Research Article

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Is organic agriculture a potential public health indicator? Evidence from literature

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Abstract: Organic agriculture is a system of production whose principles are health, ecology, fairness, and care. Bearing in mind the principle of health and its links to agriculture and human health, the main goal of this work is to suggest the inclusion of organic agriculture as a public health indicator. For this purpose, four scientific online databases such as b-on, PubMed®, Scielo, and ScienceDirect were used for searching the research publications relating organic agriculture (and organic farming) with human health. However, no study suggesting organic agriculture as a public health indicator has been found. For this reason, a pictorial conceptual model that advocates the inclusion of organic agriculture as an indicator of public health was developed for the first time. This proposal intends to provide a tool that can be used by organizations and public health institutions when revising and updating their health indicators.

Keywords: organic farming, human health, sustainability, ecological systems, health indicator

1 Introduction

Organic agriculture is a holistic production management system, which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices instead of the use of off-farm inputs, considering that regional conditions require locally adapted systems. This is accomplished by using, when available, biological, agronomic, and mechanical methods, rather than synthetic materials, to accomplish any specific function within the system (FAO and WHO 2007). The General Assembly of IFOAM – International Federation of Organic Agriculture Movements – established a succinct definition of organic agriculture: organic agriculture is a production system that sustains the health of soils, ecosystems, and people. It depends on ecological processes, biodiversity, and cycles adapted to local conditions, instead of inputs with adverse effects. Organic agriculture combines tradition, innovation, and science to support the shared environment and stimulate fair relationships and good quality of life for everyone who is involved (IFOAM 2008).

Recently, a review publication about agroecology highlights a global approach, integrating practical, scientific, and advocacy dimensions to redesign agricultural systems based on ecological and sociocultural processes and underlining biodiversity. This review is based on the results of DIVERSIFOOD, a European H2020 multi-actor research project, and examines the concept of cultivated diversity using different dimensions pertinent to stimulate sustainable organic food systems and agro-ecological transition (Chable et al. 2020).

To the best of our knowledge, there are in literature some theoretical models linking organic agriculture and health. However, the idea of establishing organic agriculture as a health indicator is a possibility that needs to be exploited. This work aims to suggest organic agriculture as a public health indicator. To achieve this aim, the present manuscript has the following main parts: (i) an introduction about organic agriculture definition and

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explanation of the importance of this work; (ii) in the methods section there is a description that mainly focuses on the methodology followed and all data source used; (iii) in the results and discussion section, there is an introductory part presenting literature overview focused on statistical data about organic agriculture in the world and Europe, followed by evidence on the positive influence of organic agriculture and organic product consumption in human health; the importance of public health is also underlined; and lastly, outcomes from search in databases and health indicators are presented; (iv) then, our proposal of organic agriculture as a potential health indicator is explained, and the example of a country (Portugal) where the proposal can be implemented is shown; and (v) finally, in the conclusions section, the main conclusions found are mentioned and future possibilities are pointed out.

2 Methods

A scoping review (Peterson et al. 2017) was conducted based on three main information sources (Table 1): (1) Online bibliographic databases: b-on, PubMed®, Scielo and ScienceDirect; (2) International organizations websites, statistical and survey reports (e.g., IFOAM, FAO [Food and Agriculture Organization of the United Nations], and WHO [World Health Organization]), and (3) Portuguese institutional websites, such as DGADR (Directorate-General for Agriculture and Rural Development), DGAV (Directorate-General of Food and Veterinary Medicine), and DGS (Directorate-General for Health). Data collection was conducted in 2020, from January until September 15.

3 Results and discussion

3.1 Literature overview

3.1.1 Organic agriculture in the world and Europe

Organic agriculture is practiced in 186 countries, and 71.5 million hectares of agricultural land are managed organically by around 2.8 million farmers. In addition, in 2018, the global sales of organic food and drink overtook 96 million euros (Willer et al. 2020).

In the European Union, organic agriculture has been certified and regulated since 1991, and new regulations were approved in 2018 (EU Reg. 2018/848) to enter into force in January 2021. However, because of the coronavirus (COVID-19) pandemic this date will be delayed.

According to the statistical data of the most recent publication from FiBL and IFOAM – Organics International (Willer et al. 2020), in Europe, 15.6 million hectares were organic in 2018 (European Union: 13.8 million hectares). Spain (2.2 million hectares) continues to be the country with the largest organic area in Europe, followed by France (2.0 million hectares) and Italy (2.0 million hectares). In Europe, there were 4,20,000 organic producers (European Union: almost 3,30,000), and the largest numbers were in Turkey (almost 80,000) and Italy (more than 69,000). Moreover, the total number of organic producers grew by 5.4% in Europe (7.2% in the European Union) in 2018. Consumers spent 50 euros on organic food per person annually in Europe, against 76 euros in European Union. The consumer spending *per capita* on organic food has doubled in the last decade. Danish and Swiss consumers spent 312 euros per capita in organic food purchasing during 2018.

Table 1: Main information sources for scoping review

	Website links
Online bibliographic databases	
b-on	https://www.b-on.pt/
PubMed®	https://pubmed.ncbi.nlm.nih.gov/
Scielo	https://scielo.org/
ScienceDirect	https://www.sciencedirect.com/
International organizations	
IFOAM (International Federation of Organic Agriculture Movements)	https://www.ifoam.bio/
FAO (Food and Agriculture Organization of the United Nations)	http://www.fao.org/home/en/
WHO (World Health Organization)	https://www.who.int/
Portuguese institutional public organizations	
DGADR (Directorate-General for Agriculture and Rural Development)	https://www.dgadr.gov.pt/
DGAV (Directorate-General of Food and Veterinary Medicine)	http://www.dgv.min-agricultura.pt/
DGS (Directorate-General for Health)	https://www.dgs.pt/

3.1.2 Organic agriculture and human health

There is a growing pool of evidence that shows some potential health benefits of organic foods when compared with conventional ones. Moreover, organic agriculture can be profitable, and organic food seems to be attractive to consumers as being a healthy and ethical choice.

The widespread use of chemicals in agriculture worldwide exposes people through contaminated food, water, and soil, to endocrine disruptors capable of altering their development and reproduction. Pesticides are potent endocrine disruptors, which bioaccumulate in the food chain, and their harmful effects on the reproductive system of several animal species have already been identified (Pontelli *et al.* 2016). Siqueira and Kruse (2008), in a review article on the risks of pesticides in human health, refer to their relationship with some types of cancer (breast, testis, prostate, and ovary), infertility, congenital malformation, respiratory symptoms, Parkinson's disease, and depression. Cassal *et al.* (2014), in a review study on the indiscriminate use of pesticides and their consequences for public health, suggest that the risks are not only limited to rural workers, they also affect groundwater, soil, air, and animals and contaminate food with toxic residues. These chemicals can be spread in the environment and accumulated in the human body, causing acute and chronic adverse effects, jeopardizing public health. Birkett and Lester (2004) related the increase in the prevalence of diseases, such as obesity, diabetes, hypothyroidism, attention deficit, autism, and respiratory problems, to the exposure to endocrine disruptors. This relationship becomes worrying, as it has the potential to overburden health systems worldwide, therefore posing a serious threat to public health worldwide. Soeiro and Ferreira (2014) concluded that endocrine disruptors are a health problem because of the high morbidity and mortality associated with endocrine-mediated diseases and because of the high economic costs related to health. They defend the need to invest in raising the population's awareness of the existence of these substances and their harmful effects, to reduce their exposure, especially of women in childbearing age, pregnant women, and children. In fact, fetal stage and early childhood are particularly vulnerable periods for the exposure to neurotoxic and endocrine disruptors.

Even short occupational exposure during the first few weeks of pregnancy, before women know they are pregnant, has been linked to lasting adverse effects on children's growth, sexual development, and brain function;

this is the result of a Danish study on children of greenhouse workers, conducted by Andersen *et al.* (2015). These researchers suggest that maternal exposure to occupational pesticides has adverse effects on their children's neurological development. Disorders of neurological development, including autism, dyslexia, attention deficit hyperactivity disorder, and other cognitive changes, affect millions of children worldwide, resulting in major health and social problems. Mie *et al.* (2017) conducted a review study on the implications of organic foods and organic agriculture on human health, comparing the production of organic versus conventional foods in relation to important parameters for human health. The study reveals that residues in conventional vegetables and fruits are the foremost source of human exposure to pesticides. It also shows that several epidemiological studies have described adverse effects of some pesticides, at current levels of exposure, on children's cognitive development. Another data of great interest are the prevalent use of antibiotics in conventional animal production, which is the main driver of antibiotic resistance in society. On the contrary, the feeding requirements for organic livestock farming, such as the consumption of grass and alfalfa, result in generally higher levels of omega-3 fatty acids, which are more heart-healthy than other fats. Indeed, these higher contents of omega-3 fatty acids are found in organic dairy, meats, and eggs (Ellis *et al.* 2006).

Barański *et al.* (2014), in a systematic literature review and meta-analysis, based on 343 studies on the differences in composition between organic and conventional crops, concluded that vegetables from organic farming have higher concentrations (18–69%) of antioxidants, such as phenolic acids, flavones, flavanones, flavonols, anthocyanins, and stilbenes, and lower concentrations of pesticide and heavy metal residues than those from conventional agriculture.

More recently, in another systematic review performed by Vigar *et al.* (2020), there was a significant positive amount of outcomes in longitudinal studies where an increased organic intake was associated with reduced incidence of pre-eclampsia, birth defects, infertility, allergic sensitization, otitis media, metabolic syndrome, high body mass index (BMI), and non-Hodgkin lymphoma. According to the authors, the current scientific evidence does not allow a definitive statement on the human health benefits of organic food intake. However, a growing number of important findings have been reported from observational studies, connecting demonstrable health benefits with organic food consumption.

3.1.3 Health: prevention is the gain

The Alma-Ata Declaration (1978) emphasizes that health is a fundamental human right. Then, health literacy was defined as “The set of cognitive and social skills and the ability of individuals to access understanding and use of information, in order to promote and maintain good health” by WHO (1998). Health literacy empowers citizens to have autonomy and accountability for their own health and to fight for a more intervening role in the functioning of the Health System (Kickbusch et al. 2013), based on the assumption of maximum responsibility and individual and collective autonomy (empowerment).

The European health literacy survey (HLS-EU) was performed in eight countries: Austria, Bulgaria, Germany, Greece, Ireland, Poland, the Netherlands, and Spain (Sørensen et al. 2015). The HLS-EU-Q presented four levels of health literacy: insufficient, problematic, sufficient, and excellent. At least 1 in 10 (12%) respondents revealed insufficient health literacy and almost 1 in 2 (47%) had limited (insufficient or problematic) health literacy. Nevertheless, the distribution of levels differed largely across countries (29–62%).

Pedro et al. (2016) referred that several studies have shown that an inadequate level of health literacy can have significant implications for health outcomes, the use of health services, and, consequently, health expenditures. These authors translated and validated the European Health Literacy Survey (HLS-EU) to the Portuguese population. In Portugal, 61% of the surveyed population has an inadequate or problematic general health literacy level, when compared with 49.2%, the nine countries’ average value (the eight countries of HLS-EU and Portugal).

The economic development and better access to knowledge led to higher expectations from society regarding health and health systems. Non-communicable chronic diseases (NCDs) are currently one of the biggest threats to public health in the European Union. According to the WHO (2008a), it was estimated that, without preventive measures, the number of deaths from NCDs will increase by 17% globally over the next 10 years. The social and economic costs of NCDs deserve a serious political response, by adopting healthier and more sustainable strategies, such as organic agriculture and the promotion of food and nutrition literacy. The resources available to NCD prevention and control are usually inadequate, especially because the large scale of the problem and the fact that it is growing year-on-year. ‘Health in all policies’ aims to include intersectoral contributions, starting with the identification of the effects of agricultural, environmental, educational, fiscal, housing,

transport, and other policies on health. It seeks to work in harmony with all these sectors to guarantee that, by contributing to well-being and wealth, these policies also have a positive impact in health (EPHAC 2013). The purpose of intersectoral collaboration is to reinforce synergies. Decision-makers in other sectors must be aware of their choices to minimize adverse health effects. Public policies developed around education, gender equality, and social inclusion also contribute positively to health and must be valued in the pursuit of health gains. Public health has evolved to value the connections between health and other sectors. It is up to the policymakers of each country to make conscious choices about the future of their health system (WHO 2008b). The health of a population is subjected to a multitude of factors. The health status of each citizen depends on the genetic heritage, the social, cultural, and physical environment in which he/she lives (Quigley et al. 2006), and the functioning of the Health System. Health indicators are instruments of summary measure that reflect, directly or indirectly, relevant information about different attributes and dimensions of health, as well as the factors that determine it (Nutbeam 1998). According to the Canadian Institute for Health Information (CIHI 2009), the term health indicator refers to a single summary measure, most often expressed in quantitative terms, that represents a key dimension of health status, the health care system, or related factors. Designed to provide comparable information at the health region and provincial or territorial levels, these health indicator statistics are produced from a varied range of the most recently available sources. In fact, the roles of health authorities in monitoring, maintaining and improving the health of the population and the functioning of the health system, are supported by produced statistics.

The argument that organic agriculture and health are linked in a positive way is supported by a considerable number of published works and studies, which address, among others, nutritional and health benefits of consuming organic products (Barański et al. 2014; Vigar et al. 2020) and reduced pesticides intake by humans or less soil, water, and environmental contamination (Siqueira and Kruse 2008; Cassal et al. 2014).

3.2 Outcomes from search in online databases

By researching in online databases, several documents about organic agriculture (Figure 1) were found.

Figure 1: Results found in four online databases according to specific keywords.

However, when we refined our search, by combining the keywords ‘organic agriculture’ and ‘organic farming’ with ‘health,’ the number of results substantially decreased. The word ‘indicator’ was also added, leaving us with zero results (zero published papers) in two databases, PubMed[®] and Scielo.

Several results including the word ‘indicator’ were found in b-on and ScienceDirect databases. When we carefully analyzed each result, we realized that the

publications did not refer to the concept of ‘organic farming’ as a ‘health indicator,’ as we were looking for. The results found were mostly about ‘soil health indicators’ or ‘environmental health indicators,’ instead.

Some documents and reports that integrate statistical information and/or relevant strategies focused on recent and future developments in the field of organic agriculture in different countries and regions have been published. Some of the most relevant are presented in Table 2.

In 2008, Hamm proposed a conceptual frame with four dimensions of healthy, livable communities: farming, economics, environment, and health. According to this author, in the agricultural dimension, it is proposed to maintain a diversity of cultures to shape the landscape; in the economic dimension, the existence of interconnected rural and urban communities stands out, assisted by networks of small business owners, instead of rural communities with financial problems; in the environmental dimension, the maintenance of natural resources for future generations is highlighted; and finally, in the health dimension, the maintenance of quality of life throughout the life cycle is emphasized and not only

Table 2: Publications focused on organic agriculture: Recent and future strategies

Title	Scope/main goals	Author/editor
Review of organic food sector and strategy for its development 2019–2025	The overall objective of the strategy is to support the development of a feasible Organic Food Sector in Ireland increasing the sustainability credentials of Irish food producing a broad range of organic products to meet enhancing national and export market opportunities The objectives launched for the specific sub-sectors acknowledge the importance of promoting organic food production, by taking into account not only market demand, but also biodiversity protection and climate change mitigation	Talmahaíochta and Mara (2018)
The World of Organic Agriculture. Statistics and Emerging Trends (2020)	Provides a comprehensive overview of late developments in global organic agriculture. It presents detailed organic farming statistics about area under organic management, particular information about land use in organic systems, the farms and other operator types’ number and market data. It also includes contributions from representatives of the organic sector worldwide	Willer et al. (2020)
Farm to Fork Strategy. For a fair, healthy, and environment-friendly food system	The Farm to Fork Strategy is a recent comprehensive approach to how Europeans value food sustainability. It is an opportunity to improve health, lifestyles, and the environment The strategy of creation of a favorable food environment that helps to choose healthy and sustainable diets will benefit quality of life and consumers’ health and decrease health-related costs. It is urgent to reduce dependency on pesticides, reduce chemical fertilization, increase organic farming numbers, improve animal welfare, and reduce the use of antibiotics and reverse biodiversity loss	European Commission (2020)

the concern in the treatment of the disease. In the conceptual model presented by Hamm (2008), there was no clear possibility of considering organic farming as an indicator of health. However, the author shows two case studies from Michigan (USA), that identify opportunities to link agricultural production opportunities directly to dietary orientation and public health issues, while also encompassing notions of community and economic development and environmental sustainability.

3.3 Health indicators

An indicator is a measure used to express the behavior of a system or part of a system. Indicators are largely used in the public sector for performance management of public health (Flowers et al. 2005).

The 2018 revision of the Global Reference List of 100 core health plus SDG (Sustainable Development Goal) related indicators (WHO 2018a) contains a selection of priority indicators relating to four domains that comprise risk factors, health status, service coverage, and health systems. Across this document there is a lack of organic agriculture and its possible contribution in health promotion or maintenance.

Health indicators are measures of health and of the factors that influence health. They can be used to manage the health care system, to improve our understanding of the broader determinants of health, to identify gaps in the health status and outcomes for specific populations, and, finally, to provide information to health policy.

Although there are countless indicators that could be calculated, the challenge is to find the most important to measure and track; what types of indicators best show the needs of those who use them; which of the present indicators are no longer relevant and may therefore be discarded or replaced by more appropriate measures; and lastly, how can the cross-cutting dimension of equity be addressed in the assessment of the indicator set (CIHI 2009). In Table 3, health indicators from Canada but which are also adopted by Portuguese DGS are presented.

Organic agriculture, if seen as a health indicator, could be included as a “Non-medical determinant of health,” inside the categories of “Health behaviours,” and/or “Living and working conditions” and/or “Environmental factors.”

In fact, there is substantial evidence on the influence of consuming organic products in health status (Vigar et al. 2020). Moreover, a report of the European Parliament (2016) about human health implications of organic

food and organic agriculture referred that epidemiological studies underline negative effects of some insecticides on children’s cognitive development at current levels of exposure. Those risks can diminish with organic food, particularly during pregnancy and in infancy.

In another perspective, there are studies that showed the link between working conditions of organic farmers and their health condition. Recently, in a systematic review, Maas et al. (2020) showed that despite the absence of technical assistance and appropriate technology, there is an increase in job satisfaction and an improvement in the health of the family, enhancing the quality of life.

Since the implementation of EC Reg. 2078/92, the EU promotes organic farming based explicitly on its positive effects to the environment. The environmental impacts of organic farming are landscape, soil, ground and surface water, and biodiversity (Stolze et al. 2011). Organic products reduce public health risks to farmworkers, their families, and consumers by minimizing their exposure to persistent and toxic chemicals in food, on the farm, soil, air, and water.

Moreover, the development of short food supply chains, where the intermediaries between organic farmers and the consumers are less or even inexistent, is also beneficial. This can be achieved by the creation of local markets that give the consumers a better access to fresh and seasonal products, also having a smaller impact on the environment, because of the smaller distances of transportation (Lopes et al. 2019; Guilherme 2020; Jarzębowski et al. 2020; Tankam and Djimeu 2020). For the first time, The Common Agricultural Policy focused on the short food supply chains, during the current funding period (2014–2020). Local producers can now be supported by the European Agricultural Fund for Rural Development.

3.4 Organic agriculture as a potential public health indicator

An original pictorial conceptual model, which intends to suggest that organic agriculture could be a public health indicator, was developed, which is shown in Figure 2.

According to Mondino (2014) and Sayão (2001), models are fundamental entities in scientific and pedagogical practice and are helpful to investigate complex phenomena from which there isn’t complete understanding. Moreover, the conceptual model building consists of choosing the system parts and the relationships that link

Table 3: Health indicators (partial adaptation from CIHI 2009)

Health status			
Health status can be measured in a variety of ways, including well-being, health conditions, disability, or death			
Well-being	Health conditions	Human function	Deaths
Broad measures of the mental, physical, and social well-being of individuals	Alterations or attributes of the health status of an individual which may interfere with daily activities, lead to distress, or contact with health services; it may be a disease (acute or chronic), injury or trauma, disorder, or reflect other health-related states such as pregnancy, congenital anomaly, stress, aging, or genetic predisposition	Levels of human function are related to the consequences of diseases, injury, disorder, and other health conditions. They include body function/structure (impairments), participation (restrictions in participation), and activities (activity limitations)	A range of age-specific, condition-specific, and mortality rates, as well as derived indicators
Non-medical determinants of health			
Non-medical determinants of health are known to affect our health and, in some cases, when and how we use health care			
Health behaviors	Living and working conditions	Personal resources	Environmental factors
Aspects of personal behavior and risk factors that epidemiological studies revealed to influence health status	Indicators linked to the socioeconomic characteristics and working conditions of the population that epidemiological studies have shown to be related to health	Measures the prevalence of factors like social support that epidemiological studies revealed to be associated with health	Environmental factors with the potential to influence human health

these parts, specifying how the parts interact and identifying missing information (Tilden et al. 2013).

The central figure of this model (Figure 2) is represented by a rocker, based on the simple lever theory of Archimedes. Archimedes, a Greek physicist and mathematician, was responsible for one of the most important inventions, the use of levers to move heavy loads. He became famous with the phrase “Give me a lever and a point of support and I will raise the world.” The swing or lever is directly linked to the concept of balance; advance or promote development (Heath 2002).

- (1) Levers are made up of three fundamental elements:
 - Fixed or support point, around which the lever can turn, which is represented by the sustainability triangle that rests on the balance, between the three pillars that compose it, that is, ecologically balanced, economically viable, and socially fair. In fact, the principles of Health, Ecology, Fairness, and Care are the roots from which organic agriculture grows and develops (IFOAM 2020).
 - Potent force or potency, exercised with the objective of lifting, sustaining, and balancing, which is represented by organic agriculture.
 - Resistant force or load, exerted by the object to be lifted, supported, and balanced, is represented by public health.
- (2) Organic agriculture positively influences public health. The strength exerted by organic agriculture will raise the public health “flag” higher. The globe of organic

agriculture represents the biosphere (sphere of life). The biosphere is formed by all living beings present on the planet Earth. It contains soil, air, light, food, and all the necessary elements for the development of life. The green color symbolizes nature. Around the globe, farmers and family farming are represented. Farmers have a fundamental role in society, as they produce food that is intended to be safe and of high quality; and they also have the important role of taking care of the natural resources (e.g., functional diversity, water resources, and crop diversity, i.e., landraces and germplasm that can be used for breeding and selection for organic) helping to fight climate change and emphasize cultural elements (e.g., landscape, gastronomy, traditions, and architectural elements).

- (3) The public health “flag” represents the resistant force or the load that is dependent on the strength or energy of organic agriculture, i.e., investment in organic farming promotes the improvement of public health. The yellow color symbolizes health. Together, with the public health banner, there is a society that includes farmers (producers) and consumers of all ages. Who benefits with organic food? The farm-workers, because there is a reduced pesticide exposure in organic agriculture; the consumers, because there is some evidence proving the increased nutritional quality and reduced pesticide contamination in organic products; and, finally, it is proven that children living in areas with high pesticide use are at a great risk of

Figure 2: Proposal of organic agriculture as a public health indicator.

health effects, because of their high susceptibility to pesticides. We should not only look at pesticide residues in food as a measure of exposure, as, although some foods do not have high final levels of residues, they were produced using pesticides and this exposure put the farmer's health at risk. Pesticide use in production and the farmworker exposure are important issues to consider, while looking at the whole pesticide problem. A shift to organic agriculture is the key to eliminate toxic pesticide exposure. The green background, present in the entire image, symbolizes nature (refers to the set of living beings and phenomena that occur naturally), hope, balance, and ecological awareness.

This model aims to provide a representation for the organization of the relationship, in a macro view, between organic agriculture and public health, supporting the view of organic agriculture as a health indicator, based on different aspects, such as:

- Organic agriculture is identified with the concept of sustainability. It is concerned with the management and sustainable use of natural resources, in promoting equality and social justice, not only focusing on the economic model (Newton 2004; Lichtfouse 2010). In fact, according to the principle of fairness, organic agriculture should build on relationships that ensure fairness regarding the common environment and life opportunities (IFOAM 2020). The Rodale Institute (Rodale 2011) has been, for 30 years, conducting a long-term comparative Farming Systems Trial. Starting in 1981, the Rodale Institute began studies comparing organically fertilized fields and conventionally fertilized fields on its 330 acre farm in Pennsylvania, USA. The main results reported were as follows: (i) organic farming systems improve soil organic matter, making it a more sustainable system; (ii) organic farming uses 45% less energy and is more efficient; (iii) conventional systems generate 40% more greenhouse gases; and (iv) conventional farming systems are less profitable than organic systems.
- Organic family farming is a sustainable production strategy that promotes the food sovereignty and nutritional security of the populations. It contributes to the social dignity of farmers; it reduces environmental risks related to food production and therefore it should be considered an important factor that promotes public health. Organic farming encourages healthy products, biodiversity, and genetic resources used to tackle with climatic changes, pest, and diseases and resilience (Nandwani 2016; Chable *et al.* 2020). In addition, there

is a positive contribution to rural development through training in organic farming (Guiné *et al.* 2015).

According to Reganold and Wachter (2016), organic farming systems produce lower yields compared with conventional agriculture. Nevertheless, they have social benefits, are more profitable and environmentally friendly, and bring equally or more nutritionally dense foods that contain less (or no) pesticide residues, against conventional farming. More recently, Costa *et al.* (2020) published a book with the compilation of several works conducted about the bridges between family farming and organic farming. According to this publication, the success of family farming explorations may involve adopting production methods such as organic farming, based on principles such as feeding the soil, optimizing nutrient cycles through the management of animals and plants in space and time, or maintaining close relationships with the market, to guarantee product quality and to ensure the improvement of household income. There are several success cases focused on building bridges between family farming and organic farming, integrating the principles of organic farming in the logic of production and contributing to its technical and economic improvement (Auerbach *et al.* 2013; von Dach *et al.* 2013; Jouzi *et al.* 2017). Furthermore, some projects were developed about family farming and organic farming. For example, the ECONewFARMERS project was a partnership with different countries, such as Portugal, Hungary, Spain, Italy, Turkey, the United Kingdom, and Slovakia, focused primarily on improving the quality and performance of education and vocational training to strengthen the European dimension in organic farming (Correia *et al.* 2017).

- The Mediterranean dietary pattern (Mediterranean Diet, MD) shares the principles of organic agriculture, generating a potentiating effect on all pillars of sustainability, public health, and, consequently, health gains. Being a dietary pattern, whose offer is mostly of plant origin (Willett *et al.* 1995), environmentally friendly, local, and incorporating a high diversity of seasonal products, it responds to many of today's concerns about food production, distribution, and consumption. Although the relationship between human diet and health is benefited by this dietary pattern, according to several epidemiological studies carried out in the last 50 years, this dietary pattern presents other perspectives that can be evidenced: food as a cultural activity and a decisive factor in protection of the environment (Graça 2015). Several studies show that a dietary pattern inspired by MD principles is associated with numerous health benefits (D'Alessandro and

De Pergola 2018; Galbete et al. 2018). Moreover, there is a relevant evidence from different countries that organic food consumers have a healthier eating pattern (Kesse-Guyot et al. 2013; Bradbury et al. 2014; Torjusen et al. 2014; Eisinger-Watzl et al. 2015).

- Healthy eating is an essential condition for disease prevention. If we consider, in the concept of healthy food, the socio-environmental perspective of organic farming and the exemption of synthetic chemicals, it is certain that organic food promotes health and quality of life. In fact, “Health” is reported as the foremost reason why consumers purchase organic food in an overwhelming majority of studies reviewed (Zanoli and Naspetti 2002; Lockie et al. 2004; Hughner et al. 2007; Brantsaeter et al. 2017; Apaolaza et al. 2018). Possibly, the most evident public health benefit from the consumption of organic food is the reduction of pesticide exposure and the risk of neurodevelopmental deficits, cancer, and other adverse health consequences that can be triggered, or worsened, by pesticide exposures (Baker et al. 2002; Smith-Spangler et al. 2012; Brantsaeter et al. 2017). In addition, also with great apprehension is the widespread use of antibiotics in conventional animal production as a promoter of antibiotic resistance in society (Mie et al. 2017), whereas in organic agriculture its use is much more restricted.

On the contrary, other studies showed a positive influence on the health effects of organic food in humans, namely, reduced risk of pre-eclampsia, prevention of pregnancy malformations, less allergies incidence, lower body weight and prevention of obesity, lower risk of eczema in children, inhibition of the development of cancer cells, and more resilience (Huber et al. 2011; Kesse-Guyot 2016; Barański et al. 2017). Furthermore, nutritional quality improvement of several organic food versus conventional, such as passion fruit, apples, milk, and meat, has been shown in recent publications (Oliveira et al. 2017; Popa et al. 2019).

- The rural environment must be a space that promotes health and healthy lifestyles, with the potential for producing quality food, free from toxic products, with respect for the environment that will be reflected in the health and quality of life of the rural and urban population (FAO 2019). Public health policies are responsible for creating programs to promote healthy eating, to guide the consumers, without forgetting the fundamental farmers’ role, who are at the base of the entire food production chain, producing food, who are intended to produce quality food, making a valuable contribution to society and favorably influencing public health.

- Scientific evidence allows us to state that organic agriculture is a sustainable strategy for promoting public health, which is why the inclusion of organic agriculture as a health indicator in the group of health determinants is proposed. Organic agriculture is a health promoter; therefore, we are proposing organic agriculture to be a health indicator, belonging to the group of health determinants, with the intention of planning, developing, and implementing public health policies adjusted to the needs of the population and obtaining health gains. Health promotion is based on the improvement of health status, and also by improving the quality of life and well-being and disease prevention. It is, undoubtedly, one of the essential pillars of health promotion. Health promotion and quality of life are inseparable factors. We cannot have a good quality of life without health (Sicoli and Nascimento 2003). The Health 2020 Strategy emphasizes the role of promoting the raise of healthy environments and resilient communities, in achieving health gains and reducing health inequalities. The actions to be developed must consider the relevance of the environment to health in general and throughout the individual and family life cycle, as well as specific environments, considering environmental or occupational factors. It is essential to empower people to learn throughout their lives, preparing them for their different stages and to cope with chronic illnesses and disabilities (WHO 2013). These interventions must take place in schools (Botelho and Lameiras 2018), at work, and community organizations, such as urban agriculture and social farming (Lohrberg et al. 2016), to reach the maximum number of citizens (WHO 2013).

3.5 Organic agriculture in Portugal

In Portugal, according to data from Directorate-General for Agriculture and Rural Development (DGADR 2019), in 2018 the agricultural area used in organic farming was 2,13,118 hectares, which corresponds to a decrease of 16% compared to 2017. In 2018, another 251 new operators were recorded in relation to 2017, reaching a total of 5,905. Producers increased and stayed at 5,213, with 539 new farmers. The interest in organic aquaculture must be highlighted, with 11 new operators registered in this sector. In relation to crops, in 2018, pastures (58%), forages (14.2%), and arable crops (1.3%) represented 73.5% of the total organic farming area. However, in

global terms, and compared to 2017, the total area of these crops decreased by 0.8%. These crops are used for animal production. National production for human consumption remains low, occupying about 25% of the total area of organic production. The olives (8.3%), dry fruits (7.85%), grapes (1.71%), vegetables (1.55%), and citrus fruits (0.12%) stand out. Regarding products of animal origin, the number of animals in 2018 increased 5.6% compared to 2017, especially in poultry and cattle, with a drop in sheep production.

In the public consultations carried out within the scope of the creation of the National Strategy for Organic Agriculture, more than 50% of the Portuguese said that they intend to consume organic products, especially fruits, vegetables, cereals, legumes, dairy products, and some meat (ICS/UL 2019). Portugal has a National Strategy for Organic Agriculture (ENAB) and the Action Plan (PA) 2017–2027 that needs to be promoted and implemented, but financial resources have been lacking to carry them into practice. Despite these difficulties, the following fruits from organic production were recently integrated into the scholar fruit and milk regimen: apple, pear, clementine, tangerine, orange, banana, cherry, grapes, plum, peach, carrot, and tomato. An increase in the payment of products from quality certified schemes is granted, namely organic production, according to budget availability.

The Resolution of the Council of Ministers No. 110/2017 of 8 June created the National Observatory of Organic Production through which it is intended to collect, process, and disseminate in a portal on organic agriculture, of free access, the information available on production, transformation, and commercialization of organic products, including their consumption and the various existing markets. Moreover, the creation of the Competence Center for Organic Agriculture and Products in Organic Production (CCBIO) in 2017 based on the same Resolution was crucial. Then, in 2018, this Competence Center was modified into an Association, and nowadays it brings together 35 partners at a national level, and it is focused on production and dissemination of scientific and technological knowledge that contributes to the robustness and sustainability of the sector either through innovation or through the contribution to the resolution of some constraints (CCBIO 2020).

According to Ferreira (2020) from Agrobio (Portuguese Organic Agriculture Association, created in 1985), there are some key actions that should be implemented in the future: (1) increase national organic production; (2) encourage specific technical support for organic agriculture; (3) promote, raise awareness, give recognition and

information about organic production; (4) allocate financial resources to the full implementation of the National Strategy for Organic Agriculture (ENAB) and the Action Plan (PA) 2017–2027; and finally (5) integrate organic agriculture into the future Common Agricultural Policy.

We can conclude that in Portugal there is a great opportunity for the increase in organic production (including aquaculture) in the next decades, and the attention in organic food consumption is growing. This interest in demand by consumers needs a strong coordination among different sectors such as producers, certification entities, governmental and public organizations, and consumers sharing a common interest about organic products, i.e., a multisectoral approach is needed.

The institutions and social actors identified, considered as potential agents of public health, are the Government and the Municipalities; the National Health Service; the Social (as Private Institutions of Social Solidarity) and Private Health Sectors; Education, Science and Research institutions; Environmental Protection Organizations; Associations of Professionals and Citizens; Non-Governmental Organizations; Pharmacies; the Business Sector; Non-Organized Citizens and the Media, among others (DGS 2016). The Government Programme establishes as a priority the promotion of health through a new ambition for Public Health, underlining that, to achieve health gains, it must intervene in the various determinants in a systemic, systematic, and integrated way. The National Health Plan 2012–2016 – Review and Extension to 2020 (DGS 2015) reinforces the citizen's position in the center of the health system and has, as strategic axes, citizenship in health, access and equity, quality, and health policies.

As a strategy, investments are made in strengthening citizens' power and responsibility in contributing to the improvement of individual and collective health, by promoting literacy in health, in a culture of proactivity, commitment, and self-control (training/active participation) for maximum individual and individual responsibility and collective autonomy (empowerment) (DGS 2015). Within this perspective, if organic agriculture makes an evident positive contribution to health, then its inclusion as a public health indicator will be of great interest, benefiting everyone.

4 Conclusions

Organic agriculture emerges as a response to the industrialization paradigm. Its principles are: Health, Ecology,

Fairness, and Care. These principles and its interactions make a positive impact on economic, environmental, social, cultural, and health contexts. Organic agriculture when compared with the conventional agriculture is proven to contribute to the maintenance of an optimal health and to decrease the risk of developing chronic diseases, because of the general association of higher quantity of bioactive compounds and lower content of unhealthy substances, such as pollutants (e.g., cadmium), pesticides, and synthetic fertilizers.

The scientific literature presented here allowed us to substantiate that organic agriculture is a health promoter. Therefore, it is proposed that organic agriculture could be considered as a public health indicator, belonging to the group of health determinants, with the purpose of planning, developing, and implementing health policies adjusted to population needs.

As organic agriculture is a certified system, well controlled by authorities, with credible statistical data outcomes and traceability of products, a strategy for gathering and analyses of data could be of great value to reinforce the implementation of organic agriculture as a health indicator, in any country or region, where organic agriculture certification already exists.

Abbreviations

Agrobio	Associação Portuguesa de Agricultura Biológica (Portuguese Organic Agriculture Association)
BC	Before Christ
BMI	Body mass index
CCBIO	Centro de Competências para a Agricultura Biológica e para o Modo de Produção Biológico (Competence Center for Organic Agriculture and Products in Organic Production)
CERNAS	Centro de Recursos Naturais, Ambiente e Sociedade (Research Centre for Natural Resources, Environment and Society)
CHTS	Centro Hospitalar do Tâmega e Sousa (Tâmega and Sousa Hospital Center)
CIHI	Canadian Institute for Health Information
DGADR	Directorate-General for Agriculture and Rural Development
DGAV	Directorate-General of Food and Veterinary Medicine
DGS	Directorate-General for Health of Portugal
EEC	European Economic Community

EC Reg.	European Community Regulation
ENAB	Estratégia Nacional para a Agricultura Biológica (National Strategy for Organic Agriculture)
EPHAC	European Public Health and Agriculture Consortium
EU Reg.	European Union Regulation
FAO	Food and Agriculture Organization of the United Nations
FCT	Fundação para a Ciência e a Tecnologia (Foundation for Science and Technology)
FiBL	Research Institute of Organic Agriculture
HLS-EU	European Health Literacy Survey
HLS-EU-Q	European Health Literacy Survey Questionnaire
IFOAM	International Federation of Organic Agriculture Movements
IPM	Integrated Pest Management
IPC/ESAC	Instituto Politécnico de Coimbra/Escola Superior Agrária de Coimbra (Polytechnic Institute of Coimbra/Coimbra Agriculture School)
MD	Mediterranean diet
NCDs	Non-communicable diseases
PA	Action plan
SDG	Sustainable development goal
USA	United States of America
WHO	World Health Organization

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