Peer Community In Ecology

Permaculture, a promising alternative to conventional agriculture

Aleksandra Walczyńska *based on peer reviews by* ***Paulina Kramarz***, ***Leda Lorenzo Montero***, ***Julia Astegiano*** *and 1 anonymous reviewer*

Julius Reiff, Hermann F. Jungkunst, Nicole Antes, Martin H. Entling (2024) Crop productivity of Central European Permaculture is within the range of organic and conventional agriculture. bioRxiv, ver. 2, peer-reviewed and recommended by Peer Community in Ecology. https://doi.org/10.1101/2024.09.09.611985

Submitted: 17 September 2024, Recommended: 24 January 2025

Cite this recommendation as:

Walczyńska, A. (2025) Permaculture, a promising alternative to conventional agriculture. *Peer Community in Ecology*, 100757. 10.24072/pci.ecology.100757

Published: 24 January 2025

As mankind develops increasingly efficient and productive methods of agriculture and food production, we have reached a point where intensive agriculture threatens several aspects of life on Earth, negatively affecting biodiversity, carbon, nitrogen and phosphorus cycles and water reservoirs, while producing considerable amounts of greenhouse gases (Krebs and Bach, 2018). There was a need to develop farming methods that were friendly to both nature and people, producing good quality, healthy food without destroying the environment. The idea of permaculture, a concept of sustainable agriculture based on methods learned directly from nature, originated in the 1960s, invented and developed by Bruce Charles Mollison and David Holmgren (Mollison and Holmgren 1979, Mollison et al. 1991, Holmgren 2002). Although the idea of permaculture has attracted scientific interest, the representation in published studies is unbalanced in favour of positive ecological and sociological effects, with much less presence of rigorous experimental testing (Ferguson and Lovell 2014, Reiff et al. 2024a).

Reiff et al. (2024b) provided the first large-scale empirical evidence of permaculture production outcomes for Central Europe. Based on results from 11 commercial permaculture sites, situated mostly in Germany but also in Switzerland and Luxembourg, the authors found that food production from permaculture sites was on average comparable to that from conventional and organic agriculture. The authors were very thorough in pointing out the issues that could potentially affect their results and which need further testing.

Among these, the authors highlight the considerable variability between the 11 sites studied, which may suggest that different permacultures should differ in details according to their specificity - an interesting issue that definitely requires further study. The other factor that the authors point out that could have influenced

the results and led to an underestimation of the real potential is the age of the permaculture sites. The sites from the study were relatively young, and their potential can be expected to increase with time.

It is important to note that the results are mostly applicable to vegetables, as vegetable production accounted for 94% of production in the permaculture sites (followed by tree crops, 6%, and soft fruit production, 0.5%). There is therefore a need to include other types of crops produced in further studies of this type.

To date, the results informing permaculture food production are urgently needed and should cover the potentially wide range of geographical regions and crops produced. The results of Reiff et al. (2025) show that rigorous testing of this issue is demanding, but the authors provide a very sound ”road map” of further steps.

Literature:

Ferguson R. S. and Lovell S. T. 2014. Permaculture for agroecology: design, movement, practice, and worldview. A review. Agronomy for Sustainable Development 34, 251-274. https://doi.org/10.1007/s13593-013-0181-6

Holmgren D. 2002. Permaculture: Principles & Pathways Beyond Sustainability. Holmgren Design Services, pp. 320.

Krebs J. and Bach S. 2018. Permaculture – scientific evidence of principles for the agroecological design of farming systems. Sustainability 10, 3218, https://doi.org/10.3390/su10093218

Mollison B. C. and Holmgren D. 1979. Permaculture One: A Perennial Agricultural System for Human Settlements. Tagari Publications, pp. 136.

Mollison B. C., Slay, R. M. and Jeeves A. 1991. Introduction to permaculture. Tagari Publications, pp. 198.

Reiff J., Jungkunst H. F., Mauser K. M., Kampel S., Regending S., Rösch V., Zaller J. G. and Entling M. H. 2024a. Permaculture enhances carbon stocks, soil quality and biodiversity in Central Europe. Communications Earth & Environment 5, 305. https://doi.org/10.1038/s43247-024-01405-8

Reiff J., Jungkunst H. F., Antes N. and Entling M. H. 2024b. Crop productivity of Central European Permaculture is within the range of organic and conventional agriculture. bioRxiv, ver.2 peer-reviewed and recommended by PCI Ecology. https://doi.org/10.1101/2024.09.09.611985

Reviews

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.1101/2024.09.09.611985
Version of the preprint: 1

Authors' reply, 21 January 2025

Download author's reply
Download tracked changes file

Decision by Aleksandra Walczyńska, posted 28 November 2024, validated 29 November 2024

Dear Authors,

The manuscript has been assessed by four reviewers and, as can be seen, they all recognise the importance of the study and its potential. They also provided helpful and valuable comments on what could be improved in the text.

It seems that the hypotheses, methods/description of methods and, to some extent, discussion of results, were most problematic for the reviewers. Please read the reviewers' comments carefully, including those detailed in the pdf files attached to the reviews.

Kind regards,
Aleksandra Walczyńska

Reviewed by Paulina Kramarz, 15 October 2024

Download the review

Reviewed by Julia Astegiano, 28 November 2024

Dear Aleksandra Walczynska,

Many thanks for the invitation to review this submission to PCI Ecology. The work authored by Reiff et al. and entitled "Crop productivity of Central European Permaculture is within the range of organic and conventional agriculture" is interesting and within the scope of PCI Ecology. Currently, there is an increasing urgency in evaluating the benefits that alternative agricultures (i.e. that care about the environment and do not separate crop productivity from the reproduction of other organisms in the agroecosystem) will provide to the unsustainable agribusiness. In this vein, this article investigates the productivity of permaculture agroecosystems compared to conventional and organic agricultures across Europe. Such comparison opens a very interesting discussion about different agricultures, scopes and the likely factors affecting yield, which in the case of permaculture is not dissociated from the reproduction of the whole system. That is why I consider this article is interesting and relevant.

I attach a pdf with my comments and suggestions to authors.

Best

Julia

Title and abstract

Does the title clearly reflect the content of the article? Yes

Does the abstract present the main findings of the study? Yes

Introduction

Are the research questions/hypotheses/predictions clearly presented? No. I added some comments in the text related to this point.

Does the introduction build on relevant research in the field? Yes

Materials and methods

Are the methods and analyses sufficiently detailed to allow replication by other researchers? No. I added suggestions in the attached pdf.

Are the methods and statistical analyses appropriate and well described? No. I added suggestions in the attached pdf.

Results

Are the results described and interpreted correctly? Yes

Discussion

Have the authors appropriately emphasized the strengths and limitations of their study/theory/methods/argument? Yes

Are the conclusions adequately supported by the results (without overstating the implications of the findings)? Yes

Download the review

Reviewed by Leda Lorenzo Montero, 23 November 2024

The manuscript entitled "**Crop productivity of Central European Permaculture is within the range of organic and conventional agriculture**" assesses crop yield in permaculture agroecosystems compared to conventional and organic agriculture in Germany and surrounding countries, with a focus on LER (Land Equivalent Ratio), an index commonly used to evaluate crop production in intercrops/polycultures compared to sole crops/monocultures.

I consider the issue to be relevant and timely, as systematic studies evaluating permaculture designs have emerged in recent years. Permaculture is a low-input agricultural approach that can be a promising tool in addressing food production in the context of global change. It is therefore essential to scientifically evaluate its benefits.

I have some suggestions regarding the analysis and interpretation of the results, especially concerning some non-significant p-values, which, in my view, could indicate marginal differences. Besides, the authors found relatively high variation in productivity among permaculture farms, as well as in other previous studies. In this context, I have also questioned the possibility of formally testing some of the proposed explanatory factors, which could be done with the data obtained. Additionally, I have made general comments and recommended some recent papers that might be of interest to the authors. All my comments are detailed in the attached version of the manuscript.

Title and abstract

Does the title clearly reflect the content of the article? [x] Yes, [ ] No (please explain), [ ] I don't know

Does the abstract present the main findings of the study? [x] Yes, [ ] No (please explain), [ ] I don't know

Introduction

Are the research questions/hypotheses/predictions clearly presented? [ ] Yes, [x] No (please explain), [ ] I don't know

A general question is presented at the end of the introduction. However, the statistical approach addresses two specific questions: one regarding yields in permaculture compared to both conventional and organic agriculture (LER), and another about the factors that might be influencing productivity. In my opinion, these questions could be more clearly articulated

Does the introduction build on relevant research in the field? [x] Yes, [ ] No (please explain), [ ] I don't know

I have recommended some recent papers that might be of interest to the authors.

Materials and methods

Are the methods and analyses sufficiently detailed to allow replication by other researchers? [x] Yes, [ ] No (please explain), [ ] I don't know

Are the methods and statistical analyses appropriate and well described? [ ] Yes, [ ] No (please explain), [x] I don't know

The methods and statistical analyses are well described and allow replication. However, I believe the model selection could be approached more efficiently. I have provided some questions and suggestions regarding the testing of influencing factors.

Results

In the case of negative results, is there a statistical power analysis (or an adequate Bayesian analysis or equivalence testing)? [x] Yes, [ ] No (please explain), [ ] I don't know

Are the results described and interpreted correctly? [x] Yes, [] No (please explain), [ ] I don't know

The relatively low sample size may partially explain the lack of significant p-values. I suggest addressing this issue and using it to support the interpretation of the observed p-values as indicating marginal differences.

Discussion

Have the authors appropriately emphasized the strengths and limitations of their study/theory/methods/argument? [ ] Yes, [x] No (please explain), [ ] I don't know

I suggest discussing the significance of the p-values in light of some methodological limitations (the sample size is small but appropriate, considering that the sampling units are farms, and the authors cannot increase n). In my view, these limitations do not invalidate the study but may explain the lack of statistically significant differences, despite clear trends in the results. I believe addressing this issue explicitly could strengthen the results and their discussion.

Conclusions

Are the conclusions adequately supported by the results (without overstating the implications of the findings)? [x] Yes, [ ] No (please explain), [ ] I don't know

References

I found two references cited in the text that do not appear in the reference list: Shepard, 2013; Perkins, 2016. It would be helpful to check this throughout the entire manuscript.

Download the review

Reviewed by anonymous reviewer 1, 15 November 2024

General comments

This manuscript investigates the crop yield of some permaculture farms in Germany, Switzerland and Luxembourg and how they compare to conventional and organic sole crops. The authors used the LER, which is a common tool to compare yields of intercrops and sole crops. I found the manuscript to be generally well written and the aim of the paper interesting and timely. I noticed two main issues that would improve the manuscript if addressed, which are:

- The lack of justification and explanations about the authors' expectation about the results. For example, the explanatory variables used in the model are not justified in the introduction, and I was surprised to find they were used as drivers of LER in the material and method section. The whole statistical design is sound, but should be better explained beforehand, so that the intentions behind it are clear.
- Some claims (flagged in specific comments) are not well supported by the results. I would recommend nuancing some of them in light of the design, statistical results and sampling effort.

I'm confident these issues are easy to fix and that the manuscript is worth publishing.

Specific comments

L 56: "qualitative interviews of farmers" seems like a method to obtain data, while the studies are cited based on what they actually measured. Maybe this should be replaced by what the qualitative interviews were after (for example: farmers' perception, social network of the farm, power relationships, etc.).

L 53-68: It would be interesting in this paragraph to have some explanation about why it is important to focus on crop yield in permaculture. For the moment I miss such an explanation about the importance of yield, while other studies focused on income diversity and economic performance.

L 66-68: What were the authors' initial expectations when comparing yields in permaculture sites with organic or conventional ones? And with the other explanatory variables tested in the models (age since establishment, investigated area and presence of livestock)? I don't see any literature related to these variables in the introduction that would justify why these factors would affect permacultural yields, or why the authors also compared permacultural yields to organic yields.

L 77: "at the agroecological production", unclear wording.

L 79: “crop yields sold by the farms” à “crop products / agricultural production sold by farms” since yields is an indicator of productivity.

L 136: “two crop varieties” à “two crop types” or ”two crops”. Because one can have two wheat varieties on the same farm, but it would still be one crop (wheat).

L 159-162: The text describing these results need some more work, as it’s quite unclear what the authors meant. First, the authors should cite the table 2 when writing about the non-significance of t-tests. I would recommend that any interpretations in the results section (“suggests that permaculture requires 20% more land …”) should be moved to the discussion. Anyway, the results are not significant so the test suggests otherwise. Moreover, I think that “by trend” (also seen in the discussion) is an odd wording and I don’t really understand what it refers to.

Fig 1: The figure does not have error bars, as stated in the figure caption, but shows boxes, like in boxplots.

L 175-177: I think this statement should be nuanced a little. On Fig. 1, we can see that most of the farms that were below or above the threshold of 1 with the conventional comparison conserved that rank (related to 1) in the organic comparison (except for farm 7).

L 182: But the test and even the LER value (1.44 ± 0.52) shows that it’s not different from 1. That sentence should be revised.

L 208-209: good point!

L 209-211: Not sure this is supported by the data. Let’s not forget that the organic yield gap is always about an organic-conventional comparison. LER values in this manuscript show that permaculture yields are on average not significantly different than organic yields. This claim would have been true if the permaculture-organic t-test (against 1) was significant, and the permaculture-conventional t-test (against 1) wasn’t. I think more data is needed to reach that conclusion, due to high inter-farm variability.

L 223: “The high proportion of vegetable yield” -> “The high contribution of vegetables to farms’ total production”

L 232-233: What do the authors mean to “compete” with industrial methods? Yield is a thing, but total production is another one. To compete with industrial production, permaculture needs to be upscaled because current surfaces are very low, and upscaling comes with other challenges.

L 240-247: Good paragraph, but I wish it came earlier in the discussion, to nuance the claims that were made about permaculture and yield gap.