| **PBDE** | Dangerous to fetus, reduces thyroxin-levels in blood |
| **Organic tin** | Damages immune system , interferes with hormone metabolism |
| **PFCs** | Liver cell hypertrophy, alters lipid metabolism, developmental disorders |
| **Pesticides, herbicides, fungicides** | Various, depending on compound |
| **Nitrate** | Reduced oxygen intake due to altered haemoglobin structure |
| **Mycotoxins** | General toxicity, liver- and kidney toxicity, carcinogenic, nausea |
| **Cyanotoxins** | Acute poisoning with headache, nausea and diarrhoea, liver and kidney defects, unconsciousness, possibly carcinogenic |
| **Gyromitrine** | Acute poisoning that can lead to death |
| **Biogenic amines** | Acute poisoning with low blood pressure, headache, diarrhoea, skin redness, rash, sweating |
| **Glycoalkaloids** | Acute poisoning with diarrhoea, nausea, vomiting |
| **PAH** | Lung cancer, problems with reproduction, birth defects, reduced immunity |
| **HAA** | Carcinogenic, genotoxic in bacterial tests, may cause Parkinson´s disease |
| **Acrylamide** | Genotoxic, neuropathological effects, possibly carcinogenic |

Source: The chemical contaminants of foodstuffs and household water (Hallikainen et al. 2010, *(93)*).

# 6. Current state recommendations on food

## 6.1. Finland

The latest update of the Finnish nutritional recommendations was published 2005 by the National Nutrition Council in collaboration with other Nordic countries *(94)*. The recommendations provide detailed guidelines about the intake of total energy, macronutrients, vitamins and minerals at the population level for different age groups. Recommendations for physical activity have also been integrated to these guidelines. Currently, the major food-related health risks for the Finnish population are obesity, type 2 diabetes and dental caries, and therefore it is recommended that Finns should:

- Exercise balance between energy intake and energy expenditure.
- Have a balanced nutrient intake.
- Increase the intake of carbohydrates with high fibre content.
- Decrease the intake of refined sugars.
- Decrease the intake of hard fat and increase the proportion of soft fats.
- Decrease the intake of salt (sodium).
- Exercise moderate alcohol consumption.
- Increase the consumption of vegetables, fruits, berries, potatoes, whole-grain cereal products, low-fat milk products, fish and lean meat.
- Have at least 30 minutes of exercise or other physical activity every day.

#### Finnish food plate model

The food plate model is commonly used by the Finnish authorities to visualise the ideal dish content.

#### Recommended intake of fat, carbohydrates and proteins as total energy intake (E%)

Total energy needs depend on age, weight, sex and physical activity and can vary between 1.4 MJ (330 kcal) and 13 MJ/d (3310 kcal/day). Infants have the lowest energy need and physically active adult men under their thirties the highest. However, the energy sources are consistent for all. The body takes its energy from fat, carbohydrates and proteins in variable proportions. The recommended share of fat is 25-35 E%, carbohydrates 50-60 E% and proteins 10-20 E% for adults and children more than 2 years of age. The intake of hard fats should not exceed 10E % and it is recommended that the share of soft fats should be increased up to 10-15 E%. The share of polyunsaturated fatty acids should be about 5-10 E%. The recommended intake of fibre is approximately 25-35 g/d.

For children under 2 years of age, the share of total fat should be 30-35 E%, carbohydrates 50-60 E% and proteins 10-15 E%. Exclusive breastfeeding is recommended for children under 6 months. It is also advised to give10 µg/d of vitamin D as a supplement to children less than 2 years of age.

### Specific guidelines for pregnant and lactating women

Pregnant women are advised to have a balanced diet and increase the energy intake only during the 3rd trimester of pregnancy at about 1.5 MJ/d (360 kcal/d). Higher energy intake (2 MJ/d or 480 kcal/d) is also necessary during breastfeeding. Blood levels of folic acid, vitamin D, calcium and iron often decrease during pregnancy and breastfeeding, and it may be recommended by the doctor to take them as supplements. Pregnant and lactating women are advised to avoid several nutrients, which are shown in Table 53.

Table 53. Recommendations for pregnant and lactating women on foods to eat and to avoid.

| Food | Recommendation | Main benefit or unfavourable effect |
|---|---|---|
| **Dairy products** | Skimmed milk products 8 dl/day | Calcium, vitamin D |
| | No un-pasteurised milk products or fresh cheeses | Listeria monocytogenes infection |
| **Fish** | Weekly 2–3 times | Vitamin D, unsaturated fatty acids |
| | No pike | Contains methylmercury |
| | Baltic Sea herring (>17 cm) and salmon 1-2 times/month | Contain dioxin and PCB compounds |
| | No vacuum-packed fish | Listeria monocytogenes infection |
| **Vegetables, fruits, and berries** | Daily 5–6 servings (≥ 500 g) | Folic acid, fibre |
| **Vegetable oil-based margarine and vegetable oil** | Daily | Essential fatty acids, vitamin D, unsaturated fatty acids |
| **Wholegrain products** | Daily | Iron, fibre |
| **Alcohol** | Not recommended | Teratogenic effect |
| **Artificial sweeteners** | No saccharin and cyclamate | Possible carcinogenic effect |
| **Coffee and other caffeine containing drinks** | < 300 mg caffeine (about 4.5 dl coffee) | Possible risk of preterm delivery, high blood pressure |
| **Herbal products** | Not recommended | Contents and effects not known |
| **Licorice and salmiak** | Continuous use or great amounts (over 50 g) are not recommended | High glycyrrhizin content (risk of preterm delivery) |
| **Liver and liver products** | Not recommended | Possible teratogenic effect (retinol) |
| **Raw sprouts** | Not recommended | Risk of salmonella infection |
| **Salt** | Recommended to reduce | High blood pressure, swelling |

Source: Evira, Elintarvikkeiden käytön rajoitukset 2011 *(95)*, Tuula Arkkola. Diet during pregnancy. Doctoral dissertation *(96)*.

Current recommendations of energy requirements are collected in Appendix 4.

## 6.2. Estonia

### *General*

The national basis to improve the health of Estonians is the National Health Plan 2009-2020 (Rahvastiku Tervise Arengukava 2009-2020), shortly ERTA *(97)*. One source document for ERTA is "National Strategy for Prevention of Cardiovascular Diseases 2005-2020" (Südame- ja veresoonkonnahaiguste ennetamise riiklik strateegia aastateks 2005-2020) *(98)* and it is the basis to improve the nutrition of Estonians. In this connection, the previous Estonian state recommendations on food (1995 and 2004) *(99, 100)* were accommodated by taking into account the Nordic Nutrition Recommendations (2004) *(101)* and various publications, treatment guides, articles and recommendations published by Estonian scientific and specialist associations. The currently valid *Estonian nutrition recommendations and food based dietary guidelines* (Toitumis- ja toidusoovitused) were composed and published in 2006 by the National Institute for Health Development (Tervise Arengu Instituut, TAI) and The Estonian Society of Nutritional Science (Eesti Toitumisteaduse Selts). The recommendations give detailed guidelines about the intake of total energy, water, macronutrients, vitamins and minerals for different age groups and for people with various special needs (e.g. those with high blood pressure, and high cholesterol). The safety of food is also discussed. Similarly to Nordic Nutrition Recommendations and state recommendations on food in Finland, the theme of physical activity is also integrated into Estonian nutrition and food recommendations.

With reference to Estonian nutrition recommendations and food-based dietary guidelines (2006) *(102)*, special recommendations on nutrition and food for various age groups have been determined, e.g. Nutrition and physical activity of elderly people (2008) *(103)*; Recommendations on food for children and adolescents (2009) *(104)*; Recommendations on nutrition and food for pregnant and lactating women (2008) *(105)*; Recommendations on nutrition and food for adolescents (2009) *(106)*; also several web pages exist that make the information about healthy nutrition and lifestyle more easily available to Estonians, e.g. www.toitumine.ee; www.terviseinfo.ee; www.nutridata.ee, www.eestitoit.ee. On the web page www.toitumine.ee, various campaigns are carried out, for example people can calculate the amount of salt they probably got with their meal(s) (http://www.toitumine.ee/kampaania/sool/).

The primary aim for composing state recommendations on food is to prevent some diseases connected with nutrition (cardiac and cardiovascular diseases, cancer, diabetes, osteoporosis). Recommendations on food intake are based on people's needs for nutrients (proteins, fats, carbohydrates, minerals, vitamins, water) and energy intake according to metabolism and the degree of activity at work and during free time. There are four principles according to which people should choose their food products: adequacy, variety, balance and moderation.

Current Estonian recommendations on food are represented as a food pyramid divided into four basic levels. For every group of food represented in the food pyramid the daily recommended food portions for adults is given. At the lower levels of the food pyramid there are the products that should be eaten more frequently or in bigger amounts, at the top of the pyramid are the products that should be eaten in smaller amounts. Food portions should be unprocessed, or should contain less fat, salt or sugar *(107)*.

1) The basis of this food pyramid is physical activity, at least 30 minutes a day, recommended every day. Water demand is 28 to 35 ml per kg body weight.

2) The first food recommendation level is the group of food containing cereal products and potatoes, which should be eaten at 8-13 portions in day. Around half of these portions should be black bread/rye bread, which should certainly be eaten every day. A quarter of the portions should be potatoes and a quarter should be other cereal products.

3) On the second food recommendations level are vegetables (including legumes and mushrooms), fruits and berries. It is recommended to eat daily at least 2 portions of fruits and berries and 3-5 portions of vegetables (the amount of vegetables can be increased up to 9 portions).

4) On the third level of food recommendations are milk, dairy products, meat, fish, poultry and eggs. Milk and dairy products should be eaten daily as 2-4 portions and meat, fish, poultry and eggs also as 2-4 portions. It is preferred that the milk, dairy products and fish with lower fat content, lean meat and low fat

meat products are consumed. It is not recommended to eat eggs every day. Fish should be eaten at least 3 times a week.

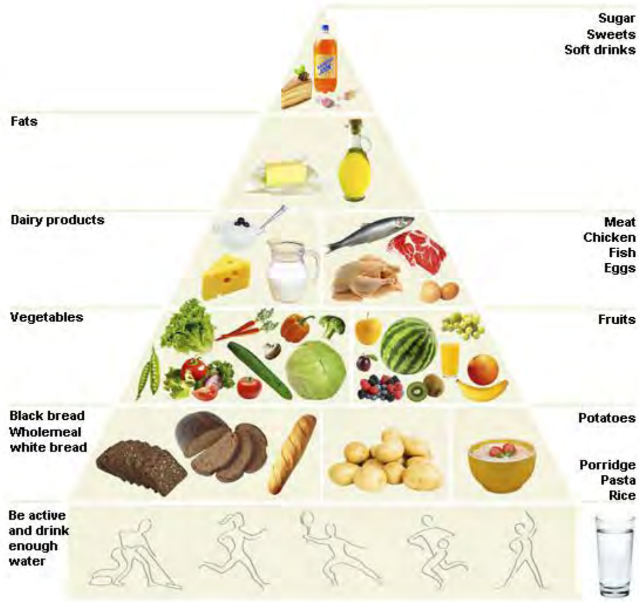
5) On the fourth level of food recommendations are fats, nuts and seeds, which should be eaten as 4-5 portions a day, but with consideration of their healthiness. It is recommended to increase the use of vegetable oils over animal fats.

6) At the peak of the pyramid are the least recommended food products: sugar, sweets and soft drinks. These can be eaten as 2-4 portions a day. Dark chocolate, honey or jam is preferred.

Practical recommendations to achieve balanced nutrition:

- The choice of everyday food should be made from all the groups of food products.
- More vegetables, rye/black bread and other whole-meal products, fruits and berries should be consumed.
- Low fat milk and dairy products are preferred.
- On 3-4 days in week, the meat should not be eaten; low fat lean meat, poultry without skin and fish are preferred; fatty meat products should be avoided.
- Olive oil, rapeseed oil or other vegetable oils are preferred over animal fats.
- Fish should be eaten at least 3 times a week.
- Egg yolk should be eaten not more than 2-3 times a week.
- Full juice or nectars are preferred.
- Instead of sweets, honey and fruits should be eaten.
- The use of table salt should be reduced to 5g per day.
- The information on food packaging should be read, especially considering the amounts of fat and salt.
- People must eat regularly (not less than 3 times in day).
- Stewing/braising and boiling are preferred methods of cooking.
- Water should be drunk every day, according to personal needs and health.
- People should consume alcohol in small amounts, and should opt for products with low alcohol content, like beer or wine.

The food plate model indicates that different salads or stewed/braised, boiled, steamed vegetables, should make up half of the food plate. The main food, like fish, chicken or meat, should make up a quarter of the plate. Additional foods, like rice, potatoes, pasta, and buckwheat, should make up another quarter of the plate. In the case of mixed food, for example lasagne or risotto, the mixed food should make up half of the plate, and salads and vegetables the other half. The food on the plate should always be at least 5 different colours (Figure 70).




Figures: www.toitumine.ee

Figure 70. Estonian food plate model and food pyramid.

#### Recommended intake of fat, carbohydrates and proteins as total energy intake (E%)

The need for total energy varies with age and sex, being lowest for infants and small children, and highest for young active adults (Table 54).

The recommended distribution of energy intake among daily meals is as follows: breakfast (20-25 %), lunch (25-35 %), dinner (25-35 %), and 1-3 snacks (5-30 %). The main sources of food energy are carbohydrates and fats, less energy can be acquired from proteins. The recommended share of carbohydrates is 55-60 %, fats 25-30 % and proteins 10-15 %. Protein intake should not exceed 20 % of daily energy intake. The need for proteins increases at the 2$^{nd}$ and 3$^{rd}$ trimester of pregnancy and among lactating women until it reaches 25 g a day. The recommended daily intake of fibre is 25-35 g. Up to 10% of total energy intake can be derived from saturated fatty acids and trans-fatty acids, 10-15 % from monounsaturated fatty acids and 5-10 % from polyunsaturated fatty acids. Essential fatty acids (omega-3 and omega-6 fatty acids) should represent at least 3 % of food energy, and in the case of pregnant and lactating women, 5 % of food energy.

#### Specific guidelines for pregnant and lactating women

TAI has distributed several brochures addressing recommendations on food and nutrients for special groups of people, including pregnant and lactating women, children and the elderly.

The need for food energy increases during pregnancy (+1260 kJ/ 300 kcal) and lactation (+2100-2650 kJ/ 500-650 kcal), however, but if physical activity decreases during these periods it is not rational to increase the food energy intake. Pregnant women should not go more than 12 hours without eating.

Table 54. Recommended energy intake in Estonia.

| Age (in years) | Men | | Women | |
|---|---|---|---|---|
| | MJ in day | Kcal in day | MJ in day | Kcal in day |
| Until 1 | Until 3.7 | Until 880 | Until 3.4 | Until 810 |
| 2 | 4.7 | 1 120 | 4.4 | 1 050 |
| 3 | 5.5 | 1 310 | 4.9 | 1 170 |
| 4 | 5.7 | 1 360 | 5.3 | 1 270 |
| 5 | 6.3 | 1 510 | 6.1 | 1 460 |
| 6 | 7.4 | 1 770 | 6.8 | 1 630 |
| 7 | 8.1 | 1 940 | 7.2 | 1 720 |
| 8 | 8.2 | 1 960 | 7.4 | 1 770 |
| 9 | 8.6 | 2 060 | 7.6 | 1 820 |
| 10 | 9.2 | 2 200 | 8.0 | 1 910 |
| 11 | 9.4 | 2 250 | 8.2 | 1 960 |
| 12 | 9.8 | 2 340 | 8.7 | 2 080 |
| 13 | 10.2 | 2 440 | 9.1 | 2 170 |
| 14 | 10.8 | 2 580 | 9.5 | 2 270 |
| 15 | 11.3 | 2 700 | 9.6 | 2 290 |
| 16 | 12.0 | 2 870 | 9.9 | 2 370 |
| 17–18 | 13.4 | 3 200 | 9.9 | 2 370 |
| 19–30 | 11.8 | 2 800 | 8.6 | 2 050 |
| 31–60 | 11.3 | 2 700 | 8.4 | 2 000 |
| 61–75 | 9.7 | 2 300 | 7.7 | 1 850 |
| Over 75 | 8.4 | 2 000 | 7.1 | 1 700 |

Source: Estonian nutrition recommendations and food based dietary guidelines (2006).

During pregnancy and lactation, the recommended intake of some vitamins (e.g. folic acid, vitamin D) and minerals (iron, magnesium, calcium) increases, but when possible it is recommended to adhere to balanced and diverse nutrition to get all the required vitamins and minerals rather than take food supplements. Lactating women need more water and should drink an additional 600-700 ml water a day.

In the case of predisposition to some allergens, pregnant women should avoid foods that induce allergies in them or in the father of the child. They should also avoid oranges, honey, nuts, chocolate, spices, and products that contain high amounts of preservatives, colorants and other additives.

It is recommended to consume less caffeine-containing drinks (strong black tea, coffee, cola drinks), milk and cream, spicy and bitter foods, carbonated and sweet drinks, sweets and products with high fat content. The food should possibly be made of unprocessed locally grown and/or produced food products. Also pregnant women should maintain moderate physical activity, at least 30 minutes a day, and certain sports that can cause traumas are not recommended.

**Specific guidelines for children and adolescents**

Children need more water than adults. In the case of consuming a diverse and balanced nutrition, it is not necessary to give additional food supplements to children. The only additional vitamin that should be given to infants and toddlers is vitamin D.

From the age of two, children's food recommendations are similar to those of adults, only the portion sizes differ, and depend on the age, sex, body type and genetics of the child.

Potatoes (boiled) are preferred in child nutrition rather than rice or pasta. Around half of vegetables eaten should be fresh, half should be eaten cooked. Pre-school children should eat 150-200 g vegetables a day, and school children 300-400 g. Various fruits and berries should be eaten at 200-300 (400) g a day. One fruit portion a day can be replaced by fruit juice or nectar. The younger the child, the more animal protein the food should contain, up to 50%. Older children should eat 1/3 animal protein and 2/3 vegetable protein. Children should not abandon meat because it is the main source for iron. Foods made of lean meat are recommended for children, the most preferred being beef, pork, chicken and turkey. Consumption of ready-made meat products (e.g. sausages) should be minimised. Liver should not be eaten more frequently than a couple of times a month. It is recommended to eat fish on two days a week.

Boiled eggs are preferred over fried eggs. School children should drink 2 glasses of milk, yoghurt or buttermilk a day and also eat cheese and cottage cheese. It is recommended that rape oil be used for frying food for children and olive oil for fresh salads.

Recommendations for parents on children's food:

- Find out what children are eating at kindergarten/school and vary lunches at home.
- Fresh vegetables should always be available for children.
- Avoid bringing home sweets and keeping them on the table.
- Water should always be available; in the mornings one can offer a child fruit juices.
- Use more potatoes and fish.
- Children should drink milk at home, and/or eat other dairy products.
- Train children to eat various salads.
- Try different food products and make various meals from them, to assure diverse nutrition for the child.
- Allow children the possibility to make their own food choices.
- Read the information on food packages. Food additives are suitable for children only in small quantities. Be careful with colourful candies, drinks, cookies, cakes and sausages with long shelf-life.

Recommendations on food preparation and planning school menus:

- Make the menu for at least 2 weeks to promote variation and balance in the food over the long-term.
- The food should be prepared mostly by boiling or stewing.
- Offer soup 2-3 times a week; soup bones and meat are preferred to bouillon powders.
- Do not use canned food as the main dish.
- Rye bread, fruits, vegetables, dairy products and meat or fish should be offered every day.
- Children should be given vegetables every day (including fresh vegetables).
- Offer fresh vegetables to children in kindergarten or preschool instead of mixed vegetable salad.
- Fresh fruits should be offered at least 3 times a week.
- Fruit-based desserts should be offered at least twice a week.
- Only pasteurised milk should be available.
- Kefir/buttermilk, yoghurt and cottage cheese without additives are preferred.
- Fish should be offered at least 2 times a week.
- Avoid meat products (e.g. sausages), these can be offered a couple of times a month.
- When preparing children's food, pork fat should not be used; mayonnaise and margarine should be used rarely.
- Dough is preferred for making bread or pies. Eggs can be offered only cooked.
- Avoid sweets and spicy snacks. Snacks recommended for children include nuts, seeds, fruits or vegetables with no additive salt, sugar or fats.
- For drinking offer water, juice, nectar, herbal tea or cocoa.
- Keep spices rather than salt on the table to add to the food.

## 6.3. Latvia

The Ministry of Agriculture is responsible for the food sector in Latvia. This is the main government institution responsible for policy implementation in the Food, Agriculture and Fisheries sector. The Food and Veterinary Service, which is under supervision of the Ministry of Agriculture, implements food monitoring according to the "from the field to the table" concept, thereby protecting consumer rights to consume safe and healthy food.

FVS has prepared a number of informative materials for consumers on safe and healthy food consumption, such as *What are E-compounds? How to avoid food poisoning, Look what you buy – all about food product labelling, Food and Veterinary Service recommendations on fish consumption, Food supplements, Myths and the truth about avian influenza, Do you know what avian influenza is?*

FVS has prepared recommendations for residents on fish consumption. The material recommends eating fish, but also contains information on the pollutant concentrations in fish and their impact on health.

The material lists the following key risk groups in relation to fish consumption: lactating women, children aged 2–15 and pregnant women. These groups are given the following recommendations:

Do not consume:

- Fish and fish products more than one portion (140 g of ready-made product) twice a week.
- Smoked, salted, dried, pickled fish more than once a month.
- Fish liver and other sub products.
- Canned cod liver.

Pregnant women are recommended not to consume:

- Fish and fish products more than one portion (140 g of ready-made product) once a week.
- Fish liver and other sub products.
- Raw fish and non-heat-treated fish products, e.g., roe, oysters, shrimps.
- Canned, smoked, salted and pickled fish.

When feeding infants and small children until 2 years of age, it is recommended:

- Not to use fish or fish products.
- Ensure breastfeeding as long as possible, so that the child receives mother's milk at least until the age of 1.

The healthy food policy is the responsibility of the Ministry of Health. In Latvia, the Healthy Food Pyramid was developed in 2001 by the Latvian Food Centre based on the World Health Organisation´s recommendations.

According to the Food Health Pyramid, 50 % of the daily energy intake should come from cereal products and potatoes; 30 % from fruit and vegetables, and 15 % from different animal origin products, milk, eggs, fish, meat, and 5 % is the permitted amount of sweets and fats (Figure 71).

Healthy Food Pyramid. Source: FVS.

Figure 71. Healthy Food Pyramid for Latvia.

The Ministry of Health website outlines 10 general dietary recommendations:

1) Diversify your diet every day;
2) Balance your menu with physical activities to preserve your body weight within recommended limits;
3) Consume sufficient amounts of liquid;
4) Consume cereal products several times a day (especially whole-grain products) and potatoes;
5) Consume vegetables, fruit and berries several times a day, especially locally-grown;
6) Eat legumes, fish or lean meat! Fish is recommended at least two times a week;
7) Consume low-fat milk and milk products;
8) Reduce the consumption of margarine, butter, fatty meat! Use a little oil;
9) Reduce salt and sugar consumption;
10) Take care of the safety and quality of food consumed at home.

In 2008, the recommended rations of energy, nutrients and mineral compounds were defined for Latvian residents in the following age groups: 0–6 months; 7–12 months; 1–3 years; 4–6 years; 7–10 years; 11–14 years; 15–18 years; grown-ups; pregnant women; lactating women. The recommendations take into account both body weight index and physical activity *(108)*.

According to the healthy food policy, the Ministry of Health has prepared recommendations on healthy food for the following resident groups:

- for babies;
- for children aged 2–18;
- for people aged up to 60.

More detailed recommendations for project target groups:

For children aged from 2–18:

1) Ensure regular meals at a defined time, 4-5 times a day. Do not replace meals with sweets.
2) Diversify the child's menu, ensure a slow eating process, teach the eating culture;
3) Make sure breakfast is eaten;
4) Include a course rich in complex carbohydrates in every meal;
5) Ensure that food products rich in protein, minerals and vitamins are included in the everyday diet. It is important to include eggs, milk and milk products, lean meat, fish, meat and fish products. It is recommended that a child receives courses containing fish twice a week;
6) Ensure sufficient calcium intake required for a child's metabolism with milk or milk products;
7) Offer your child fruit and vegetables at every mealtime, especially locally-produced, ensuring diversity;
8) Use fats moderately when cooking your child's meal;
9) Make sure vegetables, fruit and nuts are available for your child between mealtimes;
10) Make sure your child drinks a sufficient amount of liquid *(109)*.

For babies:

1) A child should receive mother's milk up to two years of age; Up to 6 months of age, an infant should receive mother's milk only (exclusive breastfeeding);
2) Starting from the age of 6 months, vegetables, porridge, fruit and fruit juices should gradually be included in an infant's diet;
3) In is not advisable to add salt and fat to vegetables in infants' food, or sugar to fruit;
4) Juice should be given from a cup after breastfeeding;
5) Starting from the age of 8 months, an infant's diet should gradually be supplemented with meat and legumes;
6) Starting from the age of 9 months, infants are given bread – 1 slice a day;
7) Starting from the age of 1 year, infants can be given cow's milk and its products (yoghurt, cottage cheese, cheese), egg yolk and fish;
8) Starting from the age of 1 year, an infant's diet should be supplemented with raw vegetables;
9) An infant's diet should supplemented by no more than one new product per week, given after breastfeeding;
10) An infant should be accustomed to ever coarser food and to an adult diet gradually;
11) In the second year, an infant's eating habits for its whole life develop *(110)*.

Other healthy food recommendations and advice are found on a number of websites, e.g.:

- Proper diets http://www.pareizs-uzturs.com/public/
- Database on ingredients in food products. Information on more than 600 products. www.partikasdb.lv
- Website about E-compounds in food products and recommendations on how to avoid them http://www.evielas.lv/lv/info
- Green Lifestyle Guide, society "Green Liberty" – recommendations on an environmentally friendly diet

# 7. Conclusions

In 2010 the population of the Foodweb project area was estimated to be 6 million and is projected to grow in Finland and decrease in Estonia and Latvia. In Estonia and Latvia the emigration rate is higher than the immigration rate and in Finland immigration is a greater cause of population growth than natural increase. In spite of the negative migration rate in Estonia and in Latvia, the total population in the project area is estimated to be 6.3 million in 2030.

Population ageing is a common trend in the project area as it is in the whole EU. The population of working age is expected to decline steadily, while elderly people will likely account for an increasing share of the population – those aged 65 years or over will account for over 24 % of the project area's population by 2030 (17 % in 2010).

In Finland the food industry is the fourth largest branch of industry, in Latvia the second largest and in Estonia it accounts for about one fifth of the total production of processing industry. Meat production, as well as milk and dairy production, are the most important branches of industry in all three countries. In Finland the baking and in Estonia the beverage industries account for a large part of production and in Latvia milk production is the largest production sector ranked by value.

Fishing is also an important branch of industry. In the Baltic Sea, fish is caught both from the open sea as from coastal waters. The most significant fish species caught from the open sea are Baltic herring and sprat. In the coastal areas pikeperch, perch and whitefish represent a major part of the total fish catch. The most fished species differ between countries and fishing areas, but sprat and Baltic herring are commonly fished in Latvia, Estonia and Finland.

The structure of agriculture has been changing in recent years in the project area. In Finland, Estonia and Latvia the number of farms is decreasing and the size of the farms is increasing, in Estonia and Latvia the total area of agricultural lands has also increased.

Finland and Latvia are entirely self-sufficient in milk and milk products, as well as in meat and eggs. In Estonia self-sufficiency in milk is about 161 % and the degree in self-sufficiency in meat around 83 %. The degree of self-sufficiency in grain in all project countries varies from year to year depending on the harvest. Due to the northern location of these countries, most fruits and some vegetables are imported.

The main sector of Estonian agriculture is milk production, which is also the most important product from domestic animals in Finland. The selection of dairy products is wide in both countries: the selection varies from non-fat and semi-skimmed products to low-lactose and non-lactose milk products. Some of the products have been differentiated to conform to health trends: in Finland and Estonia customers can choose products that lower blood pressure and blood cholesterol, for example so-termed „heart cheese'.

Organic and natural products are gaining more and more in popularity and the demand for organic food is increasing. The consumption of organic food varies among income and age groups and differs between young families and those households with older people.

The consumption trends are changing among other things due to an increasing number of single households and globalization. The food culture has adopted foreign and ethnic influences and demand of ready-made foods is increasing. At the same time the awareness of food quality and interest in the relationships between diet, nutrition, and health are quite high among the population. The demand for local, sustainable and organic food has increased.

Comparing the data on the consumption of food in Estonia, Finland and Latvia, many differences are apparent and depend on the statistics available. The Comprehensive Food Consumption Database of the European Food Safety Authority (EFSA) is designed for dietary surveys and national food consumption values, and FAO Food Balance Sheets are based on production, imports, stock changes and export values. Therefore, substantial differences are discernible when comparing the results. Data from Food Balance Sheets may be useful when examining differences in food consumption patterns and data from dietary surveys when monitoring nutrition. The data from population surveys can often be sub-divided into categories by age and sex and used to investigate regional and socio-economic variations.

When looking at the results from the EFSA food consumption database in Finland, liquids (tap water, milk, coffee and fruit juices) are the most consumed items. In Estonia potatoes and potato products are most consumed and after that liquids (coffee, milk, tea, water and beer). In Latvia tea was most popular, after that ready-to-eat soups, potatoes, potato products and bread. In Estonia there were available data only for adults, in Finland data were missing for adolescents and in Latvia consumption data for elderly people. The data from Estonia were from 1997, so it is possible that consumption has changed over the ten years since then. According to EFSA the use of their food consumption data for direct country-to-country comparisons is not advisable, however, because the data has been collected using different methodologies.

According to FAOSTAT, most calories come from wheat in every country in the project area. Meat is second in Finland, fifth in Estonia after sugar, milk and alcohol, and fourth in Latvia, after vegetable oils and milk. When looking at supply quantity in kg per capita per annum, milk is the most consumed item in the project area.

Regarding consumption habits over the long term, the differences diminish among the countries and result in accordance with the assumption that social, economic and political changes influence eating habits. During the last decade all countries experienced economic growth and adaptation of national systems to the European Union, the process having however started earlier in Finland than in Estonia and Latvia. These changes might have had an effect on eating habits, especially increased consumption of meat, which is known to correlate with better socio-economic circumstances of households.

When looking at the national food recommendations in Finland, Estonia and Latvia more similarities than differences are apparent between countries. The nutritional recommendations in all countries include limitations in consumption of fat, especially animal fat, meat products and promotion of vegetable consumption. The recommended share of fat, carbohydrates and proteins is the same in every country and the recommendations include specific advice for the nutrition of children and pregnant women. In Latvia and in Finland special dietary advice on fish consumption have been issued to children, young people and people at fertile age.

In the project area we share a common concern about the environment and food safety issues. Most residents are concerned about toxins found in food and information about hazardous compounds (contaminants, toxins, heavy metals etc.) in food is available from different sources and food safety is regulated by different laws, directives and regulations.

During recent decades a variety of toxic compounds have entered the Baltic Sea as a result of human activity. The Baltic Sea is generally considered to be one of the most polluted seas in the world. The notorious pesticide DDT, industrially used PCB and dioxins degrade very slowly in nature and although their use has been banned, they still accumulate in the biota and accumulate at the top of the food chain. These compounds hinder the reproduction and hunting capacity of several animal species and cause malformations to develop. Heavy metals, such as mercury, copper and nickel, used by industry, are also found in the Baltic Sea. They accumulate on the seafloor from where they can migrate back into the food chain. Also radioactive compounds have been found from the Baltic Sea.

Volumes of dioxins, furans and dioxin-like PCBs in Baltic herring can exceed the acceptable daily limit. And frequent consumption of contaminated fish can lead to intakes above the maxima recommended. Increasing consumption of contaminated fish among risk groups is not desirable. Risk groups include people with low body weight, including children, pregnant or nursing women and groups with high natural consumption rates for fish, such as fishermen and their families.

The environmental aspect is becoming more important when selecting a diet, and increasing knowledge of food safety is taken into account in designing national food recommendations. Consumers prefer locally produced food and organic production is increasing. Despite this, consumers do not know that cultivation of food and related production activities might cause negative impacts on the Baltic Sea.

Agriculture, transportation, and waste-waters from industry, energy production and urban areas have strongly increased the nutrient load in the Sea. However, new waste-water purification systems have reduced the eutrophication impact of industry and urban areas. The agricultural impact on eutrophication is still strong due to ineffective efforts in reducing nutrient leaching from fields.

Eutrophication of the Baltic Sea is due to the excess nitrogen and phosphorus loads coming from land-based sources. The great majority of the nutrient load to the Baltic Sea is caused by agriculture, it being estimated that 75 % of the nitrogen and 52 % of the phosphorus come from the farming and the livestock sector. The regional concentration of agricultural production and the growth in the sizes of animal farms have increased in the project area along with the increased demand and consumption of meat. Intensive farming also results in intensive fertiliser application and greater nutrient leaching to the sea. In Finland, agriculture is the most important source of coastal water nutrient loads.

The nitrogen load appears to dominate the eutrophication potential of the Baltic Sea. Its contribution to the potential of the socio-economic activities was 73 %, which is 2.7 times that for the phosphorus load. In the contribution of agriculture the domination appears slightly higher, about 3.2 times that of phosphorus load. This suggests that the importance of nitrogen emissions may be underestimated in the current sustainability discussion concerning the Baltic Sea in the context of food chains.

The Finnish eutrophication impacts of animal production chains concentrate on feed raw material production. For beef, pork and milk, feed production contributes 95 to 96 % of the total impact. For poultry and eggs the contribution is 86 to 93 %. The contribution of animal production (husbandry) is 4 to 5 % and 7 to 13 % respectively. The main causes of the eutrophication impacts are nitrogen and phosphorus runoffs from feed production fields and the NH3 emissions from animal production.

The eutrophication intensity varies among different foodstuffs: beef has the highest eutrophication intensity of all meats, about three times higher than that of pork, and seven times that of poultry. The eutrophication intensity of milk is relatively low. Nevertheless, the values associated with beef and milk are partly bound together, since a significant share of beef comes from milking cows. The eutrophication impacts of plants also vary among species: grain has the highest intensity of the plant-based raw materials.

Also climate change has its own, currently somewhat unpredictable effects on the Baltic Sea. However, the mean annual air temperature will rise, which means rainy and mild winters, warmer summers and changing ice conditions. Heavier rains in winter will likely increase erosion and nutrient leaching into the Baltic Sea. These changes must be taken into account in future analyses. The role of the food chain in the climate change impact is lesser than in eutrophication, but still quite significant. For Finland it was estimated that the food chain causes about 15 % of the domestic climate change impact of the national economy.

### *Next steps of the project*

The next step of the project will include an awareness study, which will be directed at adolescents and young families. These groups were selected because environmental consciousness evolves during adolescence and young people in the upper comprehensive school start to have independent attitudes and opinions. Young families were chosen as a target group because the restrictions of the food recommendations concern mostly this group.

In future analyses dietary risk groups must be taken into account. According to the Finnish Food Safety Authority, Evira, the risk groups include children under school age, pregnant or nursing women, elderly people and persons with impaired resistance. It is also advisable to analyse those groups following special diets (ethnic groups, vegetarian, sport anglers etc.) and trendy diets such as those incorporating low-carbohydrate intake.

All the dietary risk groups must be taken into account when communicating the results. According to the Swedish National Food Agency:

"Only 17 % of the public seems to be aware that women of childbearing age and children should follow the dietary recommendations. Thousands of children and young women are at risk of consuming above the tolerable intake levels."

### *What can a common customer do for the Baltic Sea?*

The greatest environmental load of agriculture comes from the meat production sector. Consumption of meat and meat products has become more and more popular. This increases the need for effective production and numbers of big production plants. Fodder production requires larger field areas and also areas for recycling the nutrients. There is pressure to find new ways to use manure because vegetation is not capable of binding the high nutrient contents of cattle manure and slurry. The excess production and consumption produces large volumes of nitrogen and phosphorus leachates, which reach the Baltic Sea.

It is estimated that to produce 1 kg of boneless beef, 6.5 kg of grain, 36 kg of roughage, and 155 litres of water (only for drinking and servicing) are needed. According to FAO, livestock production is one of the major causes of the world's most pressing environmental problems, including global warming, land degradation, air and water pollution, and loss of biodiversity.

The nutrient load of the Baltic Sea could be reduced simply by the surrounding populations eating less meat, especially in Finland. We can afford to this because we eat more animal products than is currently recommended. By changing our eating habits in a healthier direction and eating according to the official food recommendations, we could reduce the agricultural nutrient load by 7 %. This is not quite sufficient to cover the total reduction required by the Baltic Sea Action Plan, but would represent a significant step towards reducing the nutrient load of the Baltic Sea and would also benefit our own health.

### *What can we do at the national level?*

Human activity and land-based agricultural operations exert key effects on the nutrient contents of the Baltic Sea. The most important factors are the total area of agricultural land, its local distribution, use of different crops, use of fertilisers, and other agricultural operations. Nutrient load into the Baltic Sea can be reduced by improving crop yields, optimising fertiliser use and by practising efficient nutrient recycling.

Much has been done already at the national level, for example the EU environmental supports direct farmers to use more environmentally sustainable cultivation methods. Environmental support requires crop yield analysis, which results in accurate application of fertilisers. In addition, development of new machines and cultivation methods decrease nutrient leaching to the Baltic Sea.

These perspectives have been taken up in the actions of HELCOM and BSAP. It is essential that the countries around the Baltic Sea commit to the nutrient and hazardous compound reduction programme. An overall reduction of the concentration of nutrients in the Baltic Sea close to natural levels is one of the nationally and internationally (HELCOM) agreed environmental goals for the Baltic Sea Region. Some progress has been made, but despite this the state of the Baltic Sea has not improved and further efforts are needed. Reaching the goal requires different strategies for the different countries. In countries with nutrient-intensive agriculture, like Sweden and Finland, loads have to be decreased. Sweden and Finland are the two states that are furthest from meeting their obligations. In countries with nutrient-extensive agriculture, like Estonia and Latvia, the agricultural sector needs to develop without increasing nutrient surpluses.

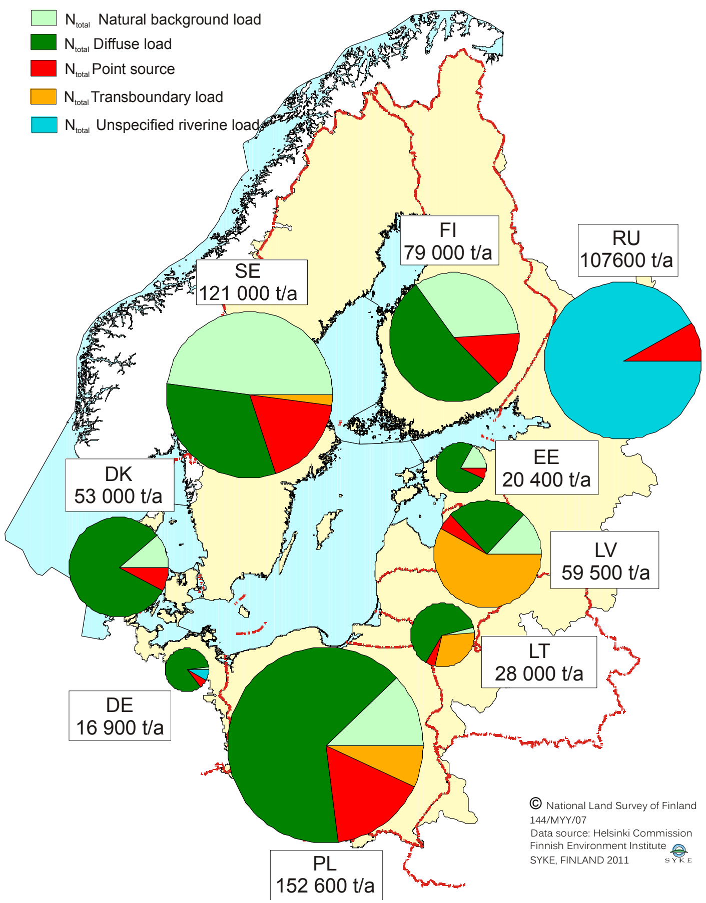
# Author contributions to the assessment

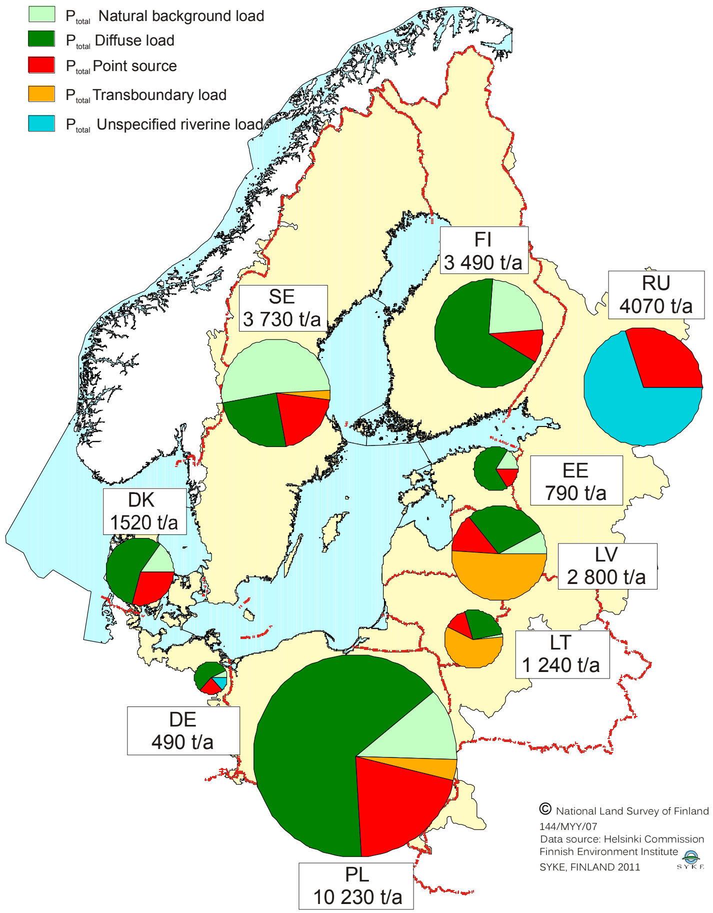
**Summary:** Mari Kovero

1. **Introduction:** Marja-Liisa Vieraankivi (Project Coordinator), Taime Puura and Mari Kovero
2. **Background:** Lila Patrikainen, Matti Verta and Virpi Vorne
3. **Methods**
   - **3.1. The food plate model:** Yrjö Virtanen and Sirpa Kurppa
   - **3.2. Life cycle analysis (LCA):** Yrjö Virtanen, Helena Hyvärinen and Sirpa Kurppa
   - **3.3. Material flow approach (MFA):** Yrjö Virtanen and Jānis Brizga
4. **Data available**
   - **4.1. Finland:** Virpi Vorne, Minna Jäälinoja and Lila Patrikainen
   - **4.2. Estonia:** Liisa Lang, Karin Pai, Anne Aan, Liina Laumets and Veljo Runnel
   - **4.3. Latvia:** Elina Līce, Sintija Kuršinska and Raimonds Ernšteins
5. **Food material flows for food system sustainability**
   - **5.1. Developments in the realm of the food chain**
     - **5.1.1. Finland:** Yrjö Virtanen, Hanna Aho and Lila Patrikainen
     - **5.1.2. Estonia:** Liina Laumets, Karin Pai and Yrjö Virtanen
     - **5.1.3. Latvia:** Jānis Brizga
   - **5.2. Environmental impacts of the food chain**: Yrjö Virtanen
6. **Environmentally based risks**
   - **6.1. Sources of hazardous compounds to the Baltic Sea:** Matti Verta, Petri Porvari, Tuomas Mattila and Päivi Munne
   - **6.2. Hazardous compounds in food:** Lila Patrikainen, Liisa Lang and Elina Līce
7. **Current state recommendations on food**
   - **7.1. Finland:** Lila Patrikainen
   - **7.2. Estonia:** Liina Laumets, Karin Pai, Liisa Lang and Anne Aan
   - **7.3. Latvia:** Elina Līce
8. **Conclusions:** Virpi Vorne and all other authors

# Appendices

**Appendix 1. Source apportionment of Tot-P and Tot-N loads by country in 2006 (The figures for Russia and Germany include also unspecified loads) Source: HELCOM 2011 (5).**



## Appendix 2. Food supply quantity according to FAOSTAT, 2007.

| FAOSTAT 2007 | Food supply quantity (kg/capita/yr) | | | Food supply (kcal/capita/day) | | | Protein supply quantity (g/capita/day) | | | Fat supply quantity (g/capita/day) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Estonia | Finland | Latvia | Estonia | Finland | Latvia | Estonia | Finland | Latvia | Estonia | Finland | Latvia |
| **Meat** + (Total) | 58.8 | 72.5 | 61 | 258 | 516 | 267 | 18.4 | 25 | 19.1 | 19.8 | 45.4 | 20.5 |
| **Bovine Meat** | 13.8 | 18.6 | 8.4 | 66 | 90 | 45 | 5.5 | 7.7 | 3.3 | 4.7 | 6.3 | 3.5 |
| **Mutton & Goat Meat** | 0.5 | 0.5 | 0.3 | 4 | 4 | 2 | 0.2 | 0.2 | 0.1 | 0.3 | 0.3 | 0.2 |
| **Pigmeat** | 26.7 | 34.3 | 31.4 | 120 | 355 | 148 | 6.5 | 9.2 | 8.5 | 10.1 | 35.1 | 12.4 |
| **Poultry Meat** | 17.3 | 17.2 | 20.6 | 67 | 61 | 71 | 5.9 | 7 | 7.2 | 4.6 | 3.4 | 4.4 |
| **Meat, Other** | 0.5 | 1.9 | 0.3 | 2 | 6 | 1 | 0.3 | 0.9 | 0.1 | 0 | 0.2 | 0 |
| | | | | | | | | | | | | |
| **Cereals** + (Total) | 121.6 | 107.6 | 112.3 | 862 | 882 | 855 | 24.3 | 28.4 | 24.7 | 6.1 | 4.3 | 3.9 |
| **Potatoes** | 127.2 | 68.6 | 97.9 | 226 | 130 | 179 | 5 | 3 | 4.2 | 0.3 | 0.2 | 0.3 |
| **Vegetables** + (Total) | 96.4 | 79.2 | 107.1 | 72 | 54 | 74 | 2.9 | 2.3 | 3.2 | 0.5 | 0.5 | 0.6 |
| **Fruits** - Excluding Wine + (Total) | 78.2 | 93.8 | 61 | 90 | 97 | 72 | 1 | 1.1 | 0.8 | 0.4 | 0.4 | 0.4 |
| **Eggs** + (Total) | 10.6 | 8.6 | 15.4 | 40 | 33 | 58 | 3.1 | 2.7 | 4.5 | 2.8 | 2.3 | 4.1 |
| **Alcoholic Beverages** + (Total) | 127,3 | 105,8 | 82 | 302 | 183 | 161 | 1,4 | 1,2 | 1 | | | |
| **Milk** - Excluding Butter + (Total) | 238,9 | 361.2 | 208.7 | 350 | 445 | 302 | 21.8 | 27.8 | 18.9 | 17.7 | 26.3 | 15.3 |
| **Animal Fats** + (Total) | 3,9 | 11,4 | 17,9 | 69 | 129 | 201 | 0,1 | 0,6 | 0,8 | 7,7 | 14 | 21,7 |
| **Fish, Seafood** + (Total) | 16.4 | 31.7 | 12.6 | 23 | 64 | 30 | 4.1 | 9.4 | 4.2 | 0.5 | 2.6 | 1.3 |

**Appendix 3. Estimated emissions of some hazardous compounds to the environment (kg/year) from Finland, Estonia and Latvia according to COHIBA (Control of Hazardous compounds in the Baltic Sea region) project.**

| Compound | Main applications | Main sources | Amount of emissions (kg/a) | Note |
|---|---|---|---|---|
| **TBT,TPHT** | Primary use in antifouling paints | Previously used, mainly in marine and yacht paints, including pipelines, mucus retardants | FI; EE; < 200 kg<br>LV; not known | Removal or over painting by the end of 2011. Emissions from paint removal from the ships is not estimated |
| | Usage as antifouling prohibited since 2003 | Now the TBT-treated timber | | Due to historical emissions, contaminated sediments exist in ports, shipyards and shipping lanes, but also in some places the wood processing industry |
| **pentaBDE, octaBDE, decaBDE** | Fire-fighting materials of plastic products and textiles. Penta and octa not in use, but occurs in the plastic products and textiles | | **pentaBDE**<br>only few kg/country | Atmospheric deposition is the main source to the environment. Sewage sludge use in land improvements, a major source to those soils |
| | Deca: wire and cable manufacturing, epoxy adhesives | | **dekaBDE**<br>< 100 kg/country | |
| **PFOS, PFOA** | Surface treatment agent (waxes, polishes, metal manufacturing, textiles, etc.) | Municipal waste water treatment plants, use in fire-fighting foams? (allowed until the end of 2011) | **PFOS**<br>FI; < 200 kg, LV;<br>EE; < 100 kg<br>**PFOA** FI; < 100 kg,<br>LV; EE; < 10 kg | Atmospheric deposition is a main source to the environment. PFOS may be formed from precursors in the atmosphere |
| **HBCDD** | Fire-fighting agent | Polystyrene manufacturing | FI; EE; < 50 kg,<br>LV; < 10 kg | Large stocks of HBCD are in the buildings. Sewage sludge use in land improvements, is a major source to soils |
| **NP, NPE** | NP; paint and varnish manufacture | Waste water treatment plants (sources; car washing, textile washing, industrial cleaning, use of paints | **NP**<br>FI; 500-1300 kg,<br>LV; EE; < 500 kg | Usage of sewage sludge as land improvements is a major source to soils |
| | NPE; chemical industry, paper producing, paint manufacturing, industrial cleaning | | **NPE**<br>FI; EE; 2000-3000 kg,<br>LV; ? | NPE may be degraded in waste water treatment plants to NP |

| Compound | Main applications | Main sources | Amount of emissions (kg/a) | Note |
|---|---|---|---|---|
| **OP, OPE** | OP minor use<br><br>OPE; industrial chemical, In consumer products, textiles from outside the EU | OP; abrasion of tyres<br><br>OPE; Waste water treatment plants (washing of textiles), | **OP** FI; 1000 kg, EE; < 1000 kg, LV; ?<br>**OPE**<br>EE; < 10 000 kg, FI; < 100 kg, LV; ? | Use is decreased from past |
| **SCCP, MCCP** | SCCP; metal cutting, application rates difficult to estimate, since it is contained in several different CAS numbers to the products<br><br>MCCP; plastics manufacturing, metal cutting, usage 12 t/v | Usage of SCCP containing products<br><br>MCCP; MCCP-rich waste, packing materials, recycling of carbon free paper, sealants, metalworking | **SCCP**<br>FI; EE; < 100 kg<br>LV; ?<br><br>**MCCP**<br>FI; 15 000-20000 kg,<br>EE; < 5000 kg; LV? | SCCP; domestic use has decreased, Deposition is relevant<br><br>MCCP; increased use in a variety of purposes |
| **Endosulphan** | Pesticide usage and sale has been prohibited since 2005 | Waste water treatment plants (source; food items, deposition) | FI; < 200 kg, EE; < 50 kg, LV, < 10 kg | Deposition is relevant |
| **PCB** | Previously been used in numerous industrial and other purposes (especially capacitors, use prohibited). There is no production of PCBs in the EU, or use in new products. A significant proportion of products and equipment containing PCB are still in use. | Diffuse (contaminated sites, buildings), point sources, waste treatment (e.g.landfills). The Stockholm Convention predicts that it will take until 2028 to achieve 'environmentally sound management' of PCB waste. Atmospheric deposition is the most important source to the environment | Intentional emissions should be close to zero (see previous columns) | From 500 000 tonnes used in Europe, some 200 000 tonnes is present in the environment. Most of the atmospheric deposition is from the old stocks as re-evaporation from soils and applications. According to Directive 96/59/EC, disposal or decontamination of equipment containing PCBs should have been completed by 2010<br><br>Some of compounds are dioxin-like |
| **Dioxins** | No usage, formed in processes and incomplete combustion | The current water discharges negligible compared to the air emissions from older sources (wood preservatives, contaminated sediments, contaminated soils) | FI; 15 g,<br>EE; 5 g,<br>LV:? | Air emissions (energy production), deposition the most important source, mostly long-range transportations<br><br>Previously used in pulp bleaching, manufacturing of clorinated phenols, contaminated sediments in the estuary of River Kymijoki, Gulf of Finland |

| Compound | Main applications | Main sources | Amount of emissions (kg/a) | Note |
|---|---|---|---|---|
| **Hg** | Amalgam usage, Usage in various products is severely restricted | Municipal waste water, wood processing industry (based on the overestimations of poor analytical methods), metal production (impurity in minerals), chlor-alkali | FI; EE; < 1000 kg,<br>LV: < 50 kg | Atmospheric emissions (especially coal combustion and metal industry), deposition has most importance. Mainly long range transportation<br>Land use (forestry) increases the load to the waters<br>River loads mostly originally derived from atmospheric deposition |
| **Cd** | Ni-Cd batteries, pigments<br>Usage in various products is severely restricted | The forest industry, metal production, acid sulphate soils | EE; LV; 1500 kg,<br>FI; < 1000 kg | Air emissions and atmospheric deposition are important<br>From the Finnish river loads (1800 kg/a) the majority is from acid sulphate soils. Land uplift and land use main drivers. |
| **PAH-compounds** | No usage, formed in incomplete combustion and other processes | Deposition and urban run off waters | **Bentzo (a) pyrene**<br>LV; 9500,<br>FI; 4700,<br>EE; 4500 | Atmospheric emissions and deposition are the most important |

Source: COHIBA (Control of Hazardous compounds in the Baltic Sea region) project (http://www.helcom.fi/projects/on_going/en_GB/cohiba/). Atmospheric emissions were mostly taken from Meteorological Synthesizing Centre–East (http://www.msceast.org/).

## Appendix 4. Current recommendations on food – energy requirements.

### Finland

**Energy need (kcal/day) for adults in different physical activity levels.**

| Age | Weight (kg) | Basic metabolism | Light work, no exercise | Light work, some exercise | Light work, regular exercise |
|---|---|---|---|---|---|
| Male | | | | | |
| 18-30 | 76 | 1 850 | 2 580 | 2 950 | 3 310 |
| 31-60 | 77 | 1 780 | 2 490 | 2 830 | 3 190 |
| 61-74 | 74 | 1 580 | 2 250 | 2 540 | 2 880 |
| ≥75 | 73 | 1 440 | 2 010 | 2 300 | 2 590 |
| Female | | | | | |
| 18-30 | 62 | 1 420 | 1 980 | 2 260 | 2 570 |
| 31-60 | 63 | 1 390 | 1 940 | 2 210 | 2 500 |
| 61-74 | 63 | 1 270 | 1 770 | 2 040 | 2 280 |
| ≥75 | 62 | 1 220 | 1 700 | 1 970 | 2 230 |

**Nordic Nutrition Recommendations for intake of fat, carbohydrates and protein as a percentage of total energy intake for adults and children over 2 years of age.**

| Macro-nutrient | | Share of total energy intake (%) |
|---|---|---|
| Fat | Total fat | 25-35 % |
| | Saturated + trans fatty acids | approx. 10 % |
| | Cis-monounsaturated fatty acids | 10-15 % |
| | Polyunsaturated fatty acids | 5-10 %, including 1 % n-3 fatty acids |
| Carbohydrates | Total | 50-60 % |
| | Fibre | 25-35 g/d |
| | Refined sugars | < 10 % |
| Protein | Total | 10-20 % |

## Latvia

Ministry of Health 15th October 2008 Ordinance act Nr. 174.

**Recommended dose of energy and nutrition for Latvian citizens.**

| Age | Gender | Average weight (kg) | Average length cm | Energy (E) kcal/ day | Proteins (%E) | Fats (% E)[1] | Carbo-hydrates (%E) |
|---|---|---|---|---|---|---|---|
| 0-6 months | | 6 | 60 | 650 | 7 – 10 | 40-55 | 35-55 |
| 7-12 months | | 9 | 71 | 900 | 7 – 10 | 35-45 | 45-60 |
| 1-3 years | | 13 | 90 | 1 300 | 10-15 | 30-35 | 50-55 |
| 4-6 years | | 20 | 112 | 1 800 | 10-15 | 30-35 | 50-55 |
| 7-10 years | | 28 | 132 | 2 000 | 10-15 | 30-35 | 50-55 |
| 11-14 years | Men | 45 | 157 | 2 500 | 10-15 | 30-35 | 50-55 |
| | Women | 46 | 157 | 2 300 | 10-15 | 30-35 | 50-55 |
| 15-18 years | Men | 66 | 176 | 3 000 | 10-15 | 30-35 | 50-55 |
| | Women | 55 | 163 | 2 400 | 10-15 | 25-30 | 50-55 |
| adults | Men | 75 | 175 | 2 400 | 10-15 | 25-30 | 55-60[2] |
| | Women | 65 | 165 | 2 000 | 10-15 | 25-30 | 55-60[2] |
| women during pregnancy | | 65 | 165 | 2 000+300 (third trimester) | 10-15 +30 g | 25-30 | 55-60[2] |
| Lactating women | | 65 | 165 | 2 000+500 | 10-15 + 20 g | 25-30 | 55-60[2] |

1 A recommended ratio of fat:
Saturated fatty acids in fats: monounsaturated fatty acids in fats: polyunsaturated fatty acids, fat = 1: 1.2: 0.8.

2 Sugar no more than 10% of the total energy.

## Estonia

Nutritional recommendations

**Energy requirement, depending on sex, age and physical activity.**

| Age | Weight kg | Energy requirement E kcal/kg | Physical activity | | | |
|---|---|---|---|---|---|---|
| | | | Very low 1,4-1,5x E | Low 1,6-1,7x E | Moderate 1,8-1,9x E | High 2,0-2,2x E |
| Men, kcal/per day | | | | | | |
| 19-30 | 70 (±)10 | 25 | 2 450(±)200 | 2 800(±)250 | 3 150(±)300 | 3 500(±)350 |
| 31-60 | 70 (±)10 | 24 | 2 350(±)200 | 2 700(±)200 | 3 050(±)250 | 3 400(±)300 |
| Over 60 | 70 (±)10 | 20 | 2 200(±)200 | 2 300(±)200 | 2 600(±)250 | 2 850(±)300 |
| Women, kcal/per | | | | | | |
| 19-30 | 60 (±)10 | 23 | 1 950(±)200 | 2 050(±)250 | 2 500(±)250 | 2 750(±)300 |
| 31-60 | 60 (±)10 | 22,5 | 1 900(±)150 | 2 000(±)150 | 2 450(±)200 | 2 700(±)200 |
| Over 60 | 60 (±)10 | 20,5 | 1  700(±)150 | 1 850(±)150 | 2 200(±)200 | 2 450(±)200 |

http://www.toitumine.ee/energia/

# Abbreviation list

AE accumulated exceedance

BDE Brominated diphenyl ether

BSAP Baltic Sea Action Plan

CAN calcium ammonium nitrate

Cd Cadmium

$CH_4$ methane

$CO_2$ carbon dioxide

Contamination ratio (CR) – The ratio between the measured contamination status and the threshold value for contamination.

DDE 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene

DDT 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane

DE Germany

decaBDE decabromodiphenyl ether

DEU domestic extraction use

DEU Domestic Extraction Used

DK Denmark

DMC Direct material consumption

DMC Domestic Material Consumption

DMI Direct Material Input

DPO Domestic Processed Output

EE Estonia

EFSA European Food Safety Authority

ELY-centre Centre for Economic Development, Transport and the Environment

eq. equivalent

EU European Union

FI Finland

Foodweb - The Baltic environment, food and health: from habits to awareness -project

FVS, the Food and Veterinary Service

GDP Gross Domestic Product

HAA heterocyclic aromatic amines

HBCDD Hexabromocyclododecane

HCB Hexachlorobenzene

HCFCs hydrochlorofluorocarbons

HCHs Hexachlorocyclohexane

HELCOM – Helsinki Commission, the body responsible for the implementation of the Helsinki Convention.

LCA life cycle assessment

LCIA life cycle impact assessment

LEA Latvian Environment Agency

LT Lithuania

LV Latvia

MCCP medium-chain chlorinated paraffins

MCPA 4 (4-Chloro-2-methylphenoxy)acetic acid

MFA Material flow approach

N Nitrogen

$N_2O$ nitrous oxide

NAS Net Addition to Stock

ng nanogram

$NH_4$+ ammonium

$NO_2$- Nitrite

$NO_3$- Nitrate

Nox nitrogen oxides

NP Nonylphenols

NPE nonyphenol ethoxylates

$O_3$ ozone

octaBDE octabromodiphenyl ether

OP Octylphenols

OPE Octylphenol ethoxylate

OSF Official Statistics of Finland

P Phosphorus

PAHs polycyclic aromatic hydrocarbons

PCBs Polychlorinated biphenyls (PCBs)

PCDD/F – "Dioxin" compounds, i.e., chlorinated

pentaBDE Pentabromodiphenyl ether

PFOA Perfl uorooctanoate. A PFCA representative with 8 carbon atoms.

PFOS Perfl uorooctane sulfonate. A PFA representative with 8 carbon atoms and a sulfonate head group.

PL Poland

$PO_4$ eq Eutrophication Potential

POP(s) Persistent organic pollutants(s)

psu – practical salinity unit (almost equivalent to parts per thousand or ‰)

PTB Physical Trade Balance

RU Russia

SCCP Short-chain chlorinated paraffins

SE Sweden

SERI Sustainable Europe Research Institute

$SO_2$ Sulfur dioxide

TBT – Tributyltin

TDO Total Domestic Output

TE-centres Employment and Economic Development Centres

TEQ Toxicity Equivalent

TIKE Information Centre of the Ministry of Agriculture and Forestry (Finland)

TMC Total Material Consumption

TMR Total Material Requirement

Tot-N - total nitrogen which includes dissolved inorganic and organic nitrogen and organically bound nitrogen

Tot-P – total phosphorus which includes dissolved inorganic and organic phosphorus and organically bound phosphorus.

TPhT triphenyltin compounds

UDE unused domestic extraction

VOC volatile organic compounds

Zn Zinc

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