cause inconvenience (the damage, therefore the environmental impact) only to neighbouring people. In this case we talk about **local** impacts. Instead, when the environmental aspect is the consumption of a global natural resource, such as oil, or the release of pollutants that reach the atmosphere, such as CO_2, the entire world population is damaged. In this case we talk about **global** impacts.

2.3 How to calculate and interpret environmental indicators

These methodological premises are useful for supporting subsequent investigations. A fundamental criterion to follow is certainly the difference between global and local aspects, especially for the methods of calculating and interpreting indicators. The global aspects (the most famous of all is certainly the greenhouse effect) are normally calculated with the approach of the **Life Cycle Assessment (LCA)** which plans to analyse all the phases of production of a food from the cultivation of raw materials up to distribution and consumption. This methodology, regulated by the international standard ISO 14040, provides in fact the sum of all the impacts generated in each single phase regardless of its position in the world, and is, therefore excellent for calculating the indicators that refer to global impacts.

Instead, when we move towards the analysis of local impacts, such as the use of water or phytosanitary substances in agriculture, the LCA approach has some limitations because the sum of local impacts may not be significant and lead to conclusions inconsistent with reality.
The most typical example of this possible inconsistency is that of water consumption. The total value of water consumed in an articulated process is not significant if it does not refer to local conditions, such as the availability of water. In other words, it is very clear that limiting the analysis to the data alone the answer to the question "what impacts more, the consumption of 10 litres of water in Israel or 20 litres in Sweden?" could reach questionable considerations.

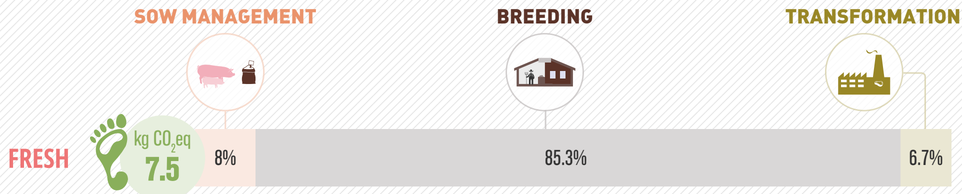
The ideal solution is therefore the construction of a set of global and local indicators each of which must be interpreted coherently to its scientific significance.

ENVIRONMENTAL IMPACT	DESCRIPTION	GLOBAL OR LOCAL IMPACT?	INSTITUTE/PROTOCOL REFERENCE
CLIMATE CHANGE [kg CO_2eq]	The greenhouse effect is a natural phenomenon due to the presence of some gases in the atmosphere. The main emissions of agri-food chains are carbon dioxide deriving from the use of fossil fuels, methane from enteric fermentations, nitrous oxide resulting from the use of nitrogen fertilisers.	GLOBAL	Intergovernmental Panel on Climate Change, 2013 ISO 14067 www.ipcc.ch
USE AND POLLUTION OF WATER [litres]	The use of water in the agri-food sector is relevant both for the volumes consumed and for eventual groundwater pollution.	LOCAL	ISO 14046
GROUND OCCUPATION [global m^2]	The food production chain involves the occupation of the soil during the agricultural cultivation phase of the raw materials as well as for the breeding farms.	GLOBAL when all components of the indicator are taken into account LOCAL when analysing specific aspects	Global Footprint Network www.globalfootprint.org
EUTROPHICATION [g PO_4^{3-}]	Eutrophication is an impact that involves an excessive amount of nitrogen in the environment (usually in water) with damage to flora and fauna. The main cause is due to the use of nitrogen-based fertilisers (natural or chemical).	REGIONAL	Evaluation method usually used is based on Heijungs's stoichiometric procedure (1992)
CONSUMPTION OF NON-RENEWABLE RESOURCES [MJ]	This impact refers mainly to the consumption of fossil fuels such as gas and oil that are used in the production of electricity and as traction fuel.	GLOBAL	Frischknecht, 2002
ECOTOXICITY [CTU, Comparative Toxic Unit]	This impact is generated by the release of chemicals that can pollute air, water or soil with damage to the ecosystem, flora and fauna. The substances responsible for this impact are predominantly the agro-drugs used in agriculture.	LOCAL	UNEP-SETAC Life Cycle Initiative www.usetox.org

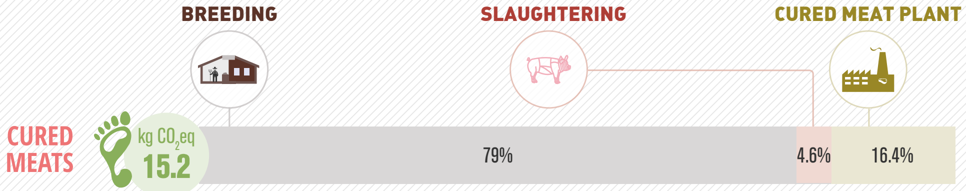
The main environmental impacts of agri-food supply chains

THE CARBON FOOTPRINT OF THE MAIN TYPES OF MEAT

PORK MEAT

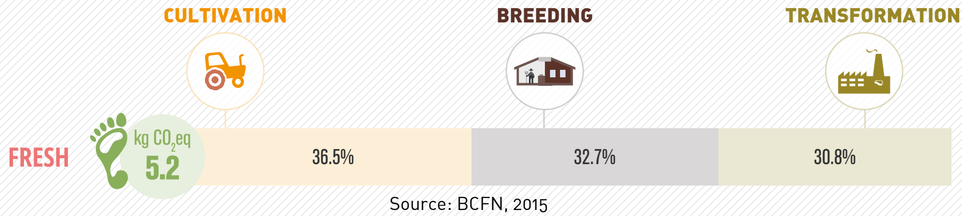


Source: BCFN, 2015



Source: BCFN, 2015

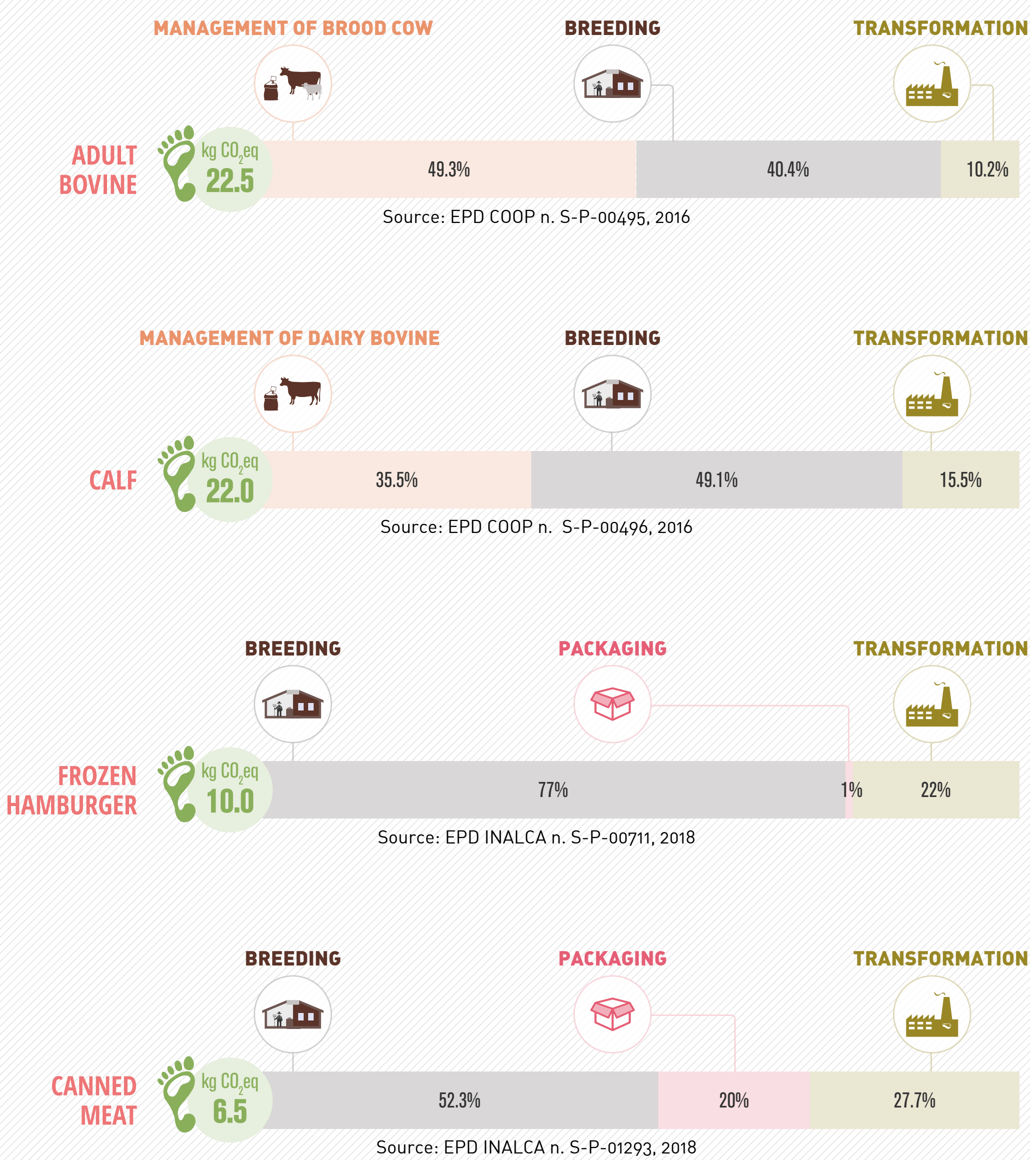
POULTRY MEAT



Source: BCFN, 2015

The impacts of the meat supply chain are more concentrated in the **management of breeding farms** and in the **cultivation of feeds** that make up the rations given to the animals; in the case of fresh pork and beef meat, part of the impact also derives from the respective management phases of the sow and the brood cow.

BEEF



Industrial processing (intended as slaughtering, transformation and meat packaging) and distribution have a limited impact, greater only in the case of more elaborate foods such as cured meats or canned meat.

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A METHOD TO AGGREGATE IMPACTS
THE CASE OF ECOSYSTEM SERVICES

The need to simplify the messages on environmental impacts and to maintain the scientific rigor in the calculation of the indicators does not always allow us to find a univocal solution. Especially when global and local indicators must be put on the same level because in many cases considerations can be of an opposite nature. For this reason, there are many attempts to find aggregated indicators aiming to simplify communication with the use of a single value.

One of the most recent and interesting methods is that of ecosystem services defined in 1997 by the economist Robert Costanza which starts from a concept that originates from the economy of the environment: that of natural capital defined as "the entire stock of natural assets - living organisms, air, water, soil and geological resources - that contribute to provide goods and services of value, direct or indirect, for humans and that are necessary for the survival of the environment from which they are generated"[34].

In a nutshell, the assessment of ecosystem services aims at transforming the impacts, be they local or global, into an economic value in order to then aggregate the value into a single datum which represents the "environmental cost" of the process.

From a methodological point of view, the value of impacts is calculated by assuming a "replacement cost" of natural capital. To do this we consider, for example, the market value for the purchase of carbon credits in the case of greenhouse gas emissions, the cost of purification of the chemical elements that contribute to eutrophication and the average cost of water supply for water consumption for company and breeding farms. Depending on the actual organisational conditions of the supply chain, other methods for estimating environmental costs could be adopted. In all cases, especially for local impacts, costs represent the real local conditions and therefore permit the focus of environmental impacts in the local geographical conditions of reference. In theory, the monetisation of the various impacts could make it possible to treat this cost as a budget item, to work to reduce it, to decide whether to internalise it in the company costs and, once reduced to the minimum terms, start local interventions of compensation.

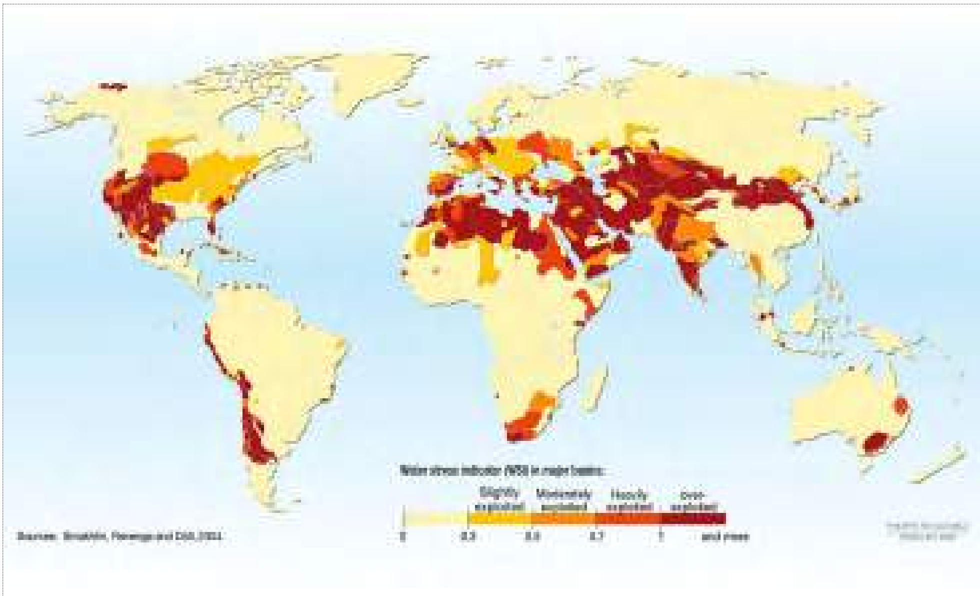
2.4 The measurement of water use

One of the most discussed environmental aspects of agricultural production and farming concerns water. This aspect must be analysed under two different points of view: on the one hand the volumes used must be considered, on the other the level of the contaminants released.

Each of the two aspects, which should always be analysed in a combined way, is checked and measured using different evaluation parameters. While the quality of water has historically been subject to greater controls (for example, the annual publication of the National plan for the research of residues of the Ministry of Health), the volumes consumed have begun to collect interest and become elements of communication. The need to provide the consumer with synthetic and comprehensible information has consequently pushed towards the definition of methods and protocols aimed at the calculation of aggregated indicators.

The most widely used approach is to relate the **direct consumption of water with local availability**, transforming a consumption data into a reduction in availability, the real form of impact.

To do this there are different methodologies that all start from the concept of **water scarcity** (defined as the impossibility of having adequate amounts of water compared to the needs) and **water availability** (i.e. the real availability of water, accessible both from the qualitative and quantitative points of view).



Map relating to areas subject to lower or greater water stress. A value close to zero indicates an area that is not subject to water stress; numbers close to or greater than 1 indicate areas where the actual availability of water - usable at affordable costs - constitutes a problem. Source: UNEP (Smakhtin V., Revenga C. and Doll P., 2004) [35].

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One of the most widespread methods of calculation is the one concerning water resource depletion, developed by the Joint Research Centre (JRC) of the European Commission, whose purpose is to evaluate how much water consumption in a specific geographical area actually affects the exhaustion of water resources in that area[36].
This method, among other things, is promoted by the European Commission as part of the initiatives to calculate the environmental footprint of products (PEF, Product Environmental Footprint) and organisations (OEF, Organisation Environmental Footprint).
In detail, the calculation is based on the factors provided by the "**Ecological Scarcity**" method[37] and plans to multiply the water consumption of the process under analysis for a characterisation factor derived from the ratio between total consumption and **availability in the reference region (low, medium and high)**. The indicator is expressed in an equivalent volume of water and is based on the factors reported in the study by Frischknecht et al. (2008) [38].

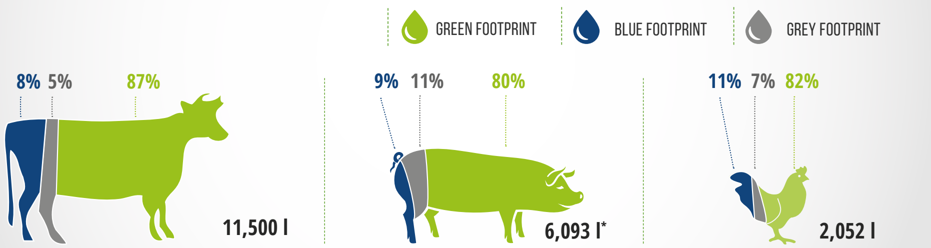
An example of calculation: the impact of beef

In this analysis it was decided to use the method suggested by the JRC[39] to "weigh" the values of direct water consumption[40]. The work is to be considered preliminary because it is based on the hypothesis, not always correct, that the whole production chain (cultivation, breeding and processing) develops in the analysed region, and that therefore all the water of the final product is consumed in the same country. This "weighing" makes it possible to better correlate the withdrawal of water with the real "damage" made to the water availability in a specific geographical area. In regions where there is a problem of water scarcity, like India, the meat production chains are effectively impacting in quantitative terms to the point that the "weighted" water footprint becomes greater than the one calculated. When the production chain is instead located in areas where there is water availability, the environmental damage is less: as is the case of Argentina or Ireland that are, among other things, countries with a large meat production.

WATER FOOTPRINT OF MEAT IN ITALY

DATA litre/kg

The **water footprint** is the sum of three contributions, partly real (blue) and partly virtual (green and grey). For meat and cured meats, the component of green water is by far the most significant of the three.



*Source: Mekonnen M.M., Hoekstra A.Y., 2010. * The figure refers to the heavy pig (160 kg, 9/11 months of age) while the most common pig abroad weighs 80/100 kg (5/7 months of age)*

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WATER FOOTPRINT
NETWORK

Most of the literature data on the water footprint of products (food and otherwise) currently available and used in communication have been published by the Water Footprint Network (WFN) or by different authors who often refer to the calculation methodology developed from the same network.

The Water Footprint Network (WFN)[41] was the most widely used protocol for accounting for the water footprint of products and processes until the publication of the ISO 14046 standard and new methodologies for calculating impacts related to water usage (Ecological Scarcity, Pfister, AWARE, to name a few) have integrated the approach with the weighing of water consumption on the basis of real availability at the production site, providing a more complete and contextualised key of interpretation. Another aspect "corrected" by the new methods has been the evaluation of ***the water evapotranspirated by plants (the green water) which consisted of more than 90% of the impacts****. This contribution was on the one hand separate from the calculation of the direct indicators, on the other hand modified with the introduction of methods aimed at calculating the differential between the evapotranspiration of the crop and the natural reference of the same area.*

The ***green water*** *footprint is a characteristic of products of agricultural or forest origin and represents the quantity of rainwater that crops use in their production cycle to live and grow. This quota represents the quantity of "evapotranspirated" water, i.e. that passes from the ground to the atmosphere both for the evaporation of the soil moisture, that is stored in the surface layer of the soil and because of the transpiration of the plants. Not all the meteoric water is exploited for reasons related to the particularities of the soil, the needs of the plants and the characteristics of the root systems.* ***The green water footprint, therefore, includes only the volumes of rainwater that are retained by the ground and are available to meet the needs of crops****, calculated according to the type of crop, weather-climatic area and average annual rainfall.*

*The blue quota (****blue water****) represents the amount of water taken from a body of water (rivers, lakes, aquifers) that is actually used in the production process and does not return, from downstream of the process that used it, back to the source from which has been withdrawn. If therefore, for example, water is taken for a refrigeration plant and subsequently re-introduced into the environment, the blue water footprint consists only of the part eventually evaporated during the process.*

*Finally, the grey component (****grey water****), i) is defined as the volume of water that is theoretically necessary to dilute the contaminants present in the water leaving the system (such as that which leaks from a cultivated field or from an industrial process) if returning the water back to its original quality is required. In practice, the higher the level of pollution generated, the higher the grey footprint will be.*

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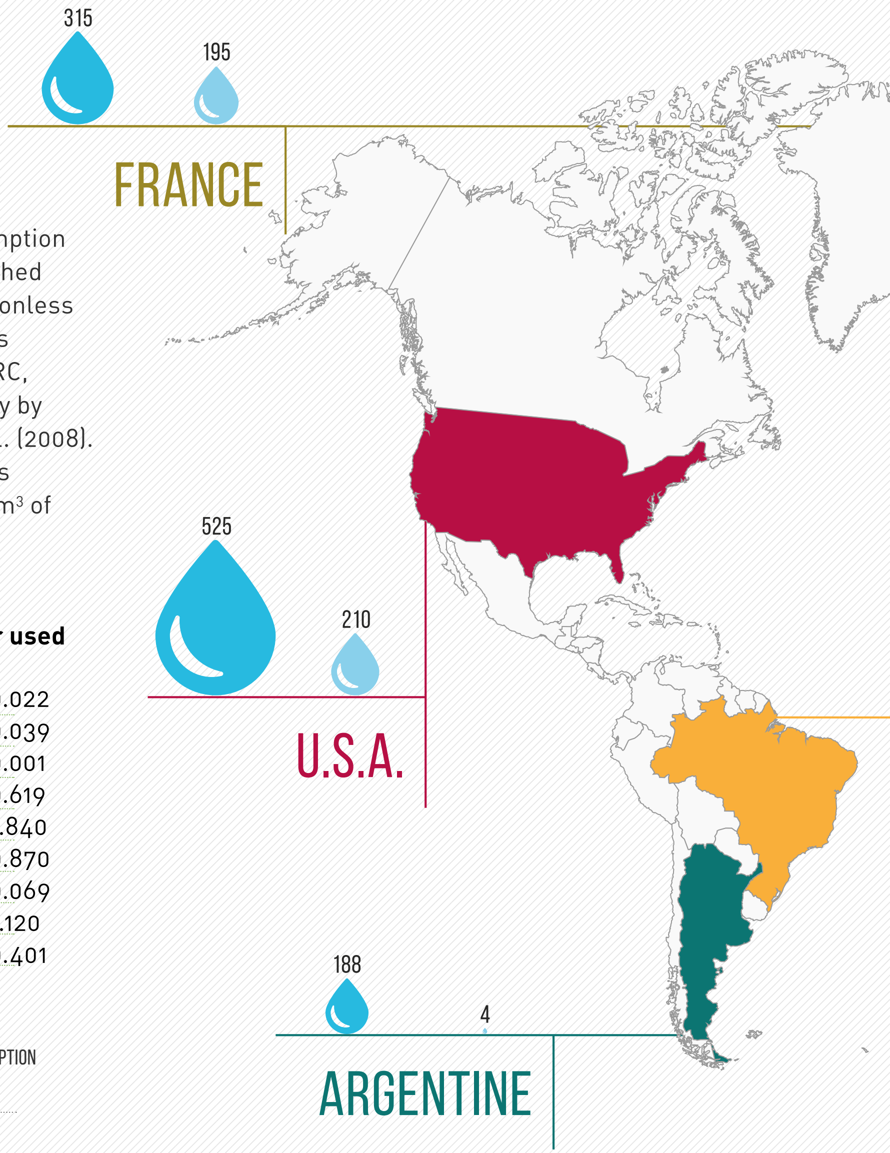
WATER FOOTPRINT OF BOVINE MEAT
WEIGHTED WITH SCARCITY INDEX

Source: Mekonnen M.M. et al. (2010); Data related to boneless Bovine cuts, fresh or chilled



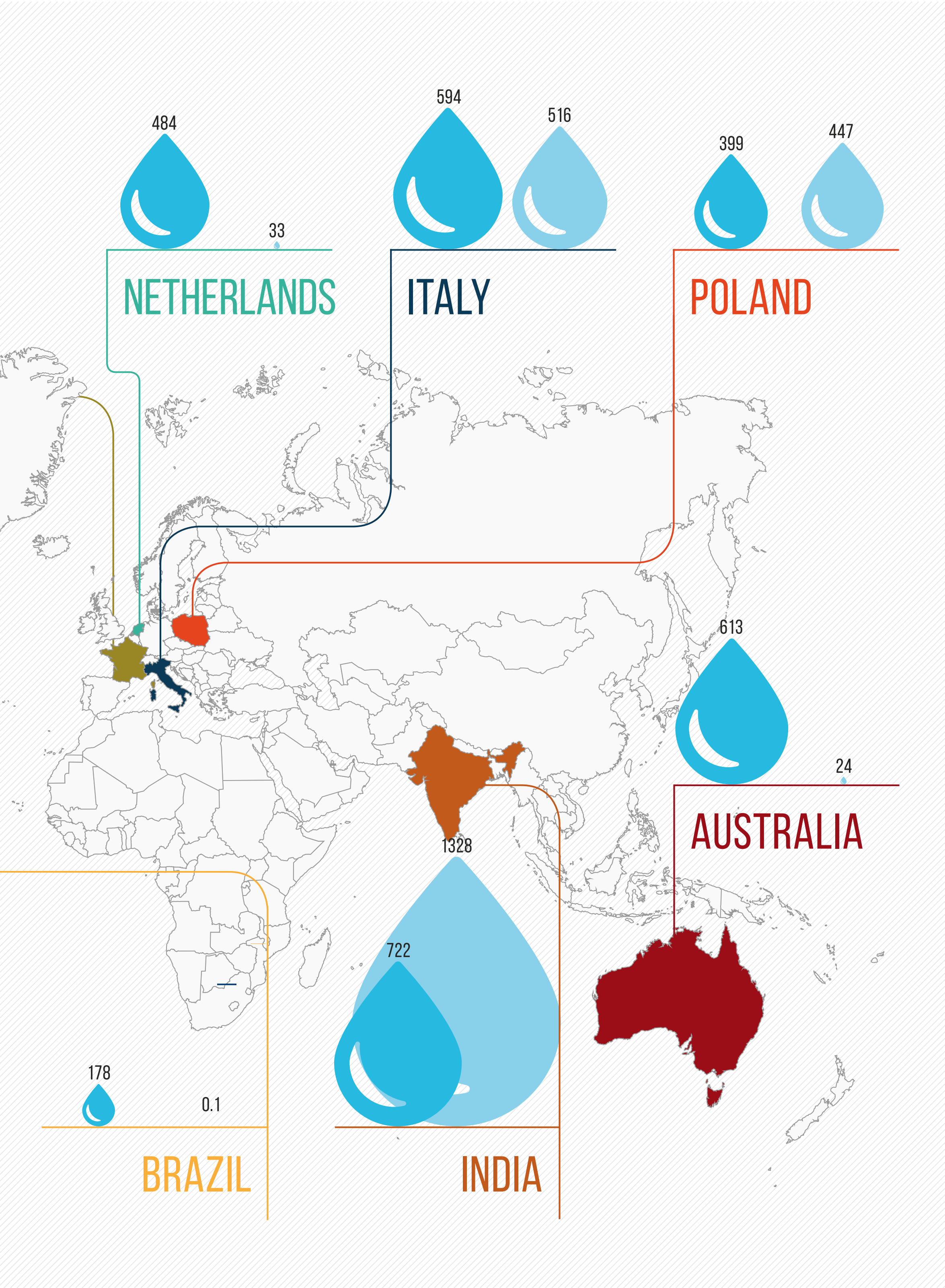
The direct consumption of water was weighed using the dimensionless conversion factors provided by the JRC, based on the study by Frischknecht et al. (2008). The correct values are expressed in m³ of equivalent water.

Conversion factor used

Argentine	0.022
Australia	0.039
Brazil	0.001
France	0.619
India	1.840
Italy	0.870
Netherlands	0.069
Poland	1.120
USA	0.401

DIRECT WATER CONSUMPTION (LITRES /KG)

NORMALISED DATA (LITRES EQUIVALENT/KG)



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THE ISO 14046 STANDARD

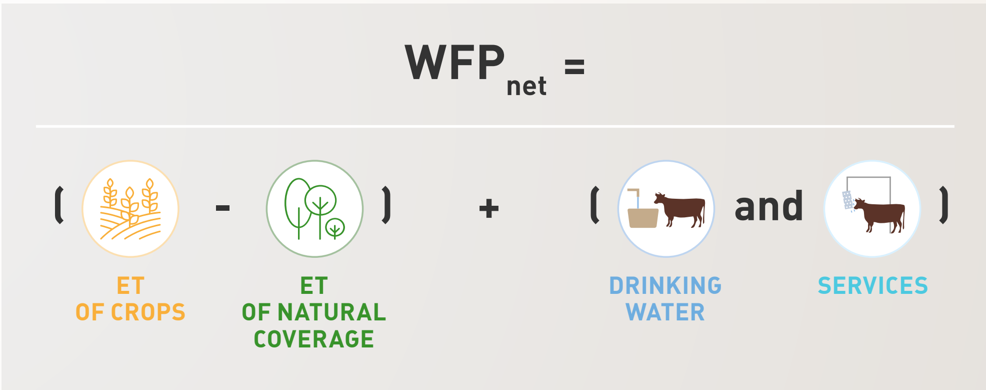
The term Water Footprint was also taken from the ISO 14046 standard, published in 2014 with the aim of defining the guidelines for assessing the water consumption of a system starting from an LCA-type analysis. The ISO standard does not refer to the concept of virtual water or to the distinction between the green, blue and grey water footprint; it is suggested, however, to take into consideration the quantity of polluting substances present in the flows and give them accountability in the representation of impacts with environmental indicators.

THE AWARE METHOD

*The AWARE (Available WAter REmaining) method, developed by the WULCA[42] working group, aims to provide the sector's operators, both in the industrial and academic fields, with an instrument to evaluate, compare and communicate the environmental performance of products regarding water use. This method has also recently been chosen by the International EPD System® as a reference for calculating water scarcity among environmental indicators reported in the product's environmental declarations. The AWARE method measures the "**potential for deprivation**" of water, for both humans and ecosystems, starting from the assumption that if less water remains available the greater the likelihood is that another user in the same area will be deprived of it (Boulay et al., 2016). The characterisation factors were first obtained by taking the difference between availability and water demand (AMD, Minus the Demand) in an area (expressed in m^3 m^{-2} $month^{-1}$). In a second phase, these values are normalised with the world average result and inverted, thus representing the relative value with respect to the average water consumed in the world.*

THE METHOD OF THE NET WATERFOOTPRINT (WFP_{NET}) [43]

Although it has been clarified that the contribution of evapotranspiration is insignificant to the discussion about the water impacts of agricultural production, in literature there are useful insights to improve its interpretation. In particular, one of the main critical aspects of the approach suggested by the method Mekonen and Hoekstra (2012) is to calculate the value of green water in absolute terms. Some authors, for example Atzori et al. in 2016[44], proposed to evolve the original approach in the Net Waterfootprint (WFP_{net}) going once at a time to calculate the evapotranspiration differential between the investigated crop and a reference situation (e.g. forest) that could be hypothesized for the geographical area of reference. In this way the indicator would represent the real impact induced by the action of man in the choice of the crop system.



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3 THE ENVIRONMENTAL IMPACTS OF THE DIET: **THE ENVIRONMENTAL HOURGLASS**

Meat and cured meats are among the foods with the greatest impacts per kilogram. This consideration becomes less clear if the comparison is made considering the quantities consumed in a diet consistent with nutritional advice. Trying to graphically represent this concept starting from the weekly consumption suggested by the nutritional guidelines and multiplying them by the average environmental impacts of the various food categories, an innovative graphic representation is obtained, similar to an **hourglass**.

A first edition of this presentation was published in 2013, by COOP Italy with a Book on the sustainability of branded beef[45]: the hourglass, which was intended to propose a different reading of the relationship between diet and environmental impact, was reviewed and updated by the Sustainable Meat Project. The most important aspect that emerges from this representation is that, in a balanced weekly diet, the environmental impact of protein rich foods (meat, fish, eggs, legumes, cured meats) is comparable with the impact generated by foods of plant origin (fruit, vegetables). If taken in the right quantities, the various food categories have in fact a similar "environmental weight", homogeneously distributed along the hourglass.

This reading allows to reinforce the consideration that **a balanced diet is not only useful for the interests of one's own health, but also for the environment**.

3.1 The construction of the hourglass

Conceptually, the process required to build the hourglass is very simple: **the environmental impacts (per kg) of food are multiplied by the quantity consumed in a week, obtaining the environmental impact**. The criticality in the calculation lies in the data, both of impact and quantity of food, that are chosen. When it comes to fruit, for example, people's food choices can be very different (from pineapple to apple) and with them the related environmental impacts. The same is true for the quantities of food, which obviously cannot be net and precise because, while remaining in the context of a balanced diet, people's choices can be very different. For these reasons the hourglass calculation was made by hypothesizing different possible food selections, with the awareness that what is presented in this document is not the only possible representation: the combinations between consumption frequencies and favourite foods are almost endless.

Environmental impact data

The hourglass setting is made taking into account the global impacts of food, then calculated using the life cycle methodology. For this reason, the impact indicator taken into consideration is that of the carbon footprint that must be read with the limitations evidenced in the previous pages.

		CARBON FOOTPRINT DATA ($kg\ CO_2/kg$ food)
MEAT. FISH. EGGS. LEGUMES	Fresh meat poultry/pork	4.6
	Fresh beef[46]	23.4
	Fresh beef - hamburger[47]	10.5
	Cured meats[48]	15.1
	Fish and shellfish	4.4
	Preserved fish[49]	4.4
	Eggs	3.8
	Legumes[50] (Fresh or in cans)	1.7
	Dry legumes	1.7
MILK. YOGURT. CHEESE	Milk/Yoghurt	1.5
	Fresh cheese	9.3
	Seasoned cheese	9.3
CONDIMENTS	Butter	8.3
	Oil	3.1
CEREALS	Bread	1.1
	Bakery products	1.6
	Pasta	1.9
	Rice	3.8
	Potatoes	1.2
FRUIT. VEGETABLES	Vegetables	1.7
	Salad	0.6
	Fruit	0.5

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The data used is for the most part from the database published by BCFN Foundation[51] and includes both the production of the food and its cooking when necessary. In the cases of meats and cured meats, the more specific knowledge of the sector has allowed us to use more representative information of the Italian production reality. **In all cases, the approach used was to exploit public data by favouring the reconstruction of the calculations, rather than the precision of the results**.

How to calculate the weekly consumption: portions and consumption frequencies

The amount of food consumed weekly can be calculated from two pieces of information: **portions** (amount of food) and **frequency** (how many portions). As for the portions, it was decided to adopt what was suggested by the Italian Society of Human Nutrition (SINU) with the LARN published in 2012[52]. The aim is to provide operators in the nutritional surveillance sector with a practical, shared reference, useful to define diets for the various age groups or groups with specific nutritional needs (pregnancy, lactation etc.). In the hypothesis of keeping portions constant, the frequency of consumption may vary according to food choices, but also to people's characteristics (gender, age, activities, etc.). To evaluate the variability of these options, three scenarios based on a different methodological approach were analysed: two of these (Scenario B and C), similar to last year, are based on INRAN's nutritional guidelines (now CREA - Food and Nutrition)[53]; and the third on the Mediterranean Diet (Scenario A) suggested by the International Mediterranean Diet Foundation[54].

In the elaborations related to the INRAN guidelines, the foods belonging to the first category (meat, fish, eggs, legumes) have been organised in various ways, maintaining the suggested constant frequency of 14 weekly portions.
Regardless of the hypotheses adopted, it should be remembered that a balanced diet should not exclude any food; for this reason, alternative food models, such as the vegetarian one, have not been taken into consideration, as this elaboration does not fall within the scope of the document and would require medical skills that go beyond those of the authors involved.

SCENARIO A LOW

The Mediterranean Diet scenario involves a very low consumption of meat and cured meats (350 grams weekly) and greater consumption of fruit and vegetables.

SCENARIO B INTERMEDIATE

The intermediate scenario takes into account a moderate consumption of meat and cured meats, which reaches 450 grams weekly.

SCENARIO C HIGH

Always in compliance with the nutritional indications, this scenario foresees a greater frequency in the consumption of food of animal origin, reaching 550 grams of meat and cured meats per week.

FOODS		g per portion (from LARN 2014)	WEEKLY CONSUMPTION FREQUENCIES A	B	C
MEAT. FISH. EGGS. LEGUMES	Fresh meat poultry/pork	100	2	3	3
	Fresh beef	100	1	1	1
	Fresh beef hamburger	100	0	0	1
	Cured meats	50	1	1	1
	Fish and shellfish	150	3	2	2
	Preserved fish	50	0	0	0
	Eggs	50	3	3	3
	Legumes (Fresh or in cans)	150	0	0	0
	Dry legumes	50	4	4	3
MILK. YOGURT. CHEESE	Milk/Yoghurt	125	10	21	21
	Fresh cheese	100	2	1	1
	Seasoned cheese	50	2	2	2
CONDIMENTS	Butter	10	7	7	10
	Oil	10	14	14	11
CEREALS	Bread	50	35	35	35
	Bakery products	30	7	7	7
	Pasta	80	5	3	4
	Rice	80	2	4	3
	Potatoes	200	2	2	2
FRUIT. VEGETABLES	Vegetables	200	14	13	12
	Salad	80	7	1	2
	Fruit	150	21	21	21
	Total meat and cured meats		**350**	**450**	**550**

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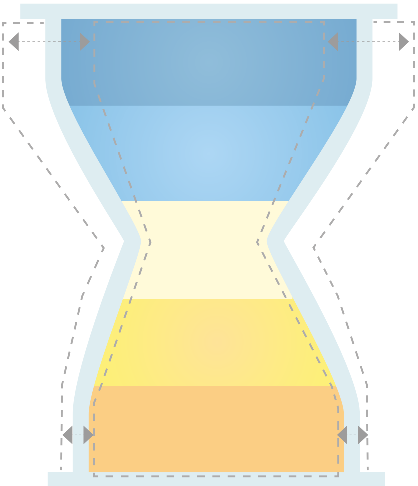
The different environmental hourglasses

The analysis of the variability of food choices leads us to observe how, despite the different consumption levels, the hourglass profile does not vary substantially: in the case of the Mediterranean Diet, on the contrary, it emerges almost paradoxically that low-impact foods such as fruit and vegetables become more impactful than those of meat.

Compared to the last edition, there are some differences in the results partly due to the constant updating that occurs in the environmental data, partly for the revision of the portions whose weights have been modified to use a more updated source. For the construction of environmental hourglasses (relating to the carbon footprint and the water footprint) reference was made to **scenario B**.



"DESPITE MEAT BEING AMONG FOODS WITH THE HIGHEST IMPACT, BY UNIT WEIGHT, A BALANCED CONSUMPTION DOES NOT INFLUENCE SUBSTANTIALLY THE WEEKLY IMPACTS"

CARBON FOOTPRINT HOURGLASS

THE THREE SCENARIOS
kg CO_2 person/week

CATEGORY	A	B	C
MEAT. FISH. EGGS. LEGUMES	6.9	6.7	7.7
MILK. YOGURT. CHEESES	4.6	5.8	5.8
DRESSINGS	1.0	1.0	1.2
CEREALS	4.2	4.5	4.3
FRUIT. VEGETABLES	6.6	6.0	5.7
TOTAL	**23.3**	**24.0**	**24.6**

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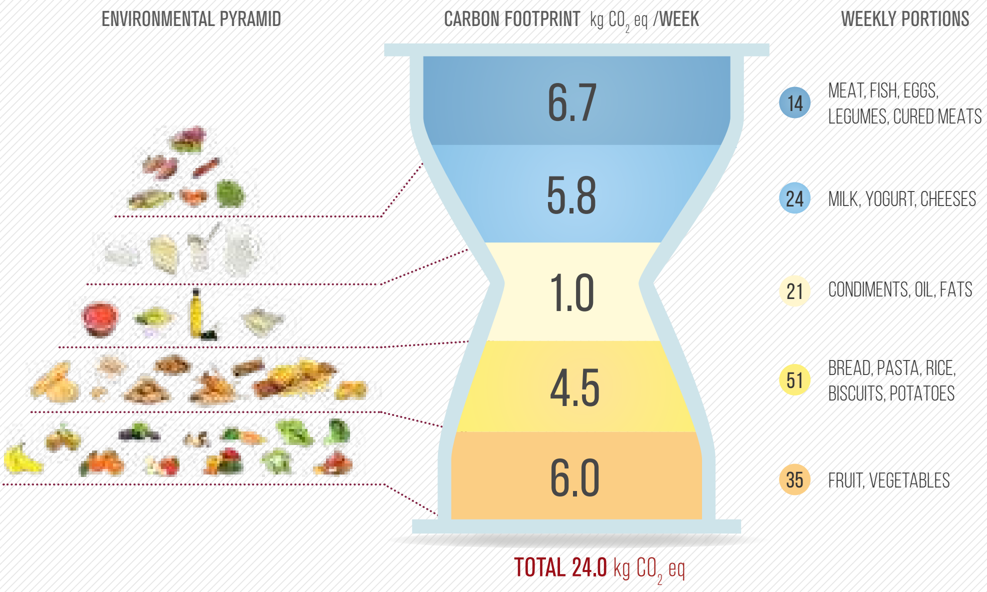
THE ENVIRONMENTAL HOURGLASS
CARBON FOOTPRINT

The Environmental Hourglass represents the carbon footprint of the foods consumed in a week following **scenario B**.

THE ENVIRONMENTAL HOURGLASS©



The Environmental Hourglass is built considering the consumption frequency suggested by INRAN (now CREA – Food and Nutrition) in the 2003 guidelines for an adult who needs 2,100 kcal per day, and the portions suggested by SINU in the guidelines published in 2012.

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ENVIRONMENTAL IMPACT CALCULATORS

There are several calculators on the Internet that allow an approximate assessment of the impact of one's lifestyle on the environment. Some permit the calculation of the environmental load of the user by evaluating the whole lifestyle, others focus attention on nutrition. They are simple and immediate calculators, which attract the user for their easiness in compilation and interpretation, taking into consideration the essential aspects of daily living.
*The official Footprint Network calculator, **calculate your footprint** [55], for example allows to calculate your "ecological footprint", i.e. how much biologically productive surface is necessary to sustain your lifestyle.*
The questions asked by the computer concern food (consumption of meat, fish, eggs and dairy products, local products), lifestyle and habits regarding clothing, home (with relative energy costs and management of household waste) and means of transport used. The result is expressed in "planets" and divided into the different components of the Ecological Footprint.
*The WWF calculator, **Make the difference!**[56], instead evaluates the environmental load of the user expressing it in mass of CO_2 equivalent, then in terms of Carbon Footprint. The overall impact of an individual is calculated starting from primary emissions (home and transport/travel sectors) and secondary emissions (food, purchase of goods and services, entertainment, etc.). The calculator asks the user what his habits are in home management, transport, supply and services, providing a final result in terms of tons of CO_2 equivalent per year.*
*The COOP calculator, the **Expenditure Footprint**[57], finally calculates the environmental impact of the user's eating habits on the basis of their weekly expenditure. In fact, it is possible to simulate the expenditure through the computer, referring to the main types of products that end up in the shopping cart and calculating the environmental impact in terms of Carbon Footprint. Multiplying the recommended quantities of each food that makes up a balanced diet (suggested by the INRAN nutritional guidelines (now CREA - Food and Nutrition) by its environmental impact, you get the average impact of the weekly diet. Once you have specified the number of family members and the days when shopping is done, you proceed to the selection of foods, indicating the relative quantities. The calculator compares the average impact of the weekly diet with that obtained from the inputs entered by the user and provides tips and suggestions of how to follow a healthier diet, highlighting how it is always necessary to consume in a balanced way all categories of foods.*

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FREQUENTLY ASKED QUESTIONS

IT IS TRUE THAT TO PRODUCE A KILOGRAM OF MEAT DIVERSE KILOGRAMS OF VEGETABLE FOOD ARE CONSUMED, POTENTIALLY INTENDED FOR HUMAN FOOD?

The feed intended for farm animals is mainly composed of a mixture which includes cereals (corn, wheat, barley) and legumes (such as soybeans) according to a diet that is established on the basis of needs related to the type and purpose of breeding. It should not be forgotten that for bovine breeding we use 80% of the plants (stem and leaf in the case of corn silage), that is not edible by humans.

Rations for animals are very often derived from crops that are not used for human consumption (corn silage, protein peas, pasture grass, alfalfa, clovers or hay). Ruminants, moreover, thanks to the microflora that dwells in the rumen, are able to transform the non-protein nitrogen present in foods into proteins of high biological value. At the same time, we are moving more and more towards the decrease, as far as possible, of the use of edible proteins for humans as livestock feed. To achieve these objectives, farms and feed mills work in close contact, in order to increasingly optimise the use of crop residues and by-products, trying new combinations that keep conversion efficiency equally as high.

IS IT TRUE THAT MEAT PRODUCTION IMPACTS MORE ON THE ENVIRONMENT THAN OTHER FOODS?

Yes, meat is one of the foods with the greatest environmental impact per kg. This is due to the fact that its production chain is undoubtedly the most complex. Unlike products of farm origin in fact, to produce meat, a "double passage" is necessary: first, food is produced for the animals, then the process of protein conversion is started during breeding. A very particular aspect, especially for the bovine supply chain, is linked to enteric fermentations generated during digestion: being mainly made up of methane, they represent a significant contribution to greenhouse gas emissions; however, some studies (Lauder A.R. et al., 2013) argue that the relative impact of methane on climate change is overestimated due to its short duration in the atmosphere respect to CO_2. Therefore, the question is not correct. As Paracelsus said, in fact, it is the dose that makes a poison: it does not make much sense to classify foods according to their impact per kg for two fundamental reasons. The first is that the production chains are extremely integrated and depend on each other, making it essentially impossible to think about the existence of agri-food production without animal husbandry. The second is that if you follow a balanced food consumption, for example consistent with the Mediterranean Diet model, the weekly impact of the diet is not particularly disadvantaged by a moderate consumption of meat, cured meats and other foods deriving from animal supply chains. As represented by the Environmental Hourglass.

IS IT TRUE THAT THE FOOTPRINT OF BARN BREEDING IS HIGHER THAN THAT AT PASTURE?

*The data circulating on the water footprint of meat (15,000 l/kg of beef) are those published by the Water Footprint Network (www.waterfootprint.org), which provide for the sum of three different contributions: **blue water**, , taken from the water table or from surface water bodies, **green water**, the rain water evapotranspiring from the soil during the growth of crops, and the **grey water**, the volume of water necessary to dilute and purify the production water discharges. This method of accounting presents some critical issues, especially when one looks only at the sum of data: since the "green" contribution is generally the highest one, it happens that **pasture breeding** is that characterised by a **higher water footprint**. A second substantial criticality*

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is that, by examining the overall value and ignoring the local context in which production and breeding take place, the withdrawal of water is not related to the availability of that territory.

BARN BREEDING IS ACCUSED OF BEING A CAUSE OF WATER POLLUTION. IS THIS THE CASE?

Animal manure is very rich in nitrogen and its uncontrolled spreading on the soil could actually generate environmental problems to the water table. However, the Nitrates Directive sets a very clear limit to this problem by defining maximum pollutant thresholds that the land can receive depending on whether or not it is near vulnerable areas.

To overcome this problem, sewage, livestock waste and slaughter waste are increasingly used for the production of biogas and, therefore, of thermal and electrical energy. This happens thanks to biomass anaerobic digestion plants that are able to treat, in addition to the sludge products from sewage treatment plants, livestock and slaughterhouse waste such as rumen content and blood. The biogas produced is normally used by the same companies through cogeneration plants aimed at the combined production of electricity and heat with two advantages: on the one hand the ***production of energy without use of fossil fuels****, on the other the reduction of waste to be treated. The result of anaerobic digestion (digestate) is a product suitable for use in agriculture (organic fertiliser for organic production)[58].*

WHAT OTHER PRODUCTS ARE OBTAINED FROM BREEDING FARMS APART FROM MEAT?

Meat production is only part of what is obtained from farm animals. Bags, shoes, medical devices and heart valves, or soaps, fertilisers, natural rennet and biogas: these are just a few examples of the enormous quantity of products and by-products which are obtained from the livestock sector. The amount of meat obtained from an animal to be used for human food consumption varies according to the type of animal. In the case of cattle, for example, the yield after meat stripping is about 33-35%, while for pigs the percentage varies from 49 to 52%. But since nothing of an animal is thrown away, over the centuries many ways have been found to valorise that obtained from farms.

The cow and sheep skin, just to give some examples close to everyone, is used for durable goods such as hides and leather, which in turn serve to produce shoes, handbags, belts or cover sofas and car seats. The bovine and pork fat, on the other hand, is used in the cosmetic industry to make soap or cosmetics. Smaller quantities, but of great importance, are used in the field of medicine. Bovine and pork provide the pericardial tissue used for the preparation of medical devices such as heart valves or medicines such as heparin, while bones and rind are very useful in the pharmaceutical field for drug encapsulation. Natural rennet (the only coagulant allowed for the production of PDO cheeses such as Grana Padano and Parmigiano Reggiano) is produced by the dairy industry thanks to the abomasum of cattle, the last of the four cavities of which the stomach of ruminants is composed. Even chickens provide important products in addition to their meat. Like fat, used for the production of feed and, in increasing quantities, for the production of biodiesel.

IT IS TRUE THAT DIETS WITH A HIGH MEAT CONTENT PRODUCE MORE GREENHOUSE GAS THAN VEGETARIAN DIETS?

There is no doubt that meat is the food that, per kilogram, has a greater impact than foods of vegetable origin, so a dish based on animal protein impacts more than a vegetarian one. However, the judgment should not be done on a single dish, but on the life cycle of the product, which is very different between plants and animals (bovine: 18-25 months, chicken: 1-2 months, pig: 9-11 months, salad: 1 month, tomatoes: 2 months).

In a balanced diet that involves the consumption of all foods, moderate consumption of meat does not substantially increase the environmental impact over a reference period of time, such as a week.

WHAT IS THE ENVIRONMENTAL HOURGLASS?

Proper nutrition should pro-

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vide for a balanced consumption of all available foods. If you follow the consumption advice suggested by the Mediterranean Diet model, the average weekly impact of meat is aligned with that of other foods, for which the unitary impacts are lower but the quantities consumed generally higher. This is the concept represented by the Environmental Hourglass, obtained by multiplying the environmental impact of food (for simplicity the Carbon Footprint) for the weekly quantities suggested by the current nutritional guidelines INRAN, now CREA - Food and Nutrition. According to this representation, eating meat in just the right amount does not significantly increase an individual's environmental impact. After all, a sustainable lifestyle should also be measured by other choices such as mobility, energy consumption, clothing, free time habits.

ARE ZERO KILOMETRE PRODUCTS THE MOST SUSTAINABLE?

The topic of food distribution is interesting both for the social implications linked to the protection of local communities and traditions and for environmental ones. The concept of food at zero kilometre is in fact spreading, to which the equation "zero-kilometre product = product with low environmental impact" is associated. Also in this case a simplistic view of the problem can lead to interpretations that are not entirely correct. Focusing only on environmental aspects, once again considering the Carbon Footprint in an exemplary way, we can easily demonstrate how the impact of food distribution is relevant only in very few cases. In fact, if it is true that the use of a truck involves a high CO_2 emission per kilometre, it is also true that the quantity of goods transported is high and therefore the impact per kilogram of product is rather limited. Given the low importance of transport, therefore, it is not always true that zero-kilometre productions have a lower environmental impact than to traditional productions. In fact, it could happen that a "far away" system is more efficient from an environmental point of view than a "near" one, and therefore the impacts due to transport are largely offset by lower production costs.
This is the case, for example, of some agricultural raw materials that, when they are grown in production areas, make cultivation very efficient: strawberries in Sweden would require energy costs for greenhouses that would not necessarily make them less impactful than those grown in Romagna and transported by truck. This does not mean that local productions are not to be preferred, but it is important to observe how this choice is often associated with other (important) advantages, such as cultural, economic and territorial valorisation.

WILL THOSE WHO DON'T EAT MEAT SAVE THE PLANET?

Since the correlation between eating habits and environmental impacts is now demonstrated by many scientific and popular publications, the question that arises is whether controlling and reducing one's food impacts can be considered "sustainable". In fact, it would be interesting to extend the concept of sustainability to the whole lifestyle, of which nutrition represents an important but not unique variable. More and more frequently it is heard said that becoming a vegetarian is the only way to save the planet. In fact, often, those who choose not to eat meat do so for environmental reasons, before even ethical reasons.
Yet eating meat in the right quantity or not eating it at all does not substantially modify one's own overall environmental impact. Other factors are more relevant to the overall environmental impact of an individual.
The choice of car, for example, can lead to important environmental repercussions: the difference in impact between a car with high horsepower and one with average power can be more than 500 tons of CO_2 per year, a value much higher than the potential benefit associated with food choices. From this data it is evident how "being sustainable" cannot be reduced to a single choice, but should be the result of a homogeneous behaviour, attentive to the many implications. A further observation is useful to understand how some of the cases presented are relatively simple to implement, as they are based on an immediate choice (such as the purchase of a car), while oth-

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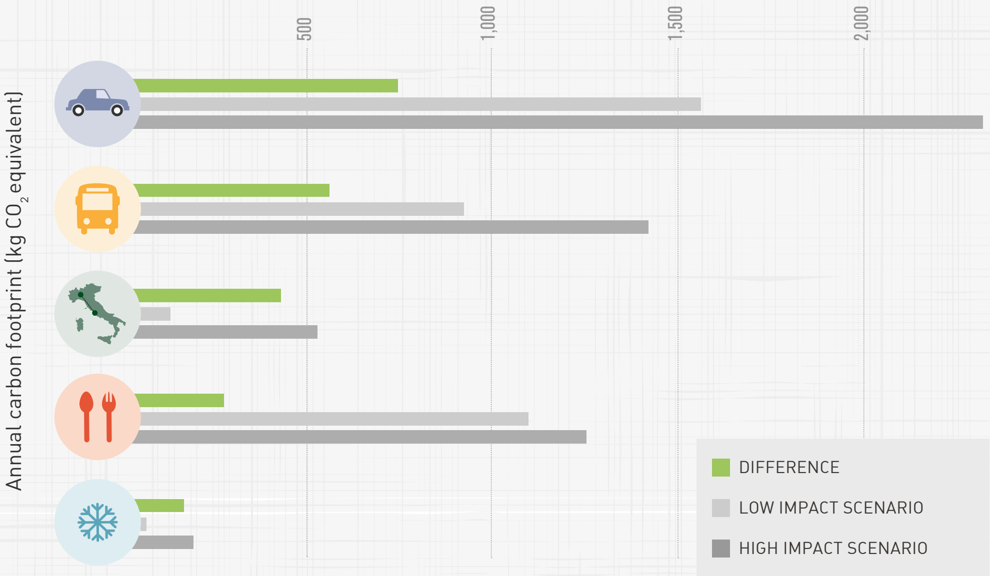
ers are more complex because they are linked to external factors or habits and behaviours that, like food choices, require different times. We should therefore adopt a 360 ° sustainable lifestyle through simple actions, such as trying to reduce consumption in your home (so not overheating in winter or overcooling in summer), choosing clothes suitable for the season.



	CHOICES AND BEHAVIOUR	LOW IMPACT SCENARIO	HIGH IMPACT SCENARIO
	Choice of car with which you travel 15,000 km per year	Car of 100 g CO_2/km **1.500 kg CO_2**	Car from 150 g CO_2/km **2.250 kg CO_2**
	Travelling in the city: 40 km a day for 5 days a week and 48 weeks a year	Use of bus **890 kg CO_2**	Use of your own car
	Business trips Rome – Milan	6 train journeys **120 kg CO_2**	6 plane trips
	Food choices	Diet of **23 kg CO_2** per week	Diet of **25 kg CO_2** per week
	Cooling an office	Use of a fan **12 kg CO_2**	Use of an air conditioner **200 kg CO_2**

Environmental impact per person, associated with some situations of "common life". The presented data are calculated on the basis of indicative hypotheses

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