ORGANIC PRODUCTION, CLIMATE AND THE ENVIRONMENT

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I KEY FINDINGS

- Our current global production and consumption of food is unsustainable. By making informed food decisions we can improve our environmental impact tremendously.
- Organic products improve animal welfare and avoid tropical deforestation, but can increase the carbon footprint per kg of product. This is especially true for meat products.
- When choosing organic products we can also reduce our carbon footprint, as the most important decision is to choose more seasonal plant-based products.
- In contrast, basing decisions only on the carbon footprint of products may conflict with tropical deforestation, animal welfare and water scarcity.
- With the methods currently available for biodiversity, soil fertility and toxic pollution, no final conclusions can yet be drawn about which food products have the lowest environmental impacts. Biodiversity impacts though are strongly influenced by the other environmental factors we can account for.
- In addition to the Eaternity App's[a] feature to design meals with a low carbon footprint, now also animal welfare, tropical rainforest deforestation and water scarcity can be considered. Organic labels play an important role in the indicators animal welfare and tropical rainforest deforestation.

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[a] Life cycle impact assessments (LCIA) accessible through Eaternity Database (EDB - edb.eaternity.org)

NOTE

This fact sheet invites to create a common ground for climate action by summarizing current knowledge on the climate and environmental impacts of conventional and organic production. It is supported by our scientific board of experts and partners. It was developed in 2017 as part of the Organic Footprint project which was made possible by the Engagement Fund Migros. As a consequence, Eaternity included additional indicators for water scarcity, tropical deforestation and animal welfare into the Eaternity App to support the overall goal of reducing the food related climate impact.

OUR CURRENT DIET IS A LEADING CAUSE FOR ENVIRONMENTAL DEGRADATION

Our current food production and consumption system is unsustainable and has to undergo a major transition. Up to 29% of global greenhouse gas emissions originate from our foods[1]. It contributes more to global warming than the whole transportation sector combined[2]. Further, agriculture is responsible for 70% of global fresh water use[3], it covers 40% of the lands surface[4], and is the main cause for deforestation[5] and biodiversity loss[6]. Already up to 30% of the global land area is degraded, reducing our capacity to produce food[7]. With a growing world population, it is more important than ever to rethink how we produce, what we produce and what we eat.

SMART DIET CHOICES ARE NECESSARY

We can reduce our environmental impacts tremendously by choosing what we eat. Smart food choices reduce our climate impact by more than 50%. To reduce our impact we can increase the proportion of foods with a lower environmental footprint in our diet.

*Your fork is your vote on **what** is produced, **how** it is produced and **where** it is produced.*

WHAT THE EXPERTS WANT US TO LOOK AT

- The 9 environmental indicators listed in the table below received the highest approval by leading experts and stakeholders as the most important indicators for measuring the impacts of agriculture[8]. A comparison between organic and conventional production is currently not feasible for 4 of the indicators as there is no standard method established or not enough data available.
- Our negative impact on climate, biodiversity and the nitrogen cycle already exceeded the safe limits of our planet[9]. This means that we are irreversibly changing our environment.

Table 1. Selection of most important indicators when judging which meals are environmental friendly. It is also indicated if methods exist to assess environmental performance in general and specifically when comparing organic and conventional agriculture.

Most important indicators	Carbon footprint	Water use	Land use	Aquatic Eutrophication[a] (nutrients oversupply)	Ecotoxicity[b] (toxic pollution)	Soil fertility	Biodiversity	Conservation of tropical rainforest	Animal welfare
Can impacts be calculated?	Yes	Yes	Yes	Yes	Yes	No	(No)[f]	(Yes)[g]	(Yes)[g]
Comparison organic/ conventional possible?	Yes	No[c]	Yes	(Yes)[d]	(No)[e]	No	No	(Yes)[g]	(Yes)[g]

a The oversupply of nutrients reduces the water quality of lakes and rivers. It disturbs the fine natural balance of plants and animals living in the water and can lead to habitat loss of certain animals.

b Toxic chemicals harm animals and plants. The chemicals either kill organism or disturb their mobility or reproduction.

c Not enough data available

d There are uncertainties, but they are not expected to change conclusions obtained in this project.

e Calculations possible except for heavy metals. The cycling of heavy metals in organic agriculture is difficult to model due to lack of data (content of heavy metal in manure is not known and may differ from conventional manure).

f Methods are still being developed.

g Only qualitative judgements possible

ORGANIC AGRICULTURE AIMS TO REDUCE OUR ENVIRONMENTAL IMPACT

- Organic agriculture contributes to minimize the human impact on the environment, while ensuring that the agricultural system operates as naturally as possible. Typical measures in organic agriculture are strict limits on synthetic pesticide and synthetic fertilizer use, livestock antibiotics and hormones, food additives and food processing aids[10]. The challenge is that all organic systems also need to operate economically.
- All organic labels share the same vision, but can differ in their environmental regulations leading to varying environmental outcomes. Most organic labels do not have regulations that specifically target the reduction of greenhouse gases emissions yet[11]. However, some regulations indirectly lead to emission reductions

ORGANIC MEAT IS BETTER FOR ANIMAL WELFARE, BUT CAN BE WORSE FOR OUR CLIMATE

SWITZERLAND [12–16]

- Organic **beef** from Switzerland has an at least 50% higher carbon footprint than beef from the predominant non-organic standard production system.

- There are three common production systems for beef: standard production, grazing production and grazing suckler cow production. The choice of system strongly influences the carbon footprint of the meat. Organic beef in Switzerland mostly originates from one of the grazing cattle production systems which cause more greenhouse gases, while non-organic beef is mostly produced in the standard production system, even though all productions systems can be found.
  1) **Standard production**, where animals are fed a higher share of concentrated feed and the calf is separated for fattening from the dairy mother cows. In Switzerland, the meat from this production system has the lowest carbon footprint.
  2) **Grazing production**, where the animals spend most of the time on grasslands. Their feed consists mainly of natural feed and only very low amounts of concentrated feed. The calves are usually separated from the dairy mother cows. Measures that are good for animal welfare such as a high amount of natural feed instead of concentrated feed and more free space to move around makes the animal mature and fatten slower and therefore it takes longer before it reaches slaughter weight. This results in a higher carbon footprint as the animal emits more of the greenhouse gas methane during his longer lifetime. The carbon footprint is 50% higher than in the standard production system.
  3) **Grazing suckler cow production**, where the calf stays with the mother and the milk of the mother is not used for human consumption. Like in the grazing system the animals also spend much time on grasslands and receive low amounts of concentrated feed. Beef from this production system has the highest carbon footprint. The main reason is that all production related emissions are fully allocated to the end-product of meat and not partially attributed to the milk.

- **Chicken** meat from organic production in Switzerland has a 45% higher carbon footprint than chicken meat from non-organic standard production in barns[12]. Organic chicken grow slower, live longer and therefore use more feed than standard chicken. This is caused as chicken breeds with unnaturally high growth hormone production are avoided and regulations that allow chicken more space to run around and cause them to burn more energy.

- For organic **pork**, there is no conflict between animal welfare and climate impact. The carbon footprint of organically and conventionally produced pig meat is similar. The reason is that similar breeds are used and thus slaughter age and feed intake are similar in conventional and organic production. However, animal welfare is higher under organic standards than under governmental minimum requirements. Typical measures that increase animal welfare do not influence the carbon footprint (e.g. provide rooting box and space on the outdoor concrete area)

- Standard production in Switzerland is special, as of 2016 practically all (99%) imported **soy** for feed was certified responsible[17]. This means that emissions related to deforestation contribute only very little to the carbon footprint of Swiss meat and are lower than in non-organic standard production systems in other countries.

OTHER COUNTRIES (EXAMPLE DE AND UK) [11,16,18,19]

- The trade-offs between animal welfare and climate impact for beef and chicken observed in Switzerland do not necessarily translate to other countries.

- The carbon footprint of **beef** differs per country and strongly depends on how cattle is typically kept. Organic beef in the UK is typically from grazing suckler cow production, while organic beef in Germany and Switzerland are 50% from grazing production and 50% from grazing suckler cow production[16]. As explained above, beef from suckler cow production has a higher carbon footprint than beef from other production systems. Therefore, organic beef produced in the UK has a higher carbon footprint than average organic beef produced in Germany or Switzerland.

- In Germany, in contrast to the findings in Switzerland, organic **beef** from grazing production and organic **chicken** both have a lower carbon footprint than meat from non-organic standard production. The carbon footprint of organic beef is 12% and that of organic chicken is 28% lower when compared to non-organic standard production[18]. A main reason is that most soy used for feed in non-organic standard production is not certified ("responsible") and therefore emissions caused by deforestation increase the carbon footprint.

- Like in Switzerland, the carbon footprint of organic and non-organic standard **pork** in Germany and the UK are similar, but animal welfare is higher for organic pig.

ORGANIC MILK IS JUST AS GOOD FOR THE CLIMATE AND BETTER FOR THE ANIMALS

Milk from organic and non-organic standard production has a similar climate impact[20]. However, animal welfare is higher when produced under organic standards than under non-organic standard production. The main reason for finding only slight differences is that in non-organic production the higher emissions related to the use of concentrated feed are reversed by a higher milk yield per cow[20]. This finding was specifically shown for Switzerland, but also a meta-analysis revealed that on average, the differences between organic and conventional milk are small[21]. Other measures that increase animal welfare do not influence the carbon footprint.

CLIMATE IMPACT OF ORGANIC VEGETABLES, CEREALS AND FRUITS CANNOT BE GENERALIZED

GRAINS, VEGETABLES AND FRUITS PRODUCED OUTDOOR [21,22]

- The carbon footprint of 1kg of crops produced under organic standards can be better, worse, or similar compared to their conventional counterparts.

- Overall, there is no conflict between eating organically produced plants and reducing our climate impact. In comparison to animal products, plant products have a lower carbon footprint than animal products.

- Several **factors** explain the diverse and contrasting results found for crop products. The balance can be easily tipped. First, measures that potentially reduce the carbon footprint can lead to other measures or circumstance that increase it. For example, not using synthetic pesticides saves energy, but might lead to the increased use of machines on the field. Further, minimizing pesticide and fertilizer use as much as possible can lead to lower yields per area and reverse the positive effect on the carbon footprint of using less inputs. In addition, there are important factors such as location that can influence crop yield more than if it was produced under organic or conventional regulations.

- Agriculture can contribute to the reduction of global greenhouse emissions by implementing measures that increase the **storage of CO_2** into the soil (soil sequestration). Methods to measure soil sequestration are still being developed. If the impact of soil sequestration can be included into the comparison of the carbon footprint of organic and conventional products this might flip the balance.

VEGETABLES PRODUCED IN GREENHOUSES [16]

- The carbon footprint of vegetables produced in greenhouses changes throughout the year: off-season vegetables grown in heated greenhouses have increased carbon footprints.

- Bio Suisse (CH) strongly restricts the use of peat and the amount of energy to heat greenhouses. Swiss organic greenhouse vegetables are available during shorter time periods – but if they are available they come with a low carbon footprint.

- The organic labels of other countries that we investigated have less strict regulations on the use of heating and peat. For example, the carbon footprint of the average Bio Suisse tomato is 45% lower than a tomato produced under UK soil association standards[16].

EATING ORGANICALLY CAN GO HAND IN HAND WITH REDUCING CLIMATE IMPACT [23]

- An analysis of 1300 meals showed that the carbon footprint of an average meal increased by 10% when all ingredients were substituted by the same ingredients from organic production. The reason for the increase is that Swiss organic chicken and beef have higher carbon footprints than in standard non-organic production, as explained above.

- However, the type of meat (e.g. minced meat or filet) and diary products, the amount of meat and diary products and how all ingredient were transported (e.g. if imported by airplane), were stronger predictors for the climate impact of a meal than whether the ingredients were organic or not.

RELYING ON CLIMATE IMPACT ALONE DOES NOT AVOID TROPICAL RAINFOREST DEFORESTATION, BUT RELYING ON ORGANIC PRODUCE TYPICALLY DOES [8]

- Agriculture is the main driver of tropical rainforest deforestation leading to a tremendous loss in biodiversity[5]. Especially the production of soy and palm oil are leading causes of tropical deforestation.

- Even when emissions from deforestation are accounted for in the carbon footprint of a product, choosing a product with a low carbon footprint can still have a negative impact on tropical deforestation. For example, a margarine spread has a lower footprint than butter[24], but margarine often contains palm oil. As large amounts of palm oil can be produced on a relatively small area its carbon footprint on the product level is relatively low even if deforestation occurs.

- Choosing foods from organic production typically ensures that no valuable nature areas or tropical rainforest was lost. There are also other certified labels that specialize to protect those valuable areas.

- In addition to buying certified products, we can reduce the human need for palm oil production by including more fresh products into our diet instead of processed products such as frozen pizza which often contain palm oil. In contrast, by just replacing all palm oil with other oils does require more land and would need additional regulations to ensure sustainability[25].

- To reduce the pressure of soy production on rainforest deforestation we can purchase soy that was produced in Europe as well as certified soy, meat and milk products, and reduce our meat consumption in general.

I REDUCING CLIMATE IMPACT CAN CONFLICT WITH WATER SCARCITY - THE LOCATION ON THE GLOBE MATTERS [8]

- Globally, we have enough fresh water resources, but water is not evenly distributed around the globe. Agriculture uses 70% of our fresh water supply[3], mainly for irrigation. In regions where water is scarce this is problematic.

- Enough data to compare the water footprint of products from organic and conventional agriculture is currently lacking. A comparison of the water scarcity footprint with the climate impact however is possible.

- Food choices that reduce climate impact can still increase water stress. For example, olives or nuts are often produced in areas where water is rather scarce.

- The **water scarcity footprint** of a food product is calculated from the amount of water (fresh water consumed) that is used for its production and the water scarcity in the particular region of production[26,27]. The footprint of the same product differs, depending on where it was produced. For example, a tomato that is produced in Spain requires 44 times more irrigation water than in Switzerland. Because water in Spain is more scarce than in Switzerland, the scarcity footprint of an average Spanish tomato is 2400 times higher than an average Swiss tomato (raw data from Ref. [27]).

- All food produced in **Switzerland** have a low water scarcity footprint, because water is not scarce in Switzerland. Water in a region is scarce when large amounts of water are used compared to the amount that is naturally provided by rainfall and other precipitation.

- Olives, nuts, chocolate, coffee, milk products, rice and beef are foods that contribute the most to the water scarcity footprint of Swiss food consumption[27]. The ranking of products may be different in other countries.

WHERE TO GO FROM HERE?

We have gained transparency on the environmental gains and conflicts of our food choices for 5 out of the 9 environmental indicators that experts approved to be most important. It is the best guide that we have to reduce our environmental impact, but some important parts of the puzzle are still missing.

Our findings summarized[8]:

- Certain **food choices** that are good for the climate reduce other environmental impacts as well. Others food choices can cause conflicts between the different indicators. Table 2 summarizes the synergies and conflicts of different meat choices in Switzerland and Europe for the most important environmental indicators. With this table we want to create transparency. The table shows that good choices are not always easy and important indicators (e.g. animal welfare) can come with trade-offs. And this is where consumer behavior becomes part of the solution by enabling consumers to consider a relevant selection of all indicators. And finally, the table also shows the knowledge gaps and where more research is urgently needed.

- Choosing plant products over animal products reduces the carbon footprint and generally also total land use and the amounts of nutrients brought into the environment.

- Reducing climate impact can **conflict** with animal welfare, water scarcity and tropical deforestation. Animal welfare and avoiding tropical deforestation are well covered by organic labels.

- It is difficult to judge the impacts of **land use** because they depend on many factors: apart from the area that is used, also the type of land, how the land is used and where its located matters. For example, grazing cattle may need more land in total, yet it offers a way to reduce land competition for human food production by using grasslands instead of crop land. Further, organic crops often need a larger area to produce the same yield. However, if soil fertility is maintained better than in other systems, it may be worthwhile to occupy a larger area. Therefore, it is too simple to state that organic might have a negative impact on land use because it uses more land.

- **Biodiversity** and **soil fertility** are important environmental indicators, but scientific methods are still being developed and therefore final general conclusions cannot be drawn yet.

- Also for **ecotoxicity** final conclusions on the relative impact of organic and conventional production cannot be drawn yet. Organic agriculture prohibits the use of synthetic pesticides, but does allow restricted use of copper. The overall evaluation of the toxicity of heavy metals is still difficult and especially challenging because relevant data on the heavy metal content in manure is still lacking.

Table 2. Table shows which production system tends to have the lowest impact (1) and the highest impact (3) for different environmental indicators and animal products. The underlying data is based on LCA studies of different origin. Thus care should be taken when comparing absolute values between studies, but the conclusions drawn within the studies are consistent[19]. The Swiss data is based on Wolff et al. 2016 (beef + chicken, Agroscope)[12] and Alig et al. 2012 (pork, Agroscope)[15]. Findings from Meier et al. 2014 (climate and beef, FIBL)[13] and the inventory of Kreuzer et al. (standard and grazing beef, ZHAW)[14] further support conclusions. The data for Germany are based on Scharfy et al. 2016[16] (ZHAW, suckler cow) and the LCI from Thierrin[18] (Quantis, standard and grazing beef, chicken, pork) and mostly agree with the conclusions found for Switzerland. Deviations are explained.

	Beef						Chicken						Pork			
	CH			EU			CH			EU			CH		EU	
	Standard (IP)	Grazing	Grazing, suckler cow [a]	Intensive [b]	Grazing	Grazing, suckler cow	Standard (IP)	Free-range	Organic	Standard (barn)	Free-range	Organic	Standard (IP)	Organic	Standard (conventional)	Organic
Climate[c]	1	2	3[a]	2	1	3	1	2	3	2	3	1	1	1	1	1
Aquatic eutrophication	1	2	nc	1	1-2[f]	3	1	2	3	1	2	3	1	1	1	2
Land use total	1	2	nc	1	2	3	1	2	3	1	2	3	1	2	1	2
Crop land use	2	1	nc	nc	nc	nc	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr
Scarce water	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
Ecotoxicity[d]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Biodiversity[d]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Soil fertility[d]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Deforestation (qualitative)	1[g]	1[g]	1[g]	2	1[h]	1[h]	1[g]	1[g]	1[g]	2[i]	3[i]	1[i]	1[g]	1[g]	2[i]	1[i]
Animal welfaree (qualitative)	3	2	1	3	2	1	3	2	1	3	2	1	2	1	2	1

Impacts are considered "similar" if impact level differed by less than 5%

IP = integrierte Produktion (standard production system in Switzerland, more strict than conventional production). nc: no data or not calculated. nr: not relevant (only relevant for cattle)

[a] Meier et al. (2014)[13] showed that the carbon footprint of suckler cow is higher than for grazing and standard beef production. Already Alig 2012[15] calculated higher carbon footprints for suckler cow production than standard beef production. Data obtained for Germany further support the conclusion.
[b] Intensive represents an intensive animal farming that could occur at any place. It does not necessarily reflect the most common conventional way to produce beef in Germany.
[c] All findings are explained in detail in the main text.
[d] no conclusions are available because methods to quantify impacts of heavy metals are still missing.
[e] animal welfare is based on expert judgements and not scientific calculation.
[f] differences are small and slightly dependent on the chosen impact assessment method
[g] Switzerland: Currently, 99% of the soy is certified ("responsible"), see main text). Grazing suckler cows produced in Switzerland are not fed with soy.
[h] In the modelling it was assumed that grazing and suckler cow were produced under organic standards and thus no deforestation occurs.
[i] ranking based on the calculated carbon emissions from biomass and soil, reflecting mainly land use change.

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