Method for reporting environmental impacts of the Finnish food sector – integration of an IO approach with that of a process based LCA

Yrjö Virtanen, Sirpa Kurppa and Merja Saarinen

MTT Biotechnology and Food Research, ET-house, FI-31600 Jokioinen, Finland.

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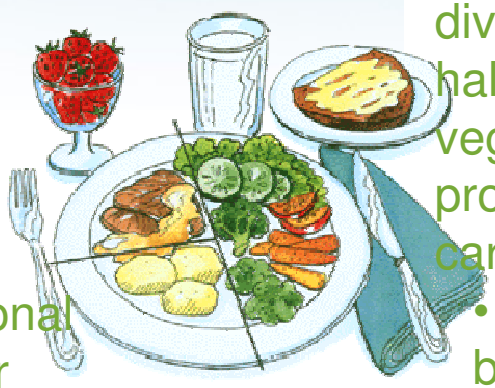
The research approach was built on:

- national input-output model (EIO-LCA) *Envimat* developed in collaboration with the Finnish Environment Institute and further developed specifically for food sector

- process based LCA models of nutritionally balanced, standard lunch plates
- the standard lunch plate represents a lunch portion following Finland's current national nutritional recommendations for young people, from 2005.



- EIO-LCA represents the macro level
- emission data for the domestic production sectors are based on national emission inventories and, to a minor extent, on activity information based estimates (Seppälä et al., 2009).
- a plate model - the principle of dividing a plate into three parts; half of the plate consists of vegetables, one quarter of protein and one quarter of carbohydrate.
  - the portion is completed with bread and milk or water.
  - shares of energy from: protein should be 10–20 %, from fat 25–35 % and from carbohydrates 50–60 %.

Concrete targets and aims

- to assess the total impacts attributable to Finnish production and imports of foodstuffs, including their transport
- to assess the specific environmental impacts of standard lunch plates
- The ultimate aims:
  - to help consumers make environmentally responsible choices in their future food consumption,
  - to help the food supply chain identify key areas for improvement in terms of various environmental impacts, and
  - to provide policy makers with a tool for monitoring the development of the food sector with respect to use of resources and the potential for climate change impact, acidification, eutrophication and tropospheric ozone formation.

EIO-LCA model

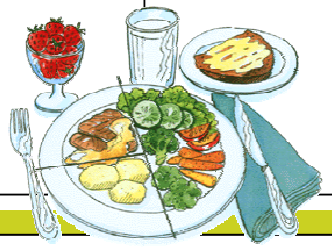
Yrjo.virtanen@mtt.fi

- cover the whole Finnish economy and are, by definition, in accordance with the classification applied to the national account system - except for agriculture, which is disaggregated in order to increase the resolution of hot spot analysis.
- Imports are modelled product-wise.
- classification of the products and the logic for their aggregation to higher level sector-products is convergent to that used in the national account system. The model includes 912 product titles.
- disaggregation of the domestic agriculture sector was based on reference inputs and reference environmental loads obtained with the help of a material flow based LCA model built in the study.
  - **sub-sectors were chosen so that each of them has only one product as their main product.**
  - **for each sub-sector of the agriculture-aggregate a share of each aggregate-input and -environmental load was allocated that corresponded to its share of the total of the respective reference flows.**
  - **thus the model includes 190 domestic production sectors, of which 44 represent agriculture.**
- sectors that use food products for non-food production, such as the paper industry (starch) and cosmetics industry (sugar), were excluded from the industrial usage.

Lunch servings, in three categories:

sirpa.kurppa@mtt.fi merja.saarinen@mtt.fi

Home-made servings	Ready-meal servings	School dining room servings
……..Macaroni casseroles……		
➢ Minced meat-macaroni casserole ➢ Minced chicken meat-macaroni casserole	➢ Minced meat-macaroni casserole ➢ Chicken-pasta casserole	➢ Minced meat-macaroni casserole ➢ Vegetable-macaroni casserole
…….Potato based casseroles……		
➢ Ham casserole, ➢ Chicken casserole, ➢ Rainbow trout casserole ➢ Vegetable casserole	➢ Ham casserole, ➢ Chicken casserole, ➢ Rainbow trout casserole ➢ Vegetable casserole	➢ Ham casserole, Rainbow trout casserole ➢ Vegetable casserole
……Chicken sauces……		
➢ Chicken sauce with wholemeal rice ➢ Chicken sauce with wholemeal pasta	➢ Chicken in cream sauce with rice	➢ Chicken sauce with wholemeal rice ➢ Chicken sauce with wholemeal pasta
……Sausage meals……		
➢ Frankfurter and mashed potatoes		
……..Porridge meals……		
➢ Barley porridge with berry fool	➢ Barley porridge with berry fool	➢ Barley porridge with berry fool
…….Vegetable patty meals……		
➢ Beetroot patty with barley, ➢ Soy bean patty with mashed potatoes (vegetarian.), ➢ Soy bean patty with mashed potatoes (ovo-lacto-vegetarian) ➢ Broad bean patty with mashed potatoes		➢ Beetroot patty with mashed potatoes



Results of the IO approach

The Finnish food chain accounts for:

- 7% of domestic CO_2 emissions,
- 43% of CH_4 emissions, and
- 50% of N_2O emissions,
- corresponding to 14% of total climate change.

- the share of the food chain in domestic N-leaching is 58% and
- that of P-leaching 67%.
- the food chain is largely responsible for eutrophication of waterways (57%).

In Finland the life cycle stages of agriculture represent a major factor in the total environmental load of food chains.

- contribution of agriculture in terms of CH_4, N_2O and NH_3 emissions, and nitrogen and phosphorus leaching, is over 90%.
- contribution of agriculture regarding CO_2, NMVOC and NOx emissions is 30-40% and for SO_2 emissions the proportion is about 23%.
- dominant position of agriculture with regard to these 5 environmental load classes is also reflected in total environmental impacts.

➢ share of agricultural processes is significantly more than 50% for all the observed classes of environmental impacts.

- share of the food processing industry is 0-5% of the chain's entire domestic environmental impact

Where does the CO_2 eq come from in each sub sector?

Product group	CH_4	CO_2-fos	N_2O	PFC (CO_2ekv)
Meat products	31%	27%	41%	2%
Milk products	36%	27%	37%	0%
HoReCa	21%	55%	23%	2%
Grain products	5%	40%	55%	0%
Vegetables	5%	67%	28%	0%
Beer and soft drinks	4%	56%	40%	0%
Fruits and vegetables	12%	61%	26%	1%
Alcohol	4%	56%	40%	0%
Fish products	4%	86%	9%	0%

How does the sectors add up for CO2 eq. ?

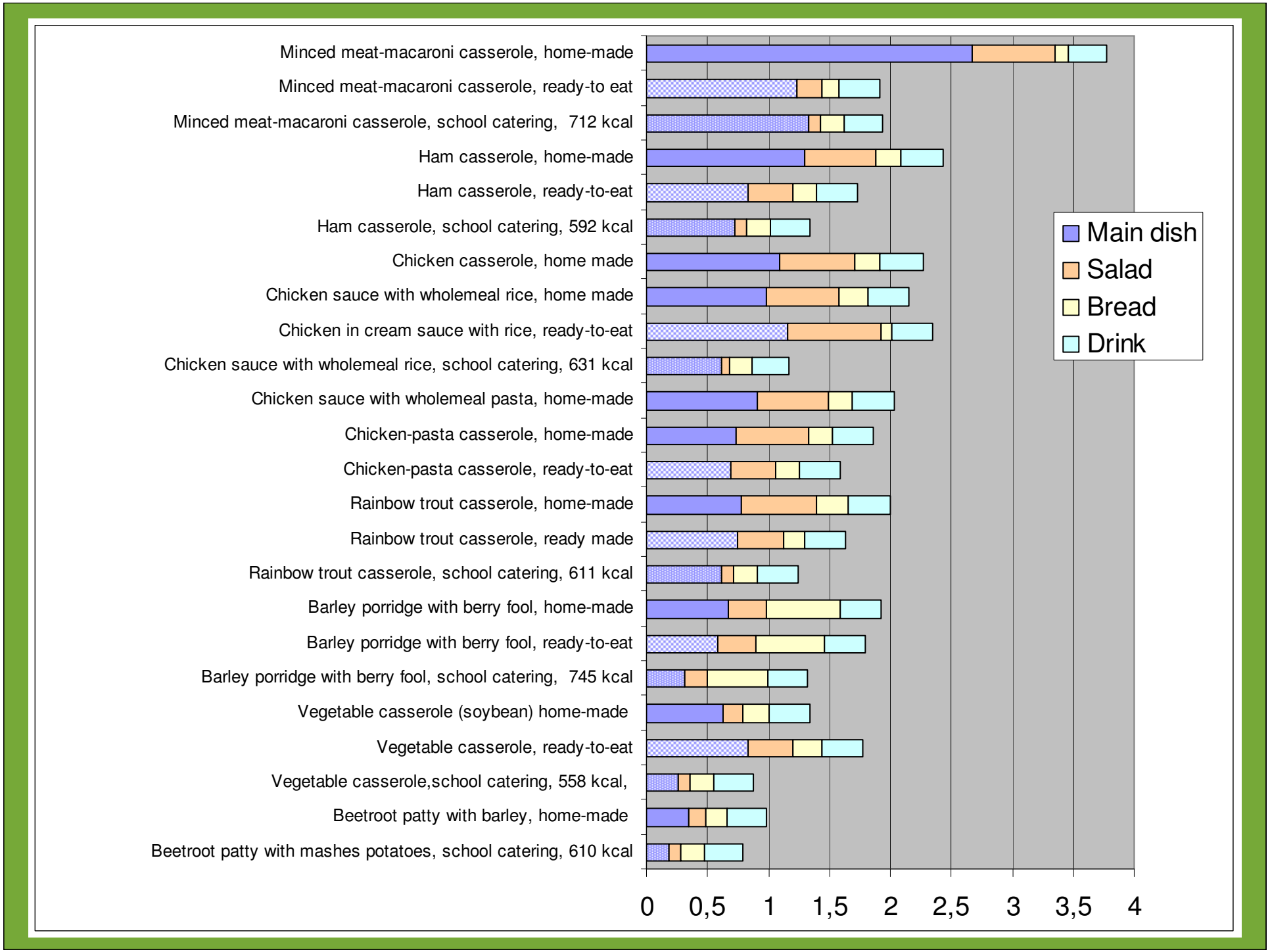
Production type	Proportion of the total **climate change impact** of animal husbandry	Proportion of the **total value** of animal husbandry	Proportion of Primary production of the total **climate change impact**
Egg production	2%	2%	37%
Milk production	48%	54%	85%
Other animal production	6%	2%	87%
Beef production	28%	6%	89%
Poultry production	3%	20%	53%
Pork production	14%	17%	66%

Total climate change impact per final unit output

Production chain	kg CO_2 eq/€	Production chain	kg CO_2 eq/€
Meat products	2.7	Mean of primary production + processing + import	1.8
Milk products	2.4	Mean of primary production + processing + end use	2.0
Grain products	1.8	Mean of all production chains	1.3
Vegetables	1.5	Beef production	4.2
Fish production	1.0	Pork production	3.3
Beer and soft drinks	1.0	Milk production	2.7
HoReCa	0.6	Poultry production	2.1
Fruits and vegetables	0.9	Egg production	6.3
Alcohol	0.9	Other animals	11.1

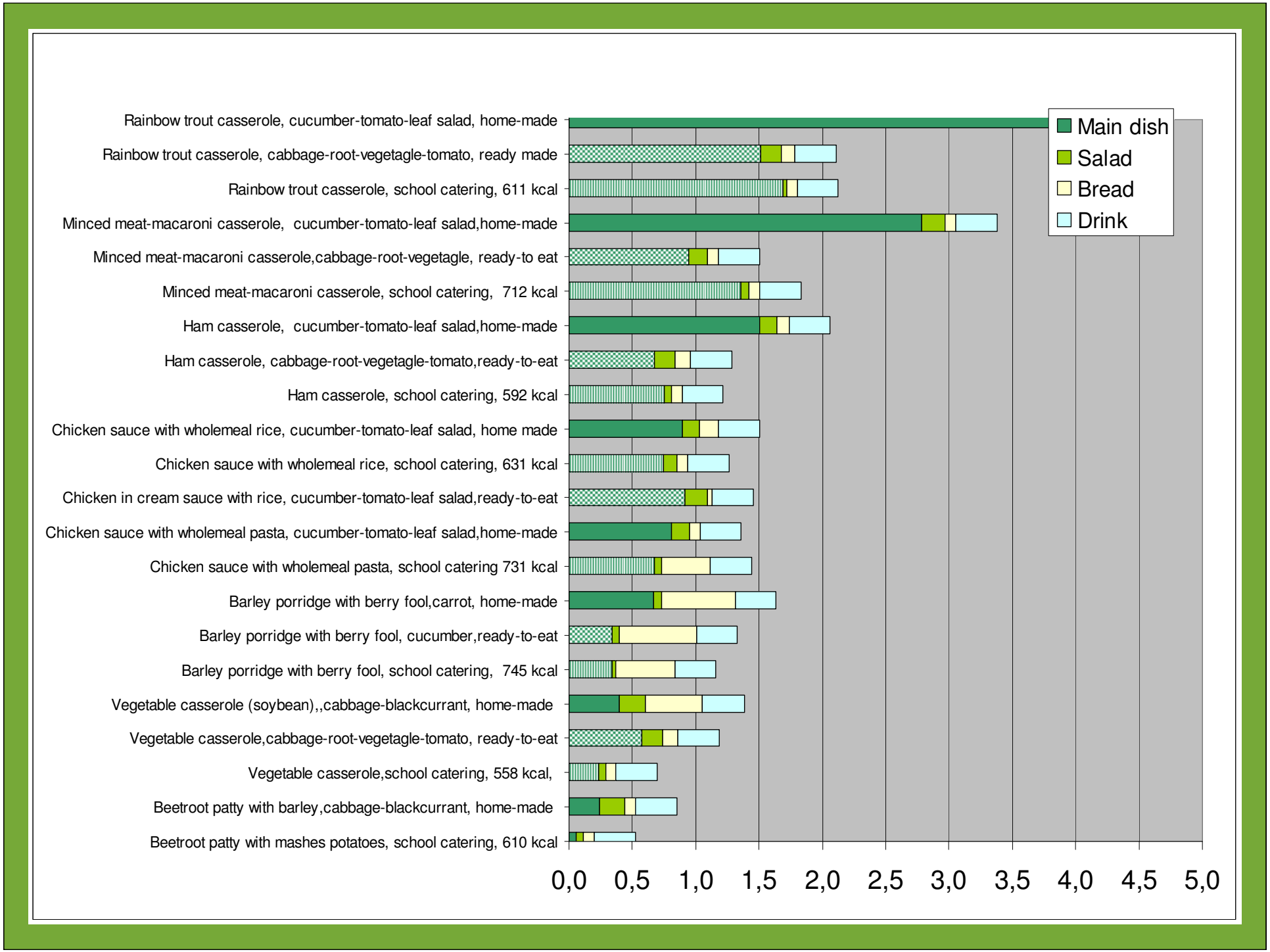
Lunch plates

- the differences between lunch plates based on animal protein and plant protein were reasonably high;
- ➢ animal protein based lunch plates having at most a five times higher impact on climate change and eutrophication than plates based on plant protein
- not any major difference between the climate change impacts of industrially processed and home processed food.
- main differences originated from differences in recipes for particular lunches when prepared industrially or at home.
- ➢ this observation is in agreement with the fact that the highest proportion of environmental impacts originates from production of raw material.


Minced meat-macaroni casserole, home-made
Minced meat-macaroni casserole, ready-to eat
Minced meat-macaroni casserole, school catering, 712 kcal
Ham casserole, home-made
Ham casserole, ready-to-eat
Ham casserole, school catering, 592 kcal
Chicken casserole, home made
Chicken sauce with wholemeal rice, home made
Chicken in cream sauce with rice, ready-to-eat
Chicken sauce with wholemeal rice, school catering, 631 kcal
Chicken sauce with wholemeal pasta, home-made
Chicken-pasta casserole, home-made
Chicken-pasta casserole, ready-to-eat
Rainbow trout casserole, home-made
Rainbow trout casserole, ready made
Rainbow trout casserole, school catering, 611 kcal
Barley porridge with berry fool, home-made
Barley porridge with berry fool, ready-to-eat
Barley porridge with berry fool, school catering, 745 kcal
Vegetable casserole (soybean) home-made
Vegetable casserole, ready-to-eat
Vegetable casserole,school catering, 558 kcal,
Beetroot patty with barley, home-made
Beetroot patty with mashes potatoes, school catering, 610 kcal
Main dish
Salad
Bread
Drink
0
0,5
1
1,5
2
2,5
3
3,5
4

Lunch plates cont.

- The contribution of diet to eutrophication impact is much higher, as average eutrophication impact of a Finn is 9.4 g PO_4- per day (Nissinen et al., 2006)
- Thus one lunch represents about 10 to 30% of the daily eutrophication impact of a Finn.
- As lunch is supposed to constitute one third of daily nutrition, an average contribution of daily food intake represents 30 - 90% of daily eutrophication impact, which agrees well with the value of 57% produced from the IO approach.

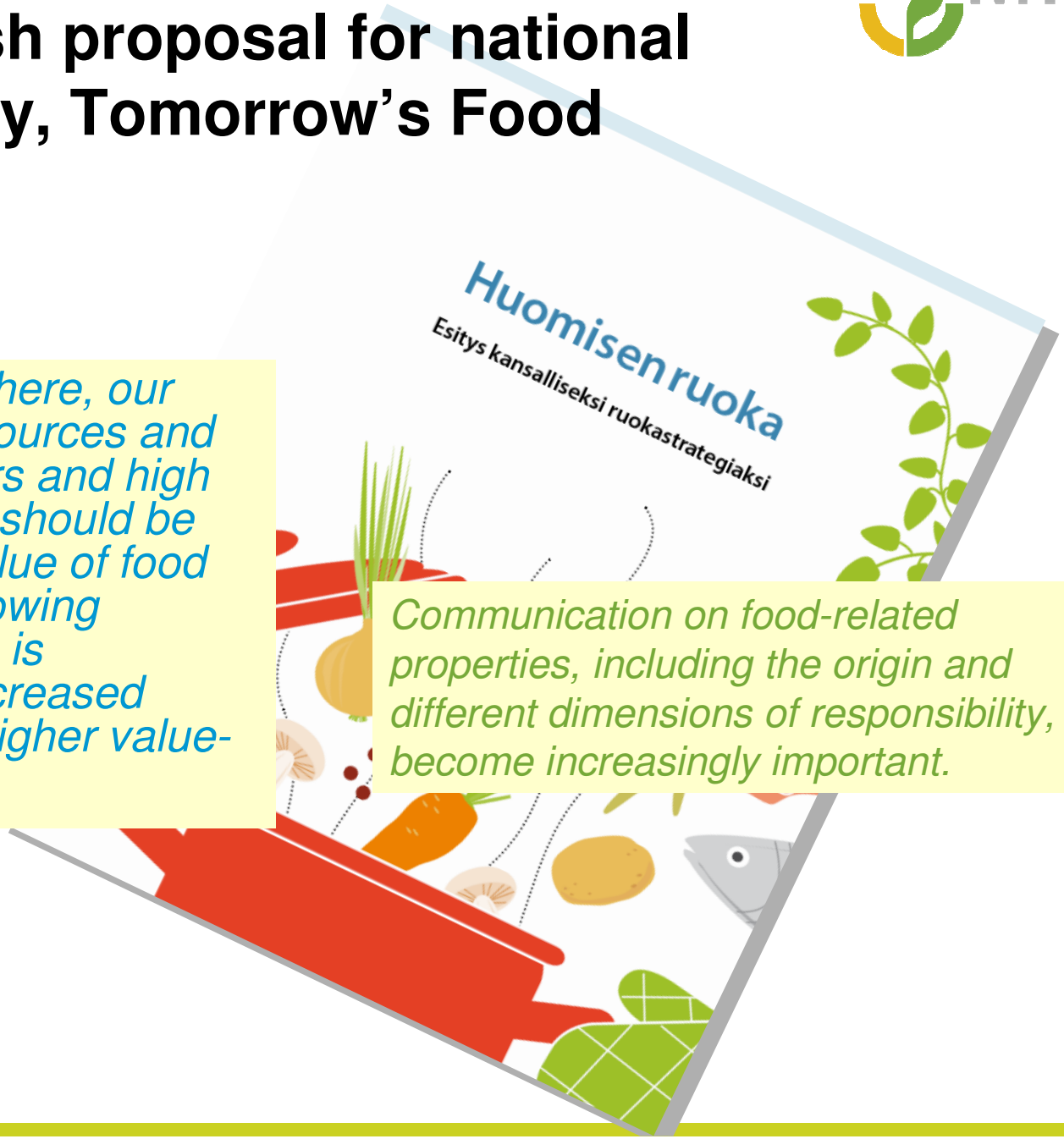

Rainbow trout casserole, cucumber-tomato-leaf salad, home-made
Rainbow trout casserole, cabbage-root-vegetagle-tomato, ready made
Rainbow trout casserole, school catering, 611 kcal
Minced meat-macaroni casserole, cucumber-tomato-leaf salad,home-made
Minced meat-macaroni casserole,cabbage-root-vegetagle, ready-to eat
Minced meat-macaroni casserole, school catering, 712 kcal
Ham casserole, cucumber-tomato-leaf salad,home-made
Ham casserole, cabbage-root-vegetagle-tomato,ready-to-eat
Ham casserole, school catering, 592 kcal
Chicken sauce with wholemeal rice, cucumber-tomato-leaf salad, home made
Chicken sauce with wholemeal rice, school catering, 631 kcal
Chicken in cream sauce with rice, cucumber-tomato-leaf salad,ready-to-eat
Chicken sauce with wholemeal pasta, cucumber-tomato-leaf salad,home-made
Chicken sauce with wholemeal pasta, school catering 731 kcal
Barley porridge with berry fool,carrot, home-made
Barley porridge with berry fool, cucumber,ready-to-eat
Barley porridge with berry fool, school catering, 745 kcal
Vegetable casserole (soybean),,cabbage-blackcurrant, home-made
Vegetable casserole,cabbage-root-vegetagle-tomato, ready-to-eat
Vegetable casserole,school catering, 558 kcal,
Beetroot patty with barley,cabbage-blackcurrant, home-made
Beetroot patty with mashes potatoes, school catering, 610 kcal
Main dish
Salad
Bread
Drink
0,0
0,5
1,0
1,5
2,0
2,5
3,0
3,5
4,0
4,5
5,0

Conclusions

- IO based approach relates the impacts to society as a whole and furnishes an idea of the magnitude of changes that can be realistically made
- it might be prudent to continue with fairly high-impact sub-sectors if the impacts related to other potential production areas are lower.
- however, process based LCA is best in showing the hot spots
- focus more intensively on local raw materials for food, but changes made in any particular area would have to be fairly comprehensive in order for them to have a measurable impact.
- there should be a broader focus, and when assessing the relationship between food consumption and production, in global food system
- the strategy of food production and consumption of a region or nation could end up being different

In the Finnish proposal for national food strategy, Tomorrow's Food 2030:

In Finland and elsewhere, our abundant natural resources and especially pure waters and high level of expertise we should be able to double the value of food production in the following decades. The growth is comprised of both increased exports and shift to higher value-added products.



Communication on food-related properties, including the origin and different dimensions of responsibility, will become increasingly important.

Thank you so much!

Sirpa.kurppa@mtt.fi
Merja.saarinen@mtt.fi
Yrjo.virtanen@mtt.fi