Sustainability Project
Legumi.net® - Yousustain.net®
Horta - Andriani - Terre Bradaniche

Description

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Legumi.net® is an interactive web tool for the cultivation of grain legumes (in particular chickpeas, lentils and peas) according to the principles of sustainable farming and precision. It is set up as a DSS, or rather an expert Decision Support System, a system that brings together a range of sources of information in order to produce simple and effective suggestions and alarms. A DSS does not take the place of an agricultural technician or businessperson, but rather integrates their experience, providing them with additional information allowing them to improve their decision-making processes with regards to the agronomic management of crops.

First implemented by Horta Srl in 2017, this consultation instrument can be accessed 24 hours a day and is available in real time via web-based platform, smartphone or tablet with access via a username and password.

What is a DSS?

A DSS is a computer platform that collects real-time crop data via sensors and scouting instruments (1), organises this data in cloud systems (2), processes the data collected with advanced modelling and big data techniques (3), and automatically integrates said data producing information, alarms and support for decision-making. Users can make use of this information for precise agronomic management of crops (5). The database also collects data regarding cultivations (6) in order to create a continuous flow of updated information between the crop, the DSS and the user (Figure 1).

Fig. 1: Elements that make up a DSS.

Legumi.net®

Legumi.net® is a fully innovative form of technical support because:

- it has a system architecture the allows for information regarding the crop and the cultivation environment to be fed into the algorithms and calculation processes in a continuous manner via sensors and monitoring activities.
- it is designed in a holistic manner that takes into account all the aspects of cultivation.
- it does not require any software to be installed on your PC. The system provides for the constant updating of the applications.
- it is capable of converting complex climatic and cultivation processes into simple and clear operational field decisions.

Legumi.net® is aimed at farms that cultivate legumes and aims to increase the yield, quality and healthiness of the products, reducing production costs and negative impacts on health and the environment in line with the modern principles of economic, environmental and social sustainability, with integrated production and IPM (Integrated Pest Management). The use of the DSS also allows users to actively keep the entire production process under control, guaranteeing better results for the agro-industrial sector. Legumi.net® allows contributors to in-field production to manage and monitor the production chain on a daily basis, receiving information on the progress of crops and the cultivation techniques used by suppliers, as well as quantify the ecological impact of raw materials entering processing plants.

Legumi.net® provides both economic and ecological value as it aims to provide clear, reliable and rapid decisional support aimed at increasing awareness of processes that regulate the ecosystem of the field, improve the quality of decisions regarding field management, make the most of available technical means, optimise the use of production factors, reduce production costs and carry out all possible actions in order to increase quality and quantity. Lastly, thanks to the relationship yousustain.net, the DSS aims to quantify and reduce environmental impact and preserve biodiversity.

Agronomic support provided by legumi.net®

Weather trends It is possible to access the relative weather station to receive real-time weather information, as well as trends for previous months, and 7-day forecasts for air, temperature, relative humidity and leaf wetness for the cultivation site.

Soil preparation and nitrogen, phosphate and potassium fertilisation. Legumi.net® provides advice on fertilisation with the main macro-elements (nitrogen, phosphate and potassium) both in pre-seeding and coverage using the soil nutrient balance method. This allows for the optimisation of timing and the quantity of fertiliser to be applied according to the type of soil, the weather, the expected yield, the type of crop and crop rotation.

Sowing. Legumi.net® provides information on the precise dose of seeds in accordance with the variety chosen, the type of soil, the weather, the geographic position of the field and the sowing data.

Crop development. Legumi.net® provides indications on the gradual progress of the phenological stages of the crop.

Weed management. Legumi.net® provides indications for both integrated and organic cultivation. With regards to integrated cultivation, the system provides information on permitted herbicides as well as details on the application of products in accordance with foresat weather conditions.

Plant protection. Legumi.net® allows users to monitor hazardous organisms such as fungi (*Ascochyta e Antracnosi*) and insects (*Helicoverpa armigera*), aiding the farmer in assessing the need for intervention and choosing the most suitable plant protection products.

Water balance. The DSS allows for the estimating of soil water levels based on the analysis of the soil, crop root depth and rainfall recorded by the relative weather station, thus avoiding hydric stress in dry periods.

Support from legumi.net for the valorisation of agricultural added value

Traceability. The legumi.net® register of Cultivation Operations allows for the recording of all cultivation operations carried out in the field, from working the soil to the delivery of the grain. This allows for an overall view of all farm management interventions. **Sustainability.** legumi.net® allows for the assessment of the environmental impact of agricultural production in the field and in the company through the association with yousustain.net, a collection of indicators (Health, Soil, Air, Biodiversity, Energy, Water) that estimate the environmental impact of the cultivation.

Yousustain.net®

Yousustain.net® is a simple, complete and precise instrument for measuring the sustainability of agricultural production comprised of a collection of indicators capable of quantifying the sustainability of crop choices both in the field and in the company. The indicators on which Yousustain.net® is structured regard human health, air, soil, conservation of biodiversity, energy consumption and water use.

The instrument quantifies emissions and the use of resources, based on the analysis of the crop life cycle and predominantly agronomic aspects. In fact, alongside the typical indicators from the LCA (Life Cycle Assessment) method such as carbon footprint, water footprint, ecological footprint, acidification and eutrophication, use is also made of agricultural indicators such as carbon sequestration, soil coverage, erosion, efficiency in water use, fuel consumption etc., as well as aspects regarding biodiversity and the assessment of toxicological and eco-toxicological risk generated by chemical products used in the field.

With this new approach, the limits of LCA (reliability of the databases, rigidity of the methods, assessment of purely environmental aspects) can be overcome.

For legumes, the service is currently available for chickpeas, lentils and peas.

Yousustain.net® is an instrument created and implemented by Horta Srl in collaboration with the Cattolica University of Piacenza and with Life Cycle Engineering (LCE Srl) for the LCA indicators.

The calculation method has been certified by CCPB of Bologna and overall consists of 20 indicators.

Political context and use of the environmental sustainability indicators

In Europe, the development of a more environmentally respectful form of agriculture is accompanied by a series of directives and regulations; the main documents are: the regulation concerning the placing of plant protection products on the market (Regulation 1107/2009/EC), the Directive on the sustainable use of pesticides (2009/120/EC), the Directive regarding machinery for pesticide application (Directive 127/2009/EC), the regulation concerning statistics on pesticides (Regulation 1185/2009/EC)., the Water Framework Directive (Directive 60/200/EC), the directive concerning the protection of waters against pollution caused by nitrates from agricultural sources (Directive 676/1991/EC) and the Directive on the sustainable use of pesticides (Directive 128/2009/EC).

Since 2001, the European Directive (Directive 42/2001/EC) is pressing for the implementation of new shared methods for assessing the environmental impact caused by human beings. The directive promotes the use of instruments with the aim of orienting the sector towards a more sustainable and respectful development of the environment. In this context, the assessment of environmental impact through indicators serves as fundamental criteria for justifying or limiting certain agricultural practices and allows or limits the use of certain chemical substances.

Through the Directive on the sustainable use of pesticides for the agricultural sector (Directive 128/2009/EC), the European Commission has imposed the use of IPM (Integrated Pest Management) strategies in European Community countries since January 2014. Among the various rules, this last directive calls for the development of instruments and strategies to mitigate the risk presented through the use of pesticides and the identification of indicators in order to assess the risk for the environment and humans associated with the use of pesticides. Of equal importance is the identification of impact indicators to assess the level of sustainability either reached or feasible by farming companies.

In order to understand how directive 128/2009/EC considers as crucial the use of sustainability indicators, a number of sections of the directive are shown below:

…“ *National Action Plans aimed at setting quantitative objectives, targets, measures, timetables and indicators to reduce risks and impacts of pesticide use on human health and the environment and at encouraging the development and introduction of integrated pest management and of alternative approaches or techniques in order to reduce dependency on the use of pesticides should be used by Member States in order to facilitate the implementation of this Directive.”*

… “*The National Action Plans shall also include indicators to monitor the use of plant protection products containing active substances of particular concern, especially if alternatives are available.”*

… “*Harmonised risk indicators as referred to in Annex IV shall be established. However, Member States may continue to use existing national indicators or adopt other appropriate indicators in addition to the harmonised ones.*

Directive 128/209/EC has therefore done much to promote the use of sustainability indicators as they will become a criteria through which to access public financial contributions of both a European nature and, in the form of direct payments regarding rural development.

In fact the new 2021-2027 common agricultural policy will be ever-increasingly green as it will recognise the importance of developing a solid base of indicators that will allow to verify to what extent the subsidised measures contribute to the reaching of the planned objectives. The availability of reliable and measurable environmental indicators that are, at the same time, sensitive to the impact that actions in the field can realistically have will be fundamental in order to be able to access forms of public support.

It is in this light that the role of yousustain.net® becomes clear, with the development of methods that allow for the use of indicators to assess the level of sustainability reached by field cultivation of a certain crop. By using yousustain.net®, the user has the guarantee of receiving information that enables the recognition of the impact generated by cultivation. The successive study of the results allows for the identification of points of criticality and provides indications on where and how to intervene. In other words, via yousustain.net® it is possible to favour production systems that allow the preservation of environmental resources (soil, water, biodiversity and fertility), reducing the environmental risks related to said agricultural practices, the protection of the health of agricultural and community workers, the creation of food products that are suitable in terms of quality, quantity and - consequentially the protection of financial earnings, as optimisation of resources provides benefits both from an environmental and economic point of view.

With regards to the emission of greenhouse gasses (Ghg) connected to farming activities (soil cultivation, crop fertilisation, animal farming etc.), these are mainly protoxide of nitrogen (N_2O), carbon dioxide (CO_2), methane (CH_4) and ammonium (NH_4).
Through various studies in the cereal sector, Horta has demonstrated that 60-70% of the impact of cultivation is due to the use of fertilisers.
A valid method for the reduction of greenhouse gas emissions is the cultivation of legumes, whose capacity to fix atmospheric nitrogen and transform it into organic nitrogen has been known for some time. This allows for a reduction in synthetic nitrogen units administered to the crops, thus reducing the emission of greenhouse gases.
The application of these and other solutions that reduce the consumption and impact of fertilisers is now imperative as regulations are becoming ever increasingly stringent and the contribution demanded from the agricultural sector to reduce emissions is ever higher. This has been demonstrated with a number of European directives, one of which is the NEC directive (n° 2284/2016), which applies limits on human emissions of various substances including nitrogen oxides and ammonia (NH_3) into the atmosphere. The objective in Italy consists in a 5% reduction in the ammonia emissions for 2005 by 2029. Farming activity is one of the main sources of these substances and therefore the identification and application of agricultural methods and techniques is essential in achieving this goal.
The use of Decision Support Systems (DSS) therefore allows for the optimisation of the amount of fertiliser used and the frequency of administration, in such a way as to considerably reduce emissions into the atmosphere.

Yousustain.net® therefore proves to be a response to the European call to develop instruments that allow farmers to move towards a more environmentally respectful form of cultivation management.

Functionality

Access to the service is exclusively via the website www.horta-srl.com and requires registration to obtain a username and password. For the Terre Bradaniche / Andriani production chain, yousustain.net® can be consulted via the legumi.net® platform.
Functionality in legumi.net® is exclusively for service administrators (Horta, Andriani e Terre Bradaniche); however, in the future, partner agricultural companies may be able to access the results.
The calculator is currently certified by CCPB (appendix 1) for the calculation of environmental

impact via the following indicators: Human Tox Score, Dose area Index, Treatment Frequency Index, Carbon footprint, Carbon sequestration, Ecological footprint, Organic matter, Soil coverage, Erosion, Soil compaction, Biodiversity, Eco Tox Score, Fuel Use, Renewable fuel, Waste, Water footprint, Water supply, Water Use Tech Efficiency (WUTE), Eutrophication and Acidification. These indicators are divided into 6 compartments: health, air, soil, biodiversity, energy and water (Figure 3).

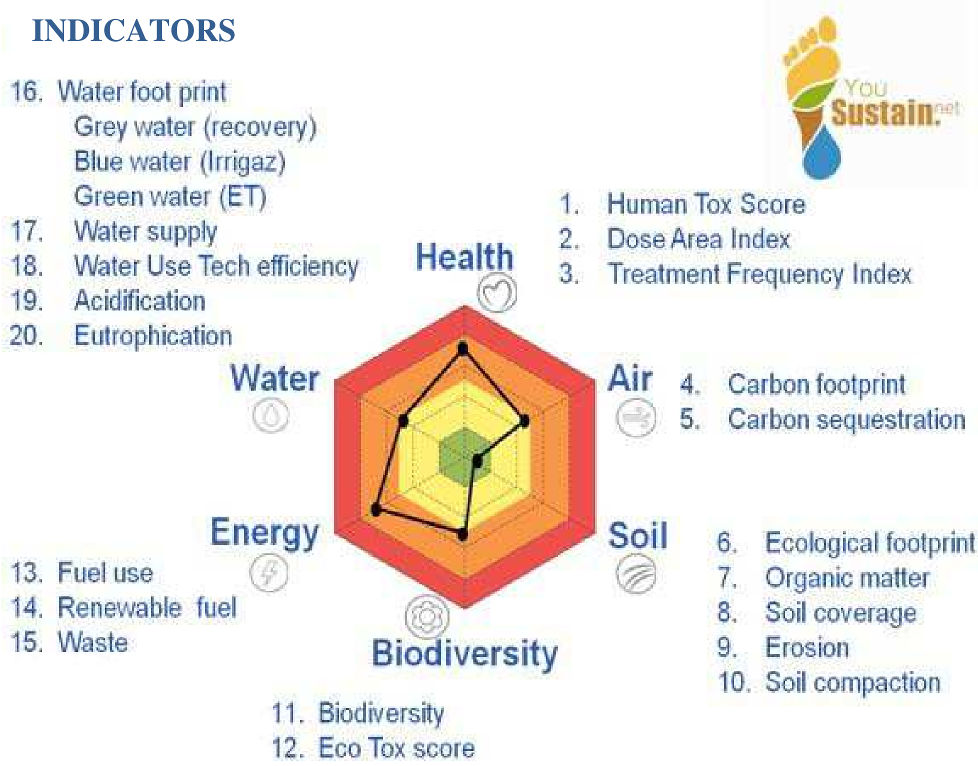

Fig. 3: A chart showing the indicators and the macro categories to which they belong, as well as a draft of the final display of results via a radar chart.

HEALTH

1. Human Tox Score

This indicator assesses the toxicological risk (in terms of hazard) to human health following the use in the field of synthetic chemicals.

The toxicological profile is assessed for all fungicides, insecticides, herbicides, acaricides etc. recorded in the Register of Cultivation Operations.

By law, each plant protection product is attributed with a precise toxicological class and relative risk phrases (hazard statements). Furthermore, the plant protection product is applied in the field at a certain dosage per hectare and this dose is compared with the maximum dose permitted by the ministerial label. The toxicological information (intrinsic hazards presented by the plant protection product) is studied in relation to the dose applied in the field (exposure to hazard) in order to evaluate the overall toxicological risk of the plant protection product used in the field.

The final evaluation takes into consideration all the plant protection products registered in the Register of Cultivation Operations, and the higher the final score, the higher the toxicological risk to the humans in the vicinity of the treated area (farm workers, bystanders and residents).

2. Dose Area Index

This index assesses the chemical exposure caused by each plant protection treatment carried out in the field. Exposure is quantified via comparison of the dose used in the field against the maximum permitted by the ministerial label and/or comparison of the area treated against the total area (the latter corresponding to the area of the production unit).
The application of a dose lower that that allowed according to the label, or the application of a product on an area smaller than the overall area, reduces the negative impact that the chemical molecules have on vegetable and animal organisms that are not the target of the treatment applied.
For example, a treatment carried out with 50% of the maximum allowed dose on 50% of the surface will subject the area of the production unit to an exposure to toxic substances that is 75% lower than a treatment using a full dose on the entire area.
The indicator takes into consideration the dose applied in the field, the maximum permitted dose according to the ministerial label, the surface area treated and the surface area of the entire production unit. The use of reduced doses and the application of the product on portions of the productive unit will guarantee lower exposure to chemicals and increased protection against natural enemies.

3. Treatment Frequency Index

This index assesses the number of times that a portion of land is treated with a plant protection product. All of the treatments carried out on the same portion of land during the farming season are combined. The more treatments carried out, the higher the chemical pressure on the land in question.
The index takes into account the surface area of the entire production unit and the area treated (which can either be lower or equal to the total area).

AIR

4. Carbon footprint

This index quantifies greenhouse gas emissions produced either directly or indirectly by human activity.
Calculation of the carbon footprint takes into account conversion factors issued by the IPCC (Intergovernmental Panel on Climate Change) in the fifth assessment report (AR5-2014). The standards used for reference are ISO 14040-44 and the Product Category Rules (PCR) issued by the International EPD system. The PCR identify specific rules and methods of assessment for each product category.
The main databases used are Ecoinvent 3.4 (2017), Agriffotprint 4.0 (2018) and Industry Data 2.0 (2018).

The carbon footprint can be expressed in two units of measurement: tons of CO2 equivalent/ton of product (when referring to a quantity) or tons of CO2 equivalent/hectare (when referring to a surface). In particular, it measures the impact of the production of goods (for example grain legumes) and all other human activities on the climate, taking into consideration all the greenhouse gases produced by various sources.

The carbon footprint is used to estimate the global warming potential (GWP) of each human activity or system. The identification and the quantification of emissions changes according to the system under examination. For examples, in agricultural systems, the focus is mainly on the emissions created by production and the agricultural use and disposal of fuel, fertilisers and pesticides.

Each greenhouse gas has a factor used to convert all the various types of emission into carbon dioxide"(CO2-eq.).

The carbon footprint is calculated as "carbon dioxide equivalent". A number of factors for the conversion of greenhouse gases (GHG) are used to convert greenhouse gas emission caused by the use of energy (pesticides, fertilisers, fuel, seeds) into carbon dioxide. Greenhouse gases (GHG) (for example carbon dioxide (CO2), methane (CH_4), Nitrous oxide (N_2O), hydrofluorocarbons (HFC), Perfluorocarbons (PFC), Sulphur hexafluoride (SF_6, a number of particulates are multiplied by a conversion factor in order to obtain the overall ecological footprint of a process.

The CO_2 emissions of all the cultivation activities recorded by users of the Register of Cultivation Operations are calculated via algorithms and counted in order to obtain the overall impact of cultivation.

Our instrument calculates the carbon footprint by taking into account the impact of:

1) **fertilisers.** Users enter the fertilisers applied (name and dose per hectare) into the relative field. The system uses the registered name to understand the compounds in the fertilisers and their individual impact. This is then multiplied by the number of doses. Fertilising compounds can be urea, ammonium nitrate, ammonium sulphate, organic nitrogen, phosphate, potassium chloride, etc.

2) **plant health products.** Users record the plant protection products applied in the Register of Cultivation Operations (name and dose per hectare). The system calculates the impact per unit according to the registered name. This is then multiplied by the dose used.

3) **seeds.** Users record the seeds used in the Register of Cultivation Operations (name of variety and dose per hectare). The system calculates the impact per unit according to the species, and this is then multiplied by the dose per hectare to gain the overall impact.

4) **other technical means** (e.g. plastic, paper, wood, steel, etc.) used during cultivation. users record the instruments used in the Register of Cultivation Operations (name and number per hectare).

5) **fuel**. Users record the cultural activities carried out in the field from the working of the soil to harvesting, including transportation of the harvest to the first storage point. For each activity (ploughing, seeding, fertilising, treating, watering, foliage management, harvesting, transportation etc.) the system estimates the fuel consumption on the basis of i) the name of the activity, ii) the slope of the land, iii) the texture of the soil (exclusively for the working of the soil), and iv) the depth the soil has been worked to (exclusively for the working of the soil). For example, for a disc

harrow on clay soil with an inclination of less than 5% and a working depth of 20-25 cm, fuel consumption is estimated at 18 litres/hectare, while for a disc harrow on sandy soil with an inclination of less than 5% and working depth of 20-25 cm used on sandy soil, fuel consumption is estimated at 15.30 litres/hectare.

70% of impact derives from the use of fertilisers. Emissions of Nitrous oxide (N2O) come from the use of nitrogen fertilisers, working of the land, management of manure and cultivation of peat, and its greenhouse effect is almost 300 times that of carbon dioxide (300 is a conversion factor). Methane (CH_4) is generated mainly by fermentation in the digestive systems of cattle, the cultivation of rice, manure and the management of wastewater, and is more than 20 times more potent than CO_2 in terms of its contribution to the greenhouse effect.

Conversion factors are available for estimated emissions over 20, 50 or 100 years. Our instrument takes into consideration conversion factors for an emission period of 100 years (Table 1).

Tab. 1: Conversion factors for methane (CH4) and nitrous oxide (also known as protoxide of nitrogen, N_2O).

Substance	Global Warming Potential Carbon footprint kg CO_2-eq./kg 20 years	Global Warming Potential Carbon footprint kg CO_2-eq./kg 100 years	Global Warming Potential Carbon footprint kg CO_2-eq./kg 500 years
CO_2	1	1	1
CH_4	72	25	7.6
N_2O	289	298	153

The calculation of the indicator is based on internationally recognised variables, parameters and algorithms. An update of the parameters and method of calculation is currently under way.

The formulae used calculate the environmental impact of all the activities carried out and recorded in the Register of Cultivation Operations that result in emissions into the atmosphere of molecules that may contribute to the greenhouse effect.

5. Carbon sequestration

The indicator estimates all the carbon sequestered by vegetable fibre (both above and below ground) during the cultivation season.

The process of photosynthesis transforms molecules of carbon from their gaseous form (carbon dioxide) to their organic form. This process reduces the quantity of CO2 present in the atmosphere, reducing the contribution to the greenhouse effect caused by the same. For each crop, an estimate based on the yield obtained is made of plant growth, and consequently carbon sequestration is calculated as tons of carbon sequestered per hectare.

The capturing of CO2 by plants is in part countered by the amount released into the atmosphere from human activities during cultivation.

Carbon skeletons that make up the vegetable biomass are produced during vegetable growth. The process involves both the edible and non-edible parts of the cultivated plant.

The higher the amount of carbon sequestered, the higher the action to counter the emission of greenhouse gases due to human activity.

SOIL

6. **Ecological Footprint**

The indicator assesses the biologically productive land and water necessary to provide the resources necessary for the production of a determined good or service and absorb emissions released due to said production.
By using this indicator, it is possible to estimate how much land and water would be required to regenerate the resources used by humankind.
The indicator can be expressed in various units according to whether it refers to a quantity or a surface area: global m_2 per hectare or global m_2 per ton of produce collected.
This indicator includes six elements for evaluation:

- The land required to produce energy. This consists of forest land necessary for the assimilation of emissions deriving from the use of fossil fuels (*Energy land*).
- the agricultural land for farmed produce (*crop land*).
- the grazing land necessary for farming (*grazing land)*.
- the forest land required for the supply of wood (*forest land*).
- developed land (*built-up land*).
- the area of sea dedicated to the growth of resources for fishing (*fishing land*).

For agricultural crops, the only items relevant for the calculation of the indicator are *Energy land* and *Crop land*, while all the other items can be considered as unimportant for herbaceous crops.
The calculation of the indicator is based on internationally recognised variables, parameters and algorithms.
The formulae used calculate the ecological footprint of all the activities carried out and recorded in the Register of Cultivation Operations which lead to a direct or indirect consumption of non-renewable resources.

7. **Organic substance**

The indicator assesses the percentage of organic substances present in the soil.
The higher the content of organic substances, the higher the fertility of the land and the durability of the productive process under way.

8. **Soil Coverage**

The indicator describes the number of days per year in which the soil is covered by vegetation or crop residue. The higher the number of days in which the land is covered by organic material, the higher the quality of the soil.
Land which is covered by crop residue will have more organic substances and be less prone to erosion and to the loss of nitrogen through leaching and volatilization.

9. **Erosion**

The indicator estimates the tons of land lost per hectare per year due to erosion caused by

precipitation.
With the use of the methodology implemented by *Wischmeyer and Smith* (1978) and summarised in the USLE (*Universal Soil Loss Equation*) based on the adaptation by Bazzoffi P. (2013), a method of calculation has been set up which takes into consideration:

- mm of precipitation/month.
- the texture of the soil and the organic substance content.
- the slope of the plots.
- soil management (e.g. grassing).
- the water system used.
- the way the soil has been worked.

The higher the level of erosion, the lower the sustainability of the production process.

10. Soil compaction

The indicator assesses the risk of soil compaction. Excessive soil compaction leads to water stagnation and restricted crop development due to poor soil airing (root suffocation caused by compacting). The method adopted considers the effect of 5 factors on soil compaction:

- the texture of the soil.
- precipitation and irrigation.
- the weight of farm vehicles and ruts caused by tyres or tracks.
- the number of times the field is crossed.
- soil management (for example grassed land rather than bare).

A score is attributed to each factor. The higher the resulting average, the lower the sustainability of the soil management method applied.

BIODIVERSITY

11. Biodiversity

The indicator assesses the level of company biodiversity through an assessment of the use of the land. In accordance with the various types of use, it is possible to indirectly estimate the level of biodiversity of the entire farm.
For each possible use of the land, a biodiversity score of between 0 and 100 is assigned, where 0 represents no organisms and therefore an absence of biodiversity, and 100 represents the highest possible level of biodiversity for the area. For example, a tarmacked area would have a biodiversity score of 0, while a centuries-old forest would have a biodiversity score of 100. All other uses of the land would be rated at between 1 and 99.

The biodiversity score takes into consideration infrastructure, herbaceous crops, tree crops, the borders of the plots, ecological areas, uncultivated areas, meadows, pastureland and any water networks present. The scores are then weighted for the relative surface areas in relation to the total surface area of the farm in order to obtain an overall final score.
The higher the final biodiversity score, the higher the diversity of animals and plants present in the farm area.

12. Eco Tox Score

The indicator assesses the eco-toxicological risk (considered as a hazard) to the health of the aquatic and terrestrial ecosystem posed by chemical substances used in the field. The toxicological profile is assessed for all fungicides, insecticides, herbicides, acaricides etc. recorded in the Register of Cultivation Operations.
According to law, each plant health product is attributes with a precise eco-toxicology class and risk phrases (hazard statements). Furthermore, the plant protection product is applied in the field at a certain e per hectare and this is compared with the maximum dose permitted by the ministerial label. The toxicological information (intrinsic hazards presented by the plant protection product) is studied in relation to the dose applied in the field (exposure to hazard) in order to evaluate the eco-toxicological risk of the plant protection product used in the field.
The final evaluation takes into consideration all the plant protection products registered in the Register of Cultivation Operations, and the higher the final score, the higher the eco-toxicological risk to the agricultural ecosystem.

ENGERY

13. Fuel use

This indicator counts the litres of fuel recorded in the Register of Cultivation Operations. The higher the overall level of fuel consumption per ton of product or per hectare, the higher the environmental impact and the impact on the consumption of non-renewable resources.

14. Renewable fuel

The indicator provides an assessment of the willingness of the farm to consume fuel produced from renewable sources.
The higher the percentage of consumption per ton, the lower the environmental impact and the impact on the consumption of non-renewable resources.

15. Waste

The indicator provides an assessment of the management of farm waste. The assessment takes into consideration the following types of waste:

- residues of plant health products and from the washing of equipment.
- crop residue management.
- materials for ties (*).
- nets and sheets (*).
- materials for plant supports (*).
- posts used for tree planting (*).

A score is attributed to each category of waste, and the higher the overall average figure (a score between 0 and 5), the higher the environmental impact and the impact on the consumption of non-renewable resources, and therefore the lower the sustainability for this indicator.
* *exclusively for crops that use these materials*.

WATER

16. Water Footprint H_2O

The indicator measures the water footprint of the cultivation system and therefore the water consumption of the production process. It is expressed in terms of volume of water used, evapotranspired and polluted during the production process.

The indicator can be expressed in various units according to whether it refers to a quantity or a surface area: m^3 of water per ton or m^3 of water per hectare, or litres of water per ton or litres of water per hectare.

Specifically, this indicator is made up of three components:

- Green Water: assessing the water that evapotranspires from the plants over the entire crop season and therefore the rainwater used by the plant.
- *Blue Water:* which takes into account any irrigation water used by the production system, including industrial consumption for the manufacturing of fertilisers and plant health products used in the field.
- *Grey Water:* which is the water required to dilute the contaminants present in the soil system water until they reach a level permitted by law or their natural concentration.
  This sub-indicator also takes into account the water necessary in order to dilute water polluted by nitrogen lost during leaching or through surface runoff caused by heavy precipitation.

The calculation of the indicator is based on internationally recognised variables, parameters and algorithms. The formulae used calculate the water consumption of all the activities carried out and recorded in the Register of Cultivation Operations which lead to a direct or indirect consumption of water.

17. Water supply

The indicator assesses the sustainability of the type of irrigation water used in the field.
Sources of irrigation water that favour the use of wastewater, rainwater or desalted water are considered to be more sustainable than water sourced from surface or underground reservoirs.

18. Water Use Technical Efficiency (WUTE)

The indicator assesses the sustainability of the irrigation method used in the field.

Methods that reduce waste, such as localised irrigation and spraying with large irrigation booms, are considered to be more sustainable than methods such as submerging and flood irrigation, which are low in sustainability due to their lack of efficiency.

19. Acidification

The indicator quantifies emissions into the air of acid gases with acidifying properties, such as nitrogen oxides (NO_X), sulphur oxides ((SO_X) and NH_3 released by production activities (such as, for example, combustion of petroleum products and the use of fertilisers).

When combined with water vapour in the atmosphere, these substances produce acid rain that

alters aquatic ecosystems and scours nutrients from the soil.
Acidified water basins are less hospitable for a range of animal and plant species which, in situations of excessive accumulation of oxides, can also die, reducing the aquatic biodiversity of the area. The indicator takes into consideration all of the potential substances responsible for the acidification of water and soil, such as sulphur dioxide (SO_2), sulphur trioxide (SO_3), nitrogen dioxide (NO_2), ammonia (NH_3) and nitrous oxide (No),as well as hydrochloric acid (HCl) and hydrofluoric acid (HF), all substances that can lead to acid rain and the progressive acidification of the soil.
The reference substance is sulphur dioxide (SO2) and the indicator can be expressed in various units of measurement according to whether the amount in question is a quantity or surface area: kg of SO_2 equivalent/ton of product or kg SO_2 equivalent/hectare. The word equivalent will hereinafter be abbreviated as "eq". Each substance with acidifying properties has a conversion factor allowing all of the various types of substance emission to be expressed as sulphur dioxide.
The conversion factors allow for a value of overall emission of SO_2eq. to be obtained, therefore obtaining an assessment of potential acidification.
For example, a molecule of NH_3 has an acidifying effect of 1.88 molecules of SO_2, while a molecule of protoxide of nitrogen (N_2O, derived from the volatilisation of nitrogen distributed in the field) has an acidifying effect of 0.7 molecules of SO_2 (Table 2).

Tab. 2: Conversion factors for various substances responsible for the acidification of ecosystems.

Substance	Acidification potential (AP_i in kg SO_2-eq./kg)
SO_2	1
NO	1.07
N_2O	0.7
NO_x	0.7
NH_3	1.88
HCl	0.88
HF	1.6

The calculation of the indicator is based on internationally recognised variables, parameters and algorithms. The formulae used calculate the potential acidification deriving from of all the activities carried out and recorded in the Register of Cultivation Operations that result in emissions into the atmosphere of highly acidifying strength.

20. Eutrophication

The indicator quantifies the effect on the aquatic ecosystem of the artificial addition of phosphate and nitrogen nutrients to the soil. These nutrients are supplied via fertilisers used during cultivation.
Quantities that exceed the actual requirements of the crops and/or particularly rainy seasons can lead to an excessive quantity of nitrates and phosphates in the aquatic environments surrounding

the cultivated areas, creating consequential toxicity (an asphyxial and excessively nutrient-loaded aquatic environment) for aquatic organisms.
The indicator takes into account all the potential substances responsible for the eutrophication of marine and fresh water, such as phosphate ion (PO_4^{3-}), from phosphate fertilisers, and nitrogen dioxide (NO_2), ammonia (NH_3), nitrous oxide (NO_x) and nitrate (NO_3) from nitrate fertilisers; all substances that can lead to an excessive accumulation of nutrients in surface fresh water through their progressive eutrophication.
The reference substance is phosphate ion (PO_4^{3-}) and the indicator can be expressed in various units of measurement according to whether the amount in question is a quantity or surface area: kg of PO_4 equivalent/ton of product or kg PO_4 equivalent/hectare. The word equivalent will hereinafter be abbreviated as "eq". Each substance with eutrophying properties has a conversion factor allowing all of the various types of substance to be expressed as phosphate ion.
The conversion factors allow for a value of overall emission of PO_4eq. to be obtained, therefore obtaining an assessment of aquatic eutrophication.
For example, a molecule of NH_3 has a eutrophying effect equal to 0.35 molecules of PO_4, whereas a molecule of phosphoric acid has a eutrophying effect of 0.95, therefore almost the same as a molecule of phosphate ion.

Tab. 3: Conversion factors for various substances responsible for the eutrophication of aquatic ecosystems.

Substance	Eutrophication (kg PO_4-equiv./kg)
PO_4	1
NO_2	0.13
NO_3	0.1
NH_3	0.35
H_3PO_4	0.95
N (in the soil and in the water)	0.42
P (in the soil and in the water)	3.06

The calculation of the indicator is based on internationally recognised variables, parameters and algorithms.
The formulae used calculate the aquatic eutrophication deriving from of all the activities carried out and recorded in the Register of Cultivation Operations that result in the dispersion of phosphate and nitrogen substances with eutrophying effects into water.

Methodological steps in the use of yousustain.net® via legumi.net®

1) Creation of Production Units in legumi.net® and insertion of company data: general aspects.

The use of the impact calculator requires the initial provision of information regarding the cultivated surface for which environmental impact is to be calculated. In order to obtain the calculation of environmental sustainability, each user needs to create a Production Unit in legumi.net®.
As well as completing the Production Units, the user is also required to complete the company information. Once the assessment of environmental impact has been obtained, this allows a report to be printed with the impact values combined with individual personal and geographic details. In further detail, by clicking in the relative section, it is possible to view a screen where information regarding the company, the registered headquarters and the legal representative must be recorded together with information of an environmental nature regarding the use of fuel and the management of waste, as well as information regarding the management of agricultural land.

2) Completion of the Register of Cultivation Operations and calculation of sustainability indicators

For each Production Unit, the Register of Cultivation Operations allows the recording of all the operations carried out in the field, from the working of the soil to the consignment of the product resulting from the Production Unit. Furthermore, at the end of the season, it allows for the printing in PDF format of all the recorded operations, in order words the traceability documentation and the farming logbook. The values relating to environmental impact can only be viewed if the Register of Cultivation Operations is completed correctly and the final yield is recorded.

3) Impact consultation

Once the Register of Cultivation Operations has been completed, by using the icon, the user (not the farm, but rather Andriani, Terre Bradaniche and Horta) can view the impact values for the individual indicators and/or an overall assessment of the entire Production Unit. The impact of the indicators (individually or grouped) can be viewed via a radar graph (figure 5) or in table form (figure 6). Further detail can be accessed by viewing graphs describing the score obtained by each indicator in a scale from 0 to 5 (figures 7, 8 and 9) and graphs that describe the evolution over time of the indicator throughout the entire crop season) figures 10 and 11).
The results of the environmental impact indicators can be viewed:

- all together in a single document.
- as individual indicators.
- as an aggregation of indicator groups belonging to a determined category.

Furthermore, the results of the environmental impact indicators can be viewed:

- by individual Production Unit.
- by groups of different Production Units.
- by all the Production Units for a single crop.
- by all the Production Units belonging to a farm.

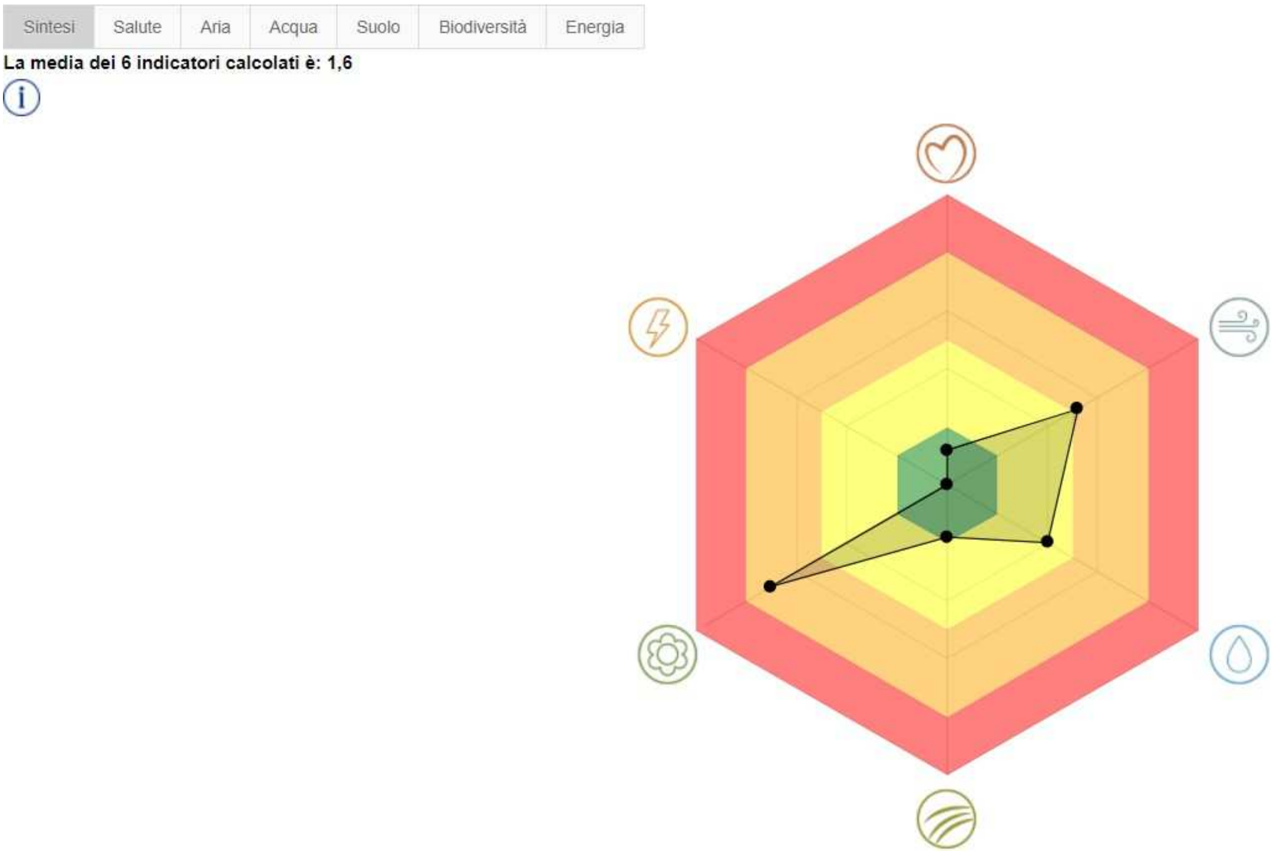

Fig. 5: example of a view of the macro categories of sustainability indicators.

Sintesi | Salute | Aria | Acqua | Suolo | Biodiversità | Energia — Caratteristiche UP | Tabella dati

Comparto		Punteggio (0 - 5)	Valore	Unità Di Misura
Salute		**0,6**		
	Human Tox Score (HTS)	0,0	4	-
	Dose Area Index (DAI)	0,0	0,5	-
	Treatment Frequency Index (TFI)	2,0	2	-
Aria		**2,6**		
	Carbon Footprint (CF)	2,0	0,266	t CO_2 eq/t di produzione
	Carbon Sequestration	5,0	1,212	t di Carbonio/ha
Suolo		**0,9**		
	Ecological Footprint (EF)	5,0	2,489	global ha/t di produzione
	Sostanza organica	-	-	%
	Soil Coverage	0,0	221	giorni
	Erosione	0,0	0	t suolo/ha
	Soil compaction	1,3	1,3	-
Biodiversità		**3,5**		
	Biodiversity	5,0	0	-
	Eco Tox Score (ETS)	0,0	4,8	-
Energia		**0,0**		
	Fuel use	0,0	30,8	l carburante/ha
	Renewable fuel	-	-	-
	Waste	-	-	-
Acqua		**2,0**		
	Water Footprint	5,0	2.400	m^3 acqua/t di produzione
	Water supply	0,0	0	-
	Water Use Technical Efficiency	0,0	0	-
	Acidification	0,0	0,003	SO_2 eq t/t di produzione

Fig. 6: example of a view of the macro categories and the sustainability indicators with their relative scores and absolute values.

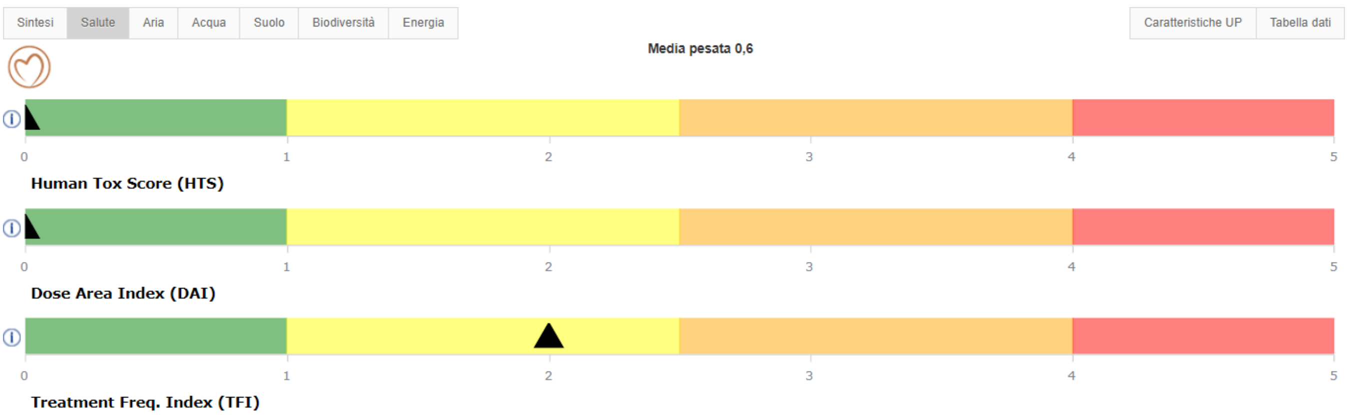

Fig. 7: example of a view of the scores for the three indicators belonging to the compartment for "Health".

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From research to field

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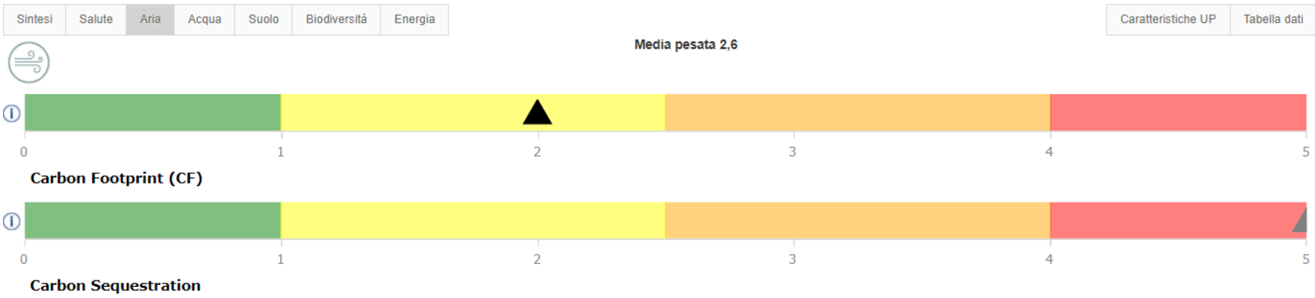


Fig. 8: example of a view of the scores for the two indicators belonging to the compartment for "Air"

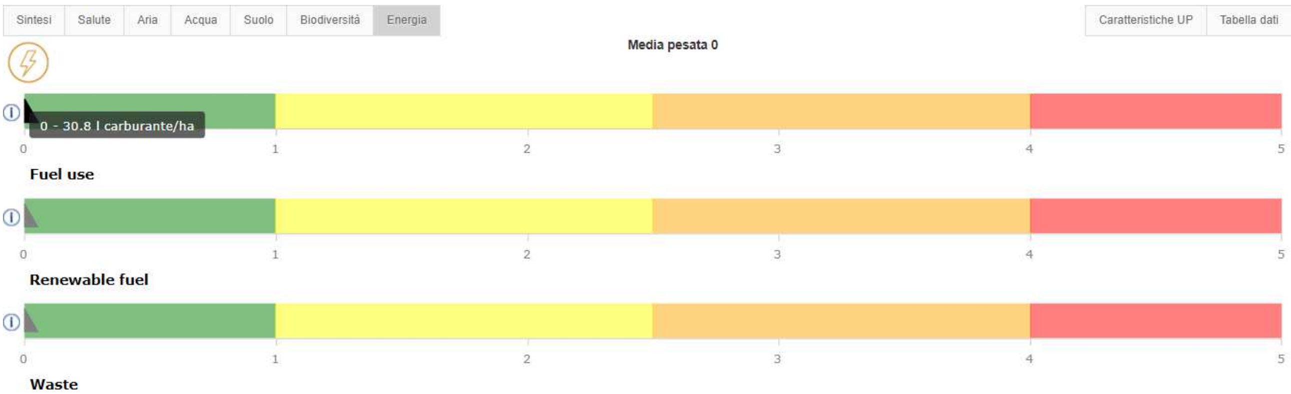


Fig. 9: example of a view of the scores and the values for the indicator via a tooltip that appears when the mouse pointer is near a black triangle.

Figures 10 and 11 below describe the detailed graphs displaying how certain indicators evolve over time. If a user registers the activities carried out in the field during the crop season, it is possible to monitor the progressive increase of certain impact indicators. This can be of great potential interest in understanding what activities and choices have the most impact, therefore allowing the identification of technical practices or means to be abandoned and those that on the contrary are to be encouraged as they are more sustainable.

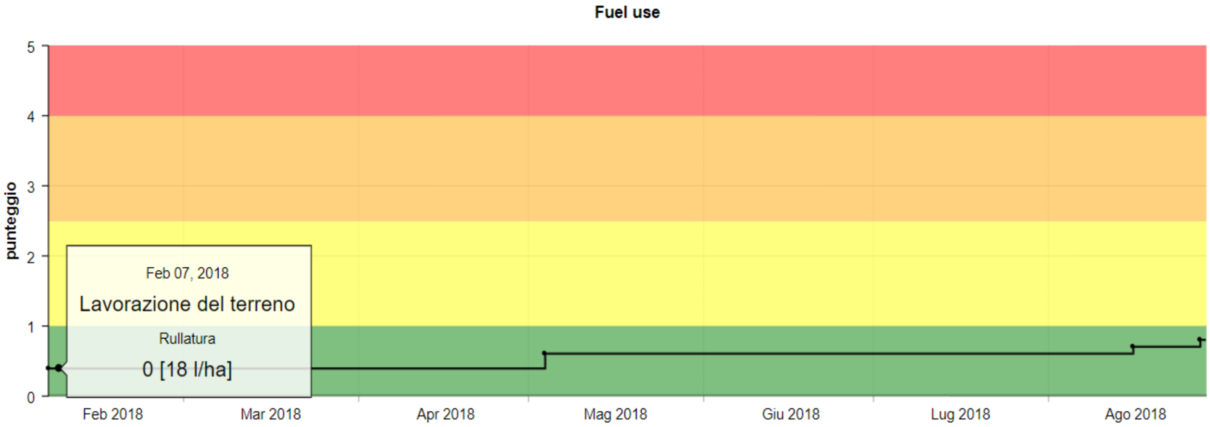


Fig. 10: example of a detailed view of the score for the "Fuel use" indicator. The tooltip shown appears when the mouse indicator is near to the black point on the line. Each point corresponds to a cultivation activity recorded in the Register of Cultivation Operations.

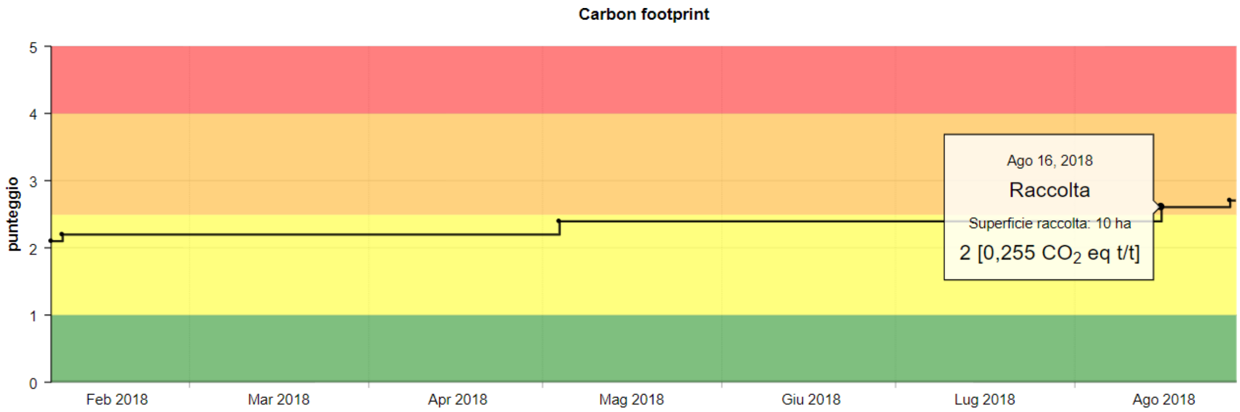


Fig. 11: example of a detailed view of the score for the "Carbon Footprint" indicator. The black line indicates the progressive increase in the indicator over the course of the season.

Yousustain.net® therefore allows for a true quantification of the impacts and overcome sustainability certification based on self-certification and imprecise methods for the assessment of impacts that do not take into account the validity of the actual operations carried out in the field.

Appendix 1: Yousustain.net® product certification

CCPB SRL
Viale Masini 36 - 40126 Bologna
Tel. 051/6089811 fax 051/254842 e-mail ccpb@ccpb.it
Registro Imprese BO P.IVA e CF 02469721209 – REA N.441882 Capitale Sociale €. 706.920 i.v.

AREA CERTIFICAZIONE DI PRODOTTO
PRODUCT CERTIFICATION BRANCH

Certificato N° *Certificate No.*	03/2016/SE	Revisione *Revision No*	01

SI ATTESTA CHE IL SERVIZIO
This is to certify that the services

YOUSUSTAIN.NET™

DELL'AZIENDA
OF THE COMPANY

HORTA SRL

INDIRIZZO SEDE LEGALE E OPERATIVE
REGISTERED AND OPERATING OFFICE

Via Egidio Gorra, 55 – 29122 Piacenza

SONO CONFORMI ALLA NORMA TECNICA
COMPLY WITH THE STANDARD

DTS 01 REV. 0

"Documento tecnico di servizio – Servizi web interattivi"

Data prima emissione *First issue date* 2016/06/01	Data di modifica *Modification date* 2019/06/01

CCPB SRL
Amministratore Delegato
General Manager
FABRIZIO PIVA

Il presente certificato è valido a condizione che il licenziatario operi in conformità a quanto previsto dalla Norma Tecnica di riferimento e rispetti i documenti contrattuali stipulati con CCPB. La validità del presente certificato è subordinata alla sorveglianza periodica effettuata da CCPB. L'elenco delle organizzazioni coperte da certificato è disponibile presso la sede di CCPB.
Lo stato di validità del presente certificato può essere verificato consultando il registro dei prodotti certificati su www.ccpb.it; eventuali ulteriori richieste possono essere indirizzate a: CCPB SRL Viale Masini 36 – 40128 Bologna Tel. +39-051-6089811 Fax. +39-051-254842 e_mail ccpb@ccpb.it.
Il certificato autorizza l'azienda a rilasciare Dichiarazioni di Conformità per i prodotti oggetto di certificazione.
This certificate is valid on condition that the licensee fulfils the requirements of the applicable standard and of the contractual agreement signed with CCPB. The validity of this certificate is subjected to periodical surveillance of CCPB. The list of the organizations covered by certificate is available at CCPB head office.
The validity of this certificate can be verified on the register of certified products available on www.ccpb.it; further information can be forwarded to: CCPB SRL Viale Masini 36 – 40126 Bologna Tel. +39-051-6089811 Fax. +39-051-254842 e_mail ccpb@ccpb.it.
The certificate authorizes the company to issue declarations of conformity only for the products listed in the certificate.

Pag. 1 di 1

Sustainability Project
Legumi.net® - Yousustain.net®
Horta - Andriani - Terre Bradaniche

Results section

Crop year 2020

2 April 2020

HORTA S.r.l.
Registered Headquarters: Via Egidio Gorra 55, 29122 Piacenza
Operational Headquarters: Via Sant'Alberto 327, 48123 Ravenna - c/o Az.
Agricola Cà Bosco VAT n./Tax Code 01529030338 - REA: PC-0170291 - Share
Capital €30.000,00 fully paid-up

Spin Off di
UNIVERSITÀ CATTOLICA del Sacro Cuore

Contents

PU: Production Unit
RCO: Register of Cultivation Operations
Standard Humidity Chickpeas 11%
Standard humidity Lentils 11%
Standard humidity peas 14%
Standard impurity threshold Peas 7%
Impurity threshold peas 7%
Impurity threshold peas 7%
Yousustain.net® score:
Range between 0 and 5.0 indicates maximum sustainability, while 5 indicates no sustainability.

General overview

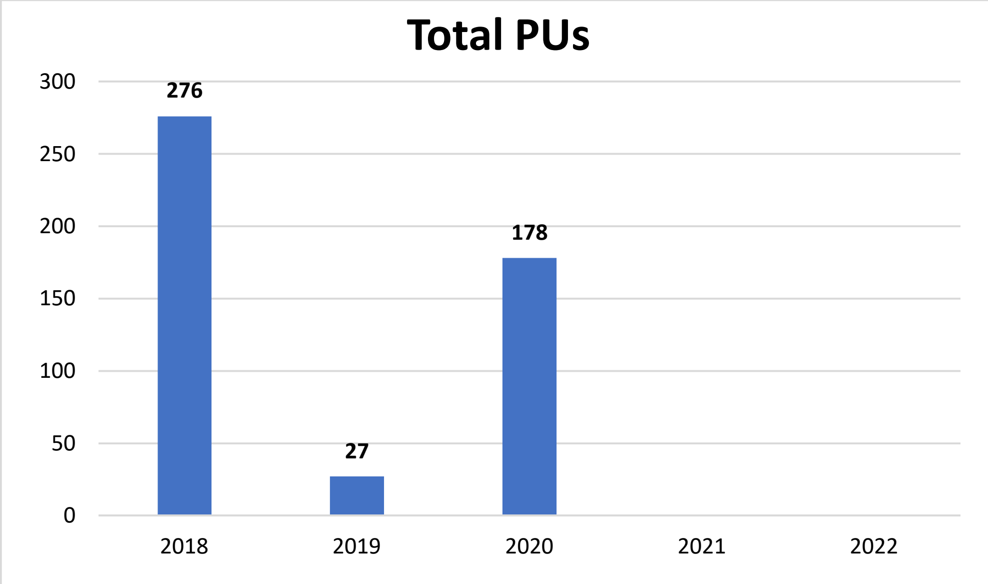
Table 1 - areas and production 2020.

Crop year 2020	Total	Chickpea	Lentil	Proteic pea
Total surface area (all Pus) (ha)	2594,3	576,0	1451,7	566,6
Total PU production (t at 11% humidity for chickpeas and lentils and 14% for proteic peas)	1569,6	373,8	575,8	620,0

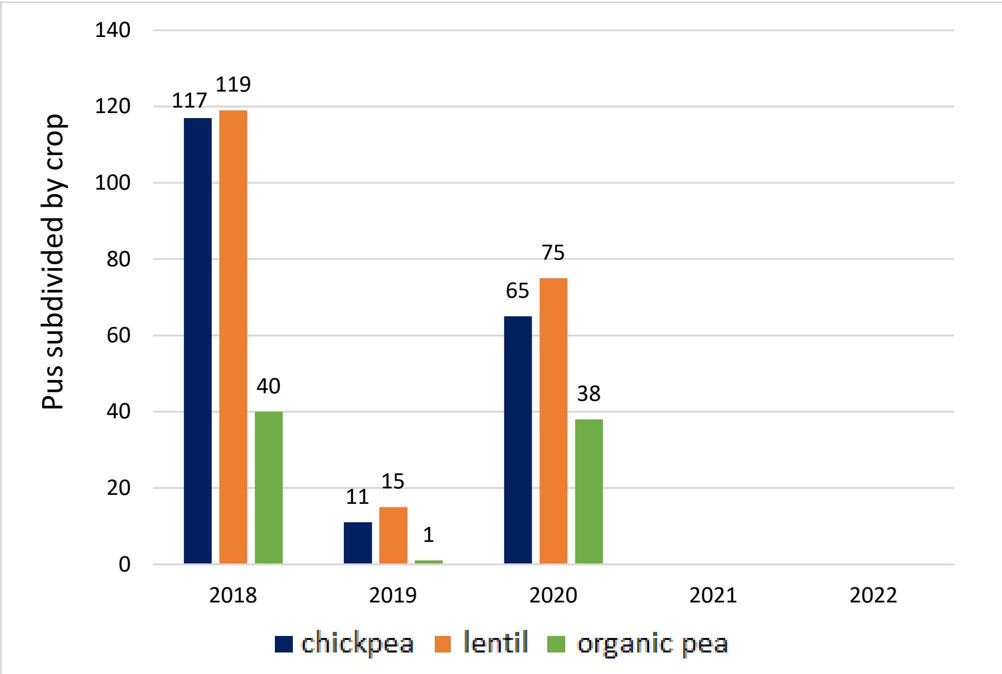
Table 2 - Production parameters, environmental indicators and indicators for performance of the use of technical means per hectare for chickpeas, lentils and peas. Average data for organic and conventional cultivation.

Index (units of measurement)	Organic chickpea	Conv. chickpea	**Chickpea average**	Organic lentil	Conv. lentil	**Lentil average**	Organic proteic pea	Conv. proteic pea	Proteic pea average	**Total average**
Yield without impurities at conventional humidity (t/ha at conventional humidity)	0,63	0,84	**0,79**	0,49	0,56	**0,54**	1,15	1,27	**1,18**	**0,77**
Carbon Footprint per hectare (CO_2 eq t/ha)	0,41	0,54	**0,51**	0,42	0,43	**0,42**	0,30	0,34	**0,31**	**0,43**
Water Footprint per hectare (H_2O m3/ha)	1347,13	2126,00	**1946,26**	3014,54	3628,02	**3415,35**	1114,93	1389,90	**1187,29**	**2403,23**
Fuel consumption per hectare (l/ha)	83,60	86,70	**85,98**	84,96	80,39	**81,97**	67,89	79,00	**70,82**	**81,06**
Nitrogen distributed per hectare (kg/ha)	0,00	7,59	**5,84**	0,00	0,88	**0,58**	0,83	0,00	**0,61**	**2,50**
Phosphate distributed per hectare (P_2O_5 kg/ha)	0,00	12,60	**9,69**	0,00	0,71	**0,47**	1,39	0,00	**1,03**	**3,96**
Fertilisers per hectare (kg/ha)	0,00	74,86	**57,58**	0,27	8,20	**5,45**	8,21	0,00	**6,05**	**24,62**
Plant health products per hectare (kg/ha)	0,21	2,48	**1,96**	0,24	1,15	**0,83**	0,11	1,02	**0,35**	**1,14**

Graph 1: Total Production Units. Only PUs with complete records have been counted.



Graph 2: Total Production Units. Only PUs with complete records have been counted. Subdivision by crop.



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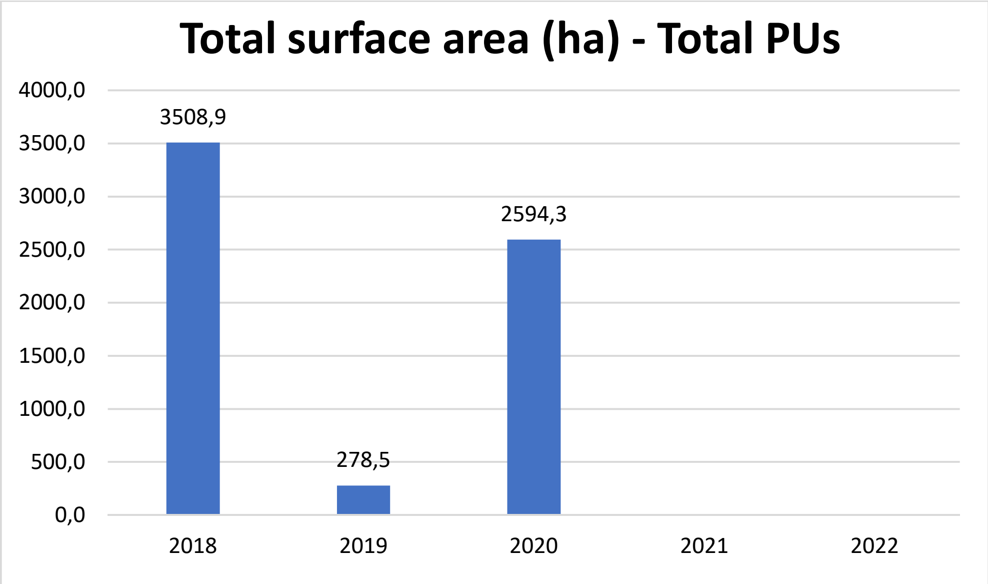
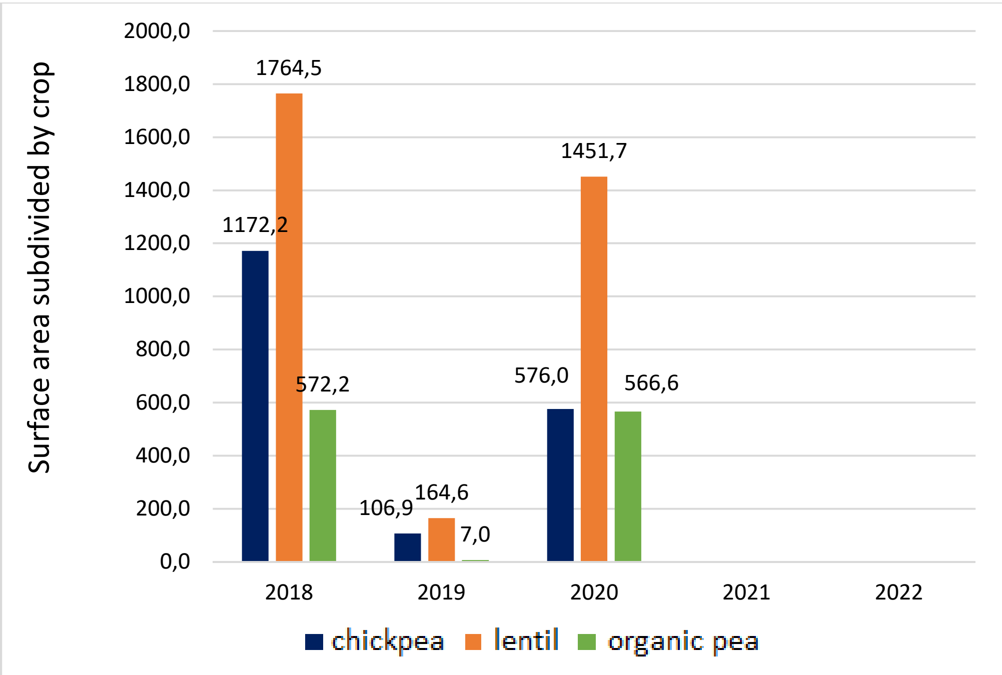
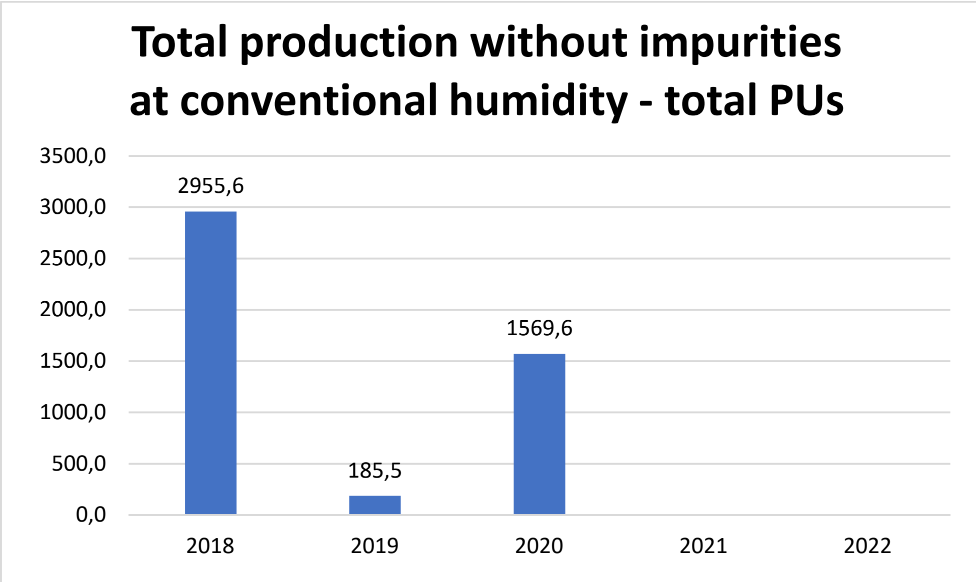
Graph 3: Total area (hectares). Only PUs with complete records in the RCO have been counted.



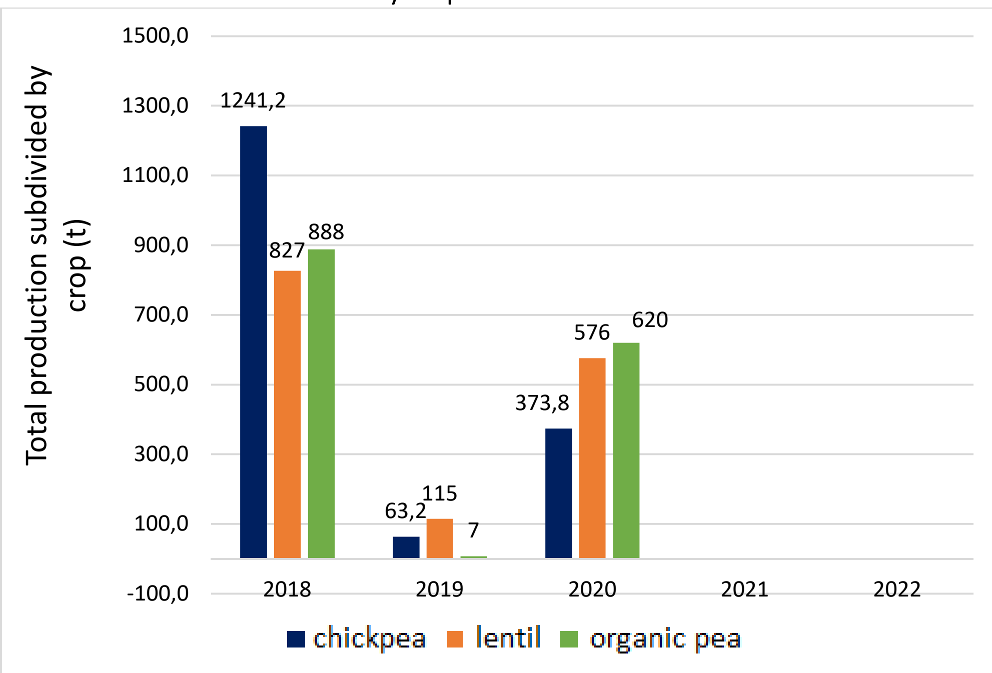
Graph 4: Total area (hectares). Only PUs with complete records in the RCO have been counted. Subdivision by crop.



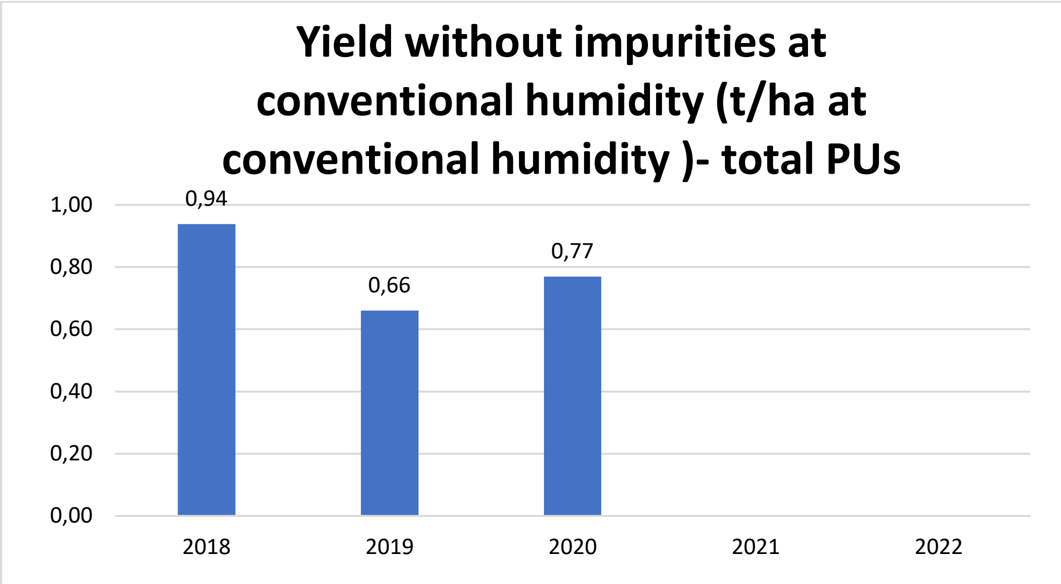
Graph 5: Total production (t) without impurities at conventional humidity. Only PUs with complete records in the RCO have been counted.



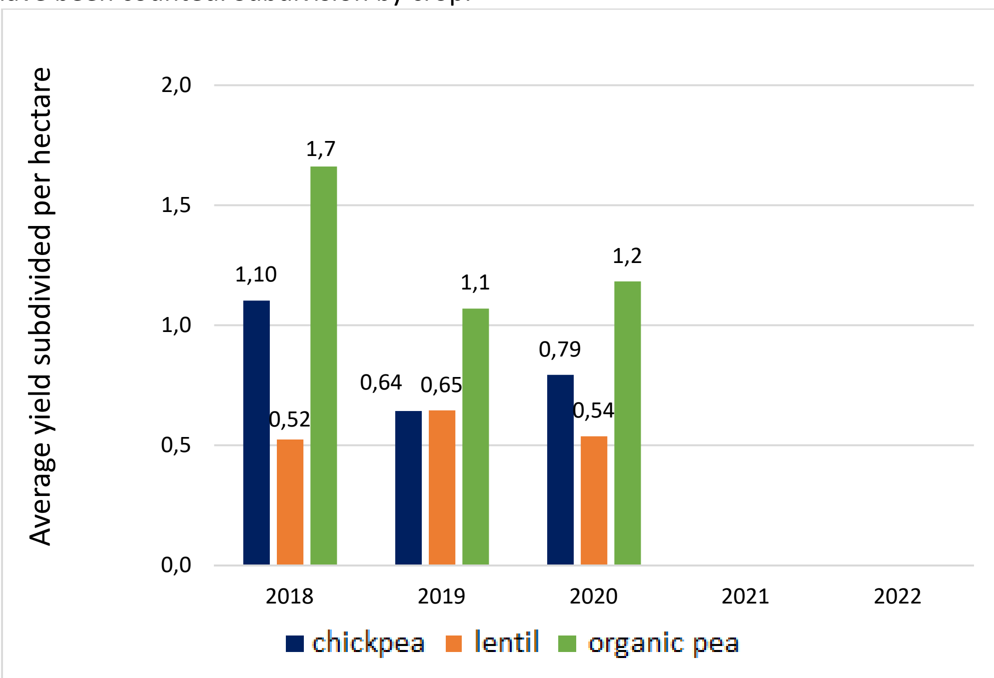
Graph 6: Total production (t) without impurities at conventional humidity. Only PUs with complete records in the RCO have been counted. Subdivision by crop.



Graph 7: Average yield (t/ha) without impurities at conventional humidity. Only PUs with complete records in the RCO have been counted.



Graph 8: Average yield (t/ha) without impurities at conventional humidity. Only PUs with complete records in the RCO have been counted. Subdivision by crop.



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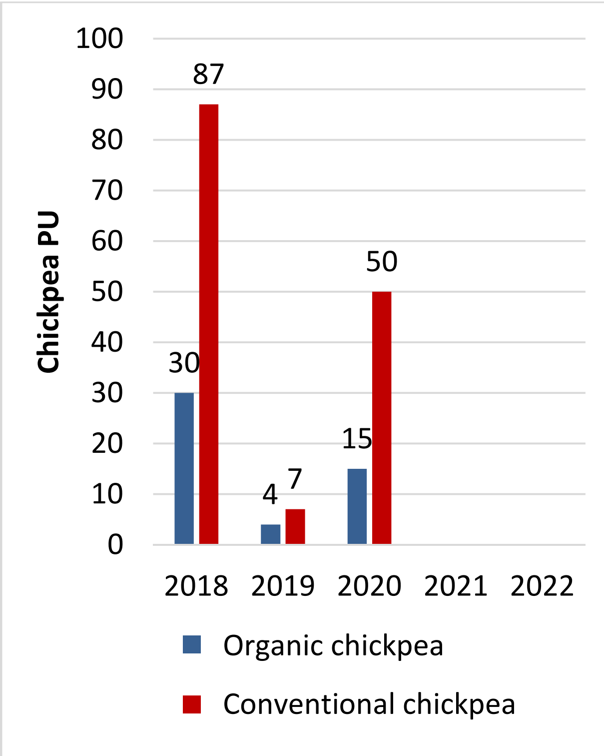

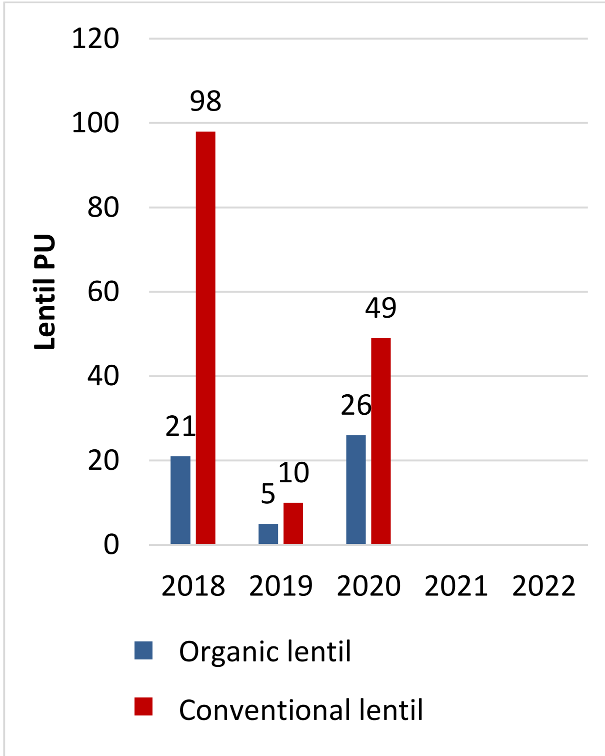

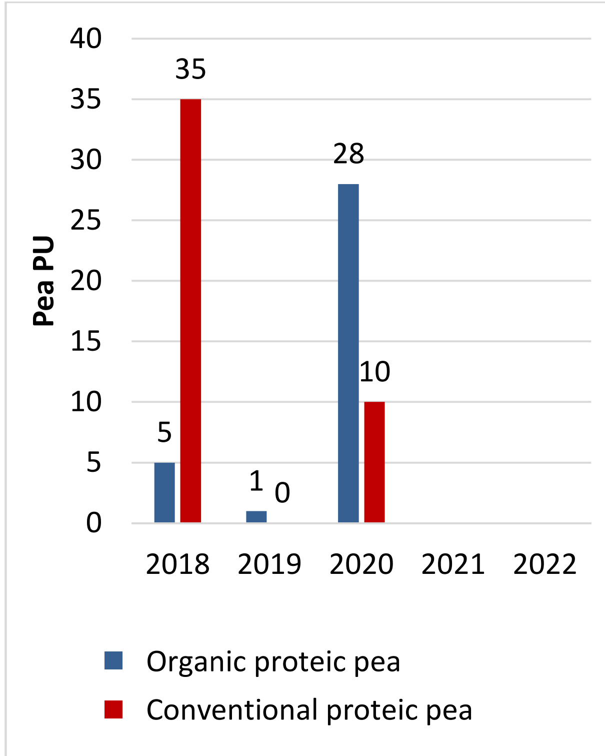

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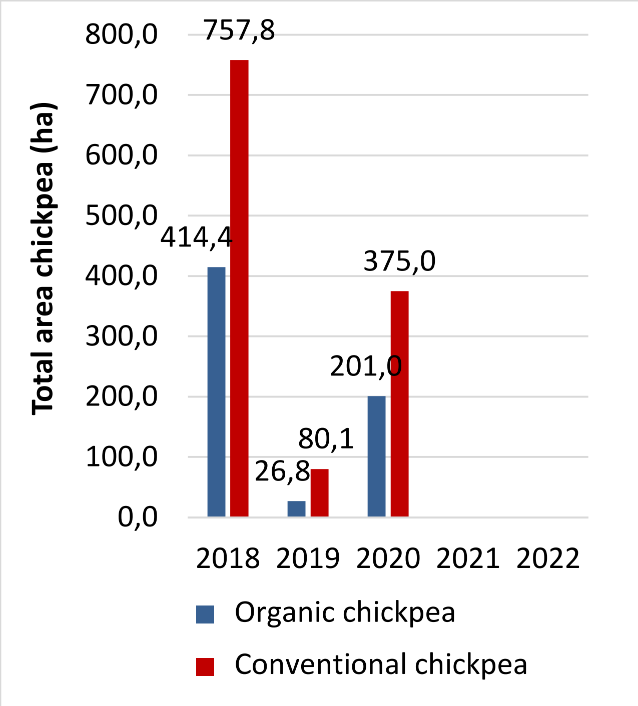

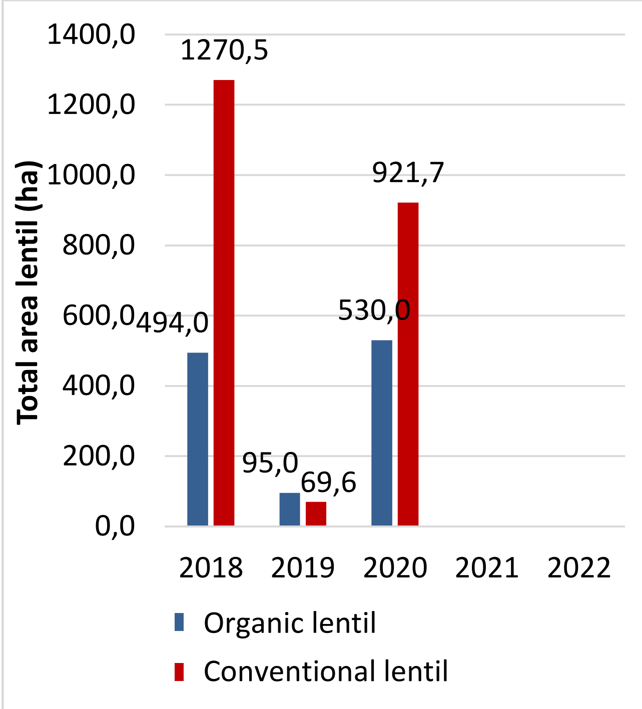

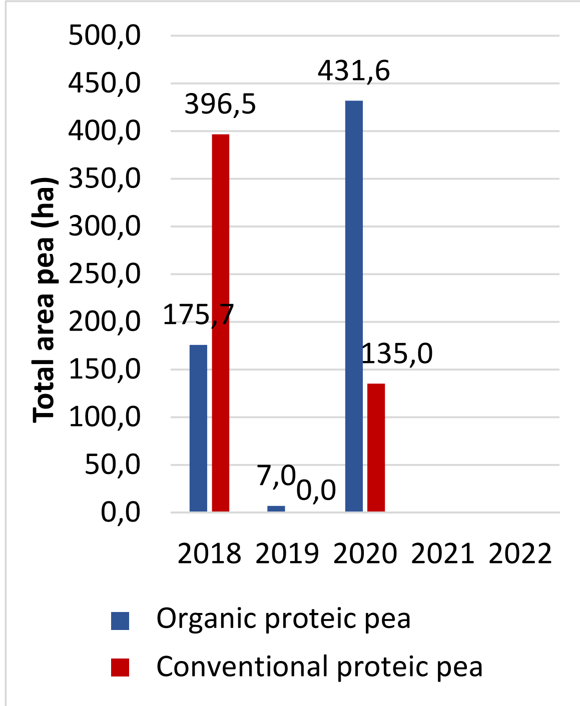

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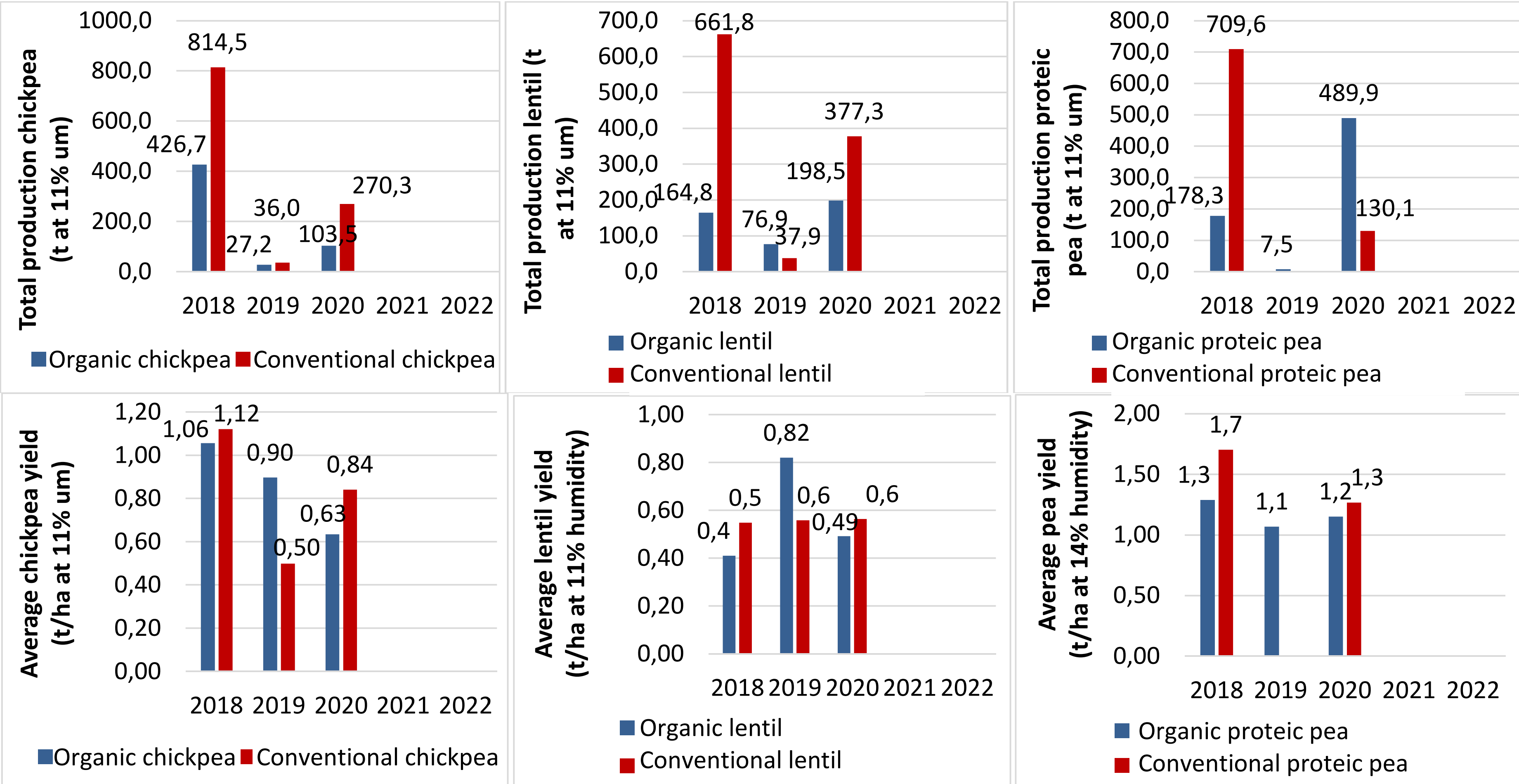
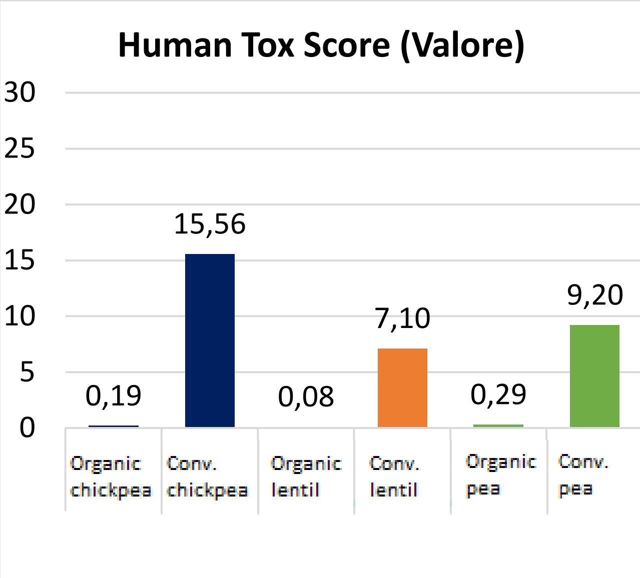
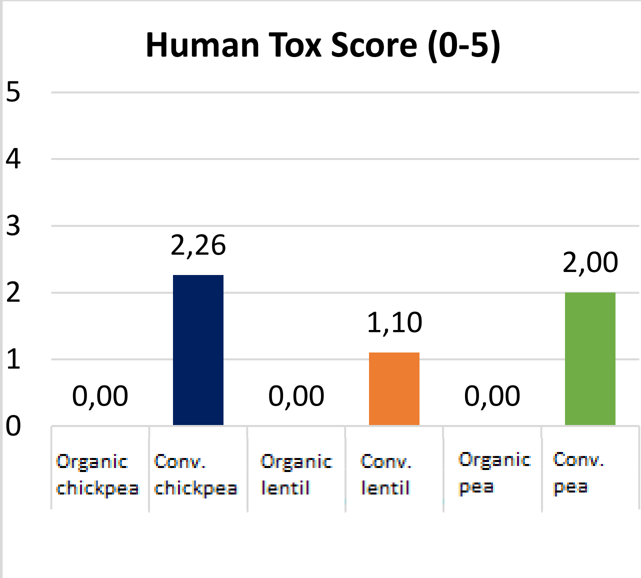


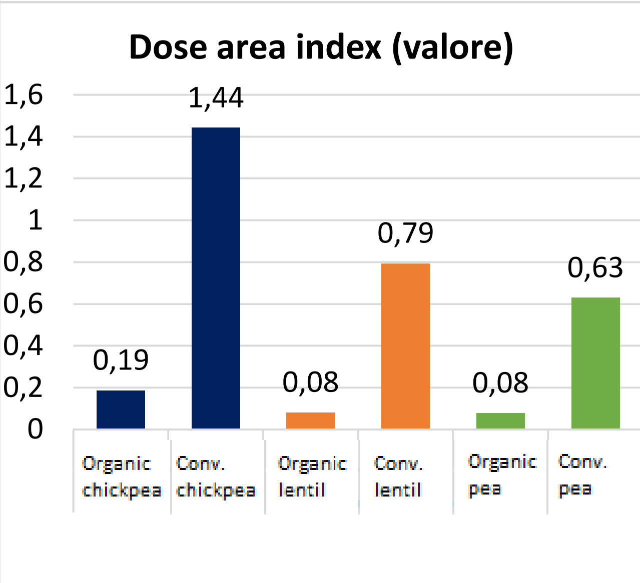
yousustain.net® Indicators

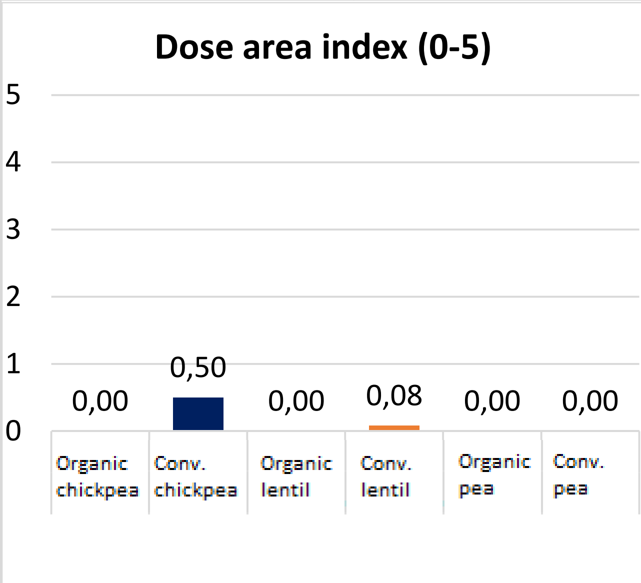
Health Section

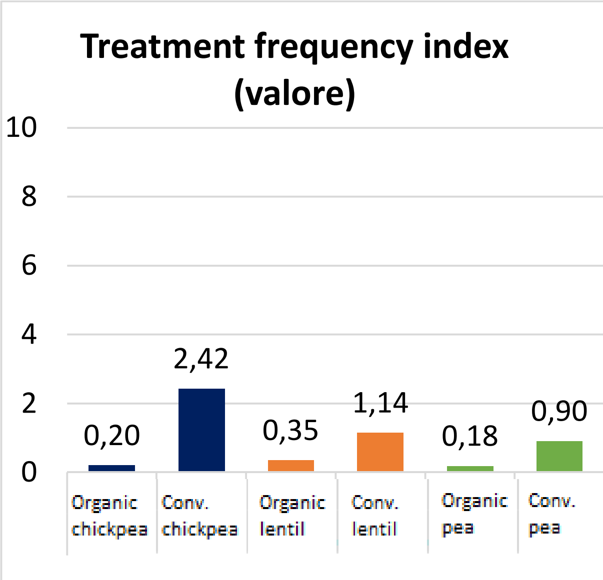
The limited use of plant health products also in conventional cultivation has guaranteed the achieving of low scores for all thre e crops and for all three indicators.

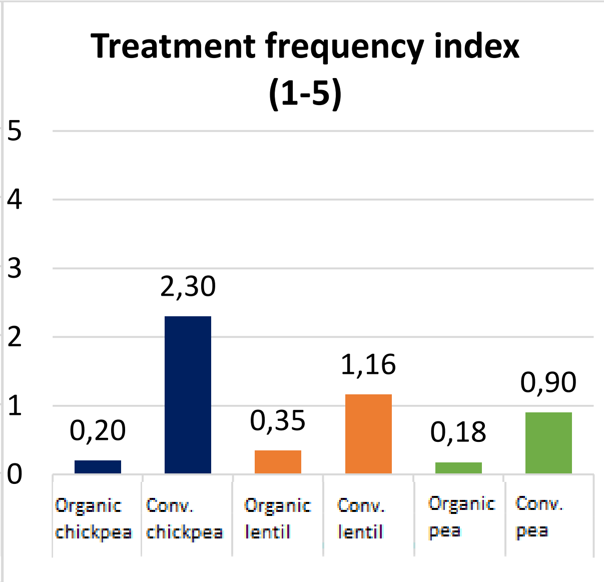










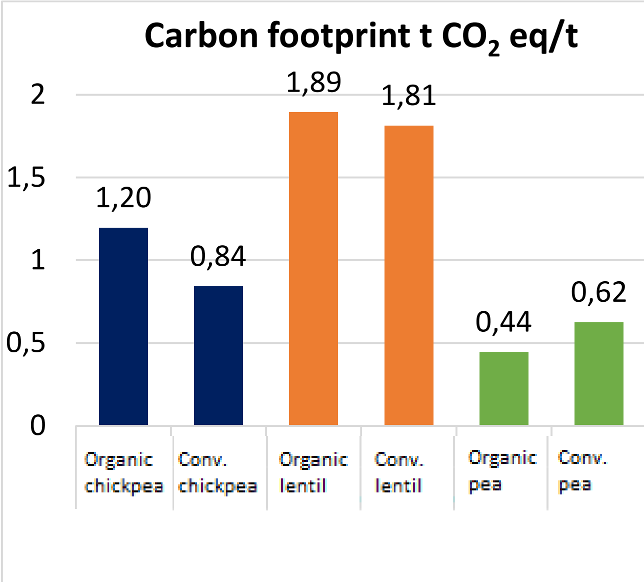


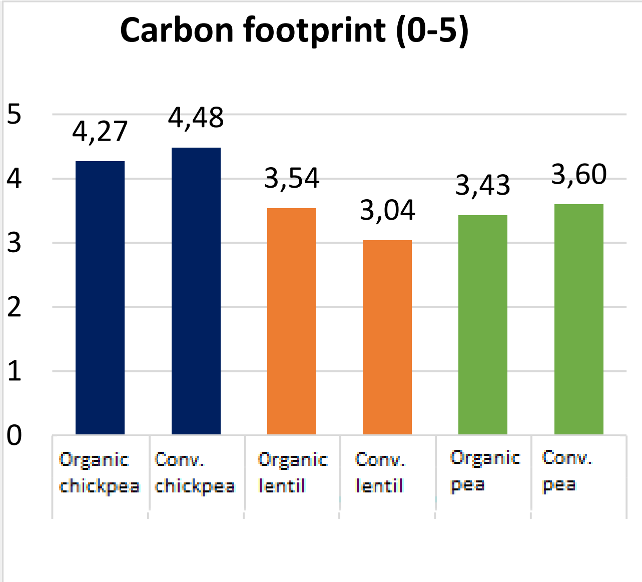
Air Section

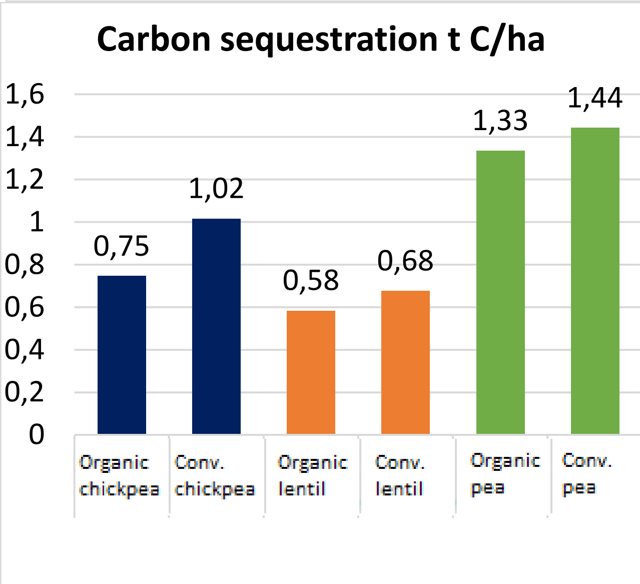
In this section, the low yields led to high scores (over 4) for all crops. In terms of the Carbon footprint indicator, it can be seen that chickpeas have scores higher than 4, while lentils and proteic peas have lower scores as their yield, while still low, is closer to standard levels than those obtained with chickpeas.

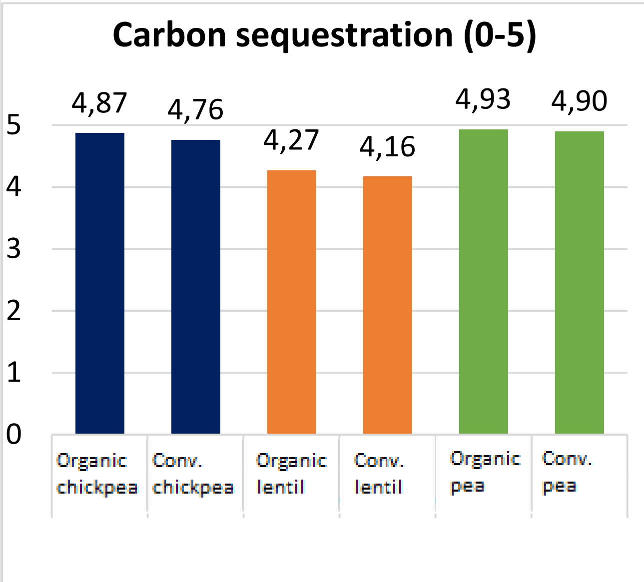
The Carbon Footprint and Carbon Sequestration indicators are heavily dependent on final yields, and therefore low yields lead to an attribution of environmental impact on less agricultural product harvested. On the contrary, high yields allow the distribution of environmental impact over a larger production quantity, rendering the crop more sustainable. Furthermore, with high yields, there is increased photosynthetic activity and therefore increased atmospheric carbon sequestration (this leads to an increased production of biomass, lower environmental impact and a consequential reduction in indicator scores).

The use of technical equipment, even for conventional cultivation, is particularly limited, and these indicators can only be improved with an increase in productivity.





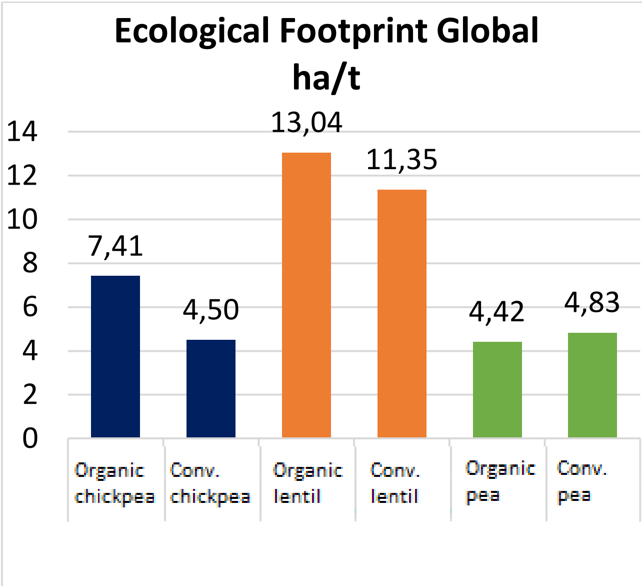


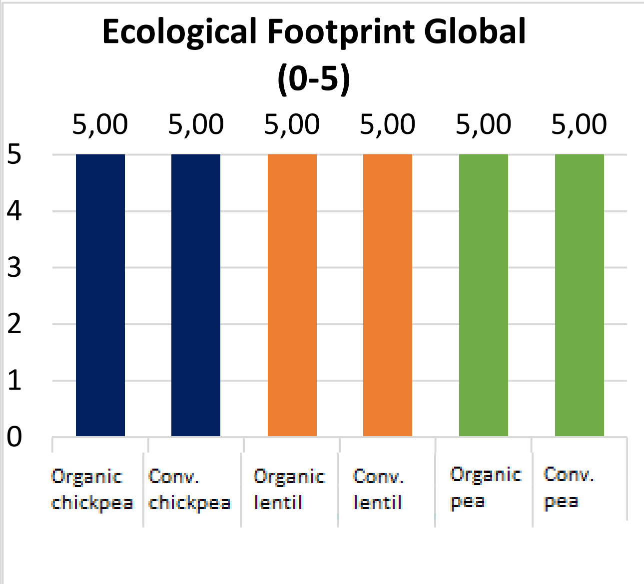


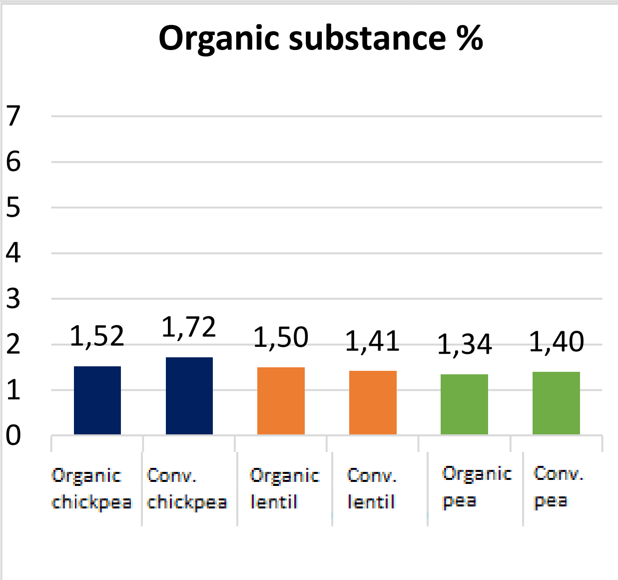
Soil Section

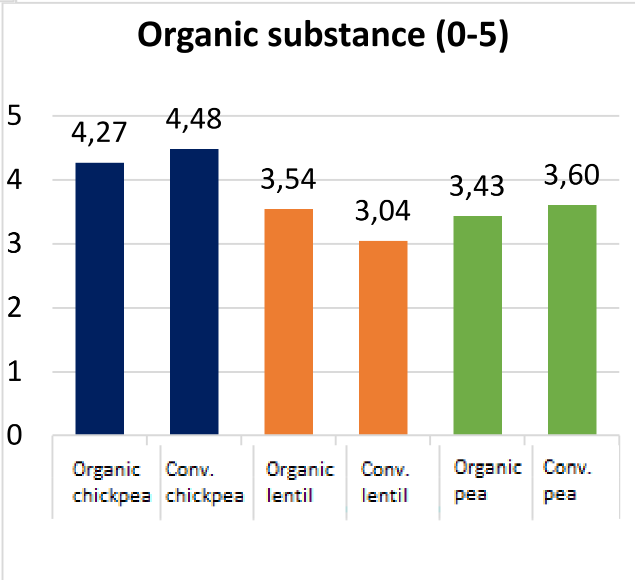
Again, due to low yields below average levels, the Ecological footprint indicator returned maximum scores. Low sustainability values (scores of over 3) were also recorded for the Organic substance and *Soil coverage* indicators as the cultivated land had a content on average lower than 2%, while the Soil Coverage indicator shows relatively low scores, indicating a moderate level of sustainability. For both indicators, lentils are shown to be more sustainable than chickpeas and proteic peas. These indexes suggest that the soils have a generally low organic substance content, but the vegetation coverage has improved in comparison to past years, providing indirect benefits in terms of soil fertility and an increased barrier against the development of weeds.

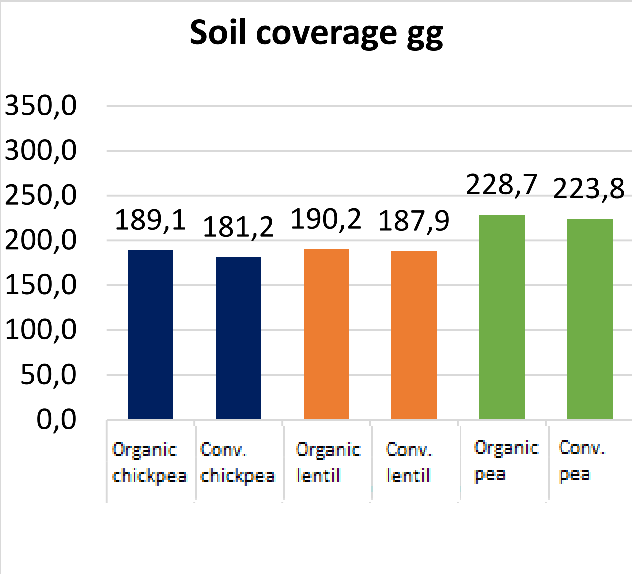
The Erosion and Soil compaction indicators show relatively low results, therefore highlighting the positive capacity of the legumes to withhold the soil and combat erosion, particularly in years characterised by little rainfall, as was the case for 2020.

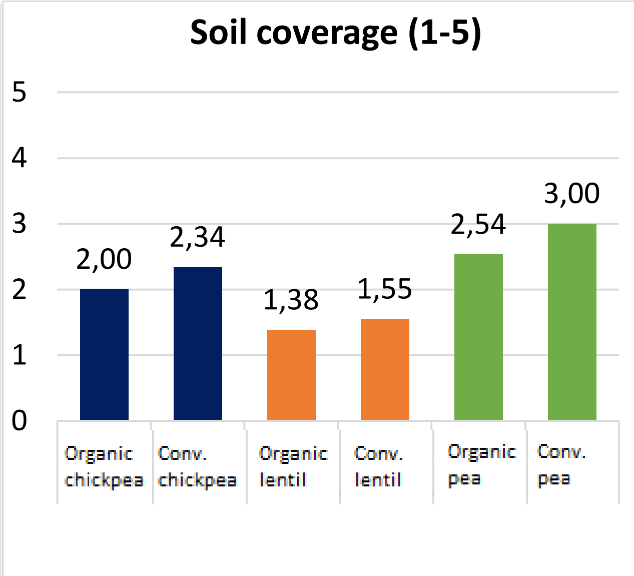

Ecological Footprint Global ha/t
14
12
10
8
6
4
2
0
7,41
4,50
13,04
11,35
4,42
4,83
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea

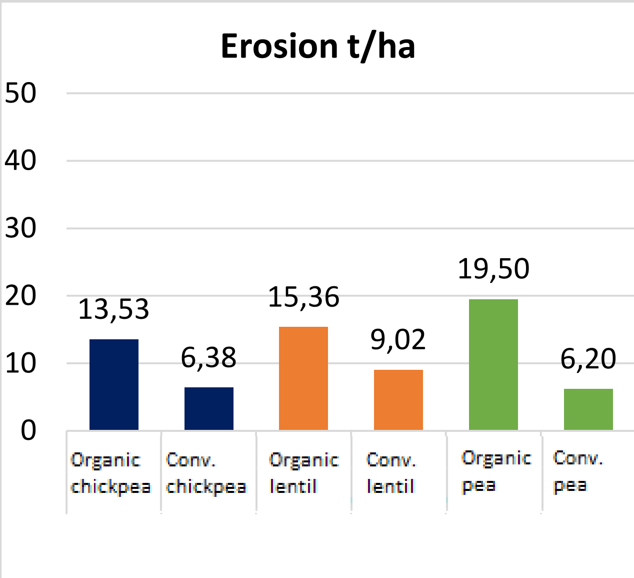

Ecological Footprint Global (0-5)
5
4
3
2
1
0
5,00
5,00
5,00
5,00
5,00
5,00
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea

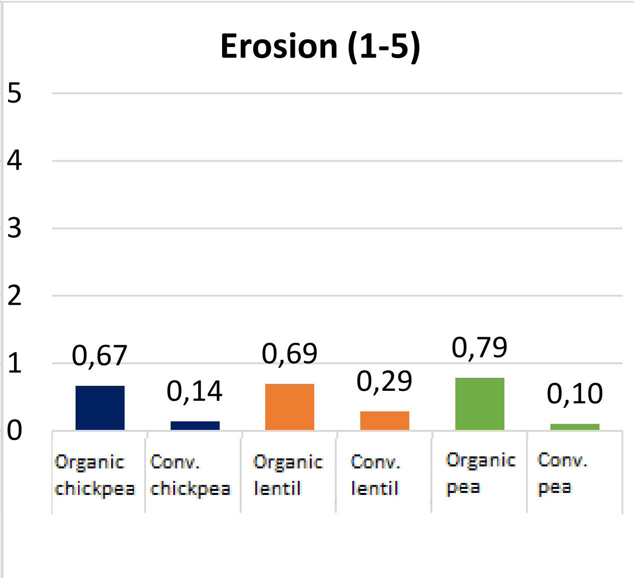

Organic substance %
7
6
5
4
3
2
1
0
1,52
1,72
1,50
1,41
1,34
1,40
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea

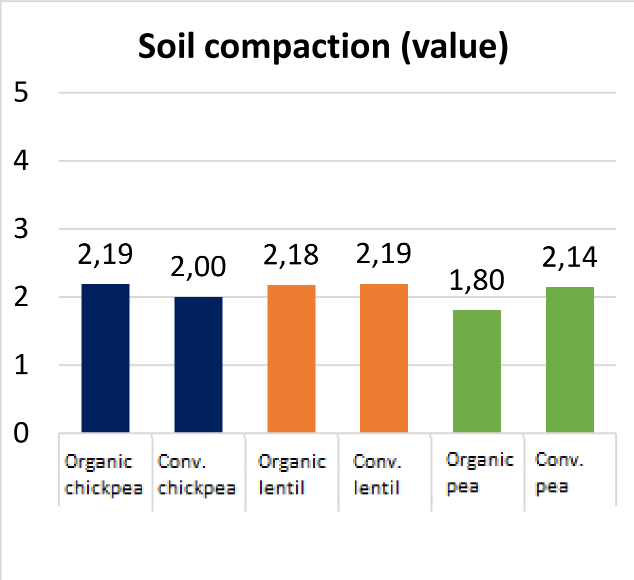

Organic substance (0-5)
5
4
3
2
1
0
4,27
4,48
3,54
3,04
3,43
3,60
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea

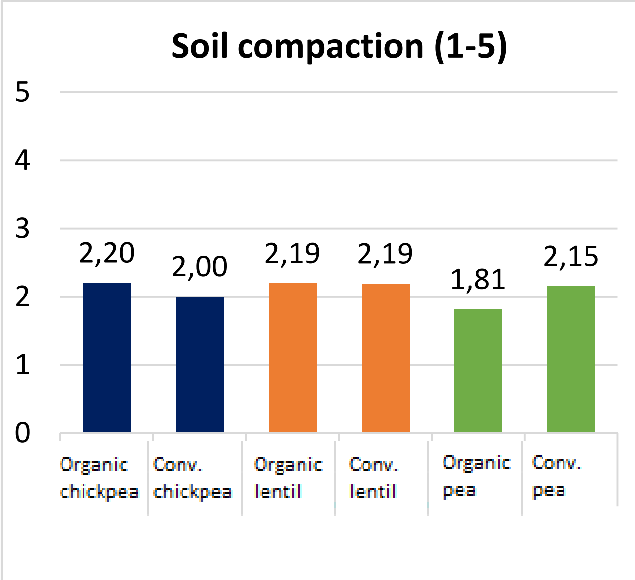

Soil coverage gg
350,0
300,0
250,0
200,0
150,0
100,0
50,0
0,0
189,1
181,2
190,2
187,9
228,7
223,8
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea


Soil coverage (1-5)
5
4
3
2
1
0
2,00
2,34
1,38
1,55
2,54
3,00
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea


Erosion t/ha
50
40
30
20
10
0
13,53
6,38
15,36
9,02
19,50
6,20
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea


Erosion (1-5)
5
4
3
2
1
0
0,67
0,14
0,69
0,29
0,79
0,10
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea



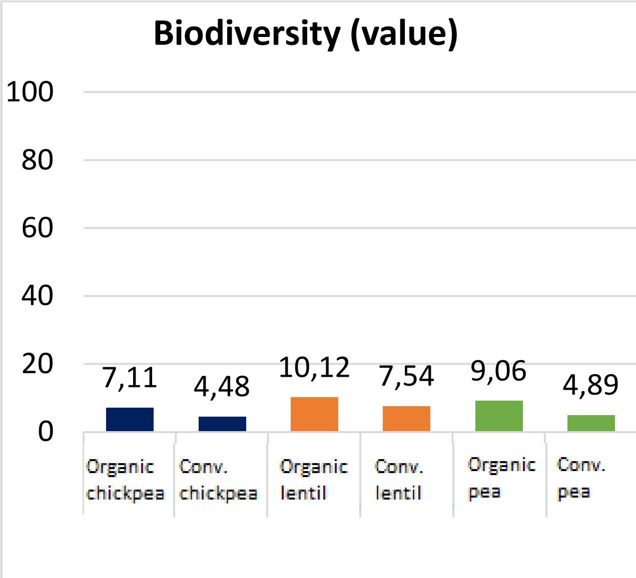


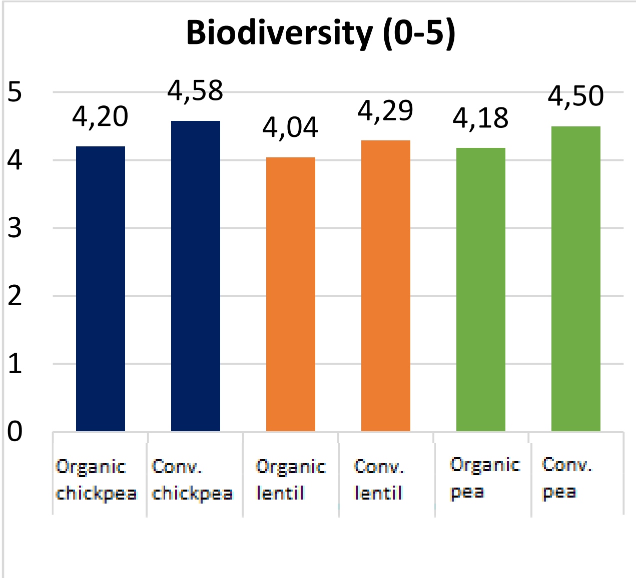
Biodiversity Section

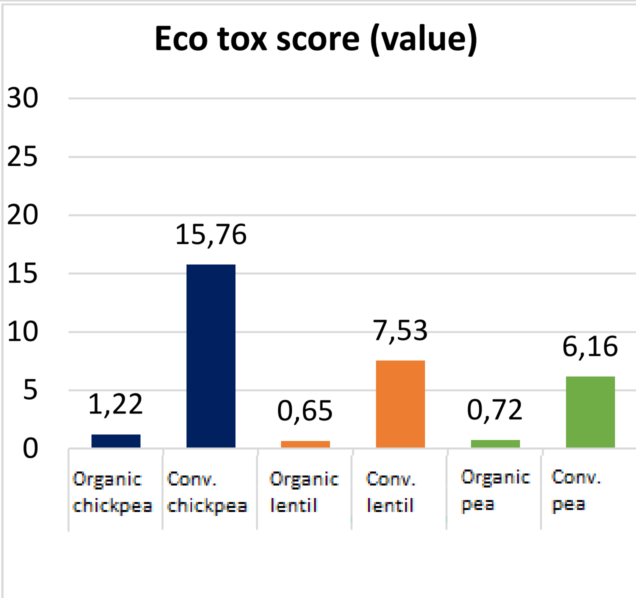
Farms in the area that cultivate legumes are characterised by a low variation in soil management. The majority of farms are dedicated to sowing, with very limited rotation over time. Furthermore, the lack of alternative uses for the land and the general lack of areas that favour biodiversity have resulted in Biodiversity indicator scores that are always higher than 3.

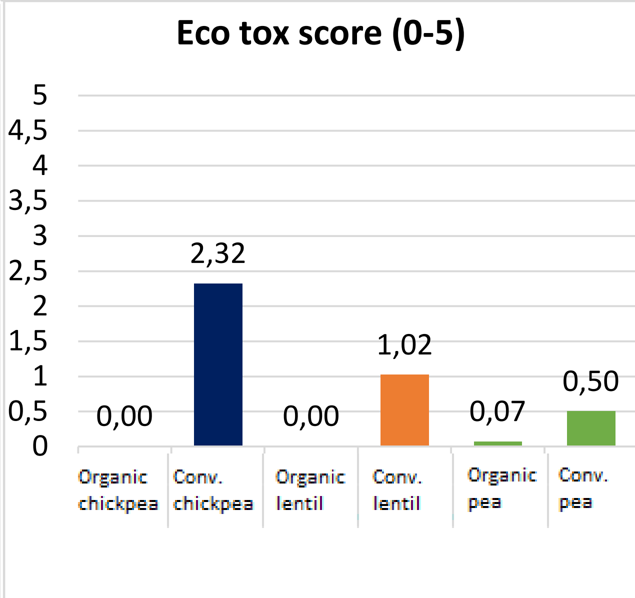
For the Eco Tox Score indicator, thanks to the scarce use of plant health products and the use of more eco-sustainable products, the final score is very low, demonstrating limited pollution of the surrounding agricultural ecosystem. The cultivation of Conventional chickpeas required the use of plant health products, with a higher percentage than the other crops and crop management systems. However, the chemical pressure generated by the plant health products is not particularly higher than standard levels, and the final score for the indicator is lower than 3.

The use of products characterised by fewer hazard statements regarding the environment and increased crop diversification are undoubtedly the most effective solutions for improving these indices



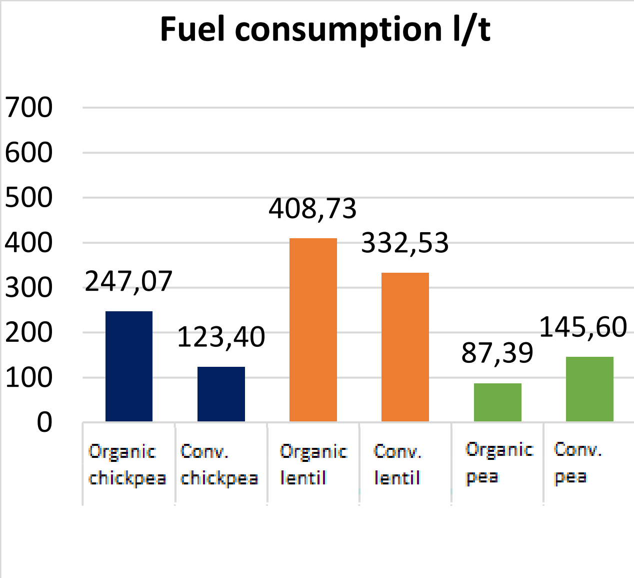


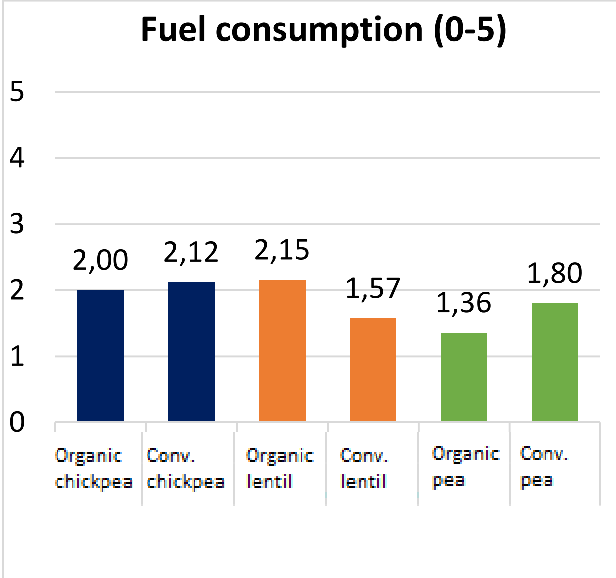


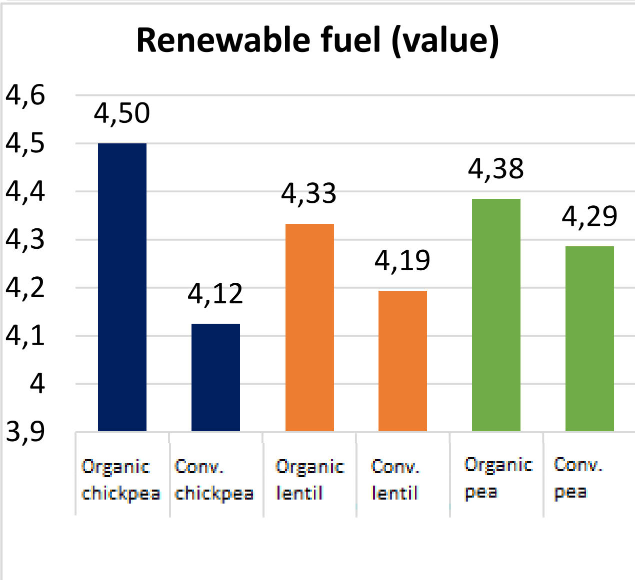


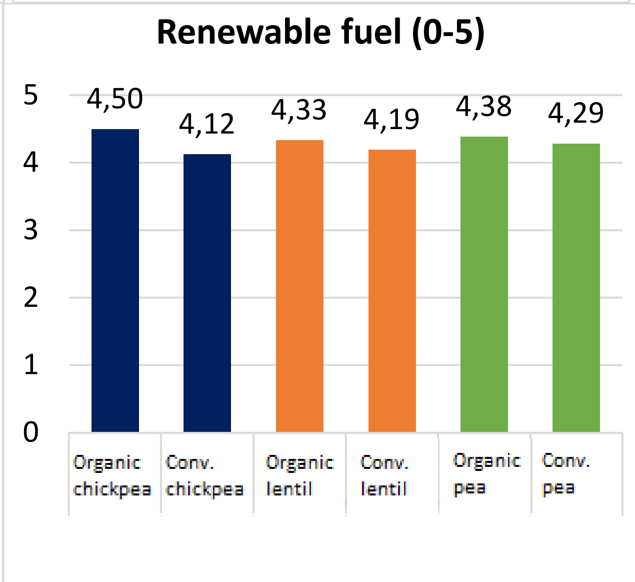
Energy compartment

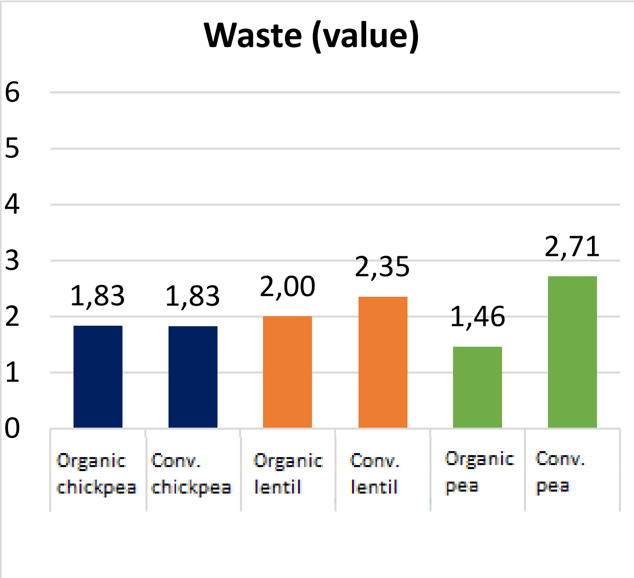
Fuel consumption resulted average (scores between 2 and 3) although the values are higher fororganic lentil, which requires numerous cultivation operations concerning mechanical weed control. On the contrary, organic pea crops have proved to be much more sustainable thanks to reduced fuel consumption. Renewable fuel is used rarely (Renewable fuel indicator scores are almost at maximum levels for all the crops). On a national level, on average 8% of fuel on sale is obtained from renewable sources. There is still no market availability of fuels with differing percentages of fossil and renewable components, and therefore all the situations reflect very similar values.

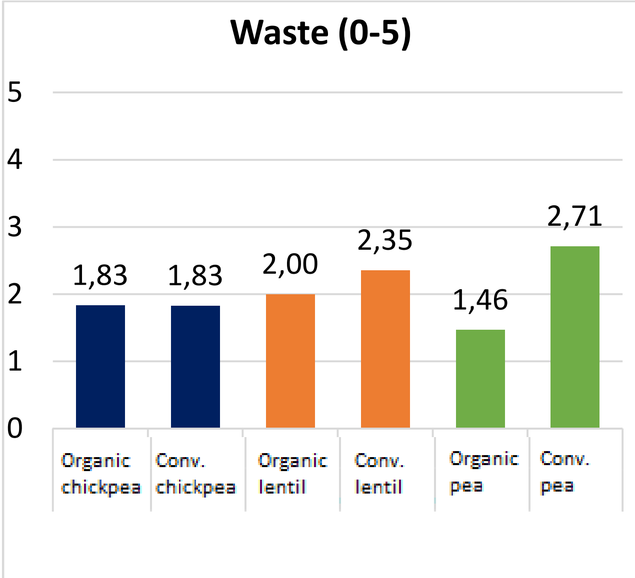

Fuel consumption l/t
700
600
500
400
300
200
100
0
247,07
123,40
408,73
332,53
87,39
145,60
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea


Fuel consumption (0-5)
5
4
3
2
1
0
2,00
2,12
2,15
1,57
1,36
1,80
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea


Renewable fuel (value)
4,6
4,5
4,4
4,3
4,2
4,1
4
3,9
4,50
4,12
4,33
4,19
4,38
4,29
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea


Renewable fuel (0-5)
5
4
3
2
1
0
4,50
4,12
4,33
4,19
4,38
4,29
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea



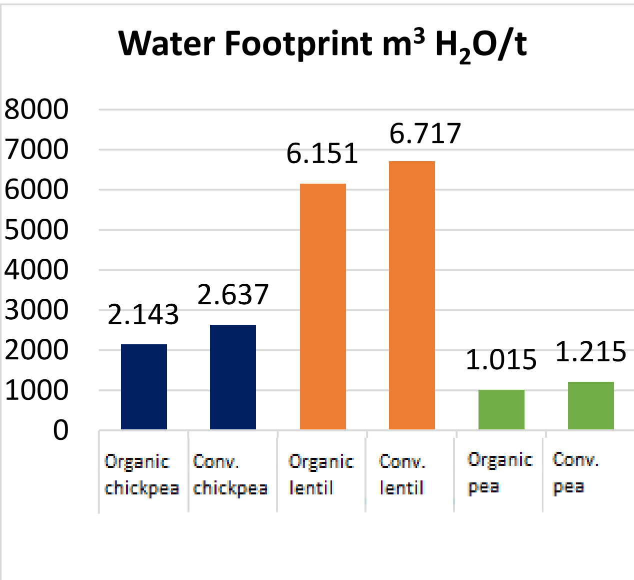


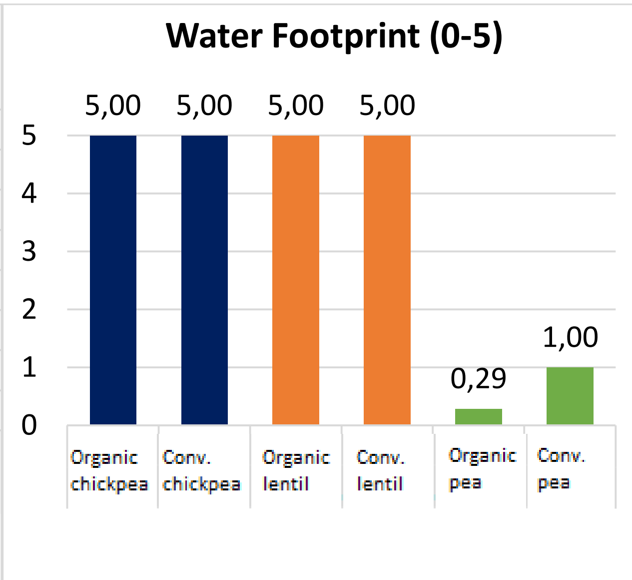
Water compartment

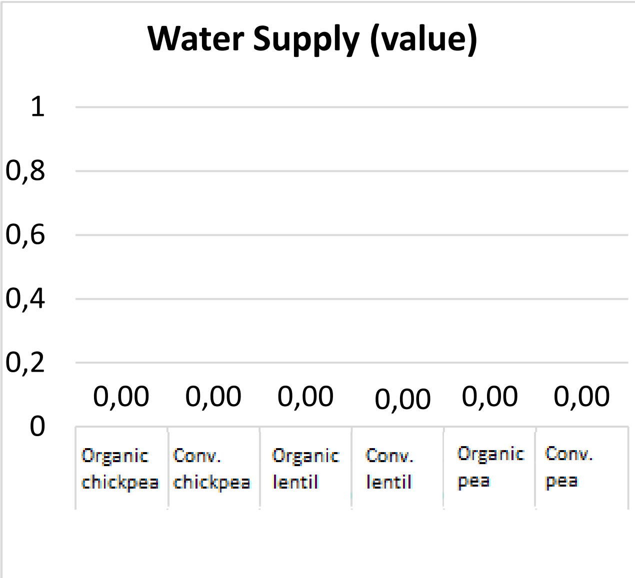
All the indicators in the water section have very low scores with the exception of the Water Footprint indicator. This depends on the final yield, and therefore low yields have a negative impact on the indicator. However, with regards to organic proteic peas, the resulting values lie between 0 and 1. This indicates that the consumption of water required to produce one ton of proteic pea gain is fairly low.

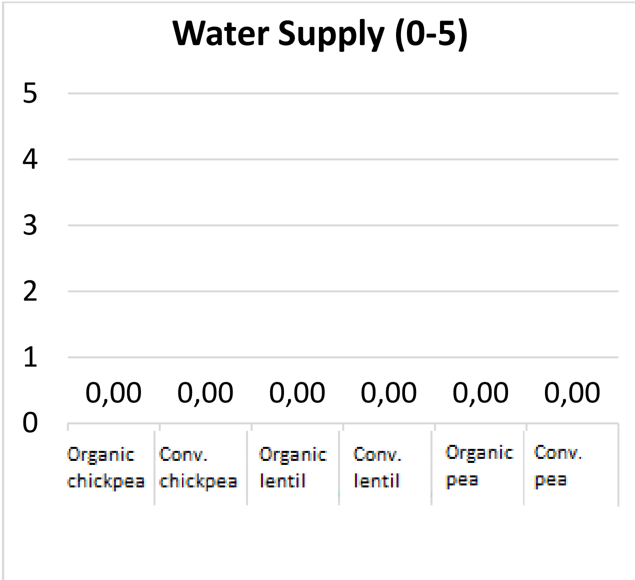
The Water supply and WUTE (Water Use Technical Efficiency) indicators have zero scores as crop irrigation has never been carried out for the crops examined.

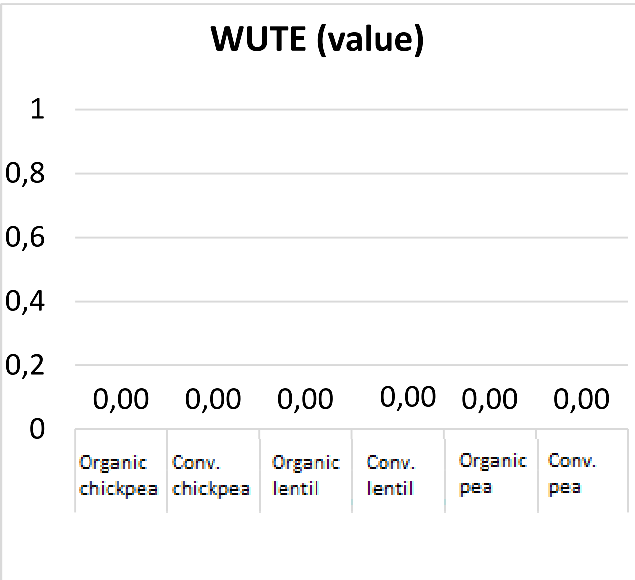
The Acidification and Etrophication indicators have very low values as the plant health products and fertilisers used were modest in quantity and had no negative effect on the quality of rainwater (acidification) or surface water (etrophication of land-based bodies of water).

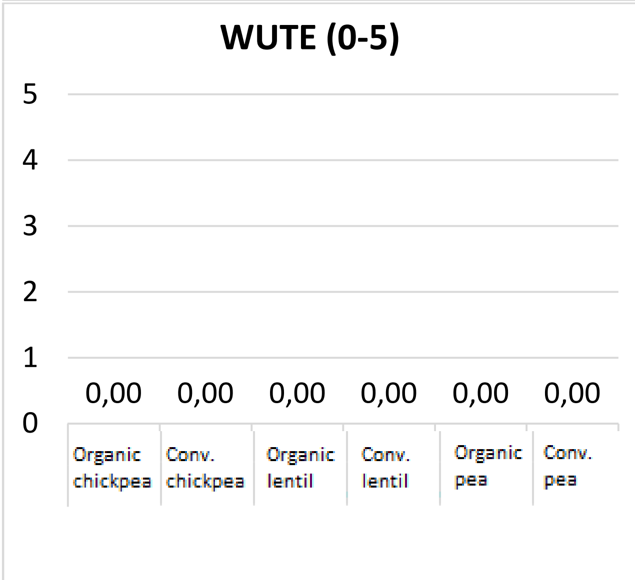












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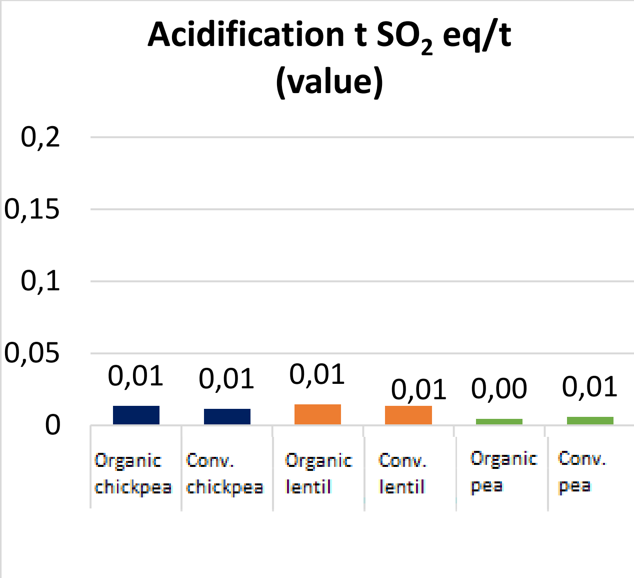
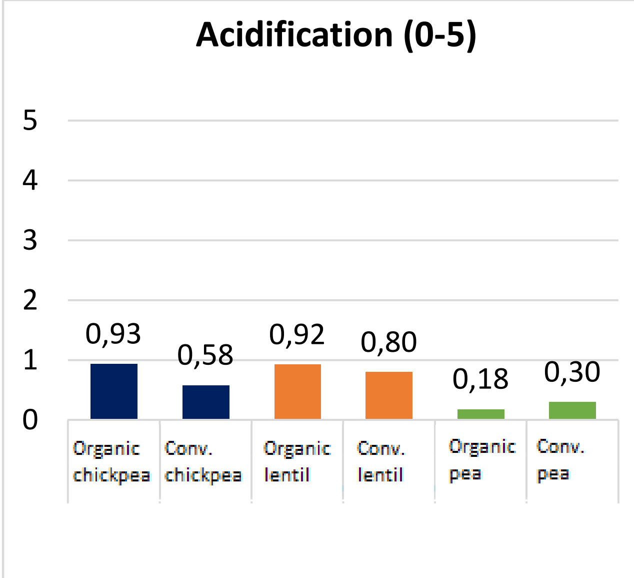
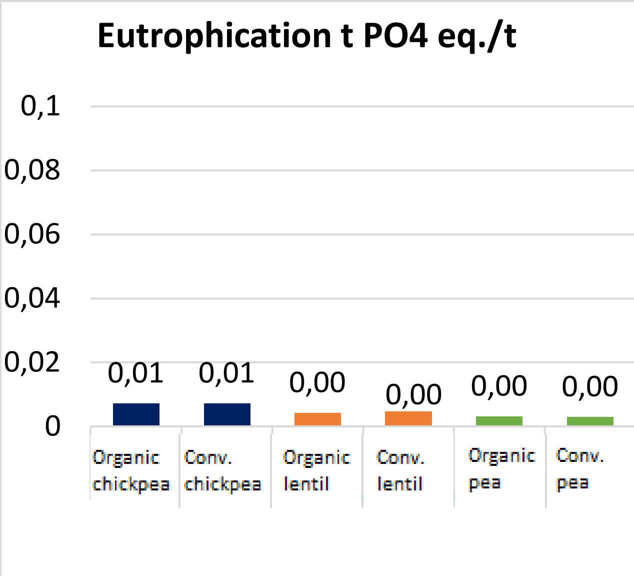
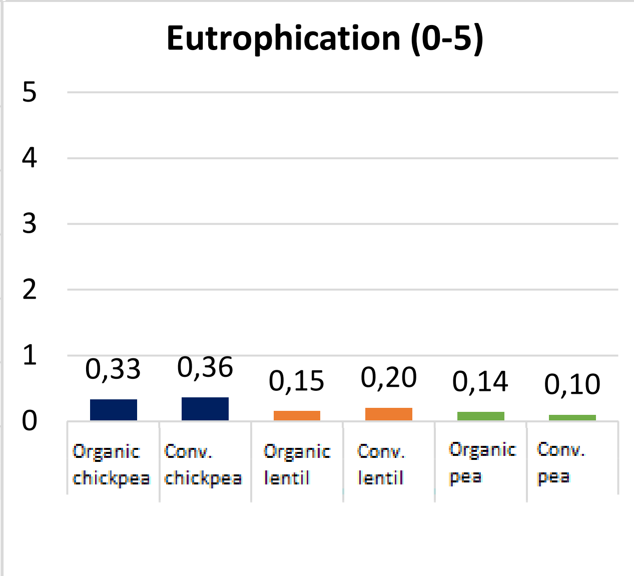
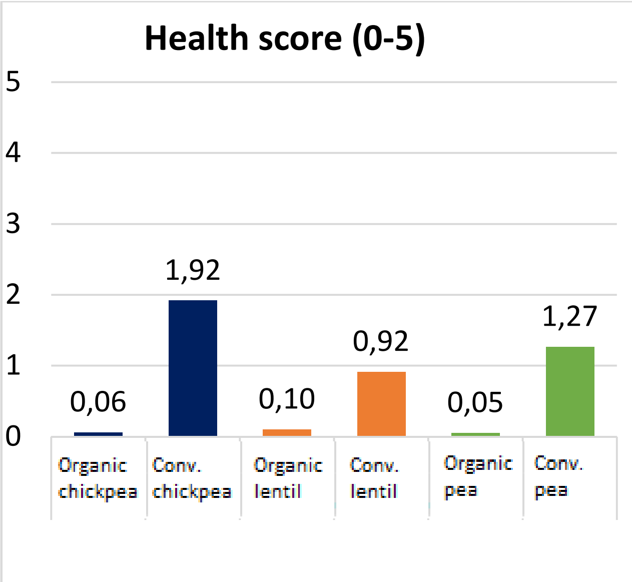

Acidification t SO_2 eq/t (value)
0,2
0,15
0,1
0,05
0
0,01
0,01
0,01
0,01
0,00
0,01
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea

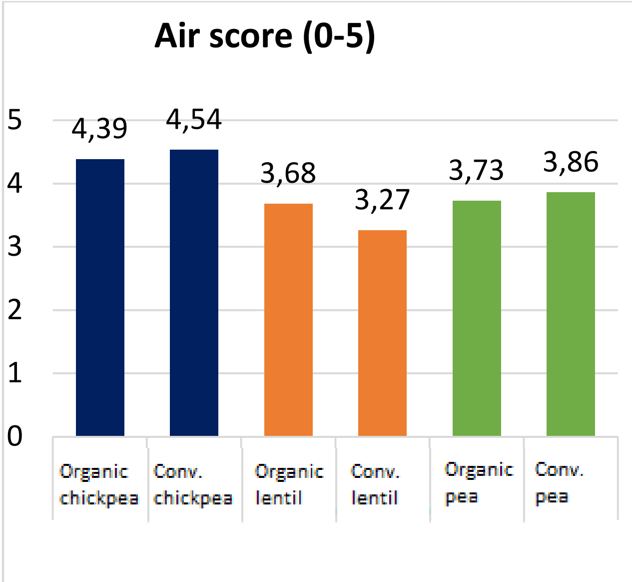

Acidification (0-5)
5
4
3
2
1
0
0,93
0,58
0,92
0,80
0,18
0,30
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea

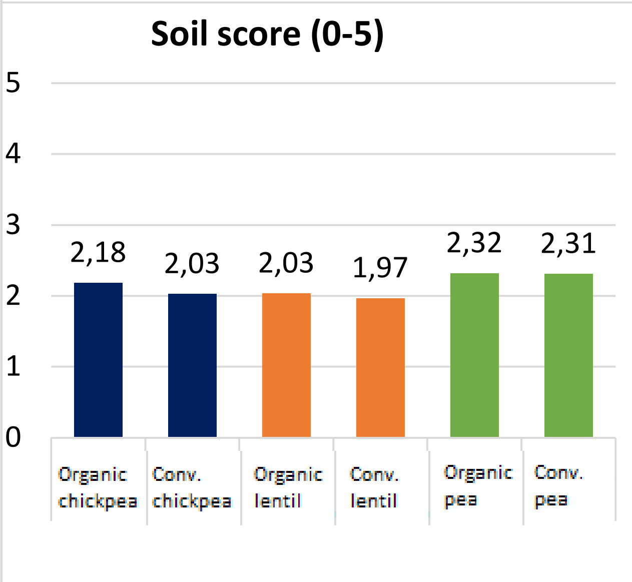

Eutrophication t PO4 eq./t
0,1
0,08
0,06
0,04
0,02
0
0,01
0,01
0,00
0,00
0,00
0,00
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea

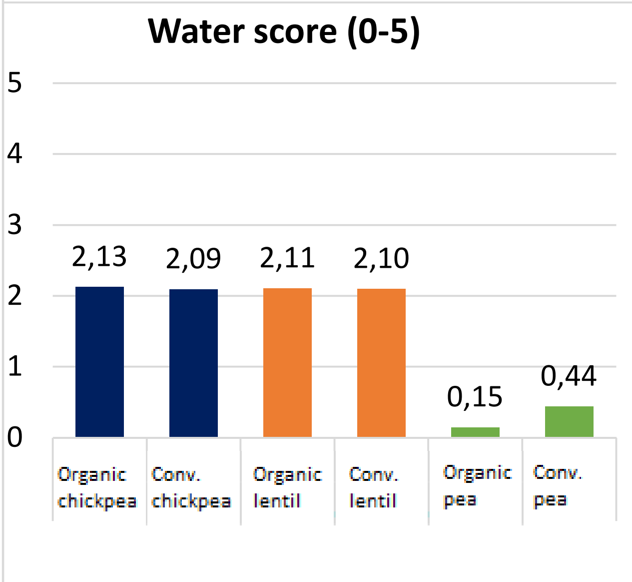

Eutrophication (0-5)
5
4
3
2
1
0
0,33
0,36
0,15
0,20
0,14
0,10
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea

Average score per section









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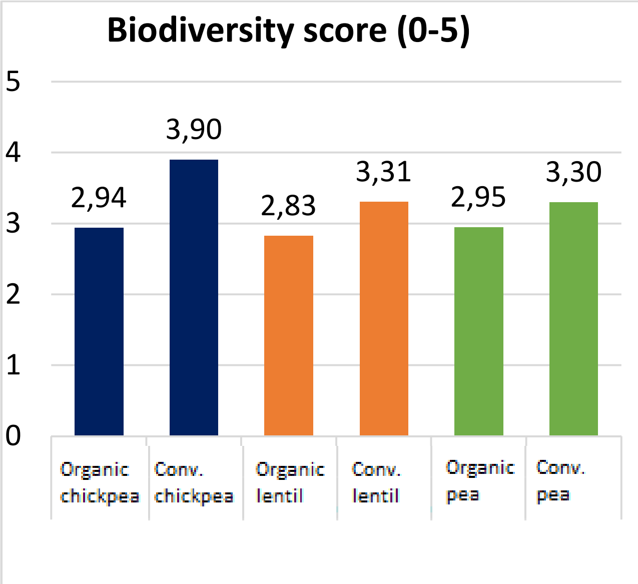
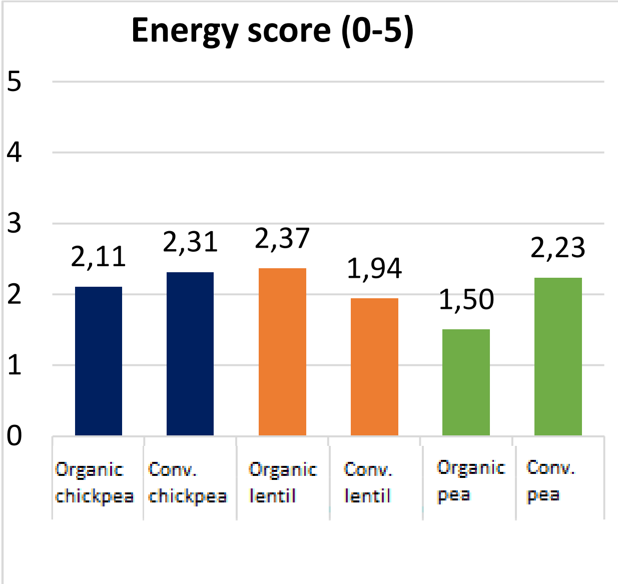
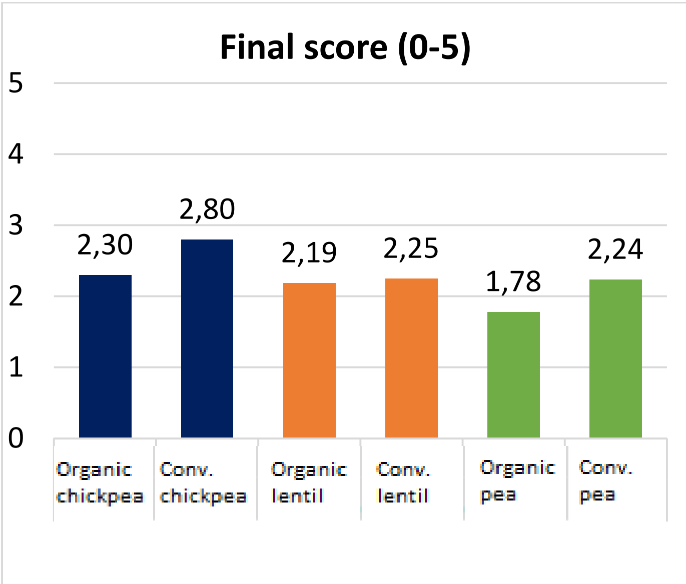




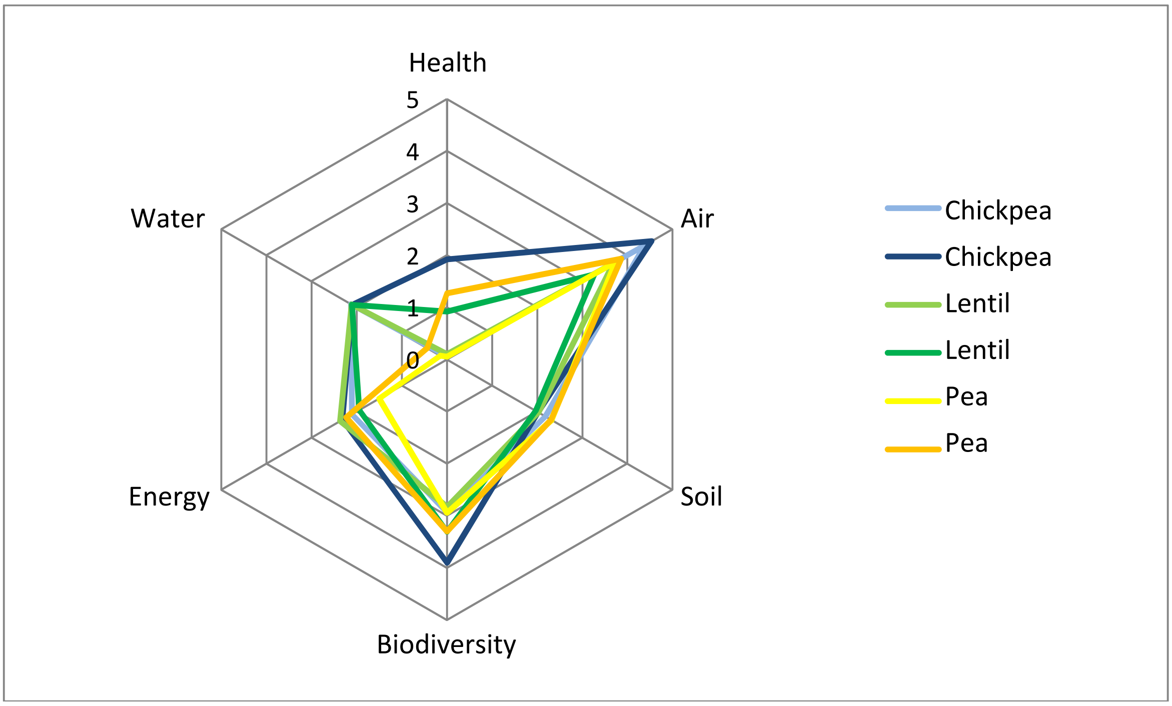
On assessing the average scores per compartment, it is seen that the most significant problems (highest scores) are to be found in the Air and in the Biodiversity section. It is, however, true that lentil crops show values of just over 3 for these sections.
The Health section shows particularly low scores for all of the crops examined, with a net advantage demonstrated for organic over conventional cultivation. This section shows scores of almost 0 for all three organic crops. As mentioned previously, the Water section demonstrates higher sustainability levels for proteic peas in comparison to chickpeas and lentils, which in any case have scores lower than 3.
The Energy section shows very similar scores for all the various crops, all of which are close to 2, with the exception of organic proteic peas, which has a value of 1.5.
In general, the organic regimes have scores that are slightly lower (demonstrating increased sustainability) for the Health and Biodiversity sections. For the other sections, there is no clear difference between organic and conventional cultivation. It should be remembered that in order to improve many of the indicators taken into consideration, it is necessary to implement cultivation strategies that are capable of better combating weeds and increasing soil fertility, consequently increasing yield.

Final score

Species	Crop system	Health	Air	Soil	Biodiversity	Energy	Water	Average
Chickpea	**Organic**	0,06	4,39	2,18	2,94	2,11	2,13	**2,30**
Chickpea	**Conv.**	1,92	4,54	2,03	3,90	2,31	2,09	**2,80**
Lentil	**Organic**	0,10	3,68	2,03	2,83	2,37	2,11	**2,19**
Lentil	**Conv.**	0,92	3,27	1,97	3,31	1,94	2,10	**2,25**
Pea	**Organic**	0,05	3,73	2,32	2,95	1,50	0,15	**1,78**
Chickpea	**Organic**	1,27	3,86	2,31	3,30	2,23	0,44	**2,24**



There are no significant differences between the crops and the different cultivation management methods. Only organically cultivated proteic peas obtained a final score (the average of all the PUs and all the indicators) that was lower than the other crops examined (a value of 1.78 compared to the general average of 2.26). On the contrary, conventional chickpea crops proved to be higher than average (a value of 2.80).

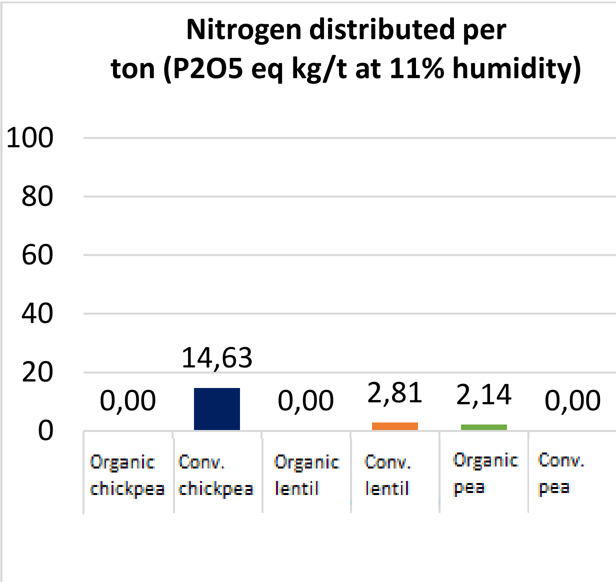

Health
5
4
3
2
1
0
Air
Soil
Biodiversity
Energy
Water
Chickpea
Chickpea
Lentil
Lentil
Pea
Pea

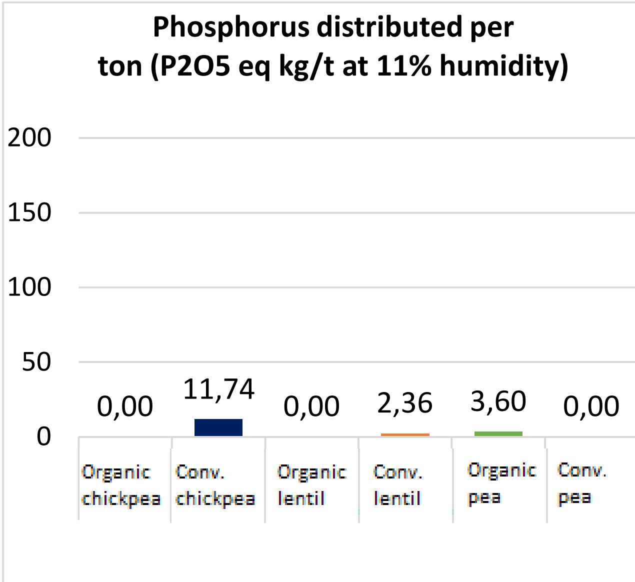
HORT@
From research to field

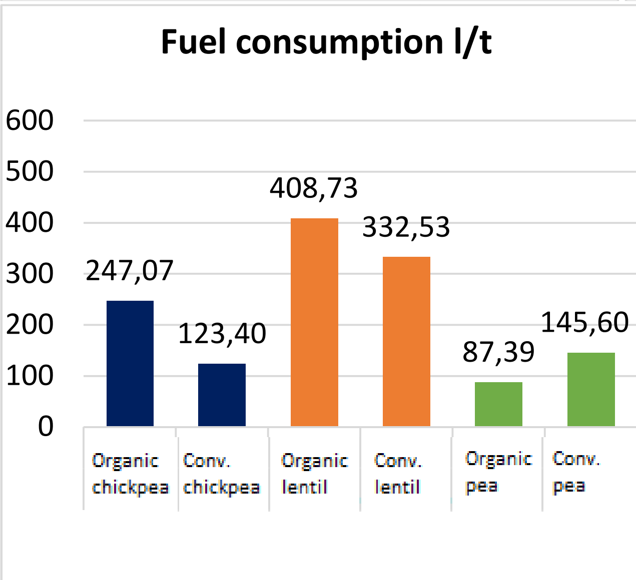
ANDRIANI
Natural Innovators

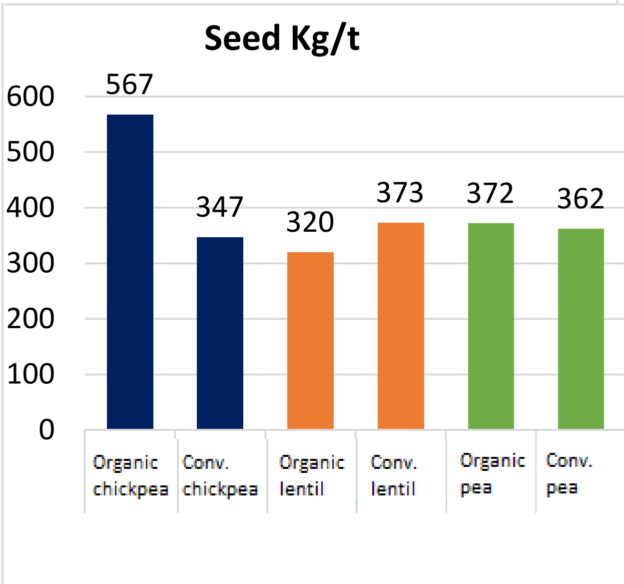
Performance of the use of technical means: data per ton produced

The units of nitrogen distributed per hectare are particularly modest, and therefore the ratio per ton is also particularly low, almost 0. Only the conventional chickpea recorded 14.63 kg of nitrogen and 11.74 kg of phosphorus distributed per ton of grain produced.
Fuel consumption per ton of grain harvested was high for the lentil and for the organic chickpea (more than 200 litres/ton), while for the proteic pea and the conventional chickpea, fuel consumption per ton was lower.
Considering the reduced production levels, the value of the seed used per ton produced is very high for all crops, above all for chickpeas and lentils.









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Spin Off di
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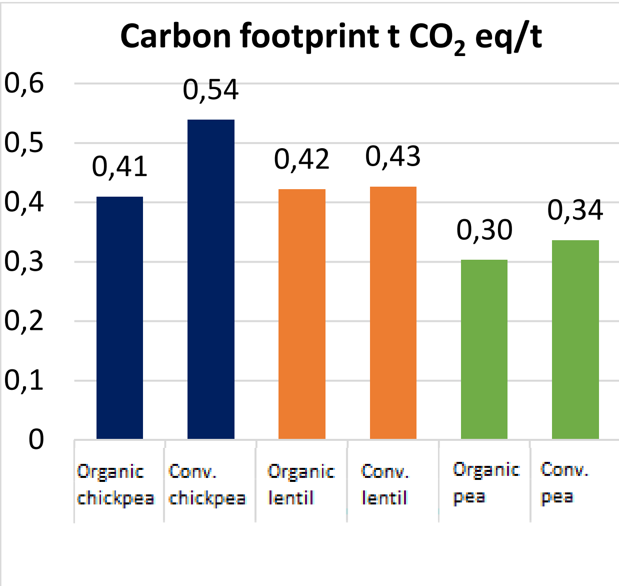
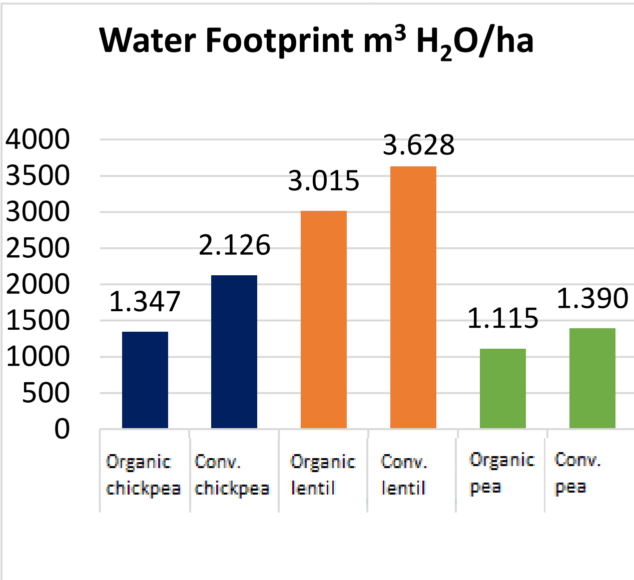
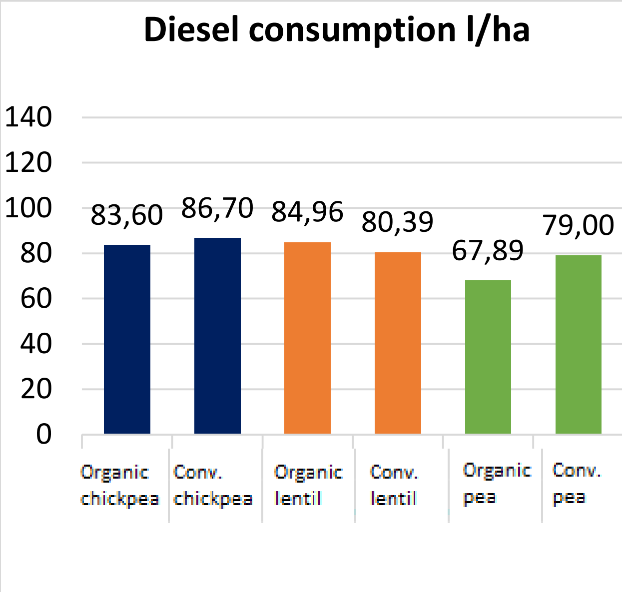
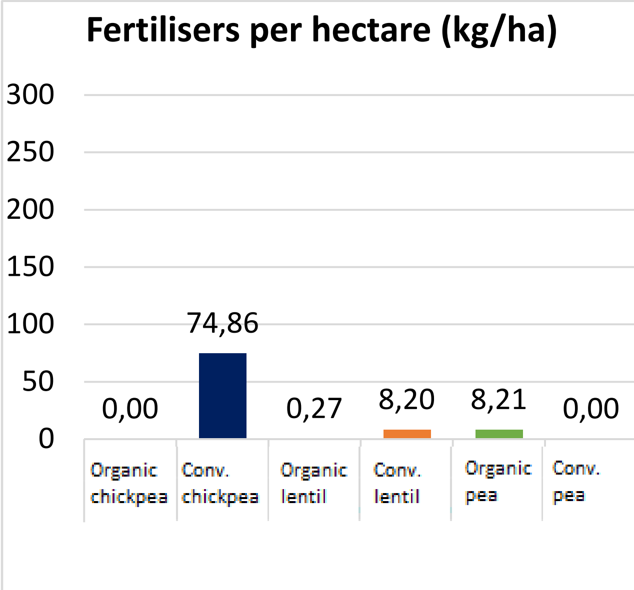
Performance of the use of technical means: data per hectare

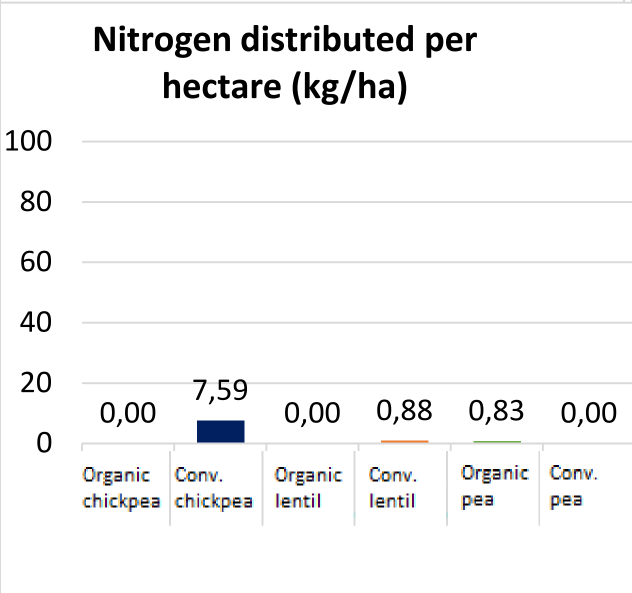
The Water Footprint per hectare shows how lentils have a lower impact compared to other crops. For the Carbon Footprint indicator, there is a higher value for conventional lentils and very similar values for the other crops, particularly for organic crops, thanks to better yields.
Fuel consumption is similar among crops, and there is no marked difference between organic and conventional cultivation. The only exception is the organic proteic pea, which has the lowest level (67.9 litres/ha).
The use of fertilisers is almost 0 in all crops, with the exception of the conventional chickpea, which shows an average of 78 kg/ha of fertiliser distributed. The graphs regarding phosphorous and nitrogen distributed per hectare demonstrate that long-term fertilisation was carried out exclusively for the conventional chickpea.
The use of plant health products in conventional cultivations is shown to be higher than for organic crops, with a higher level for the conventional chickpea. With regards to organic crops, the use of plant health products is almost 0, and there are no marked differences between the crops examined.
Lastly, with regards to the use of seed, there are no marked differences between organic and conventional crops, with the exception of the conventional proteic pea, which has a slightly lower value compared to the organic crop.

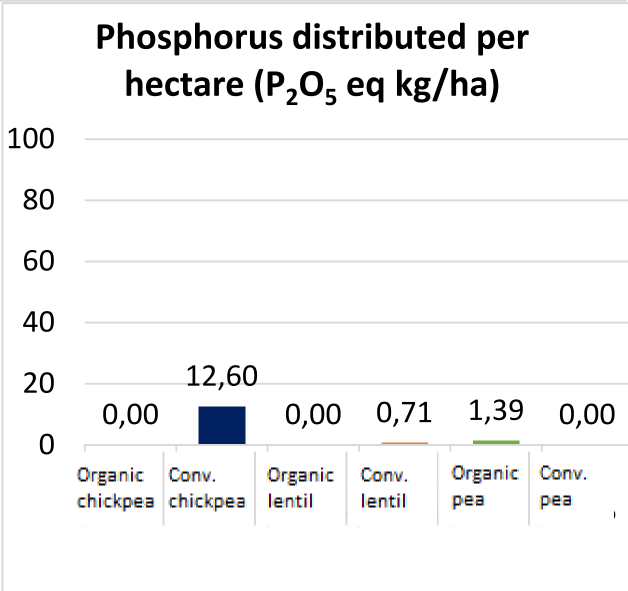


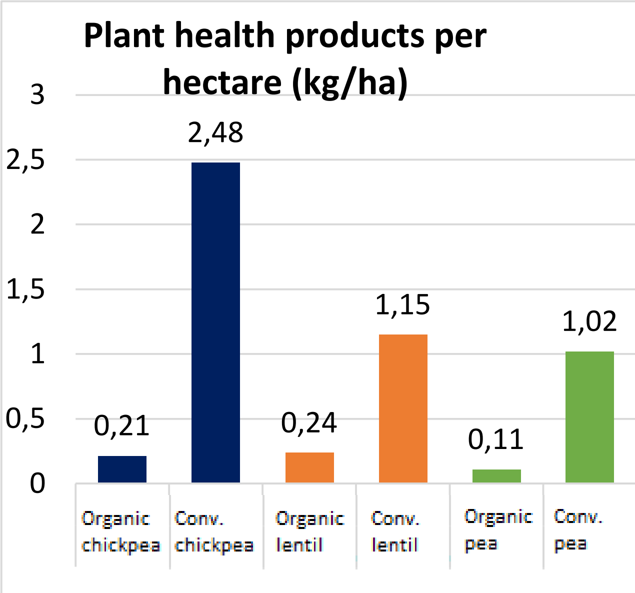


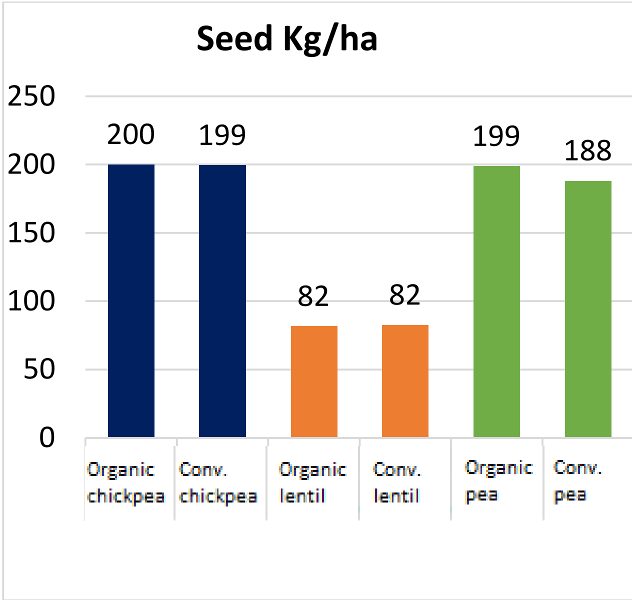

Diesel consumption l/ha
140
120
100
80
60
40
20
0
83,60
86,70
84,96
80,39
67,89
79,00
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea


Fertilisers per hectare (kg/ha)
300
250
200
150
100
50
0
0,00
74,86
0,27
8,20
8,21
0,00
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea


Nitrogen distributed per hectare (kg/ha)
100
80
60
40
20
0
0,00
7,59
0,00
0,88
0,83
0,00
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea


Phosphorus distributed per hectare (P_2O_5 eq kg/ha)
100
80
60
40
20
0
0,00
12,60
0,00
0,71
1,39
0,00
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea





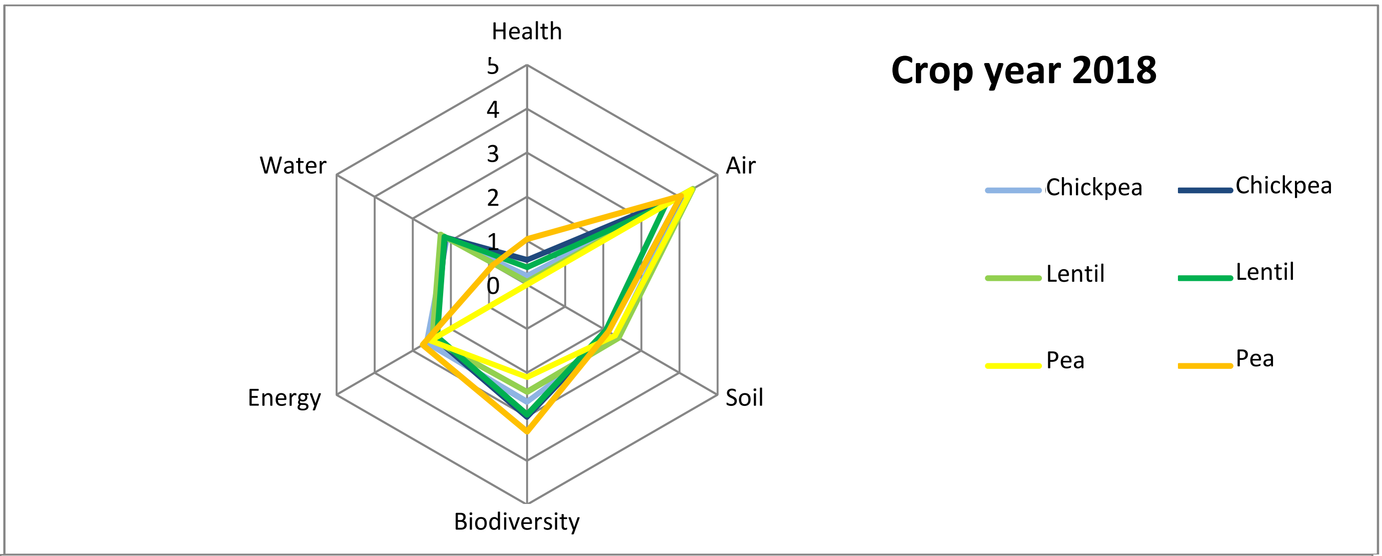
Comparison with previous years

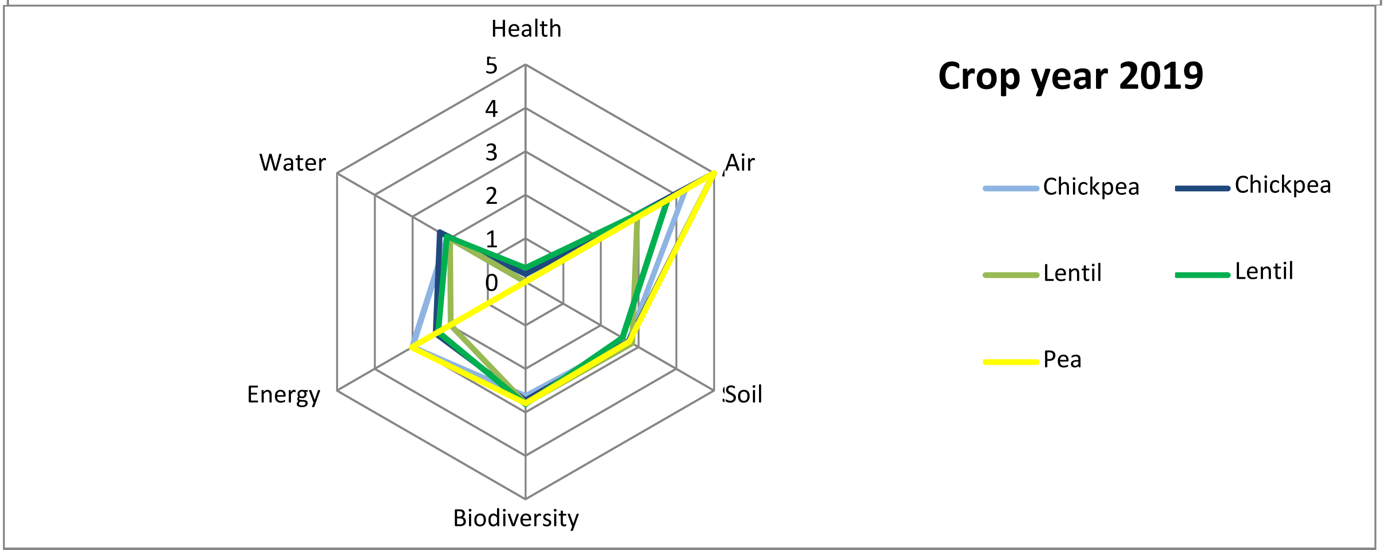
In comparing productions from the chain with previous crop years (2018 and 2019), what emerges is that the results regarding sustainability are fairly stable overall, with some differences between crops.

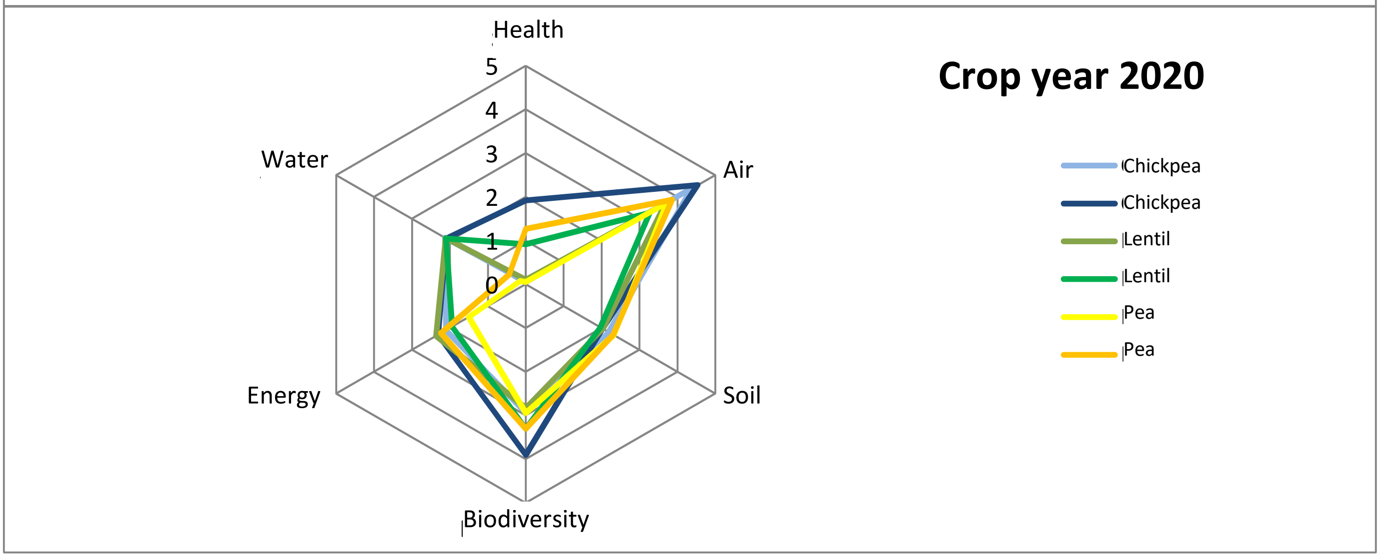
The Air section has the highest scores, particularly for 2019.

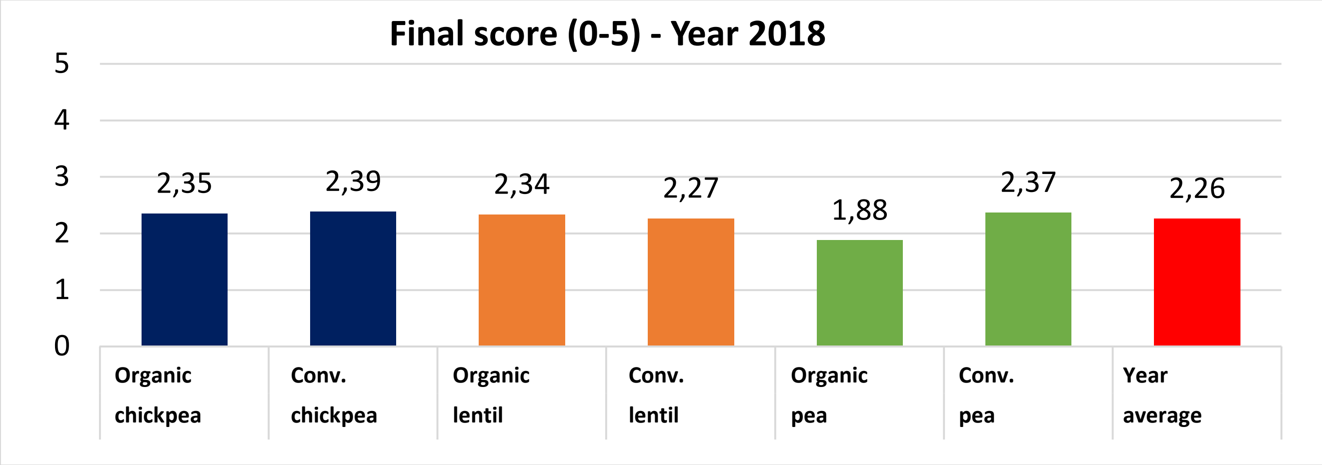
The Health section recorded extremely low indexes in 2018 and 2019, while the figures for 2020 are higher, above all for the conventional chickpea. This result demonstrates how chickpea crops required more treatment with plant health products than in previous years.

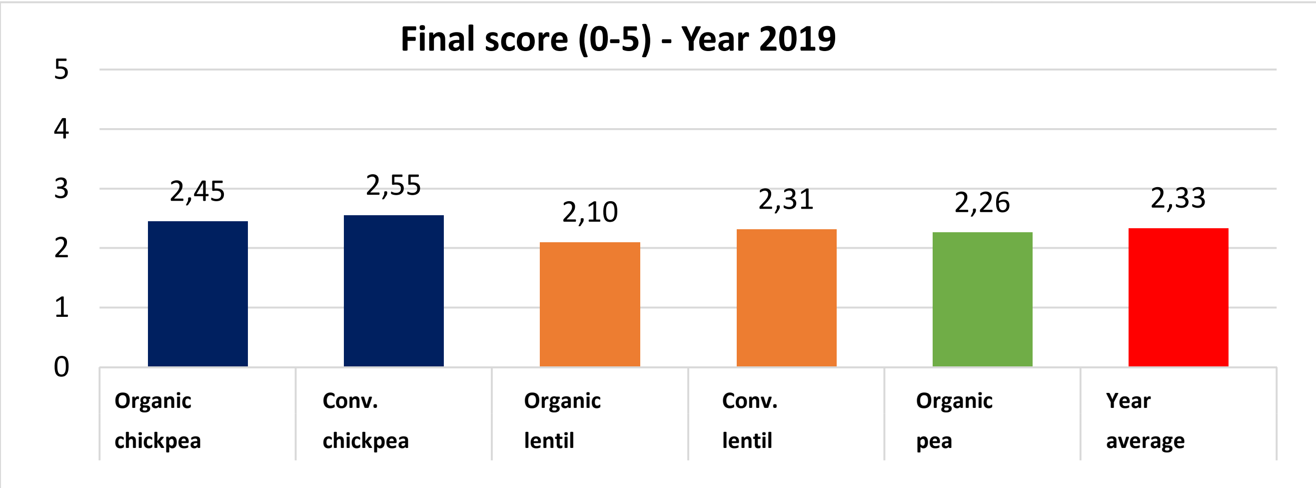
The other sections are generally very stable, even though clear improvements can be seen for a number of crops such as the proteic pea, which in 2020 demonstrated a lower environmental impact that other crops, particularly for the Energy section.

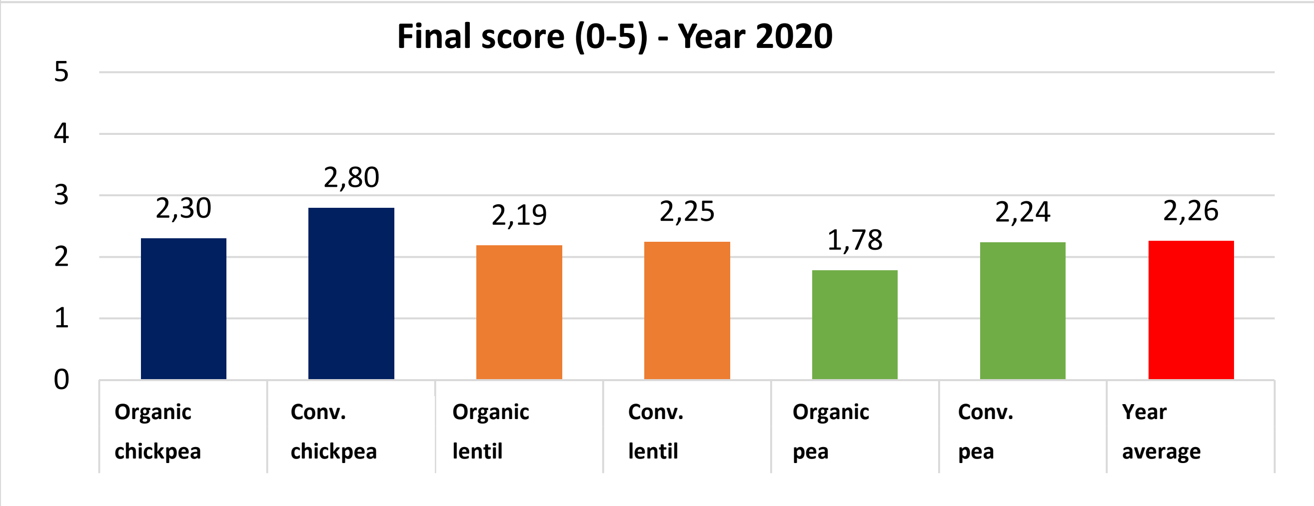

Health
5
4
3
2
1
0
Water
Air
Energy
Soil
Biodiversity
Crop year 2018
Chickpea
Chickpea
Lentil
Lentil
Pea
Pea


Health
5
4
3
2
1
0
Water
Air
Energy
Soil
Biodiversity
Crop year 2019
Chickpea
Chickpea
Lentil
Lentil
Pea


Health
5
4
3
2
1
0
Water
Air
Energy
Soil
Biodiversity
Crop year 2020
Chickpea
Chickpea
Lentil
Lentil
Pea
Pea


Final score (0-5) - Year 2018
5
4
3
2
1
0
2,35
2,39
2,34
2,27
1,88
2,37
2,26
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea
Year average


Final score (0-5) - Year 2019
5
4
3
2
1
0
2,45
2,55
2,10
2,31
2,26
2,33
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Year average


Final score (0-5) - Year 2020
5
4
3
2
1
0
2,30
2,80
2,19
2,25
1,78
2,24
2,26
Organic chickpea
Conv. chickpea
Organic lentil
Conv. lentil
Organic pea
Conv. pea
Year average

Comparing the final scores for the crops, it is possible to see that the conventional chickpea has the highest score in all the crop years, while the organic proteic pea is the most sustainable, except in 2019, when the lowest score was that of the organic lentil.
However, it should also be noted that the average score for all of the crops in the chain is relatively stable and constant over time. 2020 saw an average value that was lower than 2019, but identical to that of 2018.
It is therefore necessary to implement corrective actions that allow for a long-term improvement in sustainability performance.

How to improve

1) Increase yield through improved management of weeds.
2) Reduce the number of months of bare earth (without crops).
3) Use cover crops to:
   - increase organic substance.
   - avoid the spreading of weeds.
   - reduce fuel consumption.
   - reduce erosion.
4) Favour biodiversity. It is necessary to increase crop diversity, have small uncultivated areas that provide a refuge for wild fauna, create multi-year grasslands and/or carry out crop rotation on at least a three-year basis.
5) In uncultivated areas it is useful to have rows of trees, windbreak hedges and small areas with native shrubs. Increase wet areas wherever possible.