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Fields of Balance: An Extensive Analysis of Conventional and Organic Agriculture in the Contemporary Era

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

By 2050, it is projected that there will be 10 billion people on the planet who need to be fed. Meeting these demands and maintaining environmental protection will be greatly dependent on the paradigms of conventional and organic agriculture. By following the historical origins of these two

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agricultural paradigms and examining their methods, effects, financial implications, and contributions to global food security, this review critically analyses them. We draw emphasis to the environmental footprints, paying special focus to biodiversity, greenhouse gas emissions, water management, and soil health. A deeper examination of consumer safety, community dynamics, and global market trends will be included in the discussion of the health effects of food produced in both systems and their societal ramifications. This review makes the case for an integrated approach to agriculture that makes use of best practices from both worlds by identifying the advantages and disadvantages of both farming systems. The goal of this harmonisation is to build a sustainable agricultural future that feeds people and maintains the planet's natural equilibrium.

Keywords: Systematic review; life cycle; assessment; sustainable agriculture; cropping systems; organic; conventional.

1. INTRODUCTION

Providing food for the 11 billion people that will inhabit the earth by the end of the century is one of the most important difficulties that humanity will face [1]. Currently, 98.9% of the world's food is produced by conventional agriculture, also known as non-organically certified agriculture, in which farmers generally use synthetic, chemical inputs [2]. It is important to keep in mind, nevertheless, that in the annals of human history, what is deemed "conventional" now is rather recent. It has just been slightly over a century since Fritz Haber discovered how to combine nitrogen and hydrogen to create ammonia, which could then be used to make synthetic fertiliser [3]. Prior to World War II, there was little use of pesticides; compounds like DDT were not commercially available until 1945 [4].

Family farms employing organic methods were the norm for the most of human history. There were, of course, a lot less people to feed. Nevertheless, famine and widespread starvation-related deaths were frequent at times, even in Europe [5]. 85% of farmers worldwide still operate on 20 hectares or less of land, which is known as smallholder farming [6]. Many might be considered low-input, organic operations even if the majority are not certified. These farms' yields are lower than those of more intensive agriculture [7]. Even though food security has significantly improved, the Food and Agriculture Organisation (FAO) of the United Nations still considers one in nine people on the earth to be "hungry" [8]. Over three million children die each year from "undernutrition," which accounts for 45% of all child fatalities, according to estimates [9]. In local areas that depend on tiny, low-input businesses, the majority of those affected by food shortages reside. As Africa's population increases by three billion, this situation will only get worse [10].

Globally and especially in rich Western nations, there is a growing demand for organic products. With almost 23 million hectares under cultivation, Australia now holds the record for the largest percentage of land that is certified organic. India is the country with the highest total number of certified organic farmers. In the global context, Europe is the region where organic agriculture is most prevalent. More than any other continent, Europe is home to 26% of the world's organic croplands as of 2017 [2]. The most generous legislation for organic practices is now found in Europe [11]. Due to Europe's growing demand for organic goods, its organic certification requirements and respect for organic crops are influential worldwide [12].

The various shortcomings of traditional, industrial agricultural systems are often cited by proponents of organic agriculture. They list several alleged advantages of organic farming, including:

Farmers [15], consumers [16], and the surrounding aquatic [17] and terrestrial ecosystems [18] are all spared from both acute [14] and chronic [13] pesticide exposure.

Higher vitamin [20] and mineral content [21] are found in organic vegetables, which also has a higher nutritional value [19]. Additionally, it is claimed that because organic produce has more sugar and a higher metabolic integrity as well as a superior cellular structure, it tastes better and keeps longer [22].

Plant availability of nutrients is facilitated by the healthy soil [23], soil microbiota [24], and healthy soil [25] that are fostered by organic farming. Pest outbreaks that pesticide use may inadvertently encourage are decreased by organic agriculture, which prevents genetic changes and the development of insect immunity [26]. Organic agriculture is more cost-effective and commercially competitive since it does not require as many inputs, such as synthetic fertiliser, insecticides, or herbicides [27]. Organic agriculture is a more ethical approach for humanity since it uses natural resources, which promotes a more harmonious relationship with the environment [28].

Some of these claims are supported by empirical evidence. Among the fifteen meta-analyses that could be identified in the scientific literature, twelve of them came to the conclusion that there was proof that organic food was more nutrient-dense than conventional produce and that it had higher levels of antioxidants, vitamin C, and omega-3 fatty acids [29]. Organic farming "true believers," however, also have a tendency to overestimate the advantages of chemical-free farming, caricaturizing conventional farming and its harmful effects on the environment. Note that a number of thorough analyses in credible journals (some of which are contested [30]) have been published that do not support the purported nutritional benefits of organic vegetables [31]. In other words, more work needs to be done.

Researchers have shown that conventional agriculture systems often produce superior environmental results than organic ones, a fact that advocates easily ignore [41-45]. Often, the relative sustainability of a particular farm operation will be dominated by characteristics related to the entire food system enterprise (e.g., ploughing techniques or crop delivery distance), independent of the use of inputs and pesticides. Above all, regardless of the true extent of the hazards associated with conventional farming, its greater yields in comparison to organic farming cannot be discounted, particularly on a world where food security is becoming a critical issue for humanity due to population growth [46-49]. The topic that macro-level policy makers must address is: "Should organic agriculture be expanded as the standard farming method globally, considering current technologies and the expected demand for food?" The article's analysis of the query in light of standards related to environmental sustainability on a worldwide scale leads it to the clear conclusion that the response is no.

This article challenges the assertions of organic agriculture's unquestionable environmental superiority by reviewing the most recent research in this important subject and coming to this conclusion. The relative benefits of the various strategies are taken into account in relation to issues like the total amount of land needed, biodiversity and habitat loss, water quality, land degradation, and climate change. It goes without saying that discussions regarding the best worldwide plan for feeding the world must also include broader aspects of sustainability, such as the economic and social problems that impact food security [53,69]. It is obvious that the ability of a population to feed itself depends on a number of factors, including the overall volume of production, the corresponding distribution networks, and governmental regulations pertaining to distributive justice and equitable access to food among societies and countries. The argument put up by numerous pundits is that, in theory, the globe already produces enough food to sustain the current population [32,33]. Distributive justice and distribution can undoubtedly be used to frame the issue. These larger socioeconomic concerns, however, are outside the purview of this essay because they entail intricate political relations [39,40].

It is necessary to address valid worries about the detrimental effects of conventional agriculture on the environment and human health, as well as to change several harmful practices. However, most environmental damage connected with high-input agriculture can be avoided by cautious, sustainably maintained traditional farms [50,51]. Research indicates that in certain situations, large-scale organic farming operations may actually do more harm to the environment than ethically managed conventional farms. Sustainable strategies that enhance environmental performance ought to be incorporated into both conventional and organic farming operations, instead of rigidly adhering to specific ideologies. It is both economically and environmentally vital to be able to grow more food on less land with minimal off-site effects through the use of advanced and effective management techniques.

2. THE LAND REUIREMENT FOR A WORLDWIDE SWITCH TO ORGANIC AGRICULTURE

The consequences for food security should be the first consideration in any global assessment of the conventional vs organic agriculture conundrum. Approximately 38% of the earth's terrestrial surface is devoted to agriculture, according to the most recent estimates, despite the fact that many different assessments have been made [34]. Roughly 12% of ice-free land is utilised to grow crops for human use, while pastures occupy another 26% [35]. The percentage of lands with true agricultural potential that are actually used for farming is actually much higher when one takes into account the vast parts of the earth's surface that are covered in deserts or unsuitable mountain regions. A growing amount of land becomes unavailable for uses other than agriculture every year, not to mention the other life forms that coexist with people on the globe.

The scientific literature regularly reports yields that are noticeably higher on conventional farms than on organic ones. While yield differences can be contextual, one of the most thorough evaluations ever carried out, which was published in the esteemed journal Nature, discovered that organic agriculture has "34% lower yields when the conventional and organic systems are most comparable" [36]. A different group of European researchers published the most recent meta-analysis in Nature Communications in November 2017, comparing the productivity of conventional and organic agriculture. They came to comparable conclusions [37]. Clearly, site-specific settings that impact agricultural performances are created by the farming community's economic situation, the climate and types of soil, the crops farmed, etc. However, data on crop yields as a whole generally indicate that harvests from organic agriculture are smaller.

In order to feed nine billion people by 2050, it can be predicted that world agricultural output will need to rise by at least 50% based on normal demographic forecasts [38]. According to the most recent projections, switching to a fully organic system would require 30% more land than conventional agriculture given current consumption trends [37]. Pesticide use and N excess would be significantly reduced as a result of this change. In order to achieve these gains, the study took into account alternate scenarios and modelled how changing consumer demand and consumption patterns might affect land use. The findings suggest that more acreage would not be needed if a shift to organic farming was coupled with a 50% decrease in food waste and the consumption of agricultural goods. It is obvious that more has to be done by public policy to identify strategies to lower the astounding amounts of food that are produced but never eaten. However, it is unclear when this will be accomplished in the near future, setting up the prerequisites for biological systems to become adequate on a worldwide scale [70,71].

3. THE ORGANIC / CONVENTIONAL DIVIDE AND BIODIVERSITY

The vast and detrimental effects on biodiversity would result from expanding land cultivation worldwide in an attempt to bring in a new era of organic farming. Both a macro and a micro perspective can be used to examine this. At the micro level, organic farms, which totally eschew using toxins to secure crop yields, unquestionably have a considerably greater detrimental impact on the biodiversity of the surrounding area than do conventional agricultural systems. Numerous studies support this, including one that found that compared to equivalent conventional fields, German organic grasslands are home to a higher number of plant species [54]. More diversity and density of nematodes [57], earthworms [56], and spiders [55] have been reported in other investigations. Compared to conventional fields, organic fields include a greater variety of rare plant species [58]. Results from studies on bird species [61] and mammals [59, 60] are consistent.

At the macro level, however, a different image is revealed. This is due to the fact that habitat loss is a major contributing factor to the current biodiversity problem on Earth [62]. Although there are several reasons for the unbelievable loss of 52% of all wildlife in the globe between 1970 and 2010, chemicals are not the main culprit: The main causes include invasive species, pollution, and, above importantly, damaged or fragmented habitat [52, 69].

The "land sparing" perspective, which prioritises protecting as much of the natural habitat as possible and creating sanctuaries as much as possible, is based on this understanding [63]. In the new reality of a globe home to 10 billion people, even proponents of a "land sharing" strategy [64] would readily concede that agricultural efficiency is a top concern if any land at all is to remain for the other creatures. Economically and environmentally, integrated pest management makes sense, negating the need for pesticides altogether and supporting the idea that they should only be used as a last resort. In sensitive environments (such as those next to aquatic ecosystems), spraying ought to be prohibited in general. It is difficult to argue, however, that a worldwide switch to organic agriculture will improve the planet's dire biodiversity trends because it would replace such vast areas of habitat.

4. WATER QUALITY AND ENVIRONMENTAL EFFECTS OFF-SITE

Organic farms are often thought to be more environmentally friendly than "conventional operations." Nonetheless, a number of investigations come to the opposite result. Water quality is one example of this. An Israeli study conducted in 2014, for example, compared the effects of similar conventional agriculture with intensive organic methods by measuring water quality throughout the unsaturated zone under recently constructed greenhouses. The average nitrate concentration measured in the root zone (above one metre) beneath the organic greenhouse was 357 mg/L, with peak NO3 concentrations reaching 724 mg/L. Compared to levels recorded at comparable depths beneath the greenhouses used for conventional farming, this was an order of magnitude greater. The average nitrate contents on drip-irrigated crops were only 37 mg/L.

Researchers found, however, that conventional farms were more effectively providing high concentrations of fertiliser (270 mg/L) to the root zones; yet, these levels rapidly decreased as one moved further into the vadose zone. Measurements conducted in the root zones of organic processes concurrently revealed relative nitrate deficits. The researchers came to the conclusion that early in the growing season, when nutrients from the compost were released into the soil, this is what caused the nitrates to drain below the organic farms. Young organic plants have poor nitrogen intake at this point in the growth cycle, which makes nitrate percolation into the vadose zone and ground water inevitable [65].

Similar outcomes are observed in operations involving livestock. The organic chicken was shown to have a higher eutrophication potential when the off-site impacts on water resources of free range, organic, and conventional grill chicken systems were evaluated. This was ascribed to the variations in chicken feed supply as well as the nutrient leaching that occurred when growing organic crops [66]. The argument here is not that conventional farmers are necessarily better or less polluting of nonpoint sources of water than their organic counterparts. The nature of environmental repercussions appears to be determined more by effective management than by the use or lack thereof of pesticides in agricultural activities.

5. ENVIRONMENTAL LIFE CYCLE ANALYSIS'S AMBIGUOUS TEACHINGS

The ramifications of a policy for mitigating climate change must be taken very seriously in any debate of global sustainability today. It is wise to use a systemic approach rather than an intuitive one when comparing the carbon footprints of conventional and organic farming. Apparently, growing produce organically or conventionally has much less of an impact on agriculture's overall carbon footprint than a number of other considerations. A wide range of crops have had their varying environmental impacts evaluated through the use of life cycle assessment (LCA) research, which evaluates an item, procedure, or activity's environmental impact from "cradle to grave" [67]. Milk production has also received a great deal of attention [68].

34 LCA studies that contrasted organic and conventional agriculture were examined by a Swiss team of experts. They discovered that numerous methodological errors plagued much of the study, ranging from small sample numbers to insufficient distinction of particular farming system characteristics, with just a few number of impact categories evaluated. Organic products almost always had less of an environmental impact per area, even while conventional agriculture produced better yields per hectare. However, a number of research investigations documented deviations from this generalisation. These included detrimental effects noted in the life cycle of organic beans as well as increased eutrophication and acidification brought about by certain organic cattle, pig, and poultry operations, as well as tomatoes, wheat, and potatoes [69]. Much more recently, Clark and Tilman's study [70] comes to essentially the same findings.

LCA research also shows that there is little empirical evidence to support some of the prevalent wisdom regarding the "egregious" environmental performance of traditional agriculture. Numerous assumptions regarding the better environmental outcomes of organic farming do not withstand careful scrutiny. In Australia, 29 organic farms (representing 1.5% of all certified organic operations) were compared to conventional farms in a study that revealed increased direct energy use, energy-related emissions, and greenhouse gas emissions on organic farms [71]. Market structures and produce transportation are just two examples of the several sources of pollution connected to food production that may have a greater impact than the use of pesticides and fertilisers. Overall environmental consequences per unit of product are found to be similar when yields are compared to environmental footprint. Thus, when evaluating greenhouse gas emissions, organic operations seem beneficial when the production area serves as the functional unit of analysis. Conventional operations actually show a lesser carbon footprint when the analysis is done using emissions per kilogramme of agricultural product or kilocalorie of food grown.

This is a common occurrence in the numerous assessments that are carried out to contrast conventional and organic dairy businesses. Production of organic milk often wins out, particularly when a "allocation factor" that accounts for price differentials is included in the calculation. Additionally, compared to conventional dairy farms, organic milk operations have been demonstrated to have higher potential for global warming and acidification on the farm per kilogramme. According to this, organic farms emit more ammonia, methane, and nitrous oxide per kilogramme of milk produced than conventional farms do. Furthermore, findings indicate that commercial milk requires less land per kilogramme than organic milk.

6. THE CARBON FOOTPRINT OF AGRICULTURE AND ITS IMPACT ON CLIMATE CHANGE

The issue of what a society considers to be its top environmental priority arises from the apparent differences in benefits between conventional and organic farming for many environmental criteria. To put it another way: Can these research provide insightful information that can guide national and international policy? Because of its irreversibility and the enormous number of people and ecosystems it affects, many environmental advocates rank climate change as the most important environmental issue confronting the globe today. The United Nations approved seventeen sustainable development objectives for the planet, most of which are generic. For this reason, it is included as a specific environmental aim.

By eating seasonal fruits and vegetables and minimising produce transportation by air, it is very evident from LCA analysis that agriculture's "carbon footprint" may be significantly reduced. This presupposes that there isn't any fossil fuel heating involved in the production of fruits and vegetables, as is the case in certain greenhouses where vegetables are grown. Meisterling (2009), for example, discovered that, under the same conditions, conventional wheat systems produce around 30 g more CO2-eq per 0.67 kg wheat flour (1 kilogramme loaf of bread) than organic wheat. The carbon footprint of the synthetic nitrogen used in farming is the cause of this. That carbon-associated benefit, however, quickly vanishes if organic wheat is delivered farther than conventional wheat.

The most crucial thing to keep in mind is that producing beef results in more greenhouse gas emissions than producing all other types of food combined. Even a cursory analysis reveals the "big picture" of a global shift to organic food production: enormous amounts of manure—and the methane produced by the livestock that supplies the manure—will be needed to replenish nitrogen in the soil, and this will dominate any carbon inventory. The reasoning behind this is really straightforward: The rate at which nitrogen-fixing plants can renew themselves is limited when the soil loses nutrients. In order to sustain high yields over time in intensive agriculture, more fertilisation becomes essential.

Organic farming is predicated on avoiding synthetic fertilisers. It is true that frequent manure spreading can maintain and even increase soil fertility, despite the significant regional variance in application rates according to local conditions. The majority of organic farming operations consider farmyard manure, or the broken-down combination of waste with litter and leftover forage, to be essential. It is recognised for its ability to provide plant nutrients, including micronutrients, enhance the structure and ability of soils to retain water, and even aid in the management of parasitic nematodes by reversing the microbial balance in the soil.

Nevertheless, the issue lies in the fact that producing enough manure to guarantee sufficient nitrogen and phosphorus in the fields and orchards to feed 10 billion people would need an unfathomable increase in the global cow population. For his outstanding work enhancing grain yields through improved crop types, Norman Borlaug was awarded the Nobel Peace Prize. He maintained that even if it were possible to gather enough organic material to maintain soil fertility by adding plant leftovers, animal manures, and human waste to the soil, the nutrients would still not be sufficient to sustain the world's population of over four billion people on currently farmed land. "Drastically" expanding Cropland would be necessary. (He made this joke: "I don't see two billion volunteers to disappear [Organic approaches] can only feed four billion people."). In order to sustain an organic food system for 6.2 billion people, Borlaug estimated in 2007 that the number of cows on the earth would need to increase by nearly ten times, from the 1.5 billion that were living at the time to the 10 billion that would be needed. Since Bourlaug's figures were made, there have been an additional 1.4 billion people to feed. It's nearly impossible to imagine the extra methane emissions connected to activities based on organic dung, considering the carbon footprint of cows. Other studies, like the 2016 assessment conducted by a Washington State University team and published in Nature Plants, come to the conclusion that using manure a lot exacerbates issues with soil acidification and off-site eutrophication, with organic operations showing higher emissions and leaching per unit of production than conventional fertiliser use.

7. INCREASING THE SUSTAINABILITY OF CONVENTIONAL AND ORGANIC AGRICUL-TURE

Both sides of the organic vs conventional debate have a propensity to minimise the other and highlight extreme instances of behaviours that are harmful to the environment. In actuality, conventional, ethical farmers have had access to sustainable substitutes for a while. For instance, when synthetic fertiliser is applied excessively and improperly, it can seriously contaminate nonpoint sources of water. But for far more effective delivery, drip irrigation systems, which have been available for forty years, allow well-managed conventional operations to produce negligible nitrate pollution. In fact, studies have demonstrated that organic farms that rely on composted manure as a fertiliser source actually pollute groundwater more frequently than "conventional" farms that use drip irrigation and liquid fertilisation methods.

8. CONCLUSION

It would be incorrect to infer from research like this that, in every case, organic chicken farms pose a risk to water resources or that using synthetic fertilisers will always result in less groundwater contamination than applying manure. All the same, it implies that conventional irrigation with drip fertigation is likely a more sustainable method in regions where aquifers already experience high nitrate levels. In order to feed the three billion additional people that will soon inhabit the earth, strategic choices about food production must be grounded in facts and logic rather than ideology. It does not seem that the greatest solution to improve the environmental performance of the world food systems is to switch to organic agriculture completely. "Our analyses show that dietary shifts towards low-impact foods and increases in agricultural input use efficiency would offer larger environmental benefits than would switches from conventional agricultural systems to alternatives such as organic agriculture or grass-fed beef," Clark and Tilman wrote in their assessment of 742 agricultural systems and over 90 unique foods. [70] Policies pertaining to agriculture must take the environment, economy, and efficiency into consideration. It is beneficial to have insights from both organic and conventional agriculture that is managed responsibly.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. United Nations Convention to Combat Desertification. The Global Land Outlook, 1st ed.; UNCCD: Bonn, Germany; 2017.
2. Willer H, Lernoud J. Organic agriculture worldwide: Current Statistics; Research Institute of Organic Agriculture (FiBL): Frick, Switzerland; 2017.
3. Simpson S. Nitrogen Fertilizer: Agricultural Breakthrough—And Environmental Bane. Scientific American; 2009.
4. Mart M. Pesticides, a love story. In America’s enduring embrace of dangerous chemicals; University of Kansas Press: Laurence, KS, USA; 2015.
5. Vernon J. Hunger: A modern history; Harvard University Press: Cambridge, UK; 2009.
6. UNCTAB. United Nations Conference on Trade and Development Trade and Environmental Review; UN Publications: New York, NY, USA; 2013.

7. Cassman G, Grassini P, Wolf J, Tittonell P, Hochman Z. Yield gap analysis with local to global relevance—A review. Field Crops Res. 2013;143:4–17.
8. Food and agriculture organization. The State of Food Insecurity in the World; 2015.
9. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, De Onis M, Ezzati M, Grantham-McGregor S, Katz J, Martorell R, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013;382: 427–451.
10. United Nations Department of Economics and Social Affairs. World Population Projected to Reach 9.7 Billion by 2050. 2015.
11. Hafla AN, MacAdam JW, Soder KJ. Sustainability of US organic beef and dairy production systems: Soil, plant and cattle interactions. Sustainability. 2013;5:3009–3034.
12. (EC) No 834/2007 & Commission Regulation (EC) No 889/2009. Council of the European Union: 2007. Off. J. Eur. Union. 2017;1–34
13. Páyan-Renteria R, Garibay-Chávez G, Rangel-Ascencio R, Preciado-Martínez V, Muñoz-Islas L, Beltrán-Miranda C, Mena-Munguía S, Jave-Suárez L, Feria-Velasco A, De Celis R. Effect of chronic pesticide exposure in farm workers of a Mexico Community. Arch. Environ. Occup. Health. 2012;67:22–30.
14. Calvert G, Karnik J, Mehler L, Beckman J, Morrissey B, Sievert J, Barrett R, Lackovic M, Mabee L, Schwartz A, et al. Acute pesticide poisoning among agricultural workers in the United States, 1998–2005. Am. J. Ind. Med. 2008;5:883–898.
15. Damalas CA, Koutroubas SD. Farmers' exposure to pesticides: Toxicity Types and Ways of Prevention. Toxics. 2016;4:1.
16. Mie A, Andresen HR, Gunnarsson S, Kahl J, Kesse-Guyot E, Rembialkowska E, Quaglio G, Grandjean P. Human health implications of organic food and organic agriculture: A comprehensive review. Environ. Health. 2017;16:111.
17. Relyea R. the impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. Ecol. Appl. 2005;15:618–627.
18. Chagnon M, Kreutzweiser D, Mitchell EAD, Morrissey CA, Noome DA, Van der Sluijs JP. Risks of large-scale use of systemic insecticides to ecosystem functioning and services. Environ. Sci. Pollut. Res. 2015; 22:119–134.
19. Barański M, Srednicka-Tober D, Volakakis N, Seal C, Sanderson R, Stewart GB, Benbrook C, Biavati B, Markellou E, Giotis C, et al. 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. 2014;112:794–811.
20. Rembialkowska E. Quality of plant products from organic agriculture. J. Sci. Food Agric. 2007;87:2757–2762.
21. Magkos F, Arvaniti F, Zampelas A. Organic food: Nutritious food or food for thought? A review of the evidence. Int. J. Food Sci. Nutr. 2003;54:357–371.
22. Bourn D, Prescott J. A Comparison of the nutritional value, sensory qualities, and food safety of organically and conventionally produced foods. Crit. Rev. Food Sci. Nutr. 2002;42:1–34.
23. Liebig MA, Doran JW. Impact of organic production practices on soil quality indicators. J. Environ. Qual. 1999;28: 1601–1609.
24. Hartmann M, Frey B, Mayer J, Mader P, Widmer F. Distinct soil microbial diversity under long-term organic and conventional farming. J. Int. Soc. Microb. Ecol. 2015;9:1 177–1194.
25. Seufert V, Ramankutty N, Foley JA. Comparing the yields of organic and conventional agriculture. Nature. 2012;485: 229–234.
26. Muller A, Schader C, Scialabba NE-H, Brüggemann J, Isensee A, Erb K, Smith P, Klocke P, Leiber F, Stolze M, et al. Strategies for feeding the world more sustainably with organic agriculture. Nat. Commun. 2017;8:1290.
27. Alexandratos N, Bruinsma. J. World Agriculture towards 2030/2050: The 2012 Revision; FAO: Rome, Italy; 2012.
28. Beecher NA, Johnson RJ, Brandle JR, Case RM, Young LJ. Agroecology of birds in organic and nonorganic farmland. Conserv. Biol. 2002;16: 1620–1631.
29. Kolbert E. The Sixth Extinction: An unnatural history; henry holt and co.: New York, NY, USA; 2014.
30. Phalan B, Balmford A, Green RE, Scharlemann J. Minimising the harm to

biodiversity of producing more food globally. Food Policy. 2011;36:S62–S71.

31. Fischer J, Brosi B, Daily GC, Ehrlich PR, Goldman R, Goldstein J, Lindenmayer DB, Manning AD, HMooney A, Peichar L, et al. Should agricultural policies encourage land sparing or wildlife-friendly farming? Front. Ecol. Environ. 2008;6:380–385.
32. Dahan O, Babad A, Lazarovitch N, Russak EE, Kurtzman D. Nitrate leaching from intensive organic farms to ground water. Hydrol. Earth Syst. Sci. 2014;18:3 33–341.
33. Leinonen I, Williams AG, Wiseman J, Guy J, Kyriazakis I. Predicting the environmental impacts of chicken systems in the United Kingdom through a life cycle assessment: Broiler production systems. Poult. Sci. 2012;91:8–25.
34. Anton A, Montero JI, Munoz P, Castells F. LCA and tomato production in Mediterranean greenhouses. Int. J. Agric. Resour. Gov. Ecol. 2005;4:102–112.
35. Thomassen MA, Dalgaard R, Heijungs R, De Boer I. Attributional and consequential LCA of milk production. Int. J. Life Cycle Assess. 2008;13:339–349.
36. Meier S, Stoessel F, Jungbluth N, Juraske R, Schader C, Stolze M. Environmental impacts of organic and conventional agricultural products—Are the differences captured by life cycle assessment? J. environ. Manag. 2015;149:193–208.
37. Clark M, Tilman D. Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice. Environ. Res. Lett. 2017;12:064016.
38. Wood R, Lenzen M, Dey C, Lundie S. A comparative study of some environmental impacts of conventional and organic farming in Australia. Agric. Syst. 2006;89: 324–348.
39. Garnett T. Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? Food Policy. 2011;36: S23–S32.
40. Chatzisymeon E, Foteinis S, Borthwick AG. Life cycle assessment of the environmental performance of conventional and organic methods of open field pepper cultivation system. Int. J. Life Cycle Assess. 2017;22:896–908.
41. Basset-Mens C, Van der Werf HMG, Robinm P, Morvan T, Hassouna M, Paillat JM, Vertès F. Methods and data for the environmental inventory of contrasting pig production systems. J. Clean. Prod. 2007;15:1395–1405.
42. Stonehouse DP, Clark EA, Ogini YA. Organic and conventional dairy farm comparisons in Ontario, Canada. Biol. Agric. Hortic. 2001;19:115–125.
43. Flysjö A, Cederberg C, Henriksson M, Ledgard S. The interaction between milk and beef production and emissions from land use change—Critical considerations in life cycle assessment and carbon footprint studies of milk. J. Clean. Prod. 2012;28:134–142.
44. Thomassen MA, Van Calker KJ, Smits MCJ, Iepema GL, De Boer IJM. Life cycle assessment of conventional and organic milk production in the Netherlands. Agric. Syst. 2008;96:95–107.
45. Cederberg C, Mattson B. Life cycle assessment of milk production—A comparison of conventional and organic farming. J. Clean. Prod. 2000;8:49–60.
46. Tuomisto HL, Hodge ID, Riordan P, Macdonald DW. Does organic farming reduce environmental impacts? A meta-analysis of European research. J. Environ. Manag. 2012;112:309–320.
47. Garnett T, Appleby MC, Balmford A, Bateman IJ, Benton TG, Bloomer P, Herrero M. Sustainable intensification in agriculture: Premises and policies. Science. 2013;341:33–34.
48. Gore A. The future: Six drivers of global change; random house: New York, NY, USA; 2013.
49. United Nations. Goal 13: Take urgent action to combat climate change and its impacts. 2030 Agenda for Sustainable Development; 2015.
50. Stoessel F, Juraske R, Pfister S, Hellweg S. Life cycle inventory and carbon and water foodprint of fruits and vegetables: Application to a Swiss retailer. Environ. Sci. Technol. 2012;46: 3253–3262.
51. Stappen FV, Loriers A, Mathot M, Planchon V, Stillmant D, Debode F. Organic versus conventional farming: The case of wheat production in Wallonia (Belgium). Agric. Agric. Sci. Procedia. 2015;7:272–279.
52. Tal A, Cohen J. Adding 'Top Down' to 'Bottom Up': A new role for environmental legislation in Combating Desertifica tion. Harv. J. Environ. Law. 2007;31:163–219.

53. Foley JA, Defries R, Asner GP, Barford C, Bonan G, Carpenter SR, Chapin FS, Coe MT, Daily GC, Gibbs HK, et al. Global consequences of land use. Science. 2005;309:570–574.
54. Trivedi A. Reckoning of impact of climate change using RRL AWBM Toolkit. Trends in Biosciences. 2019;12(20):1336-1337.
55. Trivedi A, Awasthi MK. A review on river revival. International Journal of Environment and Climate Change 2020; 10(12):202-210.
56. Trivedi A, Awasthi MK. Runoff estimation by integration of GIS and SCS-CN Method for Kanari River Watershed. Indian Journal of Ecology. 2021;48(6):1635-1640.
57. Trivedi A, Gautam AK. Hydraulic characteristics of micro-tube dripper. Life Science Bulletin. 2017;14(2):213-216.
58. Trivedi A, Gautam AK. Temporal effects on the performance of emitters. Bulletin of Environment, Pharmacology and Life Sciences. 2019;8(2):37-42.
59. Trivedi A, Gautam AK. Decadal analysis of water level fluctuation using GIS in Jabalpur district of Madhya Pradesh. Journal of Soil and Water Conservation. 2022;21(3):250-259.
60. Trivedi A, Gautam AK, Pyasi SK, Galkate RV. Development of RRL AWBM model and investigation of its performance, efficiency and suitability in Shipra River Basin. Journal of Soil and Water Conservation. 2020;20(2):1-8.
61. Trivedi A, Gautam AK, Vyas H. Comparative analysis of dripper. Agriculture Update TECHSEAR. 2017;12 (4):990-994.
62. Trivedi A, Nandeha N, Mishra S. Dryland agriculture and farming technology: Problems and solutions. Climate resilient smart agriculture: Approaches & techniques. 2022;35-51.
63. Trivedi A, Pyasi SK, Galkate RV. A review on modelling of rainfall – Runoff process. The Pharma Innovation Journal. 2018;7(4): 1161-1164.
64. Trivedi A, Pyasi SK, Galkate RV. Estimation of Evapotranspiration using CROPWAT 8.0 Model for Shipra River Basin in Madhya Pradesh, India. Int.J.Curr.Microbiol. App.Sci. 2018;7(05): 1248-1259.
65. Trivedi A, Pyasi SK, Galkate RV. Impact of climate change using trend analysis of rainfall, RRL AWBM Toolkit, synthetic and arbitrary scenarios. Current; 2019.
66. Trivedi A, Pyasi SK, Galkate RV, Gautam VK. A case study of rainfall runoff modelling for Shipra River Basin. nt.J.Curr.Microbiol. App.Sci; Special Issue-2020;11:3027-3043.
67. Trivedi A, Singh BS, Nandeha N. Flood forecasting using the avenue of models. JISET - International Journal of Innovative Science, Engineering & Technology. 2020; 7(12):299-311.
68. Trivedi A, Verma NS, Nandeha N, Yadav D, Rao KVR, Rajwade Y. spatial data modelling: Remote sensing sensors and platforms. Climate resilient smart agriculture: Approaches & techniques. 2022;226-240.
69. Rieznik S, Havva D, Dehtiarov V, Pachev I. Dynamics of the number of functional groups of microorganisms under different farming systems. In Journal of Mountain Agriculture on the Balkans. 2023;26(1):54 9–567.
70. Rieznik S, Havva D, Chekar O. Enzymatic activity of typical chernozems under the conditions of the organic farming systems. Scientific Papers. Series A. Agronomy, Vol. LXIV. 2021;2:114-119.
71. Rieznik S, Havva D, Butenko A, Novosad K. Biological activity of chernozems typical of different farming practices. Agraarteadus. 2021;32(2):307-313.
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