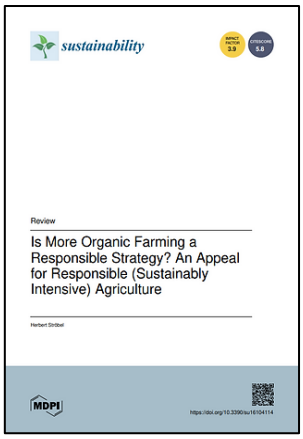
Is more organic farming a responsible strategy? An appeal for responsible (sustainable intensive) agriculture by Herbert Ströbel



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Executive Summary

In society and politics, organic farming is widely seen as an ideal way to address the many challenges facing agriculture and food security. This paper assesses the extent to which this view is realistic, using criteria such as land use, greenhouse gas emissions, biodiversity, food quality, production, environmental costs, reduced meat consumption, the need for agricultural imports and the global availability of arable land.

The analysis confirms that, on a per hectare basis, organic agriculture emits fewer greenhouse gases and supports more biodiversity than conventional agriculture. However, due to significantly lower yields per hectare, organic farming requires about two hectares to produce the same amount of crops as one hectare of conventional farming. The additional land required for organic farming comes at the expense of natural or near-natural land uses, such as short rotation plantations, forests or conservation areas, which absorb very high amounts of greenhouse gases and support significantly higher levels of biodiversity. This loss of benefits due to higher land use must be attributed to organic farming and included in its valuation as an opportunity cost. As a result, the positive impact of organic farming shown in a per hectare analysis turns into a significant negative overall impact when the foregone benefits, i.e. the opportunity costs, are fully considered. This negative effect increases when the significantly higher production costs of organic farming are taken into account. Both the higher land requirements and the higher production costs also result from the deliberate exclusion of modern technologies, such as the use of synthetic chemicals and modern breeding techniques. In a comprehensive assessment, organic farming results in significant negative impacts on climate, environment, food security and food costs, with only small and largely controversial benefits in terms of food quality, taste and pesticide residues. Therefore, in a world where agricultural land use should be limited, where food demand is not only high but growing, and where food purchasing power is limited for a large percentage of the population, organic farming is not an appropriate model for the future.

The analysis thus concludes that a technologically open development of sustainable intensive conventional agriculture, coupled with a moderate reduction in meat consumption, is the most appropriate approach to achieving the key objectives of a truly responsible agriculture. The model developed for sustainable intensive agriculture recognises the positive impulses of organic agriculture, but also includes the use and further development of all available technologies to minimise agricultural land use, greenhouse gas emissions, biodiversity loss and environmental impacts, while at the same time providing the world's population with high quality, healthy and affordable food and other agricultural products in a cost-effective and socially responsible manner.

The use and further development of all yield-enhancing and land-sparing means such as fertilisers and pesticides, as well as modern plant breeding, combined with a strong commitment to minimising negative environmental impacts, meet the criteria of truly responsible agriculture far better than the heavily subsidised and otherwise highly promoted expansion of organic farming. Without wasting valuable time, science, politics and administration should therefore focus on more sustainable forms of agriculture and concentrate the available financial and human resources primarily on improving existing conventional agriculture so that it becomes even more sustainable in ecological, economic and social terms.

Summarized Results on Main Aspects with References to the Publication

1. Understanding the value of the land

Saving agricultural land in favour of more environmentally friendly forms of land-use needs to be brought back to the forefront of the debate. High yields through advanced and more eco-efficient technologies are needed to conserve the world's forests and grasslands and thus limit climate change, biodiversity loss and freshwater scarcity on our planet to tolerable levels.

Climate change, soil degradation and restrictions on agricultural land-use make it imperative to conserve and possibly even expand ecologically valuable areas for climate and biodiversity, and to promote the productive use of farmland to feed the world's population. If this potential is to be realised, the idea of releasing and conserving land through intensive agriculture must be consistently supported by society and politicians. To this end, all sustainable technologies must be implemented.

1.1. Yields are reduced by about 50%

Three independent scientific assessments clearly show that organic farming achieves only about 50% of the yield per hectare compared to conventional farming, confirming that twice as much land is needed for organic farming to achieve the same yield. (Figure 1, Table 1 and 2)

The fact that several publications report lower yield differences may be due to the fact that often low conventional production standards practised by farmers are selectively compared with an optimised form of organic farming. A comparison of the yield potential would show the same differences as reported.

1.2. Greenhouse gas emissions are almost eight tonnes higher

Due to the higher land requirements of organic farming, its expansion reduces the land available for nature reserves, forests or short rotation plantations (SRPs), all of which absorb significant amounts of greenhouse gases. Therefore, the increased agricultural land use caused by organic farming results in a loss of GHG sequestration that must be attributed to organic farming. An example calculation shows that replacing one hectare of conventionally farmed land plus one hectare of SRP with two hectares of organic farming results in an additional atmospheric GHG load of almost eight tonnes of CO_{2eq} (Figure 2). This means that expanding organic farming in Germany to a 30% share, equivalent to 5 million hectares, would increase GHG emissions considerably. (Figure 2).

1.3 Biodiversity is reduced by about 30%

Conventional farming, e.g. in combination with Short Rotation Plantations (SRP), can achieve about 40% higher biodiversity than organic farming, which in turn means that biodiversity rates in organic farming are about 30% lower than in conventional farming (Figures 3 and 4).

1.4 Substantial yield increases in organic farming are unlikely due to given regulations

Organic farming regulations limit the use of available effective technologies to address the central problem of low yields: plant nutrient deficiencies. Yield increases are also possible through plant breeding alone, but the refusal to use modern and rapid breeding methods is slowing development considerably. In the long term, organic farming is even likely to lead to lower yields because of the often deficient nutrient balance. Progress in crop protection, biological methods, robotics and bio-stimulants is also slow. Due to lower yields, these are likely to be of less absolute benefit to organic farming than to conventional farming. (Chapter 8)

1.5 Reduced meat consumption cannot compensate for lower yields

The key question is how the calorie needs are met. A 50% reduction in animal-based foods reduces primary calorie demand by about 30%. Land use and GHG emissions are also reduced by 30% if the remaining primary

calorie demand is met by conventional agriculture. However, if the remaining calorie demand is met by organic agriculture, land use increases by up to 40% due to half the yield and results in 20% higher greenhouse gas emissions than without a reduction in animal products. Reductions in animal-based diets, therefore, only deliver significant climate and biodiversity benefits when combined with high-yield, i.e. conventional agriculture.

2 Considering the true costs

2.1 Production costs are about 60% higher

The costs of production per grain unit (GU) are about 60% higher in organic farming than in conventional farming, i.e. one GU of organic product costs on average about €50 compared to €30 per GU of conventional product (Table 4).

2.2 Environmental costs are about €30 higher per GU

As shown organic farming leads to higher GHG emissions and lower biodiversity. Consequently, the environmental costs of organic farming are €1257 higher per ha or about €30 higher per GU than in the case of conventional farming (see Table 4 and the following cost calculation).

2.3 Subsidies are up to five times higher per GU

In the case of cereal production, for example, current subsidies are up to five times higher per GU in organic production than in conventional farming (Table 6 and Figure 4). As shown, the justification for this high burden on public funds cannot be based on positive environmental effects. On the contrary, according to the results of the analysis, this expenditure supports a land use that significantly increases greenhouse gas emissions and reduces biodiversity. Moreover, the main beneficiaries of these high subsidies are wealthy buyers.

3 Eliminating limitations to scientifically proven technologies

3.1 Rejection of synthetic nitrogen fertilisers leads to economic and environmental losses

The use of synthetic nitrogen fertilisers not only increases yields and reduces production costs, but also has environmental benefits: the extra yield achieved through their use contains several times the energy required to produce and apply the fertilisers, and sequesters far more greenhouse gases than are released in the production and application of these fertilisers. These effects will be further improved when renewable ammonia becomes available in the future (Chapter 7).

3.2 Ban of synthetic nitrogen fertilisers does not necessarily reduce nitrogen leaching

Synthetic nitrogen fertilisers make it easier to match the nitrogen dose directly to the needs of the crop than is the case with organic fertilisers. Such targeted application often results in lower nitrate leaching per tonne of yield in conventional farming (Figure 5).

3.3 Avoiding synthetic pesticides is highly disadvantageous

The current use of pesticides, more than 95% of which are synthetic, prevents about 30% of global crop losses to pests and diseases. It would be irresponsible to abandon the use of these chemicals without more environmentally friendly but equally effective substitutes. The resulting yield losses are likely not only to increase the risk of more hunger or even famines, but also would contribute to a massive expansion of arable land at the expense of forests and other ecologically valuable land uses in an effort to meet demand. (Chapter 7)

3.4 Organic pesticides are often more toxic than synthetic ones

It is by no means the case that the natural substances used in organic farming are less toxic than the synthetic chemicals used in conventional farming. For example, copper sulphate, which is considered natural, is much

more toxic than the much-maligned glyphosate and would not be approved if the current exclusion criteria for plant protection products were applied strictly and equally. (Table 7)

3.5 Avoiding synthetic pesticides hardly reduces intake of toxins with food

The amounts of natural toxins ingested with our food are about 1500 times higher than the amounts from plant protection products of similar toxicity (Table 8).

3.6 Toxic pesticide contamination of food changes only marginally

Organic farming reduces the proportion of products contaminated below the limit values from two thirds to one third. However, for harmful contamination above the limit values, the proportion of food of animal origin is zero for both production systems, and for food of plant origin it is only 1.3%, which means that the contamination of conventional plant products above the limit values is less than 1.5%. The low level of harmful contamination is probably the main reason why a number of studies, including the particularly comprehensive Stanford University study, have concluded that organic products are not healthier. (Chapter 7)

The marginally lower share of plant produce with pesticide residues above the limit levels in organic food are, therefore, not a sufficient reason to forgo the considerable benefits of conventional farming, such as lower greenhouse gas emissions and greater biodiversity, as well as lower production costs and greater national food security. Moreover, as pesticides continue to improve, their negative impacts are being reduced, especially when this process becomes a targeted subject of research and development. (Figure 7).

3.7 More organic farming hardly solves the problem of insect mortality

The widespread claim that more organic farming would lead to higher insect populations is also not very plausible. If organic farming expands, the lower yields will require more land to be used for agriculture. This is at the expense of areas of high biodiversity, such as nature reserves and forests, so more organic farming leads to less biodiversity. In addition, rigorous scientific studies have not confirmed the often-claimed sharp decline in insect populations. Furthermore, the reduction in the amount, toxicity and persistence of pesticides used since 1970 (see Figure 7) and the increase in insect mortality observed only since 2000 also suggest that synthetic pesticides are not a major cause of the alleged sharp decline in insect populations.

4 Reducing land use abroad decreases risks and is in the interest of global solidarity

4.1 Increasing virtual land use abroad is risky and lacks solidarity

Germany's net imports of agricultural goods are equivalent to the yield of almost seven million hectares of agricultural land (Germany has 16.9 million hectares) (Figure 10). This means that, in order to meet its own demand for agricultural goods, Germany requires the virtual import of almost 40% of the agricultural land available in the country on a net basis, i.e. after deducting exports. Just to meet Germany's food consumption needs, the necessary net imports correspond to the yields of around five million hectares abroad (Figure 10).

It is alarming that these virtual land imports have increased by almost one million hectares between 2010 and 2017, suggesting that food self-sufficiency is declining at a worrying rate. In a world where political and economic crises are becoming more frequent, where climate change is increasingly leading to lower yields and loss of arable land, this growing dependence on foreign food supplies poses a significant and increasing risk. This is made worse by the expansion of organic farming, which requires much more land. (Figure 10)

The fact that the expansion of organic farming leads to significantly more virtual land imports and more GHG emissions was confirmed by a detailed study of the conversion to organic farming in England and Wales (Figure 11).

The high and increasing virtual imports of agricultural land also strain international agricultural markets mainly at the expense of the global South and are therefore lacking solidarity.

4.2 Organic farming hinders high self-sufficiency

A 50% reduction in the consumption of animal-based food would enable conventional agriculture in Germany to meet the net domestic demand for food, eliminating the need for net imports. It would also free up an additional 1.3 million hectares for more environmentally valuable uses, such as nature conservation or bioenergy. Achieving the same reduction in animal-based food, combined with a complete shift to organic farming, would require an additional 10 million hectares of land to be used for agricultural production. This would not only leave no land for nature conservation or bioenergy, but would also increase the virtual import of land to 8.7 million hectares. A transition to organic farming without a reduction in the consumption of animal products would increase Germany's virtual land imports to almost 20 million hectares.

4.3 Organic farming supports the expansion of arable land

From 2000 to 2018 the global gross area of arable land increased by approximately 217.5 million hectares at the expense of forests, grasslands, natural vegetation and drylands. Given the negative impacts of this expansion on climate and biodiversity, it is vital to decouple agricultural production from the conversion of valuable ecosystems. To achieve this, it is essential to optimise the use of existing arable land. The expansion of organic farming, with its inherently lower yields, will increase the amount of land required. If this trend continues, it will become a significant contributor to deforestation, accelerating climate change and damaging biodiversity. (Figure 12, Chapter 12).

4.4 The system for calculating national greenhouse gas emissions favours organic farming

Germany`s national greenhouse gas balance includes only domestic greenhouse gas emissions. These are more than 50% lower per hectare in organic farming than in conventional farming. However, yields are also about 50% lower, so that when organic farming is expanded, the lower yields often have to be compensated by additional imports. The agricultural goods produced abroad to compensate for lower yields cause significant additional greenhouse gas emissions due to land-use change, cultivation and transport. These are much higher than the emissions saved domestically by organic farming, but are not recorded in the system of national greenhouse gas statistics.

The expansion of organic farming therefore reduces greenhouse gas emissions in national statistics, and helps the German government to meet its international climate commitments. On a global scale, however, the result is the opposite. It is clear, therefore, that national emissions statistics are inappropriate as a basis for responsible government action. (Chapter 13).

5 Fostering a comprehensive discussion

5.1 Society's preconceptions about organic products

Organic farming is widely regarded as an environmentally friendly and ethical approach to agriculture. There is a common perception that nature-based production methods are inherently beneficial to health, the climate and the environment. It is rare for consumers to challenge this straightforward narrative, especially as parts of the scientific community have confirmed the positive assessment of organic farming, often overlooking the negative aspects. Furthermore, many media outlets lack their usual critical stance on the issue.

The fact that there is widespread political support for significantly higher subsidies for organic products, and that significantly higher retail prices can be enforced, indicates an unrealistic perception of organic quality and a lack of consumer information about the real facts.

It is encouraging that many people are keen to support environmental and climate protection and global justice. However, it is unfortunate that there is not more focus on providing differentiated and comprehensive information to encourage more responsible behaviour. (Chapter 14)

5.2 The sometimes-narrow view of agricultural research

The overall impression is that large parts of German agricultural research take a positive view of organic farming, often on the basis of narrow and incomplete analyses. Even reputable scientific institutions with high political influence base the alleged superiority of organic farming primarily on a comparison of environmental impacts per hectare rather than per tonne of yield, which would be the more relevant measure for minimising the environmental costs of meeting demand. More seriously, the scientific case for expanding organic production is often made without taking into account the higher land requirements and the associated loss of opportunities for greenhouse gas sequestration and biodiversity. In addition, the 60-70% higher production costs of organic products and the resulting social and economic consequences are rarely discussed. (Chapter 6.1)

Such a one-sided judgement is also illustrated by a study by Hülsbergen et al, which is briefly evaluated in an excursus in the study. Hülsbergen et al. conclude that organic farming on 30% of the agricultural land in Germany would save €4 billion in environmental costs. But this does not take into account that only 50% of the products can be harvested on this organically used land due to the lower yields of organic farming. A more robust calculation, taking into account the compensation for lower yields, shows that a 30% expansion of organic farming would not result in cost savings of €4 billion, but lead to additional costs of almost €10 billion. (Table 5).

6 Establishing a conducive framework

6.1 The entire agricultural sector should be addressed

The aim must be to create an efficient, cost-effective and environmentally responsible agricultural sector. As a starting point, conventional agriculture offers significant advantages. Not only is it the dominant form of land use, still producing well over 90% of agricultural commodities, but it is largely practised by highly skilled and responsible farmers open to and also competent to responsibly implement all these technologies which could improve climate, environment, biodiversity, yields and profitability. It is the role of policy makers to set the framework according to eco-social criteria so that all these appropriate technologies can be used and developed to create an innovative, environmentally friendly, sustainable and profitable agricultural sector**.**

6.2 Important framework conditions to be modified

- Promotion of environmentally friendly technologies (Chapter 17.3.1)
- Equal subsidies for organic and conventional farming (Chapter 17.3.2)
- Approval of plant protection products based solely on environmental criteria (Chapter 17.3.3)
- Targeted promotion of measures with positive environmental effects for all farms (Chapter 17.3.4)
- Reduction in bureaucracy within the agricultural subsidy system (Chapter 17.3.5)
- Promoting a broad and critical discourse in professional circles and society (Chapter 17.3.6)

7 Summing-up quote

Nobel laureates Norman Borlaug and Christopher Dowswell summed up the value of high yields at the end of the last century when they wrote: **"Growing less food per acre means leaving less land for nature".** (Chapter 17.6)