



HAL
open science

Organic food “Yes”, organic food “No”: a discussion between specialists with the Italian Parliament in the fray

Michaël Aubert, Damien Banas, Nicolas Bernier, Manuel Blouin, Cristian Bolzonella, Karine Bonneval, Jean-Jacques Brun, Ines Fritz, Raffaello Giannini, Herbert Hager, et al.

► To cite this version:

Michaël Aubert, Damien Banas, Nicolas Bernier, Manuel Blouin, Cristian Bolzonella, et al.. Organic food “Yes”, organic food “No”: a discussion between specialists with the Italian Parliament in the fray. 2019. hal-02499526v1

HAL Id: hal-02499526

<https://hal.science/hal-02499526v1>

Preprint submitted on 9 Dec 2019 (v1), last revised 5 Mar 2020 (v2)

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

ORGANIC FOOD “YES”, ORGANIC FOOD “NO”

A DISCUSSION BETWEEN SPECIALISTS

WITH THE ITALIAN PARLIAMENT IN THE FRAY

Michael Aubert¹, Damien Banas², Nicolas Bernier³, Manuel Blouin⁴, Cristian Bolzonella⁵, Karine Bonneval⁶, Jean-Jacques Brun⁷, Ines Fritz⁸, Raffaello Giannini⁹, Herbert Hager⁸, Klaus Katzensteiner⁸, Jeff Lowenfels¹⁰, Cristina Menta¹¹, Cristina Micheloni¹², Maurizio G. Paoletti⁵, Céline Pelosi¹³, Alessandro Piccolo¹⁴, Jean-François Ponge³, Surinder Kukal Singh¹⁵, Efrem Tassinato¹⁶, Gianni Teo¹⁷, Mauro Tomasi¹⁸, Augusto Zanella^{5*}

-
1. UFR Sciences et Techniques, Université de Rouen, FR - michael.aubert@univ-rouen.fr
 2. Université de Lorraine, Nancy, FR - damien.banas@univ-lorraine.fr
 3. Muséum National d'Histoire Naturelle de Paris, FR - bernier@mnhn.fr; ponge@mnhn.fr
 4. UMR Agroécologie, Agrosup Dijon, FR – manuel.blouin@agrosupdijon.fr
 5. Università degli Studi di Padova, IT – cristian.bolzonella@unipd.it; augusto.zanella@unipd.it
 6. École supérieure des Arts Décoratifs de Strasbourg, FR - karien@karinebonneval.com
 7. IRSTEA – Centre de Grenoble, FR – jean-jacques.brun@irstea.fr
 8. Universität für Bodenkultur Wien, AU - herbert.hager@boku.ac.at;
klaus.katzensteiner@boku.ac.at; ines.fritz@boku.ac.at
 9. Università degli Studi di Firenze, IT – raffaello.giannini@unifi.it
 10. Garden Writers of America, US - jeff@gardener.com
 11. Università degli Studi di Parma, IT – cristina.menta@unipr.it
 12. Associazione Italiana per l'Agricoltura Biologica (AIAB-FVG), Udine, IT -
c.micheloni@aiab.it
 13. UMR 1114 EMMAH, INRA, Avignon Université, 84914, Avignon, France -
celine.pelosi@inra.fr
 14. Università degli Studi di Napoli Federico II, IT - alessandro.piccolo@unina.it
 15. Punjab Agricultural University, IN - sskukal@rediffmail.com
 16. Wigwam Network, IT- comunicazione@wigwam.it
 17. Azienda Agricola ColBel, Pieve di Soligo, Treviso, IT - gianni@colbelwine.com
 18. PAN Studio Associato, Merano, IT - mauro.tomasi@panstudioassociato.eu

Authors in alphabetical order

*Corresponding author

ABSTRACT

The SETA group (Agricultural Science and Technology) sent a letter to the Italian Parliament advising them not to adopt a legislative measure that favors organic and biodynamic agriculture compared to the conventional one. Another group of scientists thinks instead that the Italian government should favor organic and biodynamic agriculture and explains its reasons. The current article lists the SETA letter and the point of view of other Italian and international ecologists, economists, pedologists, ecologists, writers and artists, which are tendentially "protectors of nature" but not idealists. Nor are they so much in agreement with each other. Judge for yourself in scrolling through the Discussion chapter. The divergence leads to the "why" it is necessary to switch to organic farming not on the "need" to do so. There are also disappointments about the use of GMOs or the costs of highly technological agriculture.

The situation is such on planet Earth that it is necessary to involve the whole society to get out of it. And politicians are also needed to structure the collective action that only if conceived by the whole society and not by individuals or by non-coordinated organizations can save our species. We are convinced that agriculture and soil are among the fundamental levers of this action.

KEYWORDS: SETA; Humusica; organic farming; organic food; food production; global change; agriculture; biodynamic; Italian parliament

TABLE OF CONTENTS

<i>Abstract</i>	2
Keywords:	2
<i>Table of Contents</i>	2
<i>Introduction</i>	5
<i>Letter sent to the Parliament by the SETA group</i>	5
<i>The point of view of other scientists (authors of the present article) on the future of agriculture</i>	6

Discussion among the authors of this article to explore the horizon of agriculture on planet Earth and program the future of mankind..... 8

Surinder S Kukal, Ph D, FNAAS, FISSS - Professor and DEAN, G S Khush Distinguished Professor - College of Agriculture - Punjab Agricultural University, LUDHIANA-141004, INDIA 8

Efrem Tassinato - Head Office Wigwam Clubs Italia. Non-profit Associative Network for the Fair, Solidarity and Sustainable Development of Local Communities. 8

Jeff Lowenfels - Scientist, gardener and writer, President of Garden Writers of America, US. Books: Plant a row for the hungry/ Teaming With Microbes, Teaming With Nutrients , Teaming With Fungi! 8

Cristian Bolzonella – PhD Technicien at the University of Padova, Economist 8

Alessandro Piccolo - Full Professor of Agricultural Chemistry, Università di Napoli Federico II. Chief Editor of "Chemical and Biological Technologies in Agriculture". Director of CERMNU Centro Interdipartimentale di Ricerca sulla Risonanza Magnetica Nucleare, Portici, Italy..... 9

Jean-François Ponge – Professor by the Museum National d'Histoire Naturelle, CNRS UMR 7179, Brunoy, France 10

Céline Pelosi - Chargée de Recherche HDR, Centre de recherche Provence-Alpes-Côte d'Azur, UMR 1114 EMMAH INRA-Avignon Université 10

Augusto Zanella – Professor of the University of Padova, Italy 10

The Val di Non, a case study 10

Imaginary dialogue between Galileo and Simplicio on biodiversity and agriculture 14

Summarizing 14

Klaus Katzensteiner – Professor of the University of Natural Resources and Life Sciences, Vienna, Austria 16

Cristina Menta – Researcher and Director of Natural History Museum of Parma University, Italy 18

Ines Fritz – Researcher by the Universität für Bodenkultur Wien. Department IFA-Tulln, Austria. 18

Herbert Hager – Professor of the Universität für Bodenkultur Wien, Austria. 19

Damien Banas – Professor of the Université de Lorraine, France 19

Nicolas Bernier – Resercher by the Museum National d'Histoire Naturelle - département « Adaptations du vivant » 4 avenue du Petit Château 91800, Brunoy, France 20

Cristina Micheloni, Agronomist, with 24 years of experience in organic farming; President of AIAB-FVG (Associazione Italiana Agricoltura Biologica – Friuli Venezia Giulia) 21

Raffaello Giannini, Professor of Forest genetics, Università degli studi di Firenze, Italy	21
Jean-Jacques Brun, Research director, Institut National de Recherche en Sciences et Technologies, Environnement et Agriculture (IRSTEA), UR LESSEM (Laboratoire Ecosystèmes et Sociétés en Montagne), Grenoble, France	22
Mauro Tomasi, Master in Forest and Environment Sciences, Forest and Environment manager, Merano, Italy	22
Manuel Blouin, Professeur en écologie, AgroSup Dijon, Département Agronomie Agroéquipements Elevage Environnement, Dijon, France	23
Maurizio G. Paoletti, Professor of Ecology by the University of Padova, Italy and of Agroecology by the University of Helsinki, Finland	23
Gianni Teo, Agronomist, owner of ColBel farm, Conegliano-Valdobbiadene Prosecco DOCG, Italy	26
<i>Artistic perspectives</i>	26
Karine Bonneval – Ecole des Beaux Arts d’Angoulême, France	26
<i>References (on relations between macro-, meso- and micro-biodiversity of the soil and soil functionality; comparisons between organic and conventional agriculture; relations between soil biodiversity and soil carbon storage; soil ecosystem services and soil biodiversity; type of agriculture and human health)</i>	28
Selected references, in Zanella, A., Geisen, S., Ponge, J.-F., Jagers, G., Benbrook, C., Dilli, T., Vacca, A., Kwiatkowska-Malina, J., Aubert, M., Fusaro, S., Nobili, M. De, Lomolino, G., Gomiero, T., 2018b. Humusica 2, article 17: techno humus systems and global change – three crucial questions. Applied Soil Ecology 122, 237–253. doi:10.1016/j.apsoil.2017.10.01:	28
Selected references, in Zanella, A., Ponge, J.-F., Hager, H., Pignatti, S., Galbraith, J., Chertov, O., Andreetta, A., De Nobili, M., 2018c. Humusica 2, article 18: Techno humus systems and global change - Greenhouse effect, soil and agriculture. Applied Soil Ecology 122, 254–270. doi:10.1016/j.apsoil.2017.10.024:.....	37
References selected in Zanella, A., Bolzonella, C., Lowenfels, J., Ponge, J.-F., Bouché, M., Saha, D., Kukal, S.S., Fritz, I., Savory, A., Blouin, M., Sartori, L., Tatti, D., Kellermann, L.A., Trachsel, P., Burgos, S., Minasny, B., Fukuoka, M., 2018a. Humusica 2, article 19: Techno humus systems and global change - Conservation agriculture and 4/1000 proposal. Applied Soil Ecology 122, 271–296. doi:10.1016/j.apsoil.2017.10.036:	40
<i>Other references (cited by the authors of this article in their interventions; other references are directly cited under the contribution and their titles help in understanding their engaged contents).....</i>	49

INTRODUCTION

Recently, a group of Italian people belonging to the SETA group (<https://www.setanet.it/>), encompassing some agronomists, some university academists, some farmers and some citizens interested in the debate addressed a letter to the Italian Parliament. The goal was to arrest a decree that the Government intends to apply for fostering organic farming.

With the present article we would like to address to the Italian Parliament another point of view, to support the decree and promote a sustainable organic agriculture in all its different variants in Europe as elsewhere in the world.

LETTER SENT TO THE PARLIAMENT BY THE SETA GROUP

"Dear Deputies and Senators of the Republic,

from different sources we learn that among the priorities of the new Government is the approval of the law decree 988 - Measures for the protection, development and competitiveness of organic farming, agri-food and aquaculture production. Given that every farmer who is respectful of the law is free to produce as he wishes, we would like, as citizens and scholars, to call the attention of our institutional representatives the following concepts that most often do not find space in the public debate:

- organic crops are less environmentally sustainable than those with the conventional / integrated method. This is because they give rise to a 20 to 70% lower yield, in equal farmed areas, therefore their generalized extension would require 20 to 70% more land to become cropped, leading to a massive destruction of forests and natural grasslands;

- compared to conventional agriculture, organic farming leads to 50% higher greenhouse gas emissions in pea crops , 70% higher ones in wheat (Searchinger et al., 2018), and 300% higher ones in rice (Bacenetti et al., 2016); emissions result moreover 61% higher per kg of bread produced (Chiriaco et al., 2017);

- organic products are marketed at prices up to 150% higher than comparable conventional products (source: EU - https://ec.europa.eu/info/news/organics-sector-rise-both-domestic-production-and-imports-see-large-increases-2019-mar-07_en), which should lead us to reflect on the economic repercussions for the consumer (or for the State, when it comes to school canteens obliged to supply only organic products);

- organic products do not show significant differences with respect to the others in terms of healthiness or nutritional characteristics as emerges from the scientific work of Dangour et al., (2009) and from the EFSA reports on pesticide residues in food (<https://www.efsa.europa.eu/en/efsajournal/pub/5743>);

- already today 45% of the net income of organic businesses is guaranteed by EU funding compared to 31% of conventional farming (source: Bioreport Crea, 2017-18 edition; Senate Research Department, note 108, June '19);

- with the law decree 988 an esoteric practice like biodynamic agriculture, achieves a formal clearance, being equated to organic farming. The biodynamic method is certified by a registered trademark owned by a multinational company and features an average turnover per hectare of 13,309 euros against the 3,207 euros of conventional farms and the 2,441 of organic ones (source Bioreport Crea, edition 2017-18). We hope that this Parliament will not want to be remembered as a reverse Robin Hood who takes away from the poor to give to the rich;

- Law Decree 988 refers to a niche sector (66773 organic and 286 biodynamic companies, which accounts for 4.5% of the 1,471,000 Italian farms - source Bioreport Crea, ed. 2017-2018);

In conclusion we would like to point out that the law decree 988 promotes organic farming by appealing to an alleged "national interest" for such agriculture. As SETA group we wonder what national interest is meant to be guaranteed in a decree which not addressing the crucial issue of controls on organic productions, undermining the national seed system, weakening the university agricultural education system, introducing a plethora of unnecessary territorial bodies, and stimulating low-productivity farming, will further increase our dependence on foreign countries, which is already close to 50% of the national demand for wheat and animal feeds. In this context the support offered to an esoteric practice such as the biodynamic practice, in the same country that along with Galileo Galilei gave birth to the Scientific Method as a system of knowledge of natural phenomena, is particularly striking, sounding almost like a new abjuration.

For the SETA group - prof. Luigi Mariani "

THE POINT OF VIEW OF OTHER SCIENTISTS (AUTHORS OF THE PRESENT ARTICLE) ON THE FUTURE OF AGRICULTURE

We agree with the following points contained in the letter from the SETA group:

- 1) organic products are sold at higher price compared to the others;
- 2) more accurate and safe controls over organic products should be done;
- 3) agriculture is very important for humans.

For the rest, however, the different issues are unjustified. The authors claim that conventional agriculture is cheaper than organic farming but do not consider the costs related to

- a) the environment (two aspects -> a1: pollution, climate alteration, soil impoverishment in structure, stability towards erosion and organic carbon reserves, biodiversity loss and -> a2. soil fertility and the ever-increasing effort with conventional machinery to keep yields at a high and not durable level),
- b) human health in an environment forced to cope with added chemicals and
- c) the indebtedness for technological machinery which is increasingly required from conventional farmers to keep up with market standards.

These are oversights that could have been tolerated 30 years ago, but not now. It is out of place today to continue to undermine the house in which we live. Organic farming and its different versions are answers that are certainly more sustainable than conventional ones. Sustainability is expressed in an already established organically operated agriculture in almost closed cycles for nutrients and organics which leads to a natural soil fertility that is independent from a steady unidirectional flow of nutrients and much less dependent on fossil energy sources. Natural soil fertility is based on an increased content of organic matter (humus, to be precise) with associated higher soil biodiversity and microbial activity.

Today's agriculture (be it conventional, organic, integrated, precision-farmed, conservative, regenerative, biodynamic, agro-ecological) has the onerous task of feeding the planet, but at the same time needs to be environmentally and socially sustainable. Therefore, comparing systems just on the basis of economic costs is no longer acceptable as our chance of continuing to use the resources of this planet depends on its own stability. When the alternative is 'no-future' any other issue comes to an end. The role of research is to provide scientific support to this critical path, without uncritically espousing partisan positions. Although Italy is the place where Galileus developed the scientific method, as stressed by opponents of the law project on organic agriculture, it is also the same country where he was imprisoned by his contemporaries.

Sustainability of the environment is a function of the extent to which we will rely on existing ecosystem services while balancing them with new technologies. If the perpetrators of the harmful consequences of intensive agriculture are to be sought, they are not among the farmers. Farmers in general follow the indications coming from science and the market. Probably as scientists and merchants we might have to pronounce a "mea culpa". When we believe in unlimited progress, we fail to consider natural resources as a precious good to be preserved for next generations. When we strive to grow plants in systems without soil and with artificial illumination we are overlooking and turning our back to nature-inherited assets of earth and light as if we were already planning our escape to the next planet. This does not sound as a workable solution for an increasing population.

On the opposite, we believe that cultivating and reconciling scientific and social spirits of humanity could lead to new levels of balance, in first instance a clearer view of the relationship between resources and the number of humans. And when we imagine how to go further, we should try to do it not just as humans but rather as Earth's ecosystems, where humans are not daring brains leading the forefront of reality but one of the biological species integrated in it.

In conclusion, there are at least three scientific reasons for preferring organic and biodynamic farming over conventional agriculture:

- 1) The best quality of the food produced (at least regarding pesticide content and flavour) and the positive consequences on human health;
- 2) The best conservation of planet's biodiversity;
- 3) The action of storing carbon in the soil in the form of humus with a consequent positive impact on climate change.

For the scientific basis of these three conclusions, instead of focusing on individual works, we prefer to refer the reader to three reviews (Zanella et al. 2018a, 2018b, 2018c). They contain respectively 154, 60 and 141 selected scientific publications with data or ecological proved deductions that support these conclusions. Other more specific references are given below in the discussion part and/or are reported at the end of the list of References.

DISCUSSION AMONG THE AUTHORS OF THIS ARTICLE TO EXPLORE THE HORIZON OF AGRICULTURE ON PLANET EARTH AND PROGRAM THE FUTURE OF MANKIND

SURINDER S KUKAL, PH D, FNAAS, FISSS - PROFESSOR AND DEAN, G S KHUSH DISTINGUISHED PROFESSOR - COLLEGE OF AGRICULTURE - PUNJAB AGRICULTURAL UNIVERSITY, LUDHIANA-141004, INDIA

I, as a Soil Scientist, believe in carbon cycle and whatever biomass has been created through photosynthesis and carbon dioxide should go back into the soil so as to sustain soil health as well as environment and reverse the disturbed carbon cycle.

But, in a country like India we need to feed millions and cannot expect to produce at the same rate as being done presently, at least during initial few years. But I strongly believe in organic agriculture at first instance (as far as possible) and if required (of course it will be) followed by or in combination with integrated agriculture (IA). I see the integrated agriculture (with combination of organic inputs + need-based inorganic inputs) to sustain our environment and at the same time to sustain agricultural productivity.

EFREM TASSINATO - HEAD OFFICE WIGWAM CLUBS ITALIA. NON-PROFIT ASSOCIATIVE NETWORK FOR THE FAIR, SOLIDARITY AND SUSTAINABLE DEVELOPMENT OF LOCAL COMMUNITIES.

I agree and therefore certainly, I endorse the petition also on behalf of the associative network I represent.

As soon as the definitive document is available, we will share it in the Wigwam Local Community network and, as far as we can, spread it even further.

JEFF LOWENFELS - SCIENTIST, GARDENER AND WRITER, PRESIDENT OF GARDEN WRITERS OF AMERICA, US. BOOKS: PLANT A ROW FOR THE HUNGRY/ TEAMING WITH MICROBES, TEAMING WITH NUTRIENTS , TEAMING WITH FUNGI!

A resounding yes!

CRISTIAN BOLZONELLA – PHD TECHNICIEN AT THE UNIVERSITY OF PADOVA, ECONOMIST

Agriculture is changing. Moving from an intensive sector based on chemical fertilizers and chemical pesticides to an agriculture where the production process is integrated in the natural cycles.

This change is highlighted also by the recent proposals of the new common agricultural policy (CAP). CAP is paid by European taxpayers who have declared their intention to continue to support agriculture in the future only if doesn't pollute and produce positive environmental effects.

The objective of the old post war agriculture namely the quantity products maximization in order to feed the growing population has reduced importance given way to other goals such as: production of high quality products containing the lowest chemical residues, land management with the maintenance of meadows and pastures through extensive farming and the direct support for small farm income which continues to be lower than other sectors.

Worldwide the undernourished population is significantly reduced. The hunger is not due to production but rather to distribution issues. New problem instead is the increasing number of obese people feed by junk foods.

In this new scenario organic farming will be important even if the experience on the fields shows that it this no always possible follow a strictly organic protocol. For instance, in the viticulture sector the number of treatments varies greatly depending on the climatic conditions. In the more humid region of France, North Italy, Austria, Germany the main disease is *Plasmopara viticola*. The fungi defense requires 15 – 20 treatments that using copper-based products will exceed the cap of organic regulation. On the other hand, in the drier areas such as South Italy, Spain, California, Argentina etc. 4-5 treatments are enough and organic rules are easily satisfied.

Do we eliminate viticulture from France, Germany, Austria and North Italy? It doesn't seem viable at all! Is it better to produce a "fake organic" or a "true sustainable" products according to the condition of the area? Personally, I think that it is preferable produce sustainable products with the minimum input of pesticides. Important give a clear and correct information on the production process.

The current technology permits to know in real time treatments done, products used and who sprayed the cultivation. This information should be public because the pesticides effects are public on water, air, etc. and on the health of the citizens. So if this data will be public there will be a new and healthy competition between farmers in order to reduce treatments and the use the less detrimental pesticides.

All we need is transparency and ethic!! This could be a new direct certification without intermediaries and without extra costs checked directly by the comments of the consumers and more in general by the citizens. A model already implemented in other sectors (TripAdvisor, booking etc.) but in this case who write a comment has to public "the real face" in order to avoid opportunistic behaviour. A model of social and environmental control that existed in the small village where all the people knows each other and where the reputation was important.

Sustainable agriculture should be based on the widespread use of bio indicators. We have to understand what nature is telling us. For example, a tool as hive with his bees' population give us many information about the health of the environment. A useful tool not only for farmers but for all the inhabitants of a territory.

United Nations Organisation has quantified pesticide victims in the agricultural sector for acute poisoning or poisoning at 200,000 a year, countless scientific studies have shown that exposure to pesticides prolonged over time - albeit in small doses - has important repercussions on health not only of those who work in agriculture, but of everyone (Abitabile et al., 2019). A new agriculture is waiting at the door, an agriculture more complex that requires new environmental skills for the production of genuine products.

ALESSANDRO PICCOLO - FULL PROFESSOR OF AGRICULTURAL CHEMISTRY, UNIVERSITÀ DI NAPOLI FEDERICO II. CHIEF EDITOR OF "CHEMICAL AND BIOLOGICAL TECHNOLOGIES IN AGRICULTURE". DIRECTOR OF CEMANU CENTRO INTERDIPARTIMENTALE DI RICERCA SULLA RISONANZA MAGNETICA NUCLEARE, PORTICI, ITALY

I fully agree with the letter. As you may know we were among the few who published scientific papers on biodynamic compost, and we intend to pursue in this scientific objective direction.

- Spaccini R., Mazzei P., Squartini A., Giannattasio M., Piccolo A. Molecular properties of a fermented manure preparation used as field spray in biodynamic agriculture. *Environmental Science and Pollution Research*, 19, 4214–4225 (2012).
- Giannattasio M, Vendramin E, Fornasier F, Alberghini S, Zanardo M, Stellin F, Concheri G, Stevanato P, Ertani A, Nardi S, Rizzi V, Piffanelli P, Spaccini R, Mazzei P, Piccolo A, Squartini A. Microbiological features and bioactivity of a fermented manure product (Preparation 500) used in biodynamic agriculture. *Journal of Microbiology and Biotechnology* 23, 644–651(2013).

JEAN-FRANÇOIS PONGE – PROFESSOR BY THE MUSEUM NATIONAL D'HISTOIRE NATURELLE, CNRS UMR 7179, BRUNOY, FRANCE

I fully agree with the purposed letter. The point of view defended by the SETA group is a short-term vision of agriculture. It does not take into account the present and future health of mankind and, moreover, the need to live in a lovely planet. It is well-known that agricultural production does not increase anymore, even if the use of mineral fertilizers and pesticides is increasing and will still increase if nothing is done to arrest it. We cannot encourage conventional agriculture, rather we must discourage it, by helping farmers to turn to other, better sustainable, methods. Subsidies are necessary in a first time to achieve this target, acting as a primer to a self-reinforcing win-win process, like we know it in the soil when earthworms provide food to bacteria then bacteria to plants then plants to the soil through the decay of their dead parts.

CELINE PELOSI - CHARGÉE DE RECHERCHE HDR, CENTRE DE RECHERCHE PROVENCE-ALPES-COTE D'AZUR, UMR 1114 EMMAH INRA-AVIGNON UNIVERSITE

Studying the impacts of pesticides on some soil organisms for a few years, we brought some evidences that some currently used pesticides can harm non-target animals that provide key functions in soils, thus fragilizing the sustainability of agrosystems. I advocate a systemic approach to what is done and evaluated in the fields. Thus, not only do we have to consider farmers and consumers when thinking about the evolution of agriculture, but also we must account for the environmental legacy left behind (ecosystem quality for provision of services). The consequences of what we decide today can be long and difficult to observe but they affect the health of the ecosystems at long-terms and determine the orientations that we wish to give to our standard of living (health, recreational values of biodiversity, etc.). Although completely stopping pesticides is, for the moment, not so obvious to implement (integrated management being promising for instance), interfering in the adoption of environnementally friendkly cropping systems is not so strategic to go towards more sustainable production systems.

AUGUSTO ZANELLA – PROFESSOR OF THE UNIVERSITY OF PADOVA, ITALY

THE VAL DI NON, A CASE STUDY

I was fond of scientific agriculture. During my university studies in 1982, with my father (I went with him to follow a particular course at the Institute of San Michele all' Adige, to learn how to do it) I destroyed a traditional orchard and replaced it with a modern one (it was said to be a "conversion"). The ancient grove was made of large apple trees up to 10 m. To eradicate one of them, we utilized a big bulldozer (we couldn't remove it with a hoe, even after a day of work). When I went to pick apples on these old trees, I found bird nests (goldfinches, blackbirds) in the branches. The Renetta apples remained fresh all the winter in the home-cellar, maybe the peel became folded like old skin, but under it, their pulp was delicious and never powdery. The new trees we planted were produced

in The Netherlands (at this time, Dutch researchers were the best of the world on this matter; and it is still the case, probably).

There were different trees' sizes: 1.5, 2, and 3, even one of 5 meters. Scientists advised the smallest because there was no need for stairs to pick the apples from them, one could stand simply beside trees. These trees were bearing fruit quickly, full production after 2-3 years, maximum 4 for the tallest. They had shallow roots and competed with herbs. It was not seen as a problem; at the end of their cycle (10 years of production), they were easier to replace. At the cooperative, they sold a weeding product that could be easily distributed, it was not dangerous for humans, no masks were needed. The grass dried out, leaving all the nutrients to the trees. Tree' roots did not take enough water, because they were confined at the surface and around the trunk. This, too, was not a problem; it was enough to implement a drip irrigation system. With my father, we ordered the new irrigation system sold with the apple trees, it didn't even cost so much. The ancient irrigation system was with high pinwheels that imitated the rain. The new water-supply plant was less expensive and much more effective. There was still a small problem that divided the producers: the plant protection products were no longer washed from the leaves by the irrigation system. This increased the efficiency of the products, but also the dust that was breathed when working in the countryside (some farmers showed allergies, not significant diseases, which were considered as physical weaknesses of the individuals, which were almost ashamed to have them). Apple growing has experienced many other technical innovations supported by the university and professional scientists of the Agricultural Institute of San Michele all' Adige (Trento, Italy).

In a few years, the landscape of the Valley changed. All the orchards were converted, and irrigation systems changed. Powerful cooperatives were born and finally turned on a single "Melinda". Farmers, even my father, had much more money. We changed the tractor, bought an "atomizer" for pesticide treatments, automated fruit harvesting machines, a flood of tools, built new roads. Today scientists drive from the Netherlands the computers that manage the apple production of the Valley. With a colleague who teaches students these things, I recently went to see a Val di Non's cooperative. Each apple is photographed 82 times, then a computer classifies it and guides a mechanical hand that put the apple in the right container that ends up in controlled storage. The apples can be sold all over the world, taking advantage of the best market windows, even 10-12 months after the harvest.

The competition is fierce, the manager of the cooperative explained. Today with a phone call, you can have a load ready after 5-6 hours from the order, with apples of the desired size and quality, to be sent to all parts of the world. The primary market is China. They compete mostly with Romania and France apple producers, which knew the same development. When I asked him about the quality, he replied that they do tests before harvesting to determine the right time to collect apples. It is about the hardness of the pulp and about the "quality of the fabric that allows it to be kept longer, fresh and good in a controlled atmosphere". They spent millions to put apples in tunnels dug under the mountains in disused calcite quarries. I went to see them. It's something like science fiction, workers with helmets, lights, computers, wifi connected with satellites and trucks entering the mountain to pick up apples.

My father died in 1998, still believing in science. He was born in 1912 and had a hard time when young. He argued: "On TV they say we are experiencing a moment of "crisis". They don't know what a real "crisis" is. This is not a crisis, but "what do you want my mouth?" He thought that science solved the problems of hunger, even though towards the end of his life, he wondered where the "boat" was going. He often said: "There is no more religion". I know what he wanted to say, that there were no more principles of respect for the living and the environment; that it was enough to have so much and of everything. When he was down in the dumps, he also accused us of his children

have ended up in a death trap. Two days before he died, he asked me: "Do you still believe in God?" I replied that I was a little lost. If God is the whole universe in evolution, with we all living inside Him, I believe that He still exists. My father proclaimed: "It is time for me to die, I no longer understand this world. Believe me, in the end, only God may help you, keep Him with you". When I came out of his bedroom, my mother (10 years younger) noticed my despair and said to me: "Don't pay excessive attention to father digressions, he still believes that there is a life after death, that sooner he will see his parents. The preservation of faith occupies a lot of time that perhaps could be invested differently by humans in search of peaceful satisfaction".

The small farms disappeared from Val di Non. One of my family too. It was a part-time occupation, and none of the members had time to do the job. The properties concentrated in the hands of a few producers who work night and day, often indebted and with powerful machinery. A young man I talked to is already trying to use drones. Precision agriculture tests are carried out using satellites, and the cooperative/region would partially finance future investments. The whole landscape is homogeneous and resembles a vineyard made of small trees. Hail protection turns the Valley into a greenhouse. I asked my brother up there whether sparrows are still there; he thinks he saw a couple near home. In Padua, I don't see these birds anymore (they were a lot of them in the 90s; sparrows, not pandas!). I remember there were so many when I was a child, that frrrrr flew away when you opened the door because they were chatting in the yard. There were also swallows that came back every year to nest under the balcony, beautiful, with a brown gag and a tail with two long spikes. My brother saw one more, in a village higher up and out of the way, just below the wood. I still buy Renetta apples at the Padua supermarket. They are still my favorite apples of all, I look for those from Val di Non and buy them. Also, other varieties of Melinda apples, with names like Fuji, Gala, Granny Smith that were unknown in the Valley 20 years ago.

In the agricultural field, Veneto experienced the same evolutionary process as in Trentino, which can also be seen in other regions and throughout the whole world. Recently, I participated in the publication of an article about pesticides used in vineyards (Bolzonella et al., 2019). We found that the cost of the insecticide (the result also applies to fungicides) is inversely proportional to their potential damage to human health. There is the risk that to earn more, the farmers proceed with the purchase of products that are cheap and most dangerous for humans and the environment.

In Val di Non, organic apples are also produced (still not sold in Padua supermarkets). Organic apples sell better than others. 15% of the total production of the Valley is organic, and every year this percentage increases by a few points. I think that this is a healthy and futuristic choice.

There is a problem nevertheless that concerns all the agricultural production of the planet: organic, for scientists, does not mean produced with the living organisms, but with as little as possible of them. The less their number, the better. It is enough to eliminate them with substances that, for now, we do not know whether they hurt or not. Once we discover that they hurt, we replace them with others that we hope won't destroy humans. These substances, also at the University of Padua, are still called and taught to students as Phyto-drugs (plant-medicines).

A few days ago, on Sciences (<https://www.sciencemag.org/news/2019/11/new-genetically-modified-corn-produces-10-more-similar-types>), researchers presented transgenic corn that produces 10% more than other corn. How to say: in 4.5 billion years, Nature passed from a few cells to such millions of complex livings that we have not yet been able to fully inventory. Today, thanks to science, we humans succeed in fabricating new organisms that know how to take more resources than ever. They know how to avoid other bodies and grow faster than ever because we artificially put into them the potential of two or three organisms. This will lower biodiversity and give more resources to humans. Is this sustainable? Is this what we want?



Fig. 1. Tassullo, a village of 800 inhabitants in Val di Non. The hardworking people of the valley transformed the environment in which they live by keeping up with science. The beige parts are orchards in the winter season, planted higher and higher instead of the forest. In the foreground on the right is an apple cooperative deposit. In the village, the pace of work follows that of the phases of apple production.



Figure 2. Val di Non. Left: after harvest, the apples are stored in the heart of the mountain, in cold rooms with a controlled atmosphere to preserve them for a long time and be sold at the right moment. The rock isolates the gas chambers and it has been calculated that the investment will be paid for with the energy savings achieved. The cooperatives provide jobs to local people on an ongoing basis. Instead, very tight work shifts are organized, and seasonal personnel is called to work from many parts of the world, at the time of the apple picking. The climate response of the valley has been studied and the harvest follows the ripening of the apples with cycles of a few days per band,

predefined by specialized personnel. Right: automated preparation of apple loads to be exported throughout the world.

IMAGINARY DIALOGUE BETWEEN GALILEO AND SIMPLICIO ON BIODIVERSITY AND AGRICULTURE

Galileo looked around with his telescope. Then he said: The accounts don't add up.

Simplicio: You're wrong. We have more to eat than once; it is evident, blinds also see it. We would all starve without pesticides.

Galileo: Biodiversity is in freefall.

Simplicio: Fortunately. It is better because this leaves more food for us.

Galileo: The opposite is exact, the less the biodiversity and the less we will have to eat.

Simplicio: Never. We compete. If insects and pests eat everything, there is nothing left for us.

Galileo: There are no more harmful animals. Do you want to understand this, will you?

Simplicio: Mad. Soon we will have solar-powered drones that will take out the parasites one by one and without cost.

Galileo: Learn to live with parasites, feed them; they bring predators with them. They can't grow that much. If they grow, it means that the whole system is developing. We may destroy the natural balance that generated us. Let's try to remain in the entire living system.

Simplicio: For the love of heaven. He is becoming mad. Seal him up. If those of SETA feel the game, they will cut the balls to us too.

SUMMARIZING

1) We need to change the type of agriculture.

2) Organic agriculture, biodynamic agriculture, and also the halfway between these and the conventional are increasing. We think that to support organic farming with a decree is the right move, waiting for something different and more performing to arrive in the future.

3) The ideal would be agriculture that "works with all the living". As Masanobu Fukuoka created? (as he presented in 自然農法, "Natural farming"). 4.5 billion years ago, there was almost nothing alive on the planet Earth. Today, there are millions of different life forms. A wrong idea lives in modern scientific spirits that living beings are always in competition. I know that Malthus argued that human population growth will continue unchecked until regulated by external factors such as hunger and disease and that Wallace and Darwin fastened that idea into evolutionary theory. However, Darwin found out above all that life forms a tree, with a trunk and many branches. Even infinite branches, because they will never stop "becoming." Sure, some went out, but many other branches will continue to grow and adapt to the future.

4) Dear Parliamentarians, you can decide in which agricultural future to go with your citizens. The SETA group fears hunger if the whole planet goes organic. However, we surely will starve if we continue as we did in recent decades. This prevision is scientifically recognized and corresponds to global warming, a decrease of biodiversity, pollution of the environment, lack of water in tropical and Mediterranean regions, human migrations ...

5) Copper is a big problem for the organic sector. Because it's a dangerous heavy metal. But it is perhaps the lesser evil. And there are already substitutes recommended by organic farming.

6) Biodynamic farmers don't hurt anyone, on the contrary. If all the world's farmers were biodynamic's, we would have less food (not sure) but no ecological problem (sure). And organic food quality is much better than conventional's (reviews in: Barański et al., 2014; Baxter et al., 2001; Benbrook, 2009, 2004 and many others).

7) The problems that humans have are above all economic. This means holding the money to eat and drink, having a home, starting a family, treating illness, supporting children when they are young and parents when they are old, all these simple and very material things. They are all tied to having a job. I would be more cautious about investments in GMOs and futuristic actions. Are we ready for them? Are we ready to go to Mars? Can we fix the house in which we live, first, and catalog / know the biodiversity that exists before creating new organisms? Can we focus a little more on people and families, and the places where they live on Earth, first, as enterprises, schools, and hospitals, to make life a little more serene for everyone? And if we stopped wars, how much money will we save to invest in a more sustainable economy?

8) Biodynamic agriculture and homeopathy touch a susceptible key that deserves a deepening up to the limit of our current knowledge: how much effect may single atoms or molecules, or even smaller particles have on the environment in which they dilute? The active principles of homeopathy (or biodynamic agriculture) make many scientists skeptical. However, there are no "minimal doses of matter". Particles that compose matter were "born" to react; they can't do anything else. We cannot grab tiny particles in the scale in which they work because, at that scale, they are objects that respond to still unknown laws. These laws can have strange effects on higher scales, not because particles or laws work poorly, but because the fact "appears" odd on an enormous scale and not corresponding to what is expected by humans. But it is ignorance, not witchcraft. We don't know why placebos work, do we? It is undoubtedly not the immaterial thought that physically heals the suffering. Yet it performs. Like a chain reaction that closely resembles the famous wing beat of a butterfly (http://eaps4.mit.edu/research/Lorenz/Butterfly_1972.pdf) that ends up causing a tornado. Recent re-examinations of Lorenz's paper suggest that it offered a significant challenge to the idea that our universe is deterministic, comparable to the challenges offered by quantum physics (Palmer, 2017; Kerry, 2018).

9) Science should change its attitude towards facts that remain unexplained with current laws. We live in an infinite world. The theory of relativity and quantum physics have re-opened the mystery: the limits, if there are any, are so small or so large that the physical laws we know are no longer valid for understanding what is happening in limits' vicinity. These limits are part of our world; we should take them into account and "accept not to be able to understand everything". It is not true that experiments are "repeatable". Science cannot explain everything. Science makes mistakes. We know what life was like on the planet Earth millions of years ago, even when humans were not there. We have an idea about what light is, very approximate and theoretical, but it makes our phones work. Other facts remain hidden: how the matter was born, where the universe comes from, or what relationship exists between the birth of matter and light. Believing to comprehend how a plant and

soil work is a huge mistake. We require more time. It could be fatal to humanity to think that the soil is not a living ecosystem.

10) Are there very safe vaccinations? Those should become mandatory. For other, less secure, the individual choice should prevail. The problem is not only scientific. As with everything: when money takes over, and we are always in the way, we need to double attention. For example, in an advanced society, non-scientific advertising should be banned. On television, today, all advertisements are more or less false. Then, it is not surprising that people no longer believe in doctors suggesting vaccinations.

11) The pigeons of our cities, for example, are good bioindicators. They get sick and lose their toes in noisy polluted and with a low percentage of green areas cities (Jiguet et al., 2019). The more they are sick and lame, the more their host cities are dangerous to humans. There is no point in driving them out of the cities. It would be better to keep them close, green up the city environment, and check that the pigeons remain healthy and with good legs.

KLAUS KATZENSTEINER – PROFESSOR OF THE UNIVERSITY OF NATURAL RESOURCES AND LIFE SCIENCES, VIENNA, AUSTRIA

I am a forest ecologist and no specialist in agriculture and agricultural systems. Nevertheless, I share your concerns and fully support your intervention. I could tell similar experiences from my home in an intensively utilized agricultural landscape as you described from your parent's place: groundwater pollution, loss of biodiversity, soil erosion etc. as a consequence of industrialized agriculture. In conventional agriculture, improved cultivation methods (partly copied from organic farming) have positive effects on water and soil quality over the last years. The continuing loss of structural diversity at the landscape level is, however, dramatic.

We all know the ipbes report on the status of our planet. It is our responsibility as scientists to act. I want to stay on the author's list, and I want to stay in dialogue, although I am no advocate of biodynamic or any other 'school' of farming.

As an ecologist, I believe in as far as possible closed nutrient cycles. As we well know from history, such closed nutrient cycles are not easy to maintain in agriculture, and an ever-increasing population needs to be fed. We know from history that science can contribute to the solution of problems but that the solutions can create new problems. Agricultural institutions have been established in the 19th century as a response to mis-harvests and famines which were partly related to climatic extremes but also to 'soil nutrient mining'. Haber-Bosch supports food production but reactive nitrogen is threatening biodiversity and water resources, and radiative forcing of N₂O contributes to the heating of the planet.

Can we escape such traps? An example of land use and land-use change from one of the regions where I study human-landscape interactions (Figs. 3 and 4): Mountain hill farming in the Himalayas functions as long as there are systems surrounding farm fields which can be 'tapped' for nutrients. 1 ha of arable land needs 2-5 ha of the forest as a nutrient source, be it exploited by grazing, lopping of trees or litter raking, the nutrients end up at the agricultural fields and ensure 'sustained' food production. There are, however, 'carrying capacities' of the landscape. In our research area, the locally, mainly organically produced, food supply lasts for approximately 4-6 months, the rest is 'filled up' with rice and lentils imported from India, probably produced in an industrial way. Still, traditional land-use practices lead to severe degradation of forests.

We support community forestry, establishment of trees on farm boundaries and agroforestry in two remote communities within a carbon offset project. Participation is the key. Farmers and researchers from Nepal and from Europe learn from each other. In the end, decisions are taken by the communities! There is no single solution 'organic', 'dynamic', 'agroforestry', 'conventional', we try to practice 'adaptive management', carefully monitoring effects of our interventions.



Figure 3. A hillfarming community in Nepal. Forests are degraded as a consequence of overutilization for agricultural purposes (cattle grazing, lopping of trees for fodder and fuelwood, litter raking (litter is used as animal bedding and the compost, mixed with urine and faeces is finally applied as a fertilizer to arable land)).



Figure 4. An agrosilvipastoral system in the Gaurishankar Conservation Area, Nepal. On farm trees provide fuelwood and fodder for cattle and mitigate the pressure on forest resources.

'Our' villages are small living labs. Working there, I also see the capacity for transformation. And I can see how joint action can ensure survival. After the 2015 earthquake almost every single house was destroyed completely. A whole settlement was threatened by landslides and had to be abandoned. When I was there a few months ago, most of the houses had been rebuilt (a whole new settlement on a safe place), the nursery which we jointly established produces seedlings: fodder trees and shrubs to be established on farmland, endangered but also economically valuable forest tree species to be planted on degraded forest land. The community members are behaving like the ones in the village of Astérix le Gaulois: quarreling and fighting, but if there is need, they are really committed and ready for joint action. Are those actions the right ones? We don't know yet. But if we don't try we will never know.

CRISTINA MENTA – RESEARCHER AND DIRECTOR OF NATURAL HISTORY MUSEUM OF PARMA UNIVERSITY, ITALY

Organic agriculture is a very counter-topic that also suffers from bad information. In my opinion, as soil scientists it is our job to help citizens and politicians to clarify some many doubts about this topic.

I am convinced that organic agriculture is a good strategy to guarantee the future of our planet. In some of my previous studies (Ghaley et al., 2018; Menta et al., 2010; Menta et al., 2011; Menta et al., 2015; Menta et al., 2017; Tabaglio et al., 2009) where we compared soil quality in terms of soil biodiversity and organic carbon content in different agriculture managements, we clarified the importance of an “conservative approach”, that often shows higher soil biodiversity and complexity. I would like to consider this discussion not only from an environmental point of view but also from a farmer’s point of view. During my experience, I met many organic agriculture farmers who strongly believe in a sustainable approach as an excellent strategy to link good food quality and respect for environment. I think that farmers attentive to the environmental problems, and not just to production, are the strength of agricultural system.

INES FRITZ – RESEARCHER BY THE UNIVERSITÄT FÜR BODENKULTUR WIEN. DEPARTMENT IFA-TULLN, AUSTRIA.

The demand for an ever-increasing amount of agricultural products at an ever decreasing price is understandable from a narrow consumers point of view. During the last several decades, this demand towed us, and not Italy alone, into a situation where we consider the product price as the one and only measure for wealth. We, as a society, forgot to see all the other cost, such as the loss of natural soil fertility, the contribution to climate change due to carbon release from soil, the loss of biodiversity and ecosystem resilience, the pollution of soil and groundwater, to name only a few of the most urgent.

Somebody will have to pay this bill. We may decide to not increase the debt for our children and grand-children (such as the two references below) or we may decide to not care at all.

As a scientist I took an oath to act in a responsible way for the benefit of all humans and for keeping our planet a worth living place: I do care!

Based on my scientific expertise, which lasts now for 25 years in soil microbial ecology, and inspired by many other scientists of the past and of the present who care about a sustainable form of living and care about our environment, I can't agree with any one-sided statement that has a chance to

cause long-term damage for human mankind. To that end, I disagree with the SETA letter against law decree 988.

1. Francé-Harrar, A., 1957. Humus – Bodenleben und Fruchtbarkeit (Engl.: Humus – soil organisms and fertility). Bayerischer Landwirtschaftsverlag Bonn-München-Wien.
2. Fukuoka M., 2009. The one-straw revolution: An introduction to natural farming. 2nd edition, New York Review Books Classics.

HERBERT HAGER – PROFESSOR OF THE UNIVERSITÄT FÜR BODENKULTUR WIEN, AUSTRIA.

I fully support the intervention in reponse to the SETA Group statement against Law decree 988.

I think organic agriculture needs all the ethical and argumentative support it can get and its environmental services are superior to modern “agribusinesses”. Your personal experience with the changes in your home area Val di Non has moved my heart strings.

But besides all the biodynamic and other close to nature land use systems I have missed in all the statements and interventions from different scientists something which can be organic farming but uses a mixed approach and which integrates (especially multipurpose) TREES into the land use system. I missed the mentioning of AGROFORESTRY. This land use system can improve the environmental services of the land use system, diversify products, improve family incomes and livelihoods and make the land use in the face of a changing climate also more resilient.

Agroforestry is now not only a land use system which is attractive to developing countries, its innovative and nowadays an increasing number of famers in Europe are finding out its benefits and its easily combined with organic production, but its still a box of many research questions to design optimal tree and crop interaction systems. See also the EURAF initiative. (<http://www.eurafagroforestry.eu/welcome>)

DAMIEN BANAS – PROFESSOR OF THE UNIVERSITE DE LORRAINE, FRANCE

I am an ecologist in aquatic environments, and I teach agronomy students. Some young people, whose parents are farmers, are tired of hearing that farmers are polluters.

There is no doubt that pesticides kill (that's their function: to kill life), they pollute. To say the opposite would be to ignore it.

The aquatic environments I study are polluted by pesticides from the head of the catchment area. My research has shown that in agricultural watersheds, at few kilometres downstream from the source, the concentration of pesticides in the water is higher than the concentrations that could kill most phytoplankton (the basis of the nutrient resource of heterotrophic aquatic organisms) in 72 hours. However, it was not the farmers alone who wanted this use of pesticides. Since the Second World War, we (consumers, politicians, scientists) have asked them to produce more and faster. It is not that without pesticides it is not possible to produce a lot. But it's easier to produce (without thinking) with pesticides. This change in agriculture, using fewer products that kill lives, must be accompanied and supported by politicians and consumers.

Wishing for more organic farming is not against progress. I am not in favour of denying progress. I think that scientists must help to fight against the current mistrust and esoteric discourses based on

fears, beliefs, and not on scientific facts. Thus, the many discourses of mistrust of medical progress must worry us (e. g. discourse against vaccines, discourse against medical treatment in favour of so-called "alternative" medicine). Scientists must help to convey the messages confirmed by science (e.g. the benefit/risk ratio is very favourable to vaccines; medicine has increased life expectancy; homeopathy, whose effectiveness is equivalent to a placebo, cannot replace heavy medical treatments). As far as the use of pesticides is concerned, science has shown that they can be very toxic for life. So, if it is possible to avoid them, they must be avoided to preserve the environment and mankind. I do not think that we should confuse the refusal of progress with a desire for less pesticide use. These pesticides pollute soils, water and living things. This has, and will continue to have, an environmental and human cost in the future. I share your concerns and fully support your intervention. Producing with an understanding of prey/predator balance cycles is much more complex than simply applying pesticides. The progress is there. We must encourage better understanding in order to grow better with as few or no pesticides as possible.

To say that by promoting organic farming we will induce famine is false because we produce more than necessary. On the contrary, intensive agriculture, which encourages the production of a single species over very large areas, exposes us to extreme vulnerability. Indeed, in the event of the appearance of a pesticide-resistant pest, it is this entire area, dedicated to a single crop, that would be lost. To say that yields will fall by 70% is not true. Pesticide-free farming, with a farmer who takes into account prey/predator cycles, who understand his field and his crop, does not lead to such yield declines (Adeux et al., 2019).

It's just a matter of will. It is possible to produce by reflecting on the functioning of nature, the ecosystem and the agrosystem. It is possible to produce with less pollution, without exposing the planet and animals (including humans) to pollutants that are often useless if we do not limit ourselves to basic agriculture.

NICOLAS BERNIER – RESEARCHER BY THE MUSEUM NATIONAL D'HISTOIRE NATURELLE -
DEPARTEMENT « ADAPTATIONS DU VIVANT » 4 AVENUE DU PETIT CHATEAU 91800,
BRUNOY, FRANCE

The concept of organic agriculture developed at about the same time as the expansion of chemical use, about 60-70 years ago. Paradoxically, the defenders of organic farming used arguments that were more ecological than related to public health. The humus was very often put forward as the seat of vital biological processes. As it was a sign of a global outcry, various "organic farming" movements rose almost simultaneously in the UK, New Zealand, Australia and the United States. They all described a dark future for our environment under the growing influence of so-called "phytosanitary" chemicals. Today, scientists of different disciplines as ecology, biology, pedology and climatology have not finished drawing the dark balance sheet of Seventy years of intensive agriculture: human poisoning (Cloredacone for example), disappearance of insects (Neonicotinoide for example), destruction of humus and soil organisms, disappearance of soil organic matter and global warming, catastrophic energy balance and agricultural production model based on industrial animal protein production, deforestation, destruction of agricultural jobs and therefore on the self-destruction ... In the end, the balance sheet is much more negative than predicted in the pre-war years. Yet, the lobbying of the so-called "conventional" agriculture is still extremely vigorous, always ready to untruths to play on the ancestral fears of the "bad harvest" and famines. Yet, everything suggests the opposite, the chemical destruction of life, the skeletonization of soil, the depletion of soil water resources are the real threats to human food. It is high time to rehabilitate the black gold that is humus and relearn to work with soil organisms.

Some well known works supporting my statement:

1. Paull, J., 2006. The Farm as Organism: The Foundational Idea of Organic Agriculture. *Journal of Bio-Dynamics Tasmania* 83, 14–18.
2. Paull, J., 2009. Australian Organic Farming and Gardening Society (1944), Australia's Victorian Compost. *Journal of Organics* 2, 49–63.
3. Paull, J., n.d. Lord Northbourne, the man who invented organic farming, a biography. *Journal of Organic Systems* 31–53.
4. Williams, J.C., 1985. The New Zealand Humic Compost Society : more than a garden club.
5. Bond, V., 2018. HUMUS: the black gold of the earth. Tradition

CRISTINA MICHELONI, AGRONOMIST, WITH 24 YEARS OF EXPERIENCE IN ORGANIC FARMING; PRESIDENT OF AIAB-FVG (ASSOCIAZIONE ITALIANA AGRICOLTURA BIOLOGICA – FRIULI VENEZIA GIULIA)

In the SETA letter the whole concept of efficiency and productivity is misused, while the scientifically proved positive effects of organic farming on soil, water quality and quantity preservation, biodiversity safeguard, human and animal health and welfare enhancement are neglected. If such aspects are taken into account organic farming becomes clearly the most efficient food system.

On the other hand, there is still room for improvement within the organic system, in farming practices, in structuring of value chains and in the certification system. That's why organic needs more knowledge and research to keep on evolving. What we do not need at all is destructive unscientific criticism.

RAFFAELLO GIANNINI, PROFESSOR OF FOREST GENETICS, UNIVERSITÀ DEGLI STUDI DI FIRENZE, ITALY

I have never dealt with food in a strict scientific sense (except, if one can say, when I sit with my feet under the table twice a day, or when I enjoy cooking). I firmly believe in respecting the environment and above all in the value of biodiversity and genetic diversity. I devoted a lot of time and passion to genetics with great effort, in the hope that certain aspects and knowledge of the discipline in the field of forest ecosystems would be disclosed, disseminated and transferred to forest management. The term "biodiversity" is used by everyone, much even by forest scientists; the term "genetic diversity" is less used, yet everything is stored in it!

Everyone today talks about food: Florence (not only) has become a manger. There are people who put the visit of the Uffizi Gallery on the same level as eating a sandwich in the shops of certain ancient streets. It is also true that that sandwich is necessary and cheap and those who supply it are very good at making it popular and in demand. Agricultural production: there is talk of revolutions and new technologies which also means the widespread use of new and more effective energy inputs (how much do they cost and who produces them?). Do you eat too much meat? No problem: the synthetic one is produced, or the animal proteins are substituted with the vegetable ones which must be supplied by the farmers themselves! Taking note that on the earth we are over 7 billion and everyone needs to eat (millions of hungry and tons of food are thrown away because they have expired), we are thinking of solving the problem with certain types of agriculture (also using strange terms such as "dynamic") . I suspect that the promoters are those who are interested in continuing to eat well and a lot, because they can offer all this to themselves!

Extremism does not lead to justice and freedom. It is right to recognize the tragic dimensions of the problems we are experiencing and that we know is growing. Precisely for this reason I see the need to reflect, which does not represent a reason for denial but the search for the best compromise.

Returning to the forest (because it is also subjected to stress), the coppice government is not an optimal use of the resource but is maintained by an economic sustainability which must be placed at the same level of environmental and social sustainability. The disaster is within the human being: in elementary schools we continue to teach history (to know it is fundamental) through the dates of battles and wars between humans, which are ancestral activities never abandoned. It is difficult to turn the other cheek. Discovering the chest for the opponent involves the danger of being hit in the heart more easily!

I am interested in learning about the development and the thinking that acts as a glue between the authors of this article, but also the deepening of the reasons that are supported in favor or against (GMO, organic cultivation, biotechnological culture, green or vertical forest) of various themes that underlie the aims of the work. Not least the pleasure of increasing the interests that bind us all.

JEAN-JACQUES BRUN, RESEARCH DIRECTOR, INSTITUT NATIONAL DE RECHERCHE EN SCIENCES ET TECHNOLOGIES, ENVIRONNEMENT ET AGRICULTURE (IRSTEA), UR LESSEM (LABORATOIRE ECOSYSTEMES ET SOCIETES EN MONTAGNE), GRENOBLE, FRANCE

In mountain regions, it is interesting to note that the rural exodus (flight from farmers to cities) is beginning to turn into a metropolitan exodus (flight of exhausted city dwellers to the mountains). Young graduates are now leaving the big alpine towns to settle in the mountains. They often engage in a project of organic farming and / or permaculture.

These young people who often felt instrumentalized in their work in the service of the dehumanizing "high-tech" find their personal coherence by recovering the broken links with the earth and the living. The Vercors plateau in the Grenoble region is a good example of this turnaround. Organic farming in the face of our fragmented and divided world is becoming a formidable school of reliance and resilience. This process is recent but many analysts predict that it will strengthen in the coming years. The revolution of rural territories is under way.

MAURO TOMASI, MASTER IN FOREST AND ENVIRONMENT SCIENCES, FOREST AND ENVIRONMENT MANAGER, MERANO, ITALY

It is difficult to summarize in a few sentences what I sometimes feel towards the human species to which I belong. Those that count for our future are choices of society, and perhaps we are not evolved enough to understand that we have received life as a gift.

From professional experience I can state that at the alpine level traditional, extensive agriculture played a positive role in terms of the biodiversity of the territory, operating the diversification of the landscape and creating new ecological niches for flora and fauna.

In recent decades, with the aim of increasing yields, we knew a rapid and incessant process of mechanization and intensification of agricultural practices. To minimize competition with species that could influence production, humans decided to simplify and trivialize the natural areas cultivated, leading to a drastic reduction in the biodiversity associated with these environments.

In my opinion, organic farming represents a good compromise between these two extremes (the non-technological cultivation of the past and the chemical-physical exploitation of the present) and must therefore be absolutely supported.

MANUEL BLOUIN, PROFESSEUR EN ECOLOGIE, AGROSUP DIJON, DEPARTEMENT AGRONOMIE AGROEQUIPEMENTS ELEVAGE ENVIRONNEMENT, DIJON, FRANCE

The most important things to me is to recognize the self determination of farmers. Farmers should develop a deep knowledge of the environment of their farms, which is specific. Agricultural practices should be adapted to each specific environment.

MICAEL AUBERT, DIRECTEUR DU LABORATOIRE ECODIV EA-1293, UNIVERSITE DE ROUEN, FRANCE

It is tough for farmers to change the economic model of their farms. Behind organic versus conventional practices, there are two contrasted economic models, low versus high operating expenses. Above all, farmers are men and women like us, who need to eat, secure, and educate their children. Even if they managed to decrease their operating expense to reach a well-balanced budget, still depend on European subsidy after having sold their production. It is a discouraging situation. As soil ecologists, we should ask politicians to make decisions, but keep in mind that farmers have to extract themselves from an implemented economic system that imposed to increase production to feed population during the reconstruction after world war two.

MAURIZIO G. PAOLETTI, PROFESSOR OF ECOLOGY BY THE UNIVERITY OF PADOVA, ITALY AND OF AGROECOLOGY BY THE UNIVERSITY OF HELSINKI, FINLAND

In the late 1980s, I was among the founders of IFOAM - Organics International at the University of California. In SantaCruz at that time there were Eugene Odum (Fig. 5), Miguel Altieri, David Pimentel, Stive Gliesman, Ben and Deb Stinner and also Masanobu Fukuoca. Beyond the labels and protocols, sustainable agriculture is based on agroecology. Odum used to say that "we must produce with a strategy similar to the forest or the prairie", these are our models. So minimal external inputs, minimal or non-tillage, rotations, landscape design to promote biodiversity, importance of wild vegetation like hedgerows, woodlots living mulchs. Great was the interest in studying agricultural systems all over the tropics.



*Figure 5. Prof. Eugene P. Odum by the University of Georgia, Athens, Institute of Ecology. With his brother Howard T. Odum, they wrote *Fundamentals of Ecology* and are known for their pioneering works on ecosystem ecology and on industrial agrosystems (Coleman et al., 1992; Odum and Barrett, 2004) (Prof. Maurizio G. Paoletti took photography in March 1981).*

Whatever you call biodynamic or biological or sustainable agriculture it doesn't matter, it must look more like a forest or a prairie (Fig. 6)! In Padua I organized three international conferences, I brought our technical colleagues to visit the four farms model of sustainability in Ohio. Unfortunately, little has changed in the cultivated fields. Nothing or almost nothing has happened in the Veneto university and in the agricultural worlds.

The food of a well-conducted organic farming is with all probability better and has the advantage of promoting greater biodiversity and reduce environment damages. I repeat if organic farming is well done!



Figure 6. In a paper on agriculture we could not miss the engineering animals that create the chemical, physical and biological characteristics of the most productive soils in Europe. A and B *Octodrilus tergestinus*, adult specimen and new soil generated by the animal respectively; C, D and E *Octodrilus mimus*, adult, generated soil and a detail of its gallery. They are animals capable of incorporating organic substance and micro-organisms deep into agricultural soils over 1-2 meters.

Published works supporting my letter:

1. Paoletti M.G., Stinner B.R., Stinner D., Barbieri S., Crosato A., Pitton G., Silvestri G., Rebuschi C., Rongaudio R., Consalter A., 1990. Casi concreti di agricoltura sostenibile: riflessioni da un viaggio in USA. Veneto Agricoltura, 12, dicembre 1990.
2. Paoletti M.G., Stinner B.R., Lorenzoni G.G., 1989. Agricultural Ecology and Environment. Proceedings of an International Symposium on Agricultural Ecology and Environment, Padova, Italy, 5-7 april 1988. Elsevier, 636 pp. ISBN: 0-444-88610-9.
3. Paoletti M.G., Pimentel D., 1992. Biotic Diversity in Agroecosystems. Paper from symposium on Agroecology and Conservation Issues in Tropical and Temperate Regions, University of Padova, Padova, Italy, 26-29 Septemer 1990. Elsevier, 356 pp. ISBN: 0-444-89390-3.
4. Gomiero T., Pimentel D., Paoletti M.G., 2011. Environmental Impact of Different Agricultural Management Practices: Conventional vs. Organic Agriculture. Critical Reviews in Plant Sciences, 30(1-2):95-124.
5. Fusaro, S., Gavinelli, F., Sommaggio, D., Paoletti, M.G., 2016. Higher Efficiency in Organic than in Conventional Management of Biological Control in Horticultural Crops in North-Eastern Italy; Biological Control; Volume 97, June 2016, Pages 89–101. DOI:10.1016/j.biocontrol.2016.03.002
6. Last Luisa, Michaela Arndorfer, Katalin Balazs, Peter Dennis, Tetyana Dyman, Wendy Fjellstad, Jürgen K. Friedel, Felix Herzog, Philipp Jeanneret, Gisela Lüscher, Gerardo Moreno,

Norman Kwikiriza, Tiziano Gomiero, Maurizio G. Paoletti, Philippe Pointereau, Jaen-Pierre Sarthou, Siyka Stoyanova, Sebastian Wolfrum, Roland Kölliker 2014. Indicators for the on-farm assessment of crop cultivar and livestock breed diversity: A survey-based participative approach. *Biodiversity and Conservation*, 23 (12): 3051-3071 I.F.2.10 Q2

GIANNI TEO, AGRONOMIST, OWNER OF COLBEL FARM, CONEGLIANO-VALDOBBIADENE PROSECCO DOCG, ITALY

I have a degree in agronomy, and I own a farm. I wanted to communicate something that seems appropriate to conclude this nice article: we no longer convert to organic farming out of passion but out of necessity.

I started 15 years ago. I live in the middle of my vineyard. The vines around the house have been organic for quite a few years; all the others will be in the coming years. Once upon a time one could live in the vineyards. Today we switch to organic or biodynamic, or, to be safe, we need to go to live with the family elsewhere during growing season. Of course, the work is not lacking and mostly done without using tractors. I even adopted few beehives just outside the vineyard. I do not collect the honey, but I need them as bioindicators. It works; bees are fine. The microclimate is good and make it possible to live well with the vineyard at the kitchen window. Other farmers do the same. If others can go a little further with the old methods, it is because they can rely on us to take care of the environment.

ARTISTIC PERSPECTIVES

KARINE BONNEVAL – ECOLE DES BEAUX ARTS D'ANGOULEME, FRANCE

I propose two complementary reflections (Figs. 7 and 8).

The first shows a controlled nature, made of bleached and ascetic ecosystems, protected in crystal spheres.

Original title: Saccharomania, domaine de Chaumont sur Loire, 2017. Plantes carnivores en sucre encloses en Victorian Wardian cases (critique de l'histoire de la culture du sucre).



Figure 7. Confined ecosystems.

The second illustrates a human attempt to become “vegetable”, at least partially. Such an attitude makes humans lose face.



Figure 8. Communication. Original title: Extrait du film *Devenir-plante (manger la terre)*, 2017.

REFERENCES (ON RELATIONS BETWEEN MACRO-, MESO- AND MICRO-BIODIVERSITY OF THE SOIL AND SOIL FUNCTIONALITY; COMPARISONS BETWEEN ORGANIC AND CONVENTIONAL AGRICULTURE; RELATIONS BETWEEN SOIL BIODIVERSITY AND SOIL CARBON STORAGE; SOIL ECOSYSTEM SERVICES AND SOIL BIODIVERSITY; TYPE OF AGRICULTURE AND HUMAN HEALTH)

SELECTED REFERENCES, IN ZANELLA, A., GEISEN, S., PONGE, J.-F., JAGERS, G., BENBROOK, C., DILLI, T., VACCA, A., KWIATKOWSKA-MALINA, J., AUBERT, M., FUSARO, S., NOBILI, M. DE, LOMOLINO, G., GOMIERO, T., 2018B. HUMUSICA 2, ARTICLE 17: TECHNO HUMUS SYSTEMS AND GLOBAL CHANGE – THREE CRUCIAL QUESTIONS. APPLIED SOIL ECOLOGY 122, 237–253. DOI:10.1016/J.APSSOIL.2017.10.01:

1. Aires, A., Carvalho, R., Rosa, E.A., Saavedra, M.J., 2013. Effects of agriculture production systems on nitrate and nitrite accumulation on baby-leaf salads. *Food Sci. Nutr.* 1 (1), 3–7.
2. Amr, A., Hadidi, N., 2001. Effect of cultivar and harvest date on nitrate (NO₃) and nitrite (NO₂) content of selected vegetables grown under open field and greenhouse conditions in Jordan. *J. Food Compos. Anal.* 14, 59–67.
3. Aneja, V.P., Schlesinger, W.H., Erisman, J.W., 2009. Effects of agriculture upon the air quality and climate: research policy, and regulations. *Environ. Sci. Technol.* 43, 4234–4240.
4. Annabi, M., Houot, S., Francou, Poitrenaud, C., Bissonnais, M., Le, Y., 2007. Soil aggregate stability improvement with urban composts of different maturities. *Soil Sci. Soc. Am. J.* 71, 413–423. <http://dx.doi.org/10.2136/sssaj2006.0161>.
5. Asami, D.K., Hong, Y.J., Barrett, D.M., Mitchell, A.E., 2003. Comparison of the total phenolic and ascorbic acid content of freeze-dried and air-dried marionberry, strawberry, and corn grown using conventional, organic, and sustainable agricultural practices. *J. Agric. Food Chem.* 51, 1237–1241.
6. Asensi, M., Ortega, A., Mena, S., Feddi, F., Estrela, J.M., 2011. Natural polyphenols in cancer therapy. *Crit. Rev. Clin. Lab. Sci.* 48, 197–216. <http://dx.doi.org/10.3109/10408363.2011.631268>.
7. Ayres, E., Dromph, K.M., Bardgett, R.D., 2006. Do plant species encourage soil biota that specialise in the rapid decomposition of their litter? *Soil Biol. Biochem.* 38, 183–186. <http://dx.doi.org/10.1016/j.soilbio.2005.04.018>.
8. Bøhn, T., Cuhra, M., Traavik, T., Sanden, M., Fagan, J., Primicerio, R., 2014. Compositional differences in soybeans on the market: glyphosate accumulates in Roundup Ready GM soybeans. *Food Chem.* 153, 207–215.
9. Baker, B.P., Benbrook, C.M., Groth III, E., Benbrook, K.L., 2002. Pesticide residues in conventional, integrated pest management (IPM)-grown and organic foods: insights from three US data sets. *Food Addit. Contamin.* 19, 427–446.
10. Balabane, M., Chenu, C., Bureau, F., Decaens, T., Akpa, M., Hedde, M., Laval, K., Puget, P., Pawlak, B., Barray, S., Cluzeau, D., Labreuche, D., Bodet, J., Le Bissonnais, Y., Saulas, P., Bertrand, M., Guichard, L., Picard, D., Houot, S., Arrouays, D., Brygoo, Y., 2005. Restauration de fonctions et propriétés des sols de grande culture intensive. Effets de systèmes de culture alternatifs sur les matières organiques et la structure des sols limoneux et approche du rôle fonctionnel de la diversité biologique des sols (Dmos, in: *Fonctions Environnementales Des Sols et Gestion Du Patrimoine Sol No. Gestion Durable Des Sols*, GESSOL NA01494.
11. Balesdent, J., Besnard, E., Arrouays, D., Chenu, C., 1998. The dynamics of carbon in particle-size fractions of soil in a forest-cultivation sequence. *Plant Soil* 201, 49–57. <http://dx.doi.org/10.1023/A:1004337314970>.
12. Balesdent, J., Chenu, C., Balabane, M., 2000. Relationship of soil organic matter dynamics to physical protection and tillage. *Soil Tillage Res.* 53, 215–230. [http://dx.doi.org/10.1016/S0167-1987\(99\)00107-5](http://dx.doi.org/10.1016/S0167-1987(99)00107-5).

13. Barański, M., Średnicka-Tober, D., Volakakis, N., Seal, C., Sanderson, R., Stewart, G.B., Benbrook, C., Biavati, B., Markellou, E., Giotis, C., Gromadzka-Ostrowska, J., Rembiałkowska, E., Skwarło-Sońta, K., Tahvonon, R., Janovská, D., Niggli, U., Nicot, P., Leifert, C., 2014. Higher antioxidant and lower cadmium concentrations and lower incidence of pesticide residues in organically grown crops: a systematic literature review and meta-analyses. *Br. J. Nutr.* 112, 794–811. <http://dx.doi.org/10.1017/S0007114514001366>.
14. Baxter, G.J., Graham, A.B., Lawrence, J.R., Wiles, D., Paterson, J.R., 2001. Salicylic acid in soups prepared from organically and non-organically grown vegetables. *Eur. J. Nutr.* 40, 289–292.
15. Benbrook, C.M., 2004. Minimizing Pesticide Dietary Exposure Through the Consumption of Organic Food. The Organic Center for Education and Promotion.
16. Benbrook, C.M., 2008. The impacts of yield on nutritional quality: lessons from organic farming. *HortScience*. <http://hortsci.ashspublications.org/content/44/1/12.full>.
17. Bernard, L., Chapuis-Lardy, L., Razafimbelo, T., Razafindrakoto, M., Pablo, A.-L., Legname, E., Poulain, J., Bruls, T., O'Donohue, M., Brauman, A., Chotte, J.-L., Blanchart, E., 2012. Endogeic earthworms shape bacterial functional communities and affect organic matter mineralization in a tropical soil. *ISME J.* 6 (1), 213–222.
18. Bertrand, M., Barot, S., Blouin, M., Whalen, J., de Oliveira, T., Roger-Estrade, J., 2015. Earthworm services for cropping systems. A review. *Agron. Sustain. Dev.* <http://dx.doi.org/10.1007/s13593-014-0269-7>.
19. Beylich, A., Oberholzer, H.-R., Schrader, S., Höper, H., Wilke, B.-M., 2010. Evaluation of soil compaction effects on soil biota and soil biological processes in soils. *Soil Tillage Res.* 109, 133–143. <http://dx.doi.org/10.1016/j.still.2010.05.010>.
20. Blagodatskaya, E., Kuzyakov, Y., 2008. Mechanisms of real and apparent priming effects and their dependence on soil microbial biomass and community structure: critical review. *Biol. Fert. Soils.* 45, 115–131.
21. Bloksma, J., Adriaansen-Tennekes, R., Huber, M., van de Vijver, L.P.L., Baars, T., de Wit, J., 2008. Comparison of organic and conventional raw milk quality in the Netherlands. *Biol. Agric. Hortic.* 26, 69–83.
22. Blouin, M., Hodson, M.E., Delgado, E.A., Baker, G., Brussaard, L., Butt, K.R., Dai, J., Dendooven, L., Peres, G., Tondoh, J.E., Cluzeau, D., Brun, J.-J., 2013. A review of earthworm impact on soil function and ecosystem services. *Eur. J. Soil Sci.* 64, 161–182. <http://dx.doi.org/10.1111/ejss.12025>.
23. Bourn, D., Prescott, J., 2002. A comparison of the nutritional value, sensory qualities and food safety of organically and conventionally produced foods. *Crit. Rev. Food Sci. Nutr.* 42, 1–34.
24. Bradbury, K.E., Balkwill, A., Spencer, E.A., Roddam, A.W., Reeves, G.K., Green, J., Key, T.J., Beral, V., Pirie, K., 2014. Organic food consumption and the incidence of cancer in a large prospective study of women in the United Kingdom. *Br. J. Cancer* 110, 2321–2326.
25. Brandt, K., Leifert, C., Sanderson, R., Seal, C.J., 2011. Agroecosystem management and nutritional quality of plant foods: the case of organic fruits and vegetables. *Crit. Rev. Plant Sci.* 30, 177–197.
26. Brglez Mojzer, E., Knez Hrnčič, M., Škerget, M., Knez Ž, Bren, U., 2016. Polyphenols: extraction methods, antioxidative action, bioavailability and anticarcinogenic effects. *Molecules* 21. <http://dx.doi.org/10.3390/molecules21070901>.
27. Brown, G.G., Barois, I., Lavelle, P., 2000. Regulation of soil organic matter dynamics and microbial activity in the drilosphere and the role of interactions with other edaphic functional domains. *Eur. J. Soil Biol.* 36, 177–198.
28. Bruning-Fann, C.S., Kaneene, J.B., 1993. The effects of nitrate, nitrite and N-nitroso compounds on human health: a review. *Vet. Hum. Toxicol.* 35 (5), 521–538.
29. Carbonaro, M., Mattera, M., Nicoli, S., Bergamo, P., Cappelloni, M., 2002. Modulation of antioxidant compounds in organic vs conventional fruit (peach, *Prunus persica* L., and pear, *Pyrus communis* L.). *J. Agric. Food Chem.* 50, 5458–5462.
30. Caris-Veyrat, C., Amiot, M.J., Tyssandier, V., Grasselly, D., Buret, M., Mikolajczak, M., Guillard, J.C., Bouteloup-Demange, C., Borel, P., 2004. Influence of organic versus conventional agricultural practice on the antioxidant microconstituent content of tomatoes and

- derived purees; consequences on antioxidant plasma status in humans. *J. Agric. Food Chem.* 52, 6503–6509.
31. Chen, R.Z., Wong, M.-H., 2016. Integrated wetlands for food production. *Environ. Res.* 148, 429–442. <http://dx.doi.org/10.1016/j.envres.2016.01.007>.
 32. Chenu, C., Plante, A.F., 2006. Clay-sized organo-mineral complexes in a cultivation chronosequence: revisiting the concept of the primary organo-mineral complex. *Eur. J. Soil Sci.* 57, 596–607. <http://dx.doi.org/10.1111/j.1365-2389.2006.00834.x>.
 33. Cluzeau, D., Pérès, G., Guernion, M., Chaussod, R., Cortet, J., Fargette, M., et al., 2009. Intégration de la biodiversité des sols dans les réseaux de surveillance de la qualité des sols: exemple du programme pilote à l'échelle régionale, le RMQS BioDiv. *Étude Gestion Sols* 16 (3–4), 187–201.
 34. Cornée, J., Lairon, D., Velema, J., Guyader, M., Berthezene, P., 1992. An estimate of nitrate, nitrite and N-nitrosodimethylamine concentrations in french food products or food groups. *Sci. Alim.* 12, 155–197.
 35. Cornucopia Institute, 2015. The Organic Hydroponics Dichotomy: Can a Soil-less Growing System Be Organic? A White Paper March 5 2015. <https://www.cornucopia.org/HydroponicsWhitePaper.pdf>.
 36. Crinnion, W.J., 2010. Organic foods contain higher levels of certain nutrients, lower levels of pesticides, and may provide health benefits for the consumer. *Altern. Med. Rev* (p.4+ Academic OneFile 2010).
 37. Crotty, F.V., Fychan, R., Sanderson, R., Rhymes, J.R., Bourdin, F., Scullion, J., Marley, C.L., 2016. Understanding the legacy effect of previous forage crop and tillage management on soil biology, after conversion to an arable crop rotation. *Soil Biol. Biochem.* 103. <http://dx.doi.org/10.1016/j.soilbio.2016.08.018>.
 38. Cunningham, S.A., Attwood, S.J., Bawa, K.S., Benton, T.G., Broadhurst, L.M., Didham, R.K., McIntyre, S., Perfecto, I., Samways, M.J., Tsharntke, T., Vandermeer, J., Villard, M.-A., Young, A.G., Lindenmayer, D.B., 2013. To close the yield-gap while saving biodiversity will require multiple locally relevant strategies. *Agric. Ecosyst. Env.* 173. <http://dx.doi.org/10.1016/j.agee.2013.04.007>.
 39. Curry, J.P., Schmidt, O., 2007. The feeding ecology of earthworms: a review. *Pedobiologia* 50, 463–477.
 40. Dai, J., Mumper, R.J., 2010. Plant phenolics: extraction, analysis and their antioxidant and anticancer properties. *Molecules* 15, 7313–7352. <http://dx.doi.org/10.3390/molecules15107313>.
 41. Dangour, A., Dodhia, S., Hayter, A., Aikenhead, M.A., Allen, E., Lock, K., Uauy, R., 2009. Comparison of Composition (nutrients and Other Substances) of Organically and Conventionally Produced Foodstuffs: a Systematic Review of the Available Literature. Report for Food Standard Agency. London School of Hygiene & Tropical Medicine, London.
 42. Dauber, J., Miyake, S., 2016. To integrate or to segregate food crop and energy crop cultivation at the landscape scale? Perspectives on biodiversity conservation in agriculture in Europe. *Energy Sustain. Soc.* 6, 25. <http://dx.doi.org/10.1186/s13705-016-0089-5>.
 43. Davis, D., 2014. Declining fruit and vegetable nutrient composition: what is the evidence? *HortScience*. <http://hortsci.ashspublications.org/content/44/1/15.full>.
 44. Delgado, C., Crisosto, G.M., Heymann, H., Crisosto, C.H., 2013. Determining the primary drivers of liking to predict consumers' acceptance of fresh nectarines and peaches. *J. Food Sci.* 78, 605–614.
 45. Dreezens, E., Martijn, C., Tenbult, P., Kok, G., Vries, N., 2005. Food and values: an examination of values underlying attitudes toward genetically modified- and organically grown food products. *Appetite* 44, 115–122.
 46. Ferlay, A., Martin, B., Pradel, P., Coulon, J.B., Chilliard, Y., 2006. Influence of grass-based diets on milk fatty acid composition and milk lipolytic system in Tarentaise and Montbeliarde cow breeds. *J. Dairy Sci.* 89, 4026–4041.
 47. Fillion, L., Arazi, S., 2002. Does organic food taste better? A claim substantiation approach. *Nutr. Food Sci.* 32 (4), 153–157. <http://dx.doi.org/10.1108/00346650210436262>.

48. Flis, B., Zimnoch-Guzowska, E., Mankowski, D., 2012. Correlations among yield, taste, tuber characteristics and mineral contents of potato cultivars grown at different growing conditions. *J. Agric. Sci.* 4 (7), 197.
49. Fornoni, J., 2013. Herbivores can select for mixed defensive strategies in plants. *New Phytol.* 197, 576.
50. Foster, R.C., 1988. Microenvironments of soil microorganisms. *Biol. Fertil. Soil* 6, 189–203.
51. Funabashi, M., 2016. Synecological farming: theoretical foundation on biodiversity responses of plant communities. *Plant Biotechnol.* 33, 213–234. <http://dx.doi.org/10.5511/plantbiotechnology.16.0219a>.
52. Fusaro, S., Gavinelli, F., Sommaggio, D., Paoletti, M.G., 2016. Higher efficiency in organic than in conventional management of biological control in horticultural crops in north-eastern Italy. *Biol. Control* 97, 89–101.
53. Fusaro, S., 2015. Evaluation, maintenance and improvement of biodiversity for environmental protection and crop. In: Squartini, A., Paoletti, G.M. (Eds.), *Doctorate Thesis. Università degli Studi di Padova (Italia)* (p. 255).
54. Gaštoł, M., Domagała-Świątkiewicz, I., Krośniak, M., 2011. Organic versus conventional – a comparative study on quality and nutritional value of fruit and vegetable juices. *Biol. Agric. Hortic.* 27, 310–319.
55. Galgano, F., Tolve, R., Colangelo, M.A., Scarpa, T., Caruso, M.C., Yildiz, F., 2016. Conventional and organic foods: a comparison focused on animal products. *Cogent. Food Agric.* 2, 1142818. <http://dx.doi.org/10.1080/23311932.2016.1142818>.
56. Gamfeldt, L., Hillebrand, H., Jonsson, P.R., 2008. Multiple functions increase the importance of biodiversity for overall ecosystem functioning. *Ecology* 89, 1223–1231. Gathorne-Hardy, A., 2016. The sustainability of changes in agricultural technology: the carbon, economic and labour implications of mechanisation and synthetic fertiliser use. *Ambio* 45, 885–894. <http://dx.doi.org/10.1007/s13280-016-0786-5>.
57. Ge, T., Chen, X., Yuan, H., Li, B., Zhu, H., Peng, P., Li, K., Jones, D.L., Wu, J., 2013. Microbial biomass, activity, and community structure in horticultural soils under conventional and organic management strategies. *Eur. J. Soil Biol.* 58, 122–128. German, R.N., Thompson, C.E., Benton, T.G., 2017. Relationships among multiple aspects of agriculture’s environmental impact and productivity: a meta-analysis to guide sustainable agriculture. *Biol. Rev.* 92, 716–738. <http://dx.doi.org/10.1111/brv.12251>.
58. Gomiero, T., Pimentel, D., Paoletti, M.G., 2011. Environmental impact of different agricultural management practices: conventional vs: organic agriculture. *Crit. Rev. Plant Sci.* 30, 95–124.
59. Gomiero, T., 2013. Alternative land management strategies and their impact on soil conservation. *Agriculture* 3, 464–483.
60. Hajšlová, J., Schulzová, V., Slanina, P., Janné, K., Hellenäs, K.E., Andersson, C.H., 2005. Quality of organically and conventionally grown potatoes: four-year study of micro-nutrients metals, secondary metabolites, enzymic browning and organoleptic properties. *Food Addit. Contam.* 22, 514–534.
61. Hakkinen, S.H., Torronen, A.R., 2000. Content of flavonols and selected phenolic acids in strawberries and *Vaccinium* species: influence of cultivar, cultivation site and technique. *Food Res. Int.* 33, 517–524.
62. Hazell, P., Wood, S., 2008. Drivers of change in global agriculture. *Philos. Trans. R. Soc. B-Biol. Sci.* 363 (1491), 495–515 (<http://dx.doi.org>).
63. Henle, K., Alard, D., Clitherow, J., Cobb, P., Firbank, L., Kull, T., McCracken, D., Moritz, R.F.A., Niemelä, J., Rebane, M., Wascher, D., Watt, A., Young, J., 2008. Identifying and managing the conflicts between agriculture and biodiversity conservation in Europe—a review. *Agric. Ecosyst. Env.* 124. <http://dx.doi.org/10.1016/j.agee.2007.09.005>.
64. Herencia, J.F., García-Galavís, P.A., Dorado, J.A.R., Maqueda, C., 2011. Comparison of nutritional quality of the crops grown in an organic and conventional fertilized soil. *Sci. Hort.* 129, 882–888.

65. Hernández, T., Chocano, C., Moreno, J.L., García, C., 2014. Towards a more sustainable fertilization: combined use of compost and inorganic fertilization for tomato cultivation. *Agric. Ecosyst. Environ.* 196, 178–184. <http://dx.doi.org/10.1016/j.agee.2014.07.006>.
66. Hoefkens, C., Sioen, I., Baert, K., De Meulenaer, B., De Henauw, S., Vandekinderen, I., Devlieghere, F., Opsomer, A., Verbeke, W., Van Camp, J., 2010. Consuming organic versus conventional vegetables: the effect on nutrient and contaminant intakes. *Food Chem. Toxicol.* 48, 3058–3066.
67. Hole, D.G., Perkins, A.J., Wilson, J.D., Alexander, I.H., Grice, P.V., Evans, A.D., 2005. Does organic farming benefit biodiversity? *Biol. Conserv.* 122, 113–130.
68. Holland, E.A., Coleman, D.C., 1987. Litter placement effects on microbial and organic matter dynamics in an agroecosystem. *Ecology* 68, 425–433.
69. Juárez, E., Diaz, M., 2016. Exploring the causes of high biodiversity of Iberian dehesas: the importance of wood pastures and marginal habitats. *Agrofor. Syst.* 90 (1), 87.
70. Kamau, S., Barrios, E., Karanja, N.K., Ayuke, F.O., Lehmann, J., 2017. Soil macrofauna abundance under dominant tree species increases along a soil degradation gradient. *Soil Biol. Biochem.* 112, 35–46. <http://dx.doi.org/10.1016/j.soilbio.2017.04.016>.
71. Keith, A.M., Robinson, D.A., 2012. Earthworms as natural capital: ecosystem service providers in agricultural soils. *Econ. J.* 2, 91–99.
72. Kimura, M., Rodriguez-Amaya, D.B., 2003. Carotenoid composition of hydroponic leafy vegetables. *J. Agric. Food Chem.* 51, 2603–2607.
73. Knight, D., Elliott, P.W., Anderson, J.M., Scholefield, D., 1992. The role of earthworms in managed, permanent pastures in Devon, England. *Soil Biol. Biochem.* 24, 1511–1517. [http://dx.doi.org/10.1016/0038-0717\(92\)90142-K](http://dx.doi.org/10.1016/0038-0717(92)90142-K).
74. Komarov, A., Chertov, O., Bykhovets, S., Shaw, C., Nadporozhskaya, M., Frolov, P., Shashkov, M., Shanin, V., Grabarnik, P., Pripulina, I., Zubkova, E., 2017. Romul-Hum: a model of soil organic matter formation coupling with soil biota activity I. Problem formulation, model description, and testing. *Ecol. Modell.* 345, 113–124.
75. Kozdrój, J., Van Elsas, J.D., 2000. Response of the bacterial community to root exudates in soil polluted with heavy metals assessed by molecular and cultural approaches. *Soil Biol. Biochem.* 32, 1405–1417.
76. Kremen, C., Miles, A., 2012. Ecosystem services in biologically diversified versus conventional farming systems: benefits, externalities and trade-offs. *Ecol. Soc.* 17 (4), 40. <http://dx.doi.org/10.5751/ES-05035-170440>.
77. Kusche, D., 2009. Organic milk and nutritional benefits for the consumer. *Org. Food Qual. Health Newslett* (Edition No. 1/2009).
78. Lages Barbosa, G., Almeida Gadelha, F.D., Kublik, N., Proctor, A., Reichelm, L., Weissinger, E., Wohlleb, G.M., Halden, R.U., 2015. Comparison of land, water, and energy requirements of lettuce grown using hydroponic vs conventional agricultural methods. *Int. J. Environ. Res. Public Health* 12, 6879–6891. <http://dx.doi.org/10.3390/ijerph120606879>.
79. Lairon, D., 2009. Nutritional quality and safety of organic food. A review. *Agron. Sustain. Dev* (Epub). www.agronomy-journal.org.
80. Lal, R., 2015. Restoring Soil Quality to Mitigate Soil Degradation. pp. 5875–5895. <http://dx.doi.org/10.3390/su7055875>.
81. Landis, D.A., 2017. Designing agricultural landscapes for biodiversity-based ecosystem services. *Basic Appl. Ecol.* 18, 1–12. <http://dx.doi.org/10.1016/j.baae.2016.07.005>.
82. Lange, M., Eisenhauer, N., Sierra, C.A., Bessler, H., Engels, C., Griffiths, R.I., Mellado-Vázquez, P.G., Malik, A.A., Roy, J., Scheu, S., Steinbeiss, S., Thomson, B.C., Trumbore, S.E., Gleixner, G., 2015. Plant diversity increases soil microbial activity and soil carbon storage. *Nat. Commun.* 6. <http://dx.doi.org/10.1038/ncomms7707>.
83. Lavelle, P., Gilot, C., 1994. Priming effects of macroorganisms on microflora: a key process of soil function? In: Ritz, K., Dighton, J., Giller, K. (Eds.), *Beyond the Biomass*. Wiley-Sayce, Chichester UK, pp. 176–181.
84. Lavelle, P., 1997. Faunal activities and soil processes: adaptive strategies that determine ecosystem function. *Adv. Ecol. Res.* 27, 93–132.

85. Magkos, F., Arvaniti, F., Zampelas, A., 2003. Organic food: nutritious food or food for thought? A review of the evidence. *Int. J. Food Sci. Nutr.* 54 (5), 357–371.
86. Magkos, F., Arvaniti, F., Zampelas, A., 2006. Organic food: buying more safety or just peace of mind? a critical review of the literature. *Crit. Rev. Food Sci. Nutr.* 46, 23–56. <http://dx.doi.org/10.1080/10408690490911846>.
87. Mazzoncini, M., Antichi, D., Silvestri, N., Ciantelli, G., Sgherri, C., 2015. Organically vs conventionally grown winter wheat: effects on grain yield, technological quality, and on phenolic composition and antioxidant properties of bran and refined flour. *Food Chem.* 175, 445–451.
88. Melillo, J.M., Steudler, P.A., Aber, J.D., Newkirk, K., Lux, H., Bowles, F.P., Catricala, C., Ahrens, T., Morriseau, S., 2002. Soil warming and carbon-cycle feedbacks to the climate system. *Science* 298, 2173–2176.
89. Mikkonen, T., Määttä, K.R., Hukkanen, A.T., Kokko, H.I., Törrönen, A.R., Kärenlampi, S.O., Karjalainen, R.O., 2001. Flavonol content varies among black currant cultivars. *J. Agric Food Chem.* 49, 3274–3277.
90. Mitchell, A.E., Hong, Y.J., Koh, E., Barrett, D.M., Bryant, D.E., Denison, R.F., Kaffka, S., 2007. Ten-year comparison of the influence of organic and conventional crop management practices on the content of flavonoids in tomatoes. *J. Agric. Food Chem.* 55 (15), 6154–6159.
91. Moreno, G., Gonzalez-Bornay, G., Pulido, F., Lopez-Diaz, M.L., Bertomeu, M., Morgan, K., Murdoch, J., 2000. Organic vs. conventional agriculture: knowledge: power and innovation in the food chain. *Geoforum* 31, 159–173.
92. Moreno, B., Garcia-Rodriguez, S., Cañizares, R., Castro, J., Benítez, E., 2009. In south-eastern Spain: Long-term effect of soil management on biological indicators of soil quality. *Agric. Ecosyst. Environ.* 131, 333–339. <https://doi.org/10.1016/j.agee.2009.02.011>.
93. Morgan, K., Murdoch, J., Organic vs. conventional agriculture: knowledge, power and innovation in the food chain. This paper emerges from a research project – Organic Supply Chains in Wales – funded by the Welsh Office, the Development Board for Rural Wales, the Welsh Development. *Geoforum* 31, 2000, 159–173. doi:[https://doi.org/10.1016/S0016-7185\(99\)00029-9](https://doi.org/10.1016/S0016-7185(99)00029-9).
94. Morriën, E., 2016. Understanding soil food web dynamics, how close do we get? *Soil Biol. Biochem.* 102, 10–13. <http://dx.doi.org/10.1016/j.soilbio.2016.06.022>.
95. Nath, A.J., Lal, R., 2017. Effects of tillage practices and land use management on soil aggregates and soil organic carbon in the north appalachian region, USA. *Pedosphere* 27, 172–176. [http://dx.doi.org/10.1016/S1002-0160\(17\)60301-1](http://dx.doi.org/10.1016/S1002-0160(17)60301-1).
96. Niemi, R.M., Vepsäläinen, M., Wallenius, K., Erkomaa, K., Kukkonen, S., Palojärvi, A., Vestberg, M., 2008. Conventional versus organic cropping and peat amendment: impacts on soil microbiota and their activities. *Eur. J. Soil Biol.* 44, 419–428.
97. Ninfali, P., Bacchiocca, M., Biagiotti, E., Esposto, S., Servili, M., Rosati, A., Montedoro, G., 2008. A 3-year study on quality, nutritional and organoleptic evaluation of organic and conventional extra-Virgin olive oils. *J. Am. Oil Chem. Soc.* 85, 151–158.
98. Nuñez de González, M.T., Osburn, W.N., Hardin, M.D., Longnecker, M., Garg, H.K., Bryan, N.S., Keeton, J.T., 2015. A survey of nitrate and nitrite concentrations in conventional and organic-Labeled raw vegetables at retail. *J. Food Sci.* 80 (5), C942–C949.
99. Nunez-Delgado, E., Sanchez-Ferrer, A., Garcia-Carmona, F.F., Lopez-Nicolas, J.M., 2005. Effect of organic farming practices on the level of latent polyphenol oxidase in grapes. *J. Food Sci.* 70, C74–8.
100. Occhipinti, A., 2013. Plant coevolution: evidences and new challenges. *J. Plant Interact.* 8, 188–196. <http://dx.doi.org/10.1080/17429145.2013.816881>.
101. Oliveira, A.B., Moura, C.F., Gomes-Filho, E., Marco, C.A., Urban, L., Miranda, M.R.A., 2013. The impact of organic farming on quality of tomatoes is associated to increased oxidative stress during fruit development. *PLoS One* 8 (2), e56354.
102. Olsson, M.E., Andersson, C.S., Oredsson, S., Berglund, R.H., Gustavsson, K.E., 2006. Antioxidant levels and inhibition of cancer cell proliferation in vitro by extracts from organically and conventionally cultivated strawberries. *J. Agr. Food Chem.* 54, 1248–1255.

103. Palm, C., Blanco-Canqui, H., DeClerck, F., Gatere, L., Grace, P., 2014. Conservation agriculture and ecosystem services: an overview. *Agric. Ecosyst. Environ.* 187. <http://dx.doi.org/10.1016/j.agee.2013.10.010>.
104. Paoletti, M.G., 1999. The role of earthworms for assessment of sustainability and as bioindicators. *Agr. Ecosyst. Environ.* 74, 137–155.
105. Parks, S., Lindhout, K., 2008. Pesticide Residues in Hydroponic Lettuce. HAL Project VG07165, Final Report. Horticulture Australia Ltd., pp. 1–36. <http://ausveg.com.au/intranet/technical-insights/docs/VG07165.pdf>.
106. Paustian, K., Lehmann, J., Ogle, S., Reay, D., Robertson, G.P., Smith, P., 2016. Climate- smart soils. *Nature* 532. <http://dx.doi.org/10.1038/nature17174>.
107. Pelosi, C., Bertrand, M., Roger-Estrade, J., 2009. Earthworm community in conventional, organic and direct seeding with living mulch cropping systems. *Agron. Sustain. Dev.* 29, 287–295. <http://dx.doi.org/10.1051/agro/2008069>.
108. Pelosi, C., Toutous, L., Chiron, F., Duns, F., Hedde, M., Muratet, A., Ponge, J.F., Salmon, S., Makowski, D., 2013. Reduction of pesticide use can improve earthworm populations in wheat crops in a European temperate region. *Agr. Ecosyst. Environ.* 181, 223–230.
109. Pelosi, C., Barot, S., Capowiez, Y., Hedde, M., Vandebulcke, F., 2014a. Pesticides and earthworms: a review. *Agron. Sustain. Develop.* 34, 199–228.
110. Pelosi, C., Pey, B., Hedde, M., Caro, G., Capowiez, Y., Guernion, M., Peigné, J., Piron, D., Bertrand, M., Cluzeau, D., 2014b. Reducing tillage in cultivated fields increases earthworm functional diversity. *Appl. Soil Ecol.* <http://dx.doi.org/10.1016/j.apsoil.2013.10.005>.
111. Pesek, J., Brown, S., Clancy, K.L., Coleman, D.C., et al., 1989. *Agriculture and the Economy Alternative Agriculture*. National Academy Press, Washington, D.C.
112. Pey, B., Nahmani, J., Auclerc, A., Capowiez, Y., Cluzeau, D., Cortet, J., Decaëns, T., Deharveng, L., Dubs, F., Joimel, S., Briard, C., Grumiaux, F., Laporte, M.-A., Pasquet, A., Pelosi, C., Pernin, C., Ponge, J.-F., Salmon, S., Hedde, M., 2014. Current use and future needs for soil invertebrate functional traits in community ecology. *Basic Appl. Ecol.* 15, 194–206. <http://dx.doi.org/10.1016/j.baae.2014.03.007>.
113. Pimentel, D., Hepperly, P., Hanson, J., Doubs, D., Seidel, R., 2005. Environmental, energetic, and economic comparisons of organic and conventional farming systems. *Bioscience* 55, 573–582.
114. Ponge, J.F., Pérès, G., Guernion, M., Ruiz-Camacho, N., Cortet, J., Pernin, C., Villenave, C., Chaussod, R., Martin-Laurent, F., Bispo, A., Cluzeau, D., 2013. The impact of agricultural practices on soil biota: a regional study. *Soil Biol. Biochem.* 67, 271–284.
115. Prashar, P., Shah, S., 2016. Impact of fertilizers and pesticides on soil microflora in agriculture. In: In: Lichtfouse, E. (Ed.), *Sustainable Agriculture Reviews*, vol. 19. Springer International Publishing, Cham, pp. 331–361. http://dx.doi.org/10.1007/978-3-319-26777-7_8.
116. Premuzic, Z., Bargiela, M., Garcia, A., Rendina, A., Iorio, A., 1998. Calcium, iron, potassium, phosphorus, and vitamin C content of organic and hydroponic tomatoes. *HortScience* 33, 255–257.
117. Rahman, M.H., Okubo, A., Sugiyama, S., Mayland, H.F., 2008. Physical, chemical and microbiological properties of an Andisol as related to land use and tillage practice. *Soil Tillage Res.* 101, 10–19. <http://dx.doi.org/10.1016/j.still.2008.05.006>.
118. Rahmann, G., Reza Ardakani, M., Bàrberi, P., Boehm, H., Canali, S., Chander, M., David, W., Dengel, L., Erisman, J.W., Galvis-Martinez, A.C., Hamm, U., Kahl, J., Köpke, U., Kühne, S., Lee, S.B., Løes, A.-K., Moos, J.H., Neuhof, D., Nuutila, J.T., Olowe, V., Oppermann, R., Rembialkowska, E., Riddle, J., Rasmussen, I.A., Shade, J., Sohn, S.M., Tadesse, M., Tashi, S., Thatcher, A., Uddin, N., von Fragstein und Niemsdorff, P., Wibe, A., Wivstad, M., Wenliang, W., Zanolli, R., 2017. *Organic Agriculture 3.0 is innovation with research*. *Org. Agric.* 7, 169–197. <http://dx.doi.org/10.1007/s13165-016-0171-5>.
119. Ranjard, L., Richaume, A., 2001. Quantitative and qualitative microscale distribution of bacteria in soil. *Res. Microbiol.* 152 (8), 707–716. [http://dx.doi.org/10.1016/S0923-2508\(01\)01251-7](http://dx.doi.org/10.1016/S0923-2508(01)01251-7).

120. Ratnadass, A., Fernandes, P., Avelino, J., Habib, R., 2012. Plant species diversity for sustainable management of crop pests and diseases in agroecosystems: a review. *Agron. Sustain. Dev.* 32, 273–303. <http://dx.doi.org/10.1007/s13593-011-0022-4>.
121. Rembialkowska, E., 2016. Organic food: effect on nutrient composition. In: Caballero, Benjamin, Finglas, Paul M., Toldrá, Fidel (Eds.), *Encyclopedia of Food and Health*, pp. 171–177.
122. Rembialkowska, E., 2003. Organic farming as a system to provide better vegetable quality. *International Conference on Quality in Chains. An Integrated View on Fruit and Vegetable Quality* 604 473–479.
123. Rembialkowska, E., 2007. Quality of plant products from organic agriculture. *J. Sci. Food Agr.* 87, 2757–2762.
124. Ren, H., Endo, H., Hayashi, T., 2001. Antioxidative and antimutagenic activities and polyphenol content of pesticide-free and organically cultivated green vegetables using water-soluble chitosan as a soil modifier and leaf surface spray. *J. Sci. Food Agric.* 81, 1426–1432.
125. Salem, M., Kohler, J., Wurst, S., Rillig, M.C., 2013. Earthworms can modify effects of hydrochar on growth of *Plantago lanceolata* and performance of arbuscular mycorrhizal fungi. *Pedobiologia (Jena)* 56. <http://dx.doi.org/10.1016/j.pedobi.2013.08.003>.
126. Schmidt, M.W.I., Torn, M.S., Abiven, S., Dittmar, T., Guggenberger, G., Janssens, I.A., Kleber, M., Kogel-Knabner, I., Lehmann, J., Manning, D.A.C., Nannipieri, P., Rasse, D.P., Weiner, S., Trumbore, S.E., 2011. Persistence of soil organic matter as an eco-system property. *Nature* 478, 49–56.
127. Schneweis, I., Meyer, K., Ritzmann, M., Hoffmann, P., Dempfle, L., Bauer, J., 2005. Influence of organically or conventionally produced wheat on health, performance and mycotoxin residues in tissues and bile of growing pigs. *Arch. Anim. Nutr.* 59, 155–163.
128. Schuphan, W., 1974. Nutritional value of crops as influenced by organic and inorganic fertilizer treatments. *Qual. Plant-Pl. Fds Hum. Nutr.* 23, 333–358.
129. Seufert, V., Ramankutty, N., Foley, J.A., 2012. Comparing the yields of organic and conventional agriculture. *Nature* 485, 229–232.
130. Shams, A.S., 2012. Effect of mineral, organic and bio-fertilizers on growth, yield, quality and sensory evaluation of Kohlrabi. *Res. J. Agric. Biol. Sci.* 8 (2), 305–314.
131. Sheibani, S., Ahangar, A.G., 2013. Effect of tillage on soil biodiversity. *JNAS ((2013 JNAS Journal-2013-2-8/273-281 ISSN 2322-5149 (2013 JNAS.))*. www.jnasci.org.
132. Six, J., Bossuyt, H., Degryze, S., Denef, K., 2004. A history of research on the link between (micro)aggregates, soil biota, and soil organic matter dynamics. *Soil Tillage Res.* 79, 7–31. <http://dx.doi.org/10.1016/j.still.2004.03.008>.
133. Sollins, P., Homann, P., Caldwell, B.A., 1996. Stabilization and destabilization of soil organic matter: mechanisms and controls. *Geoderma* 74, 65–105. [http://dx.doi.org/10.1016/S0016-7061\(96\)00036-5](http://dx.doi.org/10.1016/S0016-7061(96)00036-5).
134. Soto, G., Muñoz, C., 2002. Consideraciones teóricas y prácticas sobre el compost, y su empleo en la agricultura orgánica. *Manejo Integr. Plagas y Afroecología (Costa Rica)* 65, 123–129.
135. Sousa, C., Valentao, P., Rangel, J., Lopes, G., et al., 2005. Influence of two fertilization regimens on the amounts of organic acids and phenolic compounds of Tronchuda cabbage (*Brassica oleracea* L. var *costata* DC). *J. Agric. Food Chem.* 53, 9128–9132.
136. Spurgeon, D.J., Keith, A.M., Schmidt, O., Lammertsma, D.R., Faber, J.H., 2013. Land-use and land-management change: relationships with earthworm and fungi communities and soil structural properties. *BMC Ecol.* 13. <http://dx.doi.org/10.1186/1472-6785-13-46>.
137. Stockmann, U., Adams, M.A., Crawford, J.W., Field, D.J., Henakaarchchi, N., Jenkins, M., Minasny, B., McBratney, A.B., Courcelles, V., Courcelles, V. de R. de, Singh, K., Wheeler, I., Abbott, L., Angers, D.A., Baldock, J., Bird, M., Brookes, P.C., Chenu, C., Jastrow, J.D., Lal, R., Lehmann, J., O'Donnell, A.G., Parton, W.J., Whitehead, D., Zimmermann, M., 2013. The knowns, known unknowns and unknowns of sequestration of soil organic carbon. *Agric. Ecosyst. Environ.* 164, 80–99. <http://dx.doi.org/10.1016/j.agee.2012.10.001>.

138. Suso, M.J., del Río, R., 2015. A crop–pollinator inter–play approach to assessing seed production patterns in faba bean under two pollination environments. *Euphytica* 201, 231–251. <http://dx.doi.org/10.1007/s10681-014-1200-7>.
139. Tilman, D., Reich, P.B., Isbell, F., 2012. Biodiversity impacts ecosystem productivity as much as resources, disturbance, or herbivory. *Proc. Natl. Acad. Sci.* 109, 10394–10397. <http://dx.doi.org/10.1073/pnas.1208240109>.
140. Toor, R.K., Savage, G.P., Heeb, A., 2006. Influence of different types of fertilisers on the major antioxidant components of tomatoes. *J. Food Compos. Anal.* 19, 20–27.
141. Topoliantz, S., Ponge, J.F., Viaux, P., 2000. Earthworm and enchytraeid activity under different arable farming systems, as exemplified by biogenic structures. *Plant Soil* 225, 39–51. <http://dx.doi.org/10.1023/A:1026537632468>.
142. Torsvik, V., Øvreås, L., 2002. Microbial diversity and function in soil: from genes to ecosystems. *Curr. Opin. Microbiol.* 5, 240–245. [http://dx.doi.org/10.1016/S1369-5274\(02\)00324-7](http://dx.doi.org/10.1016/S1369-5274(02)00324-7).
143. Tsiafouli, M.A., Thébault, E., Sgardelis, S.P., de Ruiter, P.C., van der Putten, W.H., Birkhofer, K., Hemerik, L., de Vries, F.T., Bardgett, R.D., Brady, M.V., Bjornlund, L., Jørgensen, H.B., Christensen, S., Hertefeldt, T.D., Hotes, S., Gera Hol, W.H., Frouz, J., Liiri, M., Mortimer, S.R., Setälä, H., Tzanopoulos, J., Uteseny, K., Pižl, V., Sary, J., Wolters, V., Hedlund, K., 2015. Intensive agriculture reduces soil biodiversity across Europe. *Glob. Chang. Biol.* 21. <http://dx.doi.org/10.1111/gcb.12752>.
144. Vande Walle, I., Mussche, S., Samson, R., Lust, N., Lemeur, R., 2001. The above- and belowground carbon pools of two mixed deciduous forest stands located in East-Flanders (Belgium). *Ann. Sci. For.* 58, 507–517.
145. Veberic, R., Trobec, M., Herbinger, K., Hofer, M., Grill, D., Stampar, F., 2005. Phenolic compounds in some apple (*Malus domestica* Borkh) cultivars of organic and integrated production. *J. Sci. Food Agric.* 85, 1687–1694.
146. Velimirov, A., Plochberger, K., Huspeka, U., Schott, W., 1992. The influence of biologically and conventionally cultivated food on the fertility of rats. *Biol. Agric. Hortic.* 8, 325–337.
147. Vrček, I.V., Čepo, D.V., Rašić, D., Peraica, M., Žuntar, I., Bojić, M., Mendaš, G., Medić-Šarić, M., 2014. A comparison of the nutritional value and food safety of organically and conventionally produced wheat flours. *Food Chem.* 143, 522–529.
148. WHO, World Health Organization, 1995.. 44-Report of the Joint FAO-WHO Expert Committee on Food Additives (JECFA). WHO Technical Report No. 159. pp. 29–35 (Geneva).
149. Warman, P.R., Havard, K.A., 1997. Yield, vitamin and mineral contents of organically and conventionally grown carrots and cabbage Agriculture. *Ecosyst. Environ.* 61, 155–162.
- Wezel, A., Casagrande, M., Celette, F., Vian, J.-F., Ferrer, A., Peigné, J., 2014.
150. Agroecological practices for sustainable agriculture. A review. *Agron. Sustain. Dev.* 34. <http://dx.doi.org/10.1007/s13593-013-0180-7>.
151. Winter, K., Davis, S.F., 2006. Organic foods. *J. Food Sci.* 71 (9), R117–R124.
152. Wood, C.L., Byers, J.E., Cottingham, K.L., Altman, I., Donahue, M.J., Blakeslee, A.M.H., 2007. Parasites alter community structure. *Proc. Natl. Acad. Sci.* 104, 9335–9339. <http://dx.doi.org/10.1073/pnas.0700062104>.
153. Wood, S.A., Karp, D.S., DeClerck, F., Kremen, C., Naeem, S., Palm, C.A., 2015. Functional traits in agriculture: agrobiodiversity and ecosystem services. *Trends Ecol. Evol.* <http://dx.doi.org/10.1016/j.tree.2015.06.013>.
154. Worthington, V., 2001. Nutritional quality of organic versus conventional fruits, vegetables and grains. *J. Altern. Complementary Med.* 7 (2), 161–173.

SELECTED REFERENCES, IN ZANELLA, A., PONGE, J.-F., HAGER, H., PIGNATTI, S., GALBRAITH, J., CHERTOV, O., ANDRETTA, A., DE NOBILI, M., 2018C. HUMUSICA 2, ARTICLE 18: TECHNO HUMUS SYSTEMS AND GLOBAL CHANGE - GREENHOUSE EFFECT, SOIL AND AGRICULTURE. APPLIED SOIL ECOLOGY 122, 254–270. DOI:10.1016/J.APSSOIL.2017.10.024:

1. Alston, J.M., Babcock, B.A., Pardey, P.G., 2010. The Shifting Patterns of Agricultural Production and Productivity Worldwide. CARD Books 2. http://lib.dr.iastate.edu/card_books/2.
2. Asner, G.P., Elmore, A.J., Olander, L.P., Martin, R.E., Harris, A.T., 2004. Grazing systems, ecosystems responses, and global change. *Annu. Rev. Environ. Resour.* 29, 261–299. <http://dx.doi.org/10.1146/annurev.energy.29.062403.102142>.
3. Beddow, J.M., Pardey, P.G., Koo, J., Wood, S., 2010. The changing landscape of global agriculture. In: Alston, J.M., Babcock, B.A., Pardey, P.G. (Eds.), *The Shifting Patterns of Agricultural Production and Productivity Worldwide*, Chapter 2, pp. 2010. (Online Resource). http://www.card.iastate.edu/products/books/shifting_patterns/.
4. Bertrand, M., Barot, S., Blouin, M., Whalen, J., de Oliveira, T., Roger-Estrade, J., 2015. Earthworm services for cropping systems. A review. *Agron. Sustain. Dev.* <http://dx.doi.org/10.1007/s13593-014-0269-7>.
5. Blankinship, J.C., Fonte, S.J., Six, J., Schimel, J.P., 2016. Plant versus microbial controls on soil aggregate stability in a seasonally dry ecosystem. *Geoderma* 272. <http://dx.doi.org/10.1016/j.geoderma.2016.03.008>.
6. Blouin, M., Hodson, M.E., Delgado, E.A., Baker, G., Brussaard, L., Butt, K.R., Dai, J., Dendooven, L., Peres, G., Tondoh, J.E., Cluzeau, D., Brun, J.-J., 2013. A review of earthworm impact on soil function and ecosystem services. *Eur. J. Soil Sci.* 64, 161–182. <http://dx.doi.org/10.1111/ejss.12025>.
7. Bouché, M., 2014. Des Vers De Terre Et Des Hommes. Découvrir Nos écosystèmes Fonctionnant à l'énergie Solaire. Acte Sud Nature, Paris.
8. Barois, I., Lavelle, P., 2000. Regulation of soil organic matter dynamics and microbial activity in the drilosphere and the role of interactions with other edaphic functional domains. *Eur. J. Soil Biol.* 36, 177–198.
9. Brussaard, L., Aanen, D.K., Briones, M.J.I., Decaëns, T., De Deyn, G.B., Fayle, T.M., James, S.W., Nobre, T., 2012. Biogeography and phylogenetic community structure of soil invertebrate ecosystem engineers: global to local patterns, implication for ecosystem functioning and services and global environmental change impact. In: Wall, D.H., Bardgett, R., Behan-pelletier, V., Herrick, J.E., Joes, T.H., Ritz, K., Six, J., Strong, D.R., van den Putten, W.H. (Eds.), *Spoil Ecology and Ecosystem Services*. Oxford University Press, pp. 201–232.
10. Callaway, R.M., 1997. Positive interactions in plant communities and the individualistic-continuum concept. *Oecologia* 112, 143–149.
11. Carroll, M., Townshend, J., DiMiceli, C., Noojipady, P., Sohlberg, R., 2009. A new global raster
12. Cartenì, F., Bonanomi, G., Giannino, F., Incerti, G., Vincenot, C.E., Chiusano, M.L., Mazzoleni, S., 2016. Self-dna inhibitory effects: underlying mechanisms and ecological implications. *Plant Signaling Behav.* 11 (4). <http://dx.doi.org/10.1080/15592324.2016.1158381>.
13. Chen, I., Christie, P.J., Dubnau, D., 2005. The ins and outs of DNA transfer in bacteria. *Science*. <http://dx.doi.org/10.1126/science.1114021>.
14. Chen, I.C., Hill, J.K., Ohlemüller, R., Roy, D.B., Thomas, C.D., 2011. Rapid range shifts of species associated with high levels of climate warming. *Science* 333, 1024–1026.
15. Chertov, O.G., 1990. On Soil Ecological Functions and Evolution. *Herald of Leningrad State University Ser. 3*, No. 2(10), 75–81. In Russian with English summary.
16. Clements, F., 1936. Nature and structure of the climax. *J. Ecol.* 24, 252–284.

17. Collins, S., Glenn, S., Roberts, D., 1993. The hierarchical continuum concept. *J. Veg. Sci.* 4, 149–156.
18. Coughtrey, P.J., Jones, C.H., Martin, M.H., Shales, S.W., 1979. Litter accumulation in woodlands contaminated by Pb, Zn, Cd and Cu. *Oecologia* 39, 51–60.
19. Cox, P.M., Betts, R.A., Jones, C.D., Spall, S.A., Totterdell, I.J., 2000. Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model. *Nature* 408, 184–187.
20. Díaz, S., Cabido, M., 1997. Plant functional types and ecosystem function in relation to global change. *J. Veg. Sci.* 8, 463–474.
21. Datta, R., Kelkar, A., Baraniya, D., Molaei, A., Moulick, A., Meena, R.S., Formanek, P., 2017. Enzymatic degradation of lignin in soil: a review. *Sustain* 9. <http://dx.doi.org/10.3390/su9071163>.
22. Decaëns, T., Jiménez, J.J., Barros, E., Chauvel, A., Blanchart, E., Fragoso, C., Lavelle, P., 2004. Soil macrofaunal communities in permanent pastures derived from tropical forest or savanna. *Agric. Ecosyst. Environ.* 103, 301–312. <http://dx.doi.org/10.1016/j.agee.2003.12.005>.
23. Ernst, G., Emmerling, C., 2009. Impact of five different tillage systems on soil organic carbon content and the density biomass, and community composition of earthworms after a ten year period. *Eur. J. Soil Biol.* 45, 247–251.
24. Foley, J.A., De Fries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C., Gibbs, H.K., Helkowski, J.H., Holloway, T., Howard, E.A., Kucharik, C.J., Monfreda, C., Patz, J.A., Prentice, I.C., Ramankutty, N., Snyder, P.K., 2005. Global consequences of land use. *Science* 309 (80), 570–574. <http://dx.doi.org/10.1126/science.1111772>.
25. Fragoso, C., Brown, G.G., Patrón, J.C., Blanchart, E., Lavelle, P., Pashanasi, B., Senapati, B., Kumar, T., 1997. Agricultural intensification, soil biodiversity and agroecosystem function in the tropics: the role of earthworms. *Appl. Soil Ecol.* 6, 17–35. [http://dx.doi.org/10.1016/S0929-1393\(96\)00154-0](http://dx.doi.org/10.1016/S0929-1393(96)00154-0).
26. Giller, K.E., Beare, M.H., Lavelle, P., Izac, A.-M., Swift, N., 1997. Agricultural intensification, soil biodiversity and agroecosystem function. *Appl. Soil Ecol.* 6, 3–16. [http://dx.doi.org/10.1016/S0929-1393\(96\)00149-7](http://dx.doi.org/10.1016/S0929-1393(96)00149-7).
27. Gillet, S., Ponge, J.-F., 2002. Humus forms and metal pollution in soil. *Eur. J. Soil Sci.* 53, 529–539.
28. Gonzales, P., Neilson, R.P., Lenihan, J.M., Drapek, R.J., 2010. Global patterns in the vulnerability of ecosystems to vegetation shifts due to climate change. *Global Ecol. Biogeogr.* 19 (6), 755–768.
29. Gyles, C., Boerlin, P., 2014. Horizontally transferred genetic elements and their role in pathogenesis of bacterial disease. *Vet. Pathol.* 51, 328–340. <http://dx.doi.org/10.1177/0300985813511131>.
30. Handa, I.T., Aerts, R., Berendse, F., Berg, M.P., Bruder, A., Butenschoen, O., Chauvet, E., Gessner, M.O., Jabiol, J., Makkonen, M., McKie, B.G., Malmqvist, B., Peeters, E.T.H.M., Scheu, S., Schmid, B., van Ruijven, J., Vos, V.C.A., Hättenschwiler, S., 2014. Consequences of biodiversity loss for litter decomposition across biomes. *Nature* 509. <http://dx.doi.org/10.1038/nature13247>.
31. Havlicek, E., Mitchell, E.A.D., 2014. Soils supporting biodiversity. In: Dighton, J., Krumins, J.A. (Eds.), *Interactions in Soil: Promoting Plant Growth*. Springer, Netherlands Dordrecht, pp. 27–58. http://dx.doi.org/10.1007/978-94-017-8890-8_2.
32. Jones, C., McConnell, C., Coleman, K., Cox, P., Falloon, P., Jenkinson, D., Powlson, D., 2005. Global climate change and soil carbon stocks; predictions from two contrasting models for the turnover of organic carbon in soil. *Global Change Biol.* 11, 154–166.
33. Lal, R., 2000. World cropland soils as a source or sink for atmospheric carbon. *Adv. Agron.* 71, 145–191.
34. Lal, R., 2004. Soil carbon sequestration impacts on global climate change and food security. *Science* 304, 1623–1627.
35. Leff, J.W., Jones, S.E., Prober, S.M., Barberán, A., Borer, E.T., Firn, J.L., Harpole, W.S., Hobbie, S.E., Hofmockel, K.S., Knops, J.M.H., McCulley, R.L., La Pierre, K., Risch, A.C.,

- Seabloom, E.W., Schütz, M., Steenbock, C., Stevens, C.J., Fierer, N., 2015. Consistent responses of soil microbial communities to elevated nutrient inputs in grasslands across the globe. *PNAS* 112 (35), 10967–10972. <http://dx.doi.org/10.1073/pnas.1508382112>. (published ahead of print August 17, 2015).
36. Maestre, F.T., Delgado-Baquerizo, M., Jeffries, T.C., Eldridge, D.J., Ochoa, V., Gozalo, B., Quero, J.L., García-Gómez, M., Gallardo, A., Ulrich, W., Bowker, M.A., Arredondo, T., Barraza-Zepeda, C., Bran, D., Florentino, A., Gaitán, J., Gutiérrez, J.R., Huber-Sannwald, E., Jankju, M., Mau, R.L., Miriti, M., Naseri, K., Ospina, A., Stavi, I., Wang, D., Woods, N.N., Yuan, X., Zaady, E., Singh, B.K., 2015. Increasing aridity reduces soil microbial diversity and abundance in global drylands. *PNAS* 112 (51), 15684–15689. <http://dx.doi.org/10.1073/pnas.1516684112>. (published ahead of print December 8, 2015).
 37. Mazzoleni, S., Bonanomi, G., Incerti, G., Chiusano, M., Termolino, P., Mingo, A., Senatore, M., Giannino, F., Carteni, F., Rietkerk, M., 2015b. Inhibitory and toxic effects of extracellular self-DNA in litter: a mechanism for negative plant-soil feedbacks? *New Phytol.* 2015 (205), 1195–1210. <http://dx.doi.org/10.1111/nph.13121>. (PMID:25354164).
 38. Meier, I.C., Finzi, A.C., Phillips, R.P., 2017. Root exudates increase N availability by stimulating microbial turnover of fast-cycling N pools. *Soil Biol. Biochem.* 106. <http://dx.doi.org/10.1016/j.soilbio.2016.12.004>.
 39. Morgan, J.A., Follett, R.F., Allen Jr, L.H., Del Grosso, S., Derner, J.D., Dijkstra, F., Franzluebbers, A., Fry, R., Paustian, K., Schoeneberger, M.M., 2010. Carbon sequestration in agricultural lands of the United States. *J. Soil Water Conserv.* 65, 6A–13A.
 40. Morvan, X., Saby, N.P.A., Arrouays, D., Le Bas, C., Jones, R.J.A., Verheijen, F.G.A., Bellamy, P.H., Stephens, M., Kibblewhite, M.G., 2008. Soil monitoring in Europe: a review of existing systems and requirements for harmonisation. *Sci. Total Environ.* 391, 1–12.
 41. Nielsen, U.N., Wall, D.H., Six, J., 2015. Soil biodiversity and the environment. *Annu. Rev. Environ. Resour.* 40. <http://dx.doi.org/10.1146/annurev-environ-102014-021257>.
 42. Ponge, J.-F., 2005. Emergent properties from organisms to ecosystems: towards a realistic approach. *Biol. Rev.* 80, 403–411. <http://dx.doi.org/10.1017/s146479310500672x>.
 43. Roser, M., 2016. Land Use in Agriculture. (Published online at OurWorldInData.org). <https://ourworldindata.org/land-use-in-agriculture/>.
 44. Roser M., Ritchie H., 2017. Yields and Land Use in Agriculture. Published online at OurWorldInData.org. Retrieved from: <https://ourworldindata.org/yields-and-land-use-in-agriculture/> [Online Resource].
 45. Sanchez, P.A., Palm, C.A., Buol, S.W., 2003. Fertility capability soil classification: a tool to help assess soil quality in the tropics. *Geoderma* 114, 157–185.
 46. Scherber, C., Eisenhauer, N., Weisser, W.W., Schmid, B., Voigt, W., Fischer, M., Schulze, E.-D., Roscher, C., Weigelt, A., Allan, E., Beßler, H., Bonkowski, M., Buchmann, N., Buscot, F., Clement, L.W., Ebeling, A., Engels, C., Halle, S., Kertscher, I., Klein, A.-M., Koller, R., König, S., Kowalski, E., Kummer, V., Kuu, A., Lange, M., Lauterbach, D., Middelhoff, C., Migunova, V.D., Milcu, A., Müller, R., Partsch, S., Petermann, J.S., Renker, C., Rottstock, T., Sabais, A., Scheu, S., Schumacher, J., Temperton, V.M., Tschardtke, T., 2010. Bottom-up effects of plant diversity on multitrophic interactions in a biodiversity experiment. *Nature.* <http://dx.doi.org/10.1038/nature09492>.
 47. Sebastian, K., 2006. Classification of Countries by Agricultural-Ecological Zone Class. International Food Policy Research Institute, Washington, D.C.
 48. Settele, J., Scholes, R., Betts, R., Bunn, S., Leadley, P., Nepstad, D., Overpeck, J.T., Taboada, M.A., 2014. Terrestrial and inland water systems. In: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 271–359.

49. Six, J., Bossuyt, H., Degryze, S., Deneff, K., 2004. A history of research on the link between (micro)aggregates, soil biota, and soil organic matter dynamics. *Soil Tillage Res.* 79, 7–31. <http://dx.doi.org/10.1016/j.still.2004.03.008>.
50. Spohn, M., Giani, L., 2010. Water-stable aggregates, glomalin-related soil protein, and carbohydrates in a chronosequence of sandy hydromorphic soils. *Soil Biol. Biochem.* 42, 1505–1511. <http://dx.doi.org/10.1016/j.soilbio.2010.05.015>.
51. Sterritt, R.M., Lester, J.N., 1980. Interactions of heavy metals with bacteria. *Sci. Total Environ.* 14, 5–17.
52. Thompson, J.N., 1994. *The Coevolutionary Process*. University of Chicago Press, Chicago ISBN 0–226-79760–0. Retrieved 2009–07-27.
53. Vergnes, A., Blouin, M., Muratet, A., Lerch, T.Z., Mendez-Millan, M., Rouelle-Castrec, M., Dubs, F., 2017. Initial conditions during Technosol implementation shape earth- worms and ants diversity. *Landscape Urban Plann.* 159, 32–41. <http://dx.doi.org/10.1016/j.landurbplan.2016.10.002>.
54. Von Lützow, M., Kögel-Knabner, I., Ekschmitt, K., Matzner, E., Guggenberger, G., Marschener, B., Flessa, H., 2006. Stabilization of organic matter in temperate soils: mechanisms and their relevance under different soil conditions: a review. *Eur. J. Soil Sci.* 57, 426–445.
55. Whittaker, R.H., 1975. *Communities and Ecosystems*. MacMilan Publishing Co., Inc., NY.
- Willig, M.R., Kaufman, D.M., Stevens, R.D., 2003. Latitudinal gradients of biodiversity: pattern, process, scale, and synthesis. *Annu. Rev. Ecol. Evol. Syst.* 2003 (34), 273–309. <http://dx.doi.org/10.1146/annurev.ecolsys.34.012103.144032>.
56. Zak, D.R., Freedman, Z.B., Upchurch, R.A., Steffens, M., Kögel-Knabner, I., 2017. Anthropogenic N deposition increases soil organic matter accumulation without altering its biochemical composition. *Glob. Chang. Biol.* 23, 933–944. <http://dx.doi.org/10.1111/gcb.13480>.
57. Wu, K.M., Guo, Y.Y., 2004. The evolution of cotton pest management practices in China. *Annu. Rev. Entomol.* 50, 31–52. <http://dx.doi.org/10.1146/annurev.ento.50.071803.130349>.
58. Wunderlich, S.M., Feldman, C., Kane, S., Hazhin, T., 2008. Nutritional quality of organic, conventional, and seasonally grown broccoli using vitamin C as a marker. *Int. J. Food Sci. Nutr.* 59, 34–45.
59. Yang, S., 2014. Can organic crops compete with industrial agriculture? *Proc. R. Soc. B. Berkeley news.* <http://news.berkeley.edu/2014/12/09/organic-conventional-farming-yield-gap/>.
60. Young, J.E., Zhao, X., Carey, E.E., Weltl, R., et al., 2005. Phytochemical phenolics in organically grown vegetables. *Mol. Nutr. Food Res.* 49, 1136–1142.

REFERENCES SELECTED IN ZANELLA, A., BOLZONELLA, C., LOWENFELS, J., PONGE, J.-F., BOUCHÉ, M., SAHA, D., KUKAL, S.S., FRITZ, I., SAVORY, A., BLOUIN, M., SARTORI, L., TATTI, D., KELLERMANN, L.A., TRACHSEL, P., BURGOS, S., MINASNY, B., FUKUOKA, M., 2018A. HUMUSICA 2, ARTICLE 19: TECHNO HUMUS SYSTEMS AND GLOBAL CHANGE - CONSERVATION AGRICULTURE AND 4/1000 PROPOSAL. *APPLIED SOIL ECOLOGY* 122, 271–296. DOI:10.1016/J.APSOIL.2017.10.036:

1. Abbott, L.K., Murphy, D.V., 2003. *Soil Biological Fertility: A Key to Sustainable Land Use in Agriculture*. Springer Science & Business Media.
2. Agriculteurs Composteurs de France, 2015. *Charte de bonnes pratiques de compostage agricole-Ensemble pour l'environnement. Version n°6. 57 p.* http://www.composteursdefrance.com/ressources/pdf/charte_bonnes_pratiques_compostage.pdf.
3. Aira, M., Sampetro, L., Monroy, F., Domínguez, J., 2008. Detritivorous earthworms directly modify the structure, thus altering the functioning of a microdecomposer food web. *Soil Biol. Biochem.* 40, 2511–2516.

4. Alfieri, L., 2013. Agricoltura conservativa. Tenore in S.O. sullo stesso suolo rispetto all'arato (7 anni per SS, 10 per il MT). Fonte: sperimentazioni Di.Pro.Ve. Università degli Studi di Milano–DiSAA.
5. Bardgett, R.D., van der Putten, W.H., 2014. Belowground biodiversity and ecosystem functioning. *Nature* 515. <http://dx.doi.org/10.1038/nature13855>.
6. Barea, J.-M., Pozo, M.J., Azcon, R., Azcon-Aguilar, C., 2005. Microbial co-operation in the rhizosphere. *J. Exp. Bot.* 56, 1761–1778.
7. Bedano, J.C., Cantú, M.P., Doucet, M.E., 2006. Influence of three different land management practices on soil mite (Arachnida: Acari) densities in relation to a natural soil. *Appl. Soil Ecol.* 32, 293–304.
8. Bhatia, C.R., 2008. Role of microbial diversity for soil, health and plant nutrition. In: Nautiyal, C.S., Dion, P. (Eds.), *Molecular Mechanisms of Plant and Microbe Coexistence*. Springer, Berlin, Heidelberg, pp. 53–74. http://dx.doi.org/10.1007/978-3-540-75575-3_2.
9. Blankinship, J.C., Fonte, S.J., Six, J., Schimel, J.P., 2016. Plant versus microbial controls on soil aggregate stability in a seasonally dry ecosystem. *Geoderma* 272. <http://dx.doi.org/10.1016/j.geoderma.2016.03.008>.
10. Bouché, M., 2014. Des vers de terre et des hommes. This amount could compensate: Découvrir nos écosystèmes fonctionnant à l'énergie solaire, Actes Sud, Collection < Arbres en campagne > , dirigée Par Alain Canet et Bruno Sirven—336 pages.
11. Boudsocq, S., Niboyet, A., Lata, J.C., Raynaud, X., Loeuille, N., Mathieu, J., Blouin, M., Abbadie, L., Barot, S., 2012. Plant preference for ammonium versus nitrate: a neglected determinant of ecosystem functioning? *Am. Nat.* 180 (1), 60–69.
12. Brenna, S., Acutis, M., Acutis, Ballarin Denti A., Gardi, C., Gerosa, G., Valagussa, M., Lapi, M., 2013. Il ruolo dell'agricoltura conservativa nel bilancio del carbonio. Quaderni della Ricerca n. 153 – giugno 2013, Ricerca e Sperimentazione in Agricoltura, Regione Lombardia, 148 p.
13. Brennan, E.B., Acosta-Martinez, V., 2017. Cover cropping frequency is the main driver of soil microbial changes during six years of organic vegetable production. *Soil Biol. Biochem.* 109. <http://dx.doi.org/10.1016/j.soilbio.2017.01.014>.
14. Brown, G.G., Barois, I., Lavelle, P., 2000. Regulation of soil organic matter dynamics and microbial activity in the drilosphere and the role of interactions with other edaphic functional domains. *Eur. J. Soil Biol.* 36, 177–198.
15. Brussard, L., 2012. Ecosystem services provided by the soil biota. In: Wall, D.H., Bardgett, R.D., Behan-Pelletier, V., Herrick, J.E., Jones, T.H., Ritz, K., Six, J. (Eds.), *Soil Ecology and Ecosystem Services*. Oxford University Press, Oxford, pp. 45–58. Buchkowski, R.W., Schmitz, O.J., Bradford, M.A., 2015. Microbial stoichiometry overrides biomass as a regulator of soil carbon and nitrogen cycling. *Ecology* 96. [http:// dx.doi.org/10.1890/14-1327.1.sm](http://dx.doi.org/10.1890/14-1327.1.sm).
16. Buckley, D.H., Schmidt, T.M., 2003. Diversity and dynamics of microbial communities in soils from agro-ecosystems. *Environ. Microbiol.* 5, 441–452.
17. Burger, M., Jackson, L.E., 2005. Plant and microbial nitrogen use and turnover: rapid conversion of nitrate to ammonium in soil with roots. *Plant Soil* 266, 289–301. <http://dx.doi.org/10.1007/s11104-005-1362-0>.
18. Butterfield, J., Bingham, S., Savory, A., 2006. *Holistic Management Handbook Healthy Land, Healthy Profits*. Island press 272 p.
19. Chabbi, A., Lehmann, J., Ciais, P., Loescher, H.W., Cotrufo, M.F., Don, A., SanClements, M., Scippper, L., Six, J., Smith, P., Rumpel, C., 2017. Aligning agriculture and climate policy. *Nature Climate change* 7 (5), 307–309. <http://dx.doi.org/10.1038/nclimate3286>.
20. Clarholm, M., 1989. Effects of plant-bacterial-amoebal interactions on plant uptake of nitrogen under field conditions. *Biol. Fertil. Soils* 8, 373–378. <http://dx.doi.org/10.1007/BF00263171>.
21. Cluzeau, D., Fayolle, L., Burakowski, I., 1988. Impacts sur les lombriciens des traitements pesticides, en particulier cupriques, dans le vignoble champenois. *Comptes Rendus de l'Académie d'Agriculture de France* 8, 109–117. <http://prodirna.inra.fr/record/129752>.

22. Cluzeau, D., Guernion, M., Chaussod, R., Martin-Laurent, F., Villenave, C., Cortet, J., Ruiz-Camacho, N., Pernin, C., Mateille, T., Philippot, L., Bellido, A., Rougé, L., Arrouays, D., Bispo, A., Pérès, G., 2012. Integration of biodiversity in soil quality monitoring: baselines for microbial and soil fauna parameters for different land-use types. *Eur. J. Soil Biol.* 49, 63–72. <http://dx.doi.org/10.1016/j.ejsobi.2011.11.003>.
23. Copley, J., 2000. Ecology goes underground. *Nature* 406, 452–454.
24. Darwin, C., 1881. In: Murray, J. (Ed.), *The Formation of Vegetable Mould Through the Action of Worms, with Observations on Their Habits*. John Murray, London.
25. Dawkins, R., 2006. *The Selfish Gene: 30th-with a New Introduction by the Author*, anniversary edition. Oxford University Press citeulike-article-id:636057.
26. Decaëns, T., Jiménez, J.J., Barros, E., Chauvel, A., Blanchart, E., Fragoso, C., Lavelle, P., 2004. Soil macrofaunal communities in permanent pastures derived from tropical forest or savanna. *Agric. Ecosyst. Environ.* 103, 301–312. <http://dx.doi.org/10.1016/j.agee.2003.12.005>.
27. Deutschbauer, A.M., Chivian, D., Arkin, A.P., 2006. Genomics for environmental microbiology. *Curr. Opin. Biotechnol.* 17, 229–235.
28. Domínguez, J., 2004. State of the art and new perspectives on vermicomposting research. In: Edwards, C.A. (Ed.), *Earthworm Ecology*, 2nd ed. CRC Press, Boca Raton, pp. 401–424.
29. FAO, 2017. FAO SOIL PORTAL, Management, Soil carbon sequestration, What is Soil Carbon Sequestration? <http://www.fao.org/soils-portal/soil-management/soil-carbon-sequestration/en/> (Accessed 14 September 2017).
30. Fierer, N., Leff, J.W., Adams, B.J., Nielsen, U.N., Bates, S.T., Lauber, C.L., Owens, S., Gilbert, J.A., Wall, D.H., Caporaso, J.G., 2012. Cross-biome metagenomic analyses of soil microbial communities and their functional attributes. *PNAS* 109 (52), 21390–21395. <http://dx.doi.org/10.1073/pnas.1215210110>. published ahead of print December 10, 2012.
31. Fitter, A.H., Gilligan, C.A., Hollingworth, K., Kleczkowski, A., Twyman, R.M., Pitchford, J.W., 2005. Biodiversity and ecosystem function in soil. *Funct. Ecol.* 19, 369–377.
32. Fitter, A.H., 2005. Darkness visible: reflections on underground ecology. *J. Ecol.* 93, 231–243.
33. Fontaine, S., Barot, S., 2005. Size and functional diversity of microbe populations control plant persistence and long-term soil carbon accumulation. *Ecol. Lett.* 8, 1075–1087.
34. Food and Agriculture Organization (FAO), 2007. *Agriculture and Consumer Protection Department*. Rome, Italy Available from <http://www.fao.org/ag/ca/>.
35. Fritz, J.I., Franke, Franke-Whittle, I.H., Haindl, S., Insam, H., Braun, R., 2012. Microbiological community analysis of vermicompost tea and its influence on the growth of vegetables and cereals. *Can. J. Microbiol.* 58, 836–847. <http://dx.doi.org/10.1139/W2012-061>. Published by NRC Research Press.
36. Fujimura, K.E., Slusher, N.A., Cabana, M.D., Lynch, S.V., 2010. Role of the gut microbiota in defining human health. *Expert Rev. Anti. Infect. Ther.* 8, 435–454. <http://dx.doi.org/10.1586/eri.10.14>.
37. Fukuoka, M., 1985. *The Natural Way Of Farming—The Theory and Practice of Green Philosophy*. Japan Publications translator: Frederic P. Metreud, ISBN 978-0-87040- 613.
38. Fulthorpe, R.R., Rhodes, A.N., Tiedje, J.M., 1998. High levels of endemicity of 3-chlorobenzoate-degrading soil bacteria. *Appl. Environ. Microbiol.* 64 (May (5)), 1620–1627.
39. Gewin, V., 2006. Genomics: discovery in the dirt. *Nature* 439, 384–386.
40. Gleixner, G., 2013. Soil organic matter dynamics: a biological perspective derived from the use of compound-specific isotopes studies. *Ecol. Res.* 28 (5), 683–695. <http://dx.doi.org/10.1007/s11284-012-1022-9>.
41. Gobat, J.M., Aragno, M., Mtthey, W., 2010. *Le sol vivant*, 3er edn. Presses Polytechniques et Universitaires Romandes, Lausanne. <http://dx.doi.org/10.1016/j.agee.2012.10.001>.
42. Gruber, K., 2015. Deep influence of soil microbes. *Nat. Plants* 1. <http://dx.doi.org/10.1038/nplants.2015.194>.
43. Guinane, C.M., Cotter, P.D., 2013. Role of the gut microbiota in health and chronic gastrointestinal disease: understanding a hidden metabolic organ. *Therap. Adv.*

44. McHardy, A.C., Dangl, J.L., Knight, R., Ley, R., Schulze-Lefert, P., 2015. Microbiota and host nutrition across plant and animal kingdoms. *Cell Host Microbe* 17, 603–616. <http://dx.doi.org/10.1016/j.chom.2015.04.009>.
45. Han, L., Sun, K., Jin, J., Xing, B., 2016. Some concepts of soil organic carbon characteristics and mineral interaction from a review of literature. *Soil Biol. Biochem.* <http://dx.doi.org/10.1016/j.soilbio.2015.11.023>.
46. Havlicek, E., Mitchell, E.A.D., 2014. Interactions in Soil: Promoting Plant Growth. <http://dx.doi.org/10.1007/978-94-017-8890-8>.
47. Hernández, T., Chocano, C., Moreno, J.L., García, C., 2014. Towards a more sustainable fertilization: combined use of compost and inorganic fertilization for tomato cultivation. *Agric. Ecosyst. Environ.* 196, 178–184. <http://dx.doi.org/10.1016/j.agee.2014.07.006>.
48. Hodge, A., Robinson, D., Fitter, A., 2000. Are microorganisms more effective than plants at competing for nitrogen? *Trends Plant Sci.* 5, 304–308.
49. Hua, K., Wang, D., Guo, X., Guo, Z., 2014. Carbon Sequestration Efficiency of Organic Amendments in a Long-Term Experiment on a Vertisol in Huang-Huai-Hai Plain, China. <http://dx.doi.org/10.1371/journal.pone.0108594>.
50. Jastrow, J.D., Miller, R.M., Lussenhop, J., 1998. Contributions of interacting biological mechanisms to soil aggregate stabilization in restored prairie. *Soil Biol. Biochem.* 30, 905–916.
51. Jenny, H., 1941. Factors of Soil Formation. A System of Quantitative Pedology. McGraw-Hill Book Company, New York.
52. Johansson, J.F., Paul, L.R., Finlay, R.D., 2004. Microbial interactions in the mycorrhizosphere and their significance for sustainable agriculture. *FEMS Microbiol. Ecol.* 48, 1–13. <http://dx.doi.org/10.1016/j.femsec.2003.11.012>.
53. Jouquet, P., Bottinelli, N., Podwojewski, P., Hallaire, V., Tran Duc, T., 2008. Chemical and physical properties of earthworm casts as compared to bulk soil under a range of different land-use systems in Vietnam. *Geoderma*. <http://dx.doi.org/10.1016/j.geoderma.2008.05.030>.
54. Kallenbach, C.M., Frey, S.D., Grandy, A.S., 2016. Direct evidence for microbial-derived soil organic matter formation and its ecophysiological controls. *Nat. Commun.* 7, 13630. <http://dx.doi.org/10.1038/ncomms13630>.
55. Kassam, T., Derpsch, F.R., Kienzle, J., 2015. Overview of the worldwide spread of conservation agriculture. *Field Actions Sci. Rep.* 8. <http://factsreports.revues.org/3966>.
56. Keiluweit, M., Bougoure, J.J., Nico, P.S., Pett-Ridge, J., Weber, P.K., Kleber, M., 2015. Mineral protection of soil carbon counteracted by root exudates. *Nat. Clim. Change* 5, 588–595.
57. Kibblewhite, M.G., Ritz, K., Swift, M.J., 2008. Soil health in agricultural systems. *Phil. Trans. R. Soc. B* 363, 685–701.
58. Kirchmann, H., Thorvaldsson, G., 2000. Challenging targets for future agriculture. *Eur. J. Agron.* 12, 145–161.
59. Kuzyakov, Y., Blagodatskaya, E., 2015. Microbial hotspots and hot moments in soil: concept & review. *Soil Biol. Biochem.* <http://dx.doi.org/10.1016/j.soilbio.2015.01.025>.
60. Lal, R., Bruce, J.P., 1999. The potential of world cropland soils to sequester C and mitigate the greenhouse effect. *Environ. Sci. Policy* 2, 177–185.
61. Lal, R., Negassa, W., Lorenz, K., 2015. Carbon sequestration in soil. *Curr. Opin. Environ. Sustain.* <http://dx.doi.org/10.1016/j.cosust.2015.09.002>.
62. Lal, R., 2012. World soils and the carbon cycle in relation to climate change and food security. *Global Soil Week 2012*, 1–52.
63. Lam, S.K., Chen, D., Mosier, A.R., Roush, R., 2013. The potential for carbon sequestration in Australian agricultural soils is technically and economically limited. *Sci. Rep.* 3. <http://dx.doi.org/10.1038/srep02179>.
64. Lange, M., Eisenhauer, N., Sierra, C.A., Bessler, H., Engels, C., Griffiths, R.I., Mellado-Vázquez, P.G., Malik, A.A., Roy, J., Scheu, S., Steinbeiss, S., Thomson, B.C., Trumbore, S.E., Gleixner, G., 2015. Plant diversity increases soil microbial activity and soil carbon storage. *Nat. Commun.* 6. <http://dx.doi.org/10.1038/ncomms7707>.

65. Lavelle, P., 2012. Soil as a habitat. In: Wall, D.H., Bardgett, R.D., Behan-Pelletier, V., Herrick, J.E., Jones, T.H., Ritz, K., Six, J., Strong, D.R., van der Putten, W.H. (Eds.), *Soil Ecology and Ecosystem Services*, pp. 1–27.
66. Leff, J.W., Jones, S.E., Prober, S.M., Barberán, A., Borer, E.T., Firm, J.L., Harpole, W.S., Hobbie, S.E., Hofmockel, K.S., Knops, J.M.H., McCulley, R.L., La Pierre, K., Risch, A.C., Seabloom, E.W., Schütz, M., Steenbock, C., Stevens, C.J., Fierer, N., 2015. Consistent responses of soil microbial communities to elevated nutrient inputs in grasslands across the globe. *PNAS* 112 (35), 10967–10972. <http://dx.doi.org/10.1073/pnas.1508382112>. published ahead of print August 17, 2015.
67. Lehmann, J., Kleber, M., 2015. Perspective The contentious nature of soil organic matter. *Nature* 528 (7580), 0–8. <http://dx.doi.org/10.1038/nature16069>.
68. Leigh Jr., E.G., Rowell, T.E., 1995. The evolution of mutualism and other forms of harmony at various levels of biological organization. *Écologie* 26, 131–158.
69. Leigh Jr., E.G., Vermeij, G.J., 2002. Does natural selection organize ecosystems for the maintenance of high productivity and diversity? *Phil. Trans. R. Soc. Lond. B* 357, 709–718.
70. Leigh Jr., E.G., 1983. When does the good of the group override the advantage of the individual? *Proc. Natl. Acad. Sci. U. S. A.* 80, 2985–2989.
71. Liu, S., Razavi, B.S., Su, X., Maharjan, M., Zarebanadkouki, M., Blagodatskaya, E., Kuzyakov, Y., 2017. Spatio-temporal patterns of enzyme activities after manure application reflect mechanisms of niche differentiation between plants and microorganisms. *Soil Biol. Biochem.* 112, 100–109. <http://dx.doi.org/10.1016/j.soilbio.2017.05.006>.
72. Lowenfeels, J., Lewis, W., 2010. *Teaming with Microbes. The Organic Gardener's Guide to the Soil Food Web.* Timber Press, Portland, Oregon 220 p.
73. Lowenfeels, J., 2013. *Teaming with Nutrients. The Organic Gardener's Guide to Optimizing Plant Nutrition.* Timber Press, Portland, Oregon 250 p.
74. Lowenfeels, J., 2017. *Teaming with Fungi. The Organic Grower's Guide to Mycorrhizae.* Timber Press, Portland, Oregon 212 p.
75. Luo, Z., Wang, E., Sun, O.J., 2010. Soil carbon change and its responses to agricultural practices in Australian agro-ecosystems: a review and synthesis. *Geoderma* 155, 211–223.
76. Lynch, J.M., Benedetti, A., Insam, H., Nuti, M.P., Smalla, K., Torsvik, V., Nannipieri, P., 2004. Microbial diversity in soil: ecological theories, the contribution of molecular techniques and the impact of transgenic plants and transgenic microorganisms. *Biol. Fertil. Soils* 40, 363–385. <http://dx.doi.org/10.1007/s00374-004-0784-9>.
77. Maestre, F.T., Delgado-Baquerizo, M., Jeffries, T.C., Eldridge, D.J., Ochoa, V., Gozalo, B., Quero, J.L., García-Gómez, M., Gallardo, A., Ulrich, W., Bowker, M.A., Arredondo, T., Barraza-Zepeda, C., Bran, D., Florentino, A., Gaitán, J., Gutiérrez, J.R., Huber-Sannwald, E., Jankju, M., Mau, R.L., Miriti, M., Naseri, K., Ospina, A., Stavi, I., Wang, D., Woods, N.N., Yuan, X., Zaady, E., Singh, B.K., 2015. Increasing aridity reduces soil microbial diversity and abundance in global drylands. *PNAS* 112 (51), 15684–15689. <http://dx.doi.org/10.1073/pnas.1516684112>. published ahead of print December 8, 2015.
78. Malik, A.A., Chowdhury, S., Schlager, V., Oliver, A., Puissant, J., Vazquez, P.G.M., Gleixner, G., et al., 2016. Soil fungal: bacterial ratios are linked to altered carbon cycling. *Front. Microbiol.* 7, 1247. <http://dx.doi.org/10.3389/fmicb.2016.01247>.
79. Manlay, R.J., Feller, C., Swift, M.J., 2007. Historical evolution of soil organic matter concepts and their relationships with the fertility and sustainability of cropping systems. *Agric. Ecosyst. Environ.* 119, 217–233.
80. Masclaux-Daubresse, C., Daniel-Vedele, F., Dechorgnat, J., Chardon, F., Gaufichon, L., Suzuki, A., 2010. Nitrogen uptake, assimilation and remobilization in plants: challenges for sustainable and productive agriculture. *Ann. Bot.* <http://dx.doi.org/10.1093/aob/mcq028>.
81. Mazzoleni, S., Carteni, F., Bonanomi, G., Senatore, M., Termolino, P., Gianino, F., Incerti, G., Rietkerk, M., Lanzotti, V., Chiusano, M.L., 2015b. Inhibitory effects of extracellular self-DNA: a general biological process? *New Phytol.* 2015 (206), 127–132. <http://dx.doi.org/10.1111/nph.13306>. PMID. 25628124.

82. McBratney, A., Koppi, T., Field, D.J., 2016. Radical soil management for Australia: a rejuvenation process. *Geoderma Reg.* 7, 132–136. <http://dx.doi.org/10.1016/j.geodrs.2016.02.001>.
83. Meinshausen, M., Meinshausen, N., Hare, W., Raper, S.C.B., Frieler, K., Knutti, R., Frame, D.J., Allen, M.R., 2009. Greenhouse-gas emission targets for limiting global warming to 2 °C. *Nature* 458, 1158–1162.
84. Meli, P., Benayas, J.M.R., Balvanera, P., Ramos, M.M., 2014. Restoration enhances wetland biodiversity and ecosystem service supply, but results are context-dependent: a meta-analysis. *PLoS One* 9.
85. Miltner, A., Bombach, P., Schmidt-Brücken, B., Kästner, M., 2012. SOM genesis: microbial biomass as a significant source. *Biogeochemistry* 111 (1–3), 41–55. <http://dx.doi.org/10.1007/s10533-011-9658-z>.
86. Minasny, B., Mcbratney, A.B., 2017. Limited effect of organic matter on soil available water capacity. *Eur. J. Soil Sci.* 1–9. <http://dx.doi.org/10.1111/ejss.12475>.
87. Monroy, F., Aira, M., Domínguez, J., 2011. Epigeic earthworms increase soil arthropod populations during first steps of decomposition of organic matter. *Pedobiologia* 54 (2), 93–99. <http://dx.doi.org/10.1016/j.pedobi.2010.10.003>.
88. Morriën, E., 2016. Understanding soil food web dynamics, how close do we get? *Soil Biol. Biochem.* 102, 10–13. <http://dx.doi.org/10.1016/j.soilbio.2016.06.022>.
89. Murphy, B., 2010. *Greener Pastures on Your Side of the Fence: Better Farming With Voisin Management Intensive Grazing*, seventh printing. Arriba Publishing ISBN-10: 0961780738, 675 p.
90. Mustin, M., 1987. *Le Compost. Gestion e la matière organique*. Ed. François Dubusc, Paris 954 p.
91. Nebbioso, A., Piccolo, A., 2012. Advances in humeomics: enhanced structural identification of humic molecules after size fractionation of a soil humic acid. *Anal. Chim. Acta* 720, 77–90.
92. Nikol'skii, A.A., 2014. Ecological inheritance in the biological signal field of mammals. *Russ. J. Ecol.* 45, 76–79.
93. Odling-Smee, J.D.H., Erwin, D.H.E.P., Palkovacs, E.P.M.W., Feldman, M.W., Laland, K.N., 2013. Niche construction theory: a practical guide for ecologists. *Q. Rev. Biol.* 88, 3–28.
94. Olof, A., Lindberg, T., Boström, U., Clarholm, M., Hansson, A.-C., Johansson, G., Lagerlöf, J., Paustian, K., Persson, J., Pettersson, R., Schnürer, J., Sohlenius, B., Wivstad, M., 1990. Organic carbon and nitrogen flows. *Ecol. Bull.* 40, 85–126 Web. 14 Sept. 2017.
95. Palm, C., Blanco-Canqui, H., DeClerck, F., Gatere, L., Grace, P., 2014. Conservation agriculture and ecosystem services: an overview. *Agric. Ecosyst. Environ.* 187. <http://dx.doi.org/10.1016/j.agee.2013.10.010>.
96. Paoletti, M.G., 1999. The role of earthworms for assessment of sustainability and as bioindicators. *Agr. Ecosyst. Environ.* 74, 137–155.
97. Paul, E.A., 2016. The nature and dynamics of soil organic matter: plant inputs, microbial transformations, and organic matter stabilization. *Soil Biol. Biochem.* <http://dx.doi.org/10.1016/j.soilbio.2016.04.001>.
98. Paustian, K., Lehmann, J., Ogle, S., Reay, D., Robertson, G.P., Smith, P., 2016. Climate-smart soils. *Nature* 532. <http://dx.doi.org/10.1038/nature17174>.
99. Pietramellara, G., Ascher, J., Borgogni, F., Ceccherini, M.T., Guerri, G., Nannipieri, P., 2009. Extracellular DNA in soil and sediment: fate and ecological relevance. *Biol. Fertil. Soils* 45, 219–235. <http://dx.doi.org/10.1007/s00374-008-0345-8>.
100. Pinton, R., Varanini, Z., Nannipieri, P., 2007. *The Rhizosphere: Biochemistry and Organic Substances at the Soil-Plant Interface*, Second Edition, Books in Soils Plants, and the Environment. CRC Press.
101. Ponge, J.-F., 2015. The soil as an ecosystem. *Biol Fertil Soils* 51, 645. <https://doi.org/10.1007/s00374-015-1016-1>.
102. Prashar, P., Shah, S., 2016. Impact of fertilizers and pesticides on soil microflora in agriculture. In: In: Lichtfouse, E. (Ed.), *Sustainable Agriculture Reviews*, vol. 19. Springer International Publishing, Cham, pp. 331–361. http://dx.doi.org/10.1007/978-3-319-26777-7_8.

103. Pugesgaard, S., Schelde, K., Larsen, S.U., Lærke, P.E., Jørgensen, U., 2015. Comparing annual and perennial crops for bioenergy production-influence on nitrate leaching and energy balance. *GCB Bioenergy* 7, 1136–1149. <http://dx.doi.org/10.1111/gcbb.12215>.
104. Rahmani, M., Hodges, A., Kiker, C., 2004. Compost users' attitudes toward compost application in Florida. *Compost. Sci. Util.* 12, 55–60.
105. Rovira, A.D., 1969. Plant root exudates. *Bot. Rev.* (1969) 35, 35.
106. Sánchez-de León, Y., Lugo-Pérez, J., Wise, D.H., Jastrow, J.G., González-Meler, M.A., 2014. Aggregate formation and carbon sequestration by earthworms in soil from a temperate forest exposed to elevated atmospheric CO₂: A microcosm experiment. *Soil Biol. Biochem.* 68. <http://dx.doi.org/10.1016/j.soilbio.2013.09.023>.
107. Saha, D., Kukal, S.S., Sharma, S., 2011. Land use impacts on SOC fractions and aggregate stability in Typic Ustochrepts of Northwest India. *Plant Soil* 339, 457–470.
108. Saha, D., Kukal, S.S., Bawa, S.S., 2014. Soil organic carbon stock and fractions in relation to land use and soil depth in the degraded Shiwaliks hills of lower Himalayas. *Land Degrad. Dev.* 25, 407–416.
109. Salmon, S., 2004. The impact of earthworms on the abundance of Collembola: improvement of food resources or of habitat? *Biol. Fertil. Soils* 40, 323–333.
110. Savory, A., Butterfield, J., 2016. *Holistic Management, Third Edition. A Commonsense Revolution to Restore Our Environment.* Allan Savory with Jody Butterfield. Island Press, Washington, D.C./Covelo, California 552 p.
111. Scheu, S., 2002. The soil food web: structure and perspectives. *Eur. J. Soil Biol.* 38, 11–20. Schipanski, M.E., Barbercheck, M., Douglas, M.R., Finney, D.M., Haider, K., Kaye, J.P., Kemanian, A.R., Mortensen, D.A., Ryan, M.R., Tooker, J., White, C., 2014. A framework for evaluating ecosystem services provided by cover crops in agroecosystems. *Agric. Syst.* 125. <http://dx.doi.org/10.1016/j.agsy.2013.11.004>.
112. Schlesinger, W.H., 2000. Carbon sequestration in soils: some cautions amidst optimism. *Agric. Ecosyst. Environ.* 82, 121–127.
113. Schmidt, M.W.I., Torn, M.S., Abiven, S., Dittmar, T., Guggenberger, G., Janssens, I.A., Kleber, M., Kogel-Knabner, I., Lehmann, J., Manning, D.A.C., Nannipieri, P., Rasse, D.P., Weiner, S., Trumbore, S.E., 2011. Persistence of soil organic matter as an ecosystem property. *Nature* 478, 49–56.
114. Scott, D., Markewitz, D., Hendrix, P., Coleman, D., 2014. Soil aggregates and associated organic matter under conventional tillage no-tillage, and forest succession after three decades. *PLoS One* 9 (1), e84988. <http://dx.doi.org/10.1371/journal.pone.0084988>.
115. Sechi, V., De Goede, R.G.M., Rutgers, M., Brussaard, L., Mulder, C., 2017. A community trait-based approach to ecosystem functioning in soil. *Agric. Ecosyst. Environ.* 239. <http://dx.doi.org/10.1016/j.agee.2017.01.036>.
116. Smil, V., 1999. Crop residues: agriculture's largest harvest: crop residues incorporate more than half of the world's agricultural phytomass. *Bioscience* 49 (4), 299–308.
117. Smith, J., Smith, P., Wattenbach, M., Zaehle, S., Hiederer, R., Jones, R.J.A., Montanarella, L., Rounsevell, M.D.A., Reginster, I., Ewert, F., 2005. Projected changes in mineral soil carbon of European croplands and grasslands, 1990–2080. *Global Change Biol.* 11 (2005), 2141–2152 ISSN 1354–1013.
118. Soil Health, 2016. *Soil Health.* N.p., n.d. Web. 15 Oct. 2016. <http://www.soilhealth.com>. Spaccini, R., Piccolo, A., Conte, P., Haberhauer, G., Gerzabek, M.H., 2002. Increased soil organic carbon sequestration through hydrophobic protection by humic substances. *Soil Biol. Biochem.* 34, 1839–1851.
119. Spohn, M., Giani, L., 2010. Water-stable aggregates, glomalin-related soil protein, and carbohydrates in a chronosequence of sandy hydromorphic soils. *Soil Biol. Biochem.* 42, 1505–1511. <http://dx.doi.org/10.1016/j.soilbio.2010.05.015>.
120. Spohn, M., Klaus, K., Wanek, W., Richter, A., 2016. Microbial carbon use efficiency and biomass turnover times depending on soil depth—implications for carbon cycling. *Soil Biol. Biochem.* 96. <http://dx.doi.org/10.1016/j.soilbio.2016.01.016>.
121. Stevenson, F.J., 1994. *Humus Chemistry: Genesis, Composition, Reactions.* John Wiley & Sons.

122. Stockmann, U., Adams, M.A., Crawford, J.W., Field, D.J., Henakaarchchi, N., Jenkins, M., Zimmermann, M., et al., 2013. The knowns, known unknowns and unknowns of sequestration of soil organic carbon. *Agric. Ecosyst. Environ.* 164, 80–99. <http://dx.doi.org/10.1016/j.agee.2012.10.001>.
123. Stockmann, U., Padarian, J., McBratney, A., Minasny, B., de Brogniez, D., Montanarella, L., Hong, S.Y., Rawlins, B.G., Field, D.J., 2015. Global soil organic carbon assessment. *Global Food Secur.* 6, 9–16.
124. Sutton, R., Sposito, G., 2005. Critical review molecular structure in soil humic substances: the new view. *Environ. Sci. Technol.* 39 (510), 9009–9015. <http://dx.doi.org/10.1021/es050778q>.
125. Taylor, J.P., Wilson, B., Mills, M.S., Burns, R.G., 2002. Comparison of microbial numbers and enzymatic activities in surface soils and subsoils various techniques. *Soil Biol. Biochem.* 34, 387–401.
126. Ursell, L.K., Metcalf, J.L., Parfrey, L.W., Knight, R., 2012. Defining the human microbiome. *Nutr. Rev.* 70, S38–S44. <http://dx.doi.org/10.1111/j.1753-4887.2012.00493.x>.
127. Van der Wal, A., de Boer, W., 2017. Dinner in the dark: illuminating drivers of soil organic matter decomposition. *Soil Biol. Biochem.* <http://dx.doi.org/10.1016/j.soilbio.2016.11.006>.
128. Verhulst, N., Cox, R., Govaerts, B., 2013. *Soil Aggregate Stability by Wet Sieving: A Practical Guide for Comparing Crop Management Practices*. CIMMYT, Mexico, DF (Mexico) 7 pages.
129. Wade, M.J., 1977. An experimental study of group selection. *Evolution* 31, 134–153.
130. Wamelink, G.W.W., Frissel, J.Y., Krijnen, W.H.J., Verwoert, M.R., Goedhart, P.W., 2014. Can plants grow on mars and the moon: a growth experiment on mars and moon soil simulants. *PLoS One* 9. <http://dx.doi.org/10.1371/journal.pone.0103138>.
131. Wasak, K., Drewnik, M., 2015. Land use effects on soil organic carbon sequestration in calcareous Leptosols in former pastureland—a case study from the Tatra Mountains (Poland). *Solid Earth* 6, 1103–1115. <https://www.solid-earth.net/6/1103/2015/10.5194/se-6-1103-2015>.
132. West, T.O., Post, W.M., 2002. Soil organic carbon sequestration rates by tillage and crop rotation. *Soil Sci. Soc. Am. J.* 66, 1930–1946.
133. Wheeler, I., 2014. *The Auditability of Soil Carbon at the Farm Scale*. PhD Thesis. The University of Sydney, Sydney, Australia.
134. Whitford, W.G., 2000. Keystone arthropods as webmasters in desert ecosystems. In: Coleman, D.C., Hendrix, P.F. (Eds.), *Invertebrates as Webmasters in Ecosystems*. CAB International, Wallingford, pp. 25–41.
135. Wickenbrock, L., Heisler, C., 1997. Influence of earthworm activity on the abundance of collembola in soil. *Soil Biol. Biochem.* 29, 517–521.
136. Wieland, G., Neumann, R., Backhaus, H., 2001. Variation of microbial communities in soil, rhizosphere, and rhizoplane in response to crop species, soil type, and crop development. *Appl. Environ. Microbiol.* 67, 5849–5854.
137. Wilson, D.S., Wilson, E.O., 2008. Evolution ‘for the good of the group’. *Am. Sci.* 96, 380–389.
138. Wise, D.H., Snyder, W.E., Tuntibunpakul, P., Halaj, J., 1999. Spiders in decomposition food webs of agroecosystems: theory and evidence. *J. Arachnol.* 27, 363–370.
139. Xie, J., Hou, M., Zhou, Y., Wang, R., Zhang, S., Yang, X., Sun, B., 2017. Carbon sequestration and mineralization of aggregate-associated carbon in an intensively cultivated Anthrosol in north China as affected by long term fertilization. *Geoderma* 296, 1–9. <http://dx.doi.org/10.1016/j.geoderma.2017.02.023>.
140. Yoder, R.E., 1936. A direct method of aggregate size analysis of soils and a study of the physical nature of erosion losses. *J. Am. Soc. Agron.* 28, 337–351.
141. Zhang, T., Wooster, M.J., Green, D.C., Main, B., 2015. New field-based agricultural biomass burning trace gas, PM_{2.5}, and black carbon emission ratios and factors measured in

situ at crop residue fires in Eastern China. *Atmospheric Environment* 121, 22–34 IISN 1352-2310, <https://doi.org/10.1016/j.atmosenv.2015.05.010>.

OTHER REFERENCES (CITED BY THE AUTHORS OF THIS ARTICLE IN THEIR INTERVENTIONS; OTHER REFERENCES ARE DIRECTLY CITED UNDER THE CONTRIBUTION AND THEIR TITLES HELP IN UNDERSTANDING THEIR ENGAGED CONTENTS)

1. Palmer T., 2017. "The Butterfly Effect - What Does It Really Signify?". Oxford U. Dept. of Mathematics Youtube Channel. Retrieved 13 February 2019.
2. Kerry E., 2018. "Edward N. Lorenz and the End of the Cartesian Universe". MIT Department of Earth, Atmospheric, and Planetary Sciences Youtube channel. Retrieved 13 February 2019.
3. Ghaley, B.B., Rusu, T., Sandén, T., Spiegel, H, Menta, C., Visioli, G., O'Sullivan, L., Gattin, I.T., Delgado, A., Liebig, M.A., Vrebos, D., Szegi, T., Michéli, E., Cacovean, H., Henriksen C.B., 2018. Assessment of benefits of conservation agriculture on soil functions in arable production systems in Europe. *Sustainability*, 10, 794. DOI: 10.3390/su10030794.
4. Menta C, Bonati B, Staffilani F, Conti FD. 2017. Agriculture Management and Soil Fauna Monitoring: The Case of Emilia-Romagna Region (Italy). *Agri Res & Tech: Open Access J.*, 4(5): 555649. DOI: 10.19080/ARTOAJ.2017.04.555649003.
5. Menta C., Tagliapietra A., Caoduro G., Zanetti A., Pinto S., 2015. Ibs-Bf and Qbs-Ar Comparison: Two Quantitative Indices Based on Soil Fauna Community. *EC Agriculture 2.5* (2015): 427-439.
6. Menta C., Leoni A., Gardi C., Conti F. 2011. Are grasslands important habitats for soil microarthropod conservation? *Biodiversity and Conservation*, 20, 1073-1087. DOI 10.1007/s10531-011-0017-0.
7. Menta C., Leoni A., Tarasconi K., Affanni P., 2010. Does compost use affect microarthropod soil communities? *Fresenius Environmental Bulletin*, 19, 2303-2311.
8. Tabaglio V., Gavazzi C., Menta C., 2009. Physico-chemical indicators and microarthropod communities as influenced by no-till, conventional tillage and nitrogen fertilisation after four years of continuous maize. *Soil & Tillage Research*, 105, 135-142.
9. Adeux, G., Vieren, E., Carlesi, S., Bàrberi, P., Munier-Jolain, N., Cordeau, S., 2019. Mitigating crop yield losses through weed diversity. *Nature Sustainability* 2, 1018–1026. doi:10.1038/s41893-019-0415-y
10. Barański, M., Średnicka-Tober, D., Volakakis, N., Seal, C., Sanderson, R., Stewart, G.B., Benbrook, C., Biavati, B., Markellou, E., Giotis, C., Gromadzka-Ostrowska, J., Rembiałkowska, E., Skwarło-Soñta, K., Tahvonen, R., Janovská, D., Niggli, U., Nicot, P., Leifert, C., 2014. Higher antioxidant and lower cadmium concentrations and lower incidence of pesticide residues in organically grown crops: a systematic literature review and meta-analyses. *The British Journal of Nutrition* 112, 794–811. doi:10.1017/S0007114514001366
11. Abitabile, C., Marras, F., Viganò, L., et. al., 2019. Bioreport 2017-2018. L'agricoltura biologica in Italia, ReteRurale. ed. EU - MIPAAFT - CREA, Roma.
12. Bolzonella, C., Lucchetta, M., Teo, G., Boatto, V., Zanella, A., 2019. Is there a way to rate insecticides that is less detrimental to human and environmental health? *Global Ecology and Conservation* 20, e00699. doi:10.1016/J.GECCO.2019.E00699
13. Jiguet, F., Sunnen, L., Prévot, A.-C., Princé, K., 2019. Urban pigeons losing toes due to human activities. *Biological Conservation* 240, 108241. doi:10.1016/j.biocon.2019.108241
14. Coleman, D.C., Odum, E.P., Crossley, D.A., 1992. Soil biology, soil ecology, and global change. *Biology and Fertility of Soils* 14, 104–111. doi:10.1007/BF00336258
15. Odum, E.P., Barrett, G.W., 2004. Redesigning Industrial Agroecosystems. *Journal of Crop Improvement* 11, 45–60. doi:10.1300/J411v11n01_03