Agriculture at a Tipping Point

Only Ecological Farming Can Feed Ten Billion People

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Initial Remarks

1.1 Why Argue?

"*Business as Usual is Not an Option*," was the central message summarizing the findings of the World Agriculture Report back in 2008, which as a consequence called for a change of direction in the agricultural and food policies of the industrialized countries.[1] So far, this call has remained unheard by political decision makers. The trend, identified as threatening by more than 400 scientists, has thus continued unrelentingly.

The world's population is growing and with it are food and nutrition-related problems. 815 million people are currently suffering from hunger, 1.5 billion people from malnutrition. Another 2 billion are grappling with health issues caused by a diet that leads to overeating but doesn't provide them with the nutrients they need and results in obesity instead. At the same time, more than half of the grain crops worldwide disappears in the livestock and dairy industries' feeding troughs or is used as agrofuel or raw material in industrialized countries. The ecological costs of the industrialized countries' food system have come to outweigh its benefits substantially. The extinction of entire species, declining soil fertility, and the depletion of water resources as well as intensive agriculture's increasing impact on the climate are threatening future generations' food security.

Insects are disappearing from the open fields. In the summer of 2017 we learned of the decline of 75 percent of the total flying insect biomass in parts of Germany, which has been officially recorded since, and is close to a system collapse. In May 2018, the German National Academy of Sciences "Leopoldina" criticized the use of pesticides on German fields, raising the question whether the occurrence of a "silent spring" could still be averted.[2] More and more children are affected by food allergies. The Food and Agriculture Organization of the United Nations has warned that the use of antibiotics in animal husbandry increases threats posed by multi-drug resistant organisms. The industrial food system is affecting the health of the world's population to a growing degree. At the same time, global food supply security is decreasing. Due to the just-in-time logistics currently in place, the world's major cities hold supplies sufficient for no more than three days.

The industrial agricultural and food system is incapable of reliably providing the current world population of 7 billion people with healthy food, and will be even less able to do so with future generations because it undermines the very foundations it builds on. A system change thus is imperative, a change in direction in politics overdue. The future can only belong to a system that sustains eco systems, enables climate change adaptation, preserves and increases resilience to extreme weather events, droughts, and floods, maintains and improves soil fertility, and is thus capable of effectively fighting hunger, undernutrition, and malnutrition. There is no alternative to the comprehensive ecologization of world agriculture. This includes ensuring that women and family run farms have sufficient incomes at their disposal, as well as gaining access to land, knowledge,

financial means, and markets. The world's rural regions must be strengthened as living environments with the help of education, infrastructure, markets, and communication. This requires a system as outlined by the United Nations Agenda 2030,[3] the implementation of which both the Federal Republic of Germany and the European Union advocated in 2015.[4] However, neither developmental nor agricultural and food policies in Germany presently commit to the Agenda 2030's obligations.

The issue is no longer to cure some of the agro-industrial system's symptoms, as proposed by some of the system's representatives. Partial ecologization wouldn't take any effect on the character of the situation as a whole at this point. Instead, it is necessary to understand that the agro-industrial system of intensive farming is based on the exploitation of natural resources and is hence no longer capable of meeting the challenges of the 21st century. The priority now is a new agricultural and food system, an innovative system based on biological cycles and ecological networks that builds on social relationships and economic compensation and is thus able to provide food security for generations to come, without transgressing the ecological boundaries of our planet. This holistic innovation project is among the most urgent and pressing of the 21st century. We call for a public debate on this concern.

This debate is mandatory because we are running out of time. Increasing collateral damages caused by the agro-industrial system indicate its impending collapse. Furthermore, the debate must be held with the decision-makers of our political system who are displaying a lack of discernment. The debate is also necessary because politics are conceding to an agro-industry which obfuscates its market power and hides its profit motive behind the claim to serve the public interest with its actions. In this inevitable debate, this document aims at taking sides, while also providing a base of current knowledge. It intends to equip those ready to take on the debate with the understanding that there is an alternative to the prevailing industrial system and that it is worth fighting for.

1.2. What Is at the Center of the Debate

This polemic paper concentrates on one question: which kind of agricultural system can provide sufficient and healthy food for the ever-growing world population? The conflict focuses on two opposing key concepts. We use the term **industrial intensive farming** for currently prevailing agricultural practices aiming at the extensive cultivation of a limited amount of products oriented towards maximum yields in technology-driven monocultures with the help of nitrogen fertilizers, herbicides, and pesticides. **Ecological agriculture** is used by us to denote a form of agriculture that centers on soil fertility, does not include nitrogen fertilizers or pesticides in its practice, integrates regional knowledge and is thus particularly successful in small-scale farming settings, though under certain circumstances it can also take on industrial characteristics while adhering to the aforementioned principles.

To prevent misinterpretations, it is important to clarify from the onset that the variety of organic systems in world agriculture is much larger than the amount of farmlands certified and cultivated according to the criteria of organic farming associations. In total, certified organic farmlands amount to only 1 percent of all agricultural land worldwide.[5] However, there is a substantially larger number of—uncertified—ecological systems around the world also refraining from synthetic fertilizers and pesticides, employing crop rotation and thus furthering biodiversity and soil fertility.[6] Hence, the model for sustainable agriculture on a global scale should not be oriented towards the codified regulations of organic agriculture practiced in Europe, but towards food systems in different cultures and regions which elementarily apply the principles of ecological agriculture.

Consequently, our goal is not a homogeneous global system. Instead, we strive for the ecologization of agriculture according to the individual characteristics and conditions in each respective region. Our model is neither Eurocentric nor geared towards industrial manufacturing, with a small number of stakeholders determining farming and marketing conditions.

At this point, the magnitude of the task of transforming intensive industrial agriculture into ecologically sustainable systems is barely imaginable. The extent of decision paralysis, lack of discernment, colliding interests and overt resistance it will likely face can be deduced from a similarly enormous task: the Paris Climate Agreement. Despite overwhelming signs of climate change and despite the signatories' understanding that decisive action is of the essence, adopted measures are coming into operation at a tedious pace. Meanwhile it has already become obvious that the decisions that will have to be made in the years and decades to come are of a gravitas hardly conceivable today. This also serves as an indicator of how vast the challenges of transforming the current agricultural system into a sustainable system are.

The issues this polemic paper advocates must be addressed by this generation, even if sustainable results will most probably be achieved only in the succeeding generation. We do not know how the process of this transformation will unfold. However, we do know its goal and we know where to start. This is our responsibility out of which all further steps will arise.

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1 Reports of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD): https://www.globalagriculture.org/whats-new/news/news/de/19849.html
2 https://www.leopoldina.org/en/press/press-releases/press-release/press/2539/
3 https://sustainabledevelopment.un.org/sdg2
4 http://ecdpm.org/wp-content/uploads/DP197-Implementation-2030-Agenda-EU-Gregersen-Mackie-Torres-July-2016.pdf
5 Willer , Lermoud, The World of Organic Agriculture Statistics and Emerging Trends, FiBL – IFOAM 2015.
6 http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf, p. 13.

2. Why Intensive Industrial Agriculture in its Current Form Will Fail at the Task of Feeding the World

2.1 It Destroys its own Foundations

In a few decades, agriculture as it prevails today will have destroyed its foundations. The agro-industrial system, which has become the model for agricultural development in industrialized countries over the past 60 years, faces irresolvable conflicts. Its objective is to yield highest possible returns for invested capital. In contrast to peasant farming in former times, which aimed at preserving soil fertility, securing water supplies, and ensuring household food security through diversity, the industrial system today is focused mainly on increasing short-term profits through maximum yields on the fields and in the stables. This includes the use of high-performance technologies both in machines and seeds. In order to achieve this performance, the system requires synthetic nitrogen and fertilizer components such as phosphate and potassium which are combined with synthetic pesticides and—in many parts of the world—irrigation. Similar conditions can be found in livestock farming. Animals are selected according to the quantities of meat and milk they can yield in the shortest possible time. The result of this selection process is a small number of high-performing lines which can only reach their maximum production capacities with the help of mostly imported high-energy animal feed and chemical performance enhancers. The high levels of productivity achieved by this agricultural system can only be maintained through the massive use of fossil fuels. This strategy of maximum yields results in grave damages that destroy the very foundations of world food.

2.1.1 It Heats up the World Climate

The system of industrialized agriculture dominating the Global North today has a severe impact on the world climate. On a global scale, its contribution to the greenhouse effect amounts to more than 20 percent.[7] Global emissions from agriculture, forestry, and fisheries have nearly doubled in the past 50 years.[8] According to the Food and Agriculture Organization, atmospheric pollution caused by agriculture and the food industry will increase by another 30 percent if decisive measures fail to be taken.[9] This impact on the atmosphere is mainly caused by intensive meat and dairy production and its animal feed imports from South America as well as the resulting continued clear-felling of primeval forests there.[10]

Synthetic nitrogen fertilizers are another source of pollution which has remained widely ignored to date. Large amounts of fossil fuels are required for their production, leading to the release of greenhouse gasses. However, the fertilizers' impact on the climate is even larger when used on the fields, where they produce nitrous oxide, known as the most potent greenhouse gas (around 290 times stronger than CO2). According to estimates by the Food and Agriculture Organization, emissions generated during the application of synthetic fertilizers accounted for 13 percent of agricultural emissions in 2011. They are regarded the

fastest growing emissions source in agriculture.[11] Animal fattening in livestock farming furthermore results in the additional release of methane and ammonia.

2.1.2 It Destroys Soil Fertility

The agricultural practices described above have resulted in soil degradation in arable land around the world. According to the Global Land Outlook, one quarter of all arable land worldwide today contains substantially less humus and nutrients than 25 years ago and has in some cases been rendered unusable for farming.[12,13] In the United Nations University's report "The Value of Land," the degradation of fertile agricultural land is even estimated at 52 percent.[14] Extensive monocultures are the worst enemy of soil fertility. Crop rotation of only a small number of similar crops, synthetic nitrogen fertilizers, insecticides, and herbicides damage biodiversity on the fields and thus the soil's natural stability.[15] Furthermore, the lack of soil cover before sowing and after harvesting facilitates erosion through rain and wind. In this way, 10 million hectares in fertile land are lost worldwide every year. These losses occur ten times faster than nature can generate new soil.[16,17]

2.1.3 It Depletes Water Supplies

In many parts of the world what is grown on the fields and how much can be yielded essentially depends on how much it rains. This, however, is not the case in regions where intensive farming is practiced. Here, irrigation is often the decisive factor for profitability. Top-performing plants require especially large amounts of water, around 1500 liters per 1 kilogram of grain. As cattle, swine, and poultry are fed with grains, animal husbandry is also part of the issue. 15,000 liters of drinking water are needed to produce 1 kilogram of beef. Around 80 percent of the world's water supplies are used by agriculture. Groundwater reservoirs are the world's largest freshwater resources, however, they are increasingly exploited by intensive agriculture. As a consequence, the water levels in these underground aquifers are sinking at a faster rate than they can be recharged through precipitation.

A 2015 study by NASA stated that 13 of the world's 37 largest aquifers will soon be depleted. Eight more are barely recharging. Five more are endangered because more water is extracted than can be recharged.[18] India and North Africa are most strongly affected, but also the United States' Midwest, i.e. the industrialized countries' breadbasket.[19]

Extreme weather, heat waves, and droughts aggravate the water crisis, as more and more farmlands require irrigation to maintain productivity levels. At the same time, climate change is affecting large-scale precipitation patterns with shifting climate zones and disruptions to the monsoon, the world's most important "weather machine." In many parts of the world it has become increasingly apparent that industrial agriculture's high-performance concept is reaching its limits with regard to water. This is also the case for water quality. According to 2017 findings by the German Federal Environment Agency, German groundwater

supplies exceed the limit values of 50 mg/l for nitrate by 27 percent.[20] The main perpetrator is intensive livestock farming, particularly meat production.

2.1.4 It Accelerates Species Loss

Two aspects are of significance here: the wild flora and fauna, as well as agricultural crops and livestock. Both have suffered major losses due to agriculture. A 2017 survey of insect populations in parts of Germany concluded that insect biomass declined by 75 percent over the past three decades.[21] The number of birds in the EU declined by 300 million between 1980 and 2010—more than half of the overall populations.[22] With the exception of scattered remnants, the brown hare has disappeared completely from intensively farmed agricultural landscapes.[23]

Species used in agriculture are affected by erosion most notably. More than 90 percent of crop varieties which served as food sources in the beginning of the 20th century have disappeared from the fields. Genetically modified crops additionally further the decline of biodiversity, particularly in the United States and South America where they prevail. The same can be said for livestock farming.[24] Species loss is particularly extreme in the case of poultry, mainly due to the introduction of so-called hybrid breeding which achieved explosive rises in productivity by crossing "pure inbred lines."

Patents for crops essentially accelerate the depletion of species. Patenting has become a widespread practice only since the turn of the century. Seeds were also selected before, however, in the past they used to remain a part of farming culture, preserved and further developed not to serve economical purposes but for the common good, with no individual being in the position of asserting property claims. The introduction of laws regarding the seed regulation of cultivated plants in 1953, and their open-source character, helped secure the financial resources of small and medium-sized breeders. The situation changed profoundly with the introduction of patent protection for crops and livestock. Patents make it possible to claim intellectual property rights for production processes and any biological materials generated there-in. This is what seed corporations capitalize on.

Seed corporations thus further the loss of species. Following the most recent mergers, three agrochemical seed corporations (Bayer/Monsanto, DuPont/Dow and ChemChina/Syngenta) now command two thirds of the global market for seeds and pesticides.[25] The situation is aggravated by the corporations' strategy to gear their selection processes towards plants resistant to the respective company's applied active ingredients, as exemplified by Monsanto's "Roundup" herbicide (with its active ingredient glyphosate).

2.1.5 It Exhausts Nutrient Reserves

Phosphorus is the most important nutrient in agriculture. No plant can grow without phosphorus. It is essential for gaining yields. In the past, nutrient cycling on farms ensured that the fields were enriched with it via animal manure. This practice proves insufficient in the case of high-performing plants, resulting in the use of large amounts of mineral fertilizers. Phosphorus is derived from phosphate rock mining, however, these supplies will not last infinitely. Extraction is expected to peak by the middle of the century, hence the end of phosphorus supplies in intensive farming is imminent, as is the end of their productivity.

2.1.6 It Facilitates Antibiotic Resistance

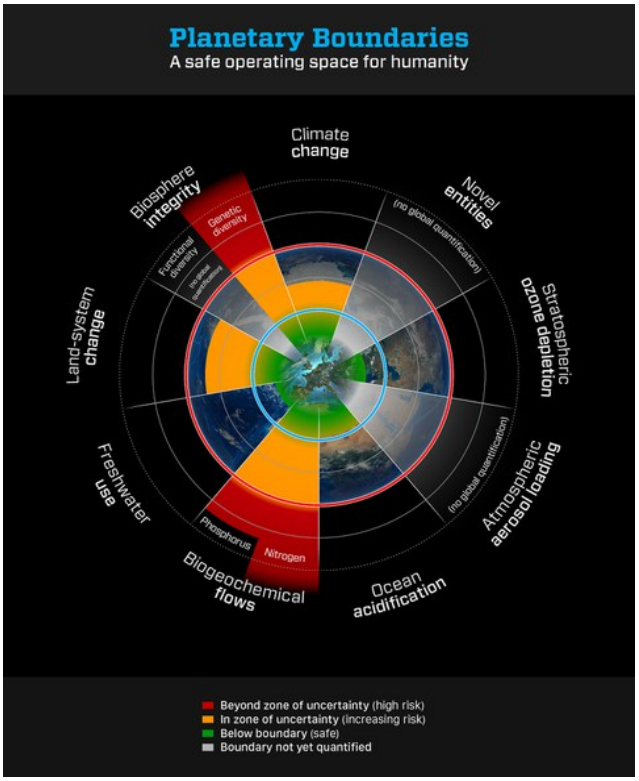
Antimicrobial resistance in bacteria originating in agriculture has reached alarming levels in large parts of the world, the FAO noted in 2016.[26] Antimicrobial resistance is life threatening.[27] The World Health Organization has identified it as a growing risk for world health and food security. According to the FAO's analysis, the main cause for antimicrobial resistance stems from the inappropriate use and overuse of antibiotics in industrial livestock farming systems. Reserve antibiotics, which are intended as drugs of last resort in human medicine but which have increasingly come to be used in animal husbandry, pose the greatest threat.[28,29] The problem of antimicrobial resistance is exported to developing and advanced developing countries through the introduction of intensive animal farming. According to the FAO, this will pose an increasing risk in the coming decades both for veterinary and for human medicine.[30]

2.2 It Transgresses Planetary Boundaries

The industrial agricultural system disregards the planet's boundaries. The concept of the planetary boundaries was proposed by a group of 28 renowned scientists and defines nine quantitative boundaries and thresholds which should—in the interest of humankind—never be transgressed.[31]

The concept's lead author Johan Rockström, then the Director of the Stockholm Resilience Centre, and Director of the Potsdam Institute of Climate Impact Research as of October 2018, summarized its main concerns as follows: "To continue to live and operate safely, humanity has to stay away from critical 'hard-wired' thresholds in the Earth's environment, and respect the nature of the planet's climatic, geophysical, atmospheric and ecological processes."[32]

However, when the concept was introduced in 2009, three thresholds had already been crossed, namely for "climate change," "rate of biodiversity loss," and "changes to the global nitrogen cycle."[33] In the 2015 update, the team of researchers found that the boundary regarding "land system changes" had also been transgressed; according to the scientists, climate change and biosphere integrity are "core boundaries" and particularly sensitive. 'Significantly altering either of these would drive the Earth System into a new state, endangering the safe lives of future generations.'[34]



Source: www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html

Intensive farming and the food industry are chiefly responsible for the transgressions of these boundaries. They are the main perpetrators with respect to biosphere integrity, biochemical flows/nitrogen, and land-system change. Their part in the transgression of the boundary for climate change amounts to more than 20 percent. Taken seriously, the warning by the scientists surrounding Johan Rockström means that the renunciation of industrial agricultural production and radical ecologization are mandatory for agriculture.

2.3 It Poses a Threat to Food Security

The industrial agricultural and food system builds on globalization. It purports to create food security. However, this claim fails to pass the reality check, given the monopolization in trade on the one hand, and the limitation of production to a small number of exporting countries on the other.

2.3.1 It Benefits Monopolies and Promotes Manipulation and Speculation

Only four corporations dominate world food trade: Archer Daniels Midland, Bunge, Cargill, and Dreyfus. In 2017 they controlled three quarters of global grain trade and thus the world market's supply situation, quantities, and pricing. [35]

The global food price crisis of 2007/'08 illustrated how easily the food supply chain can break down. Within a few weeks it resulted in price explosions for basic food stuffs and food riots in over 20 countries. A politically condoned lack of supplies and speculation were identified as the crisis' direct causes at the time.

This is aggravated by political tensions and the threat of a trade war with the United States, the world's largest agricultural exporter. The United States' assurances to feed the world with its produce surplus are dissolving under the current administration. This further weakens the global supply chain's dependability and is particularly hard on those countries that have chosen to rely on world trade, including the wealthy Gulf States which do not have sufficient water reserves at their disposal, as well as South Korea and Japan, where food self-sufficiency has declined significantly over the past 40 years, in Japan from 80 to 40 percent. [36]

China and India also face an increasing risk, due to changed eating habits, amongst other reasons: more meat, more fast food, less traditional diets. Furthermore, over 50 "Low-Income and Food-Deficit Countries,"[37] which according to the FAO rely heavily on imports for survival under the current food system, are affected. This concerns 16 percent of the world's population. [38]

2.3.2 It Exacerbates Global Climate Risks

Climate change is one of the largest elements of uncertainty with respect to the globalized food supply chain. Its effects reach far beyond immediately affected regions. The IPCC – Intergovernmental Panel on Climate Change predicts that extreme weather events and the shifting monsoon circulation especially in India, the Middle East, and Central America as well as Africa will cause massive crop failures, [39] failures which even the large agricultural exporters Brazil and the United States will not be able to compensate, no least since their own yields will likely also become less reliable due to extreme weather. [40] Soy production in Brazil, the largest exporter of animal feed, will not be able to withstand future heat waves and periods of drought. [41] The grain fields of the American Midwest are also at risk,[42] as are the yields from the rice paddies in California and Thailand, the largest exporter of rice, due to a growing threat of droughts and floods.

2.4 It Fails as a Strategy to Feed the Global South

The concept of industrial agriculture and food production is not suited to feed the Global South's masses; it is bound to fail, notably in the megacities. In a few decades, our planet will have to sustain 10 to 12 billion people, about one third more than in 2018. Most of them will be living in the Global South's megacities. Especially in regions with fertile soils, these cities are growing. They will cover extensively more space than the present urban landscapes. This consumption of land will come at the expense of local food resources. Rivers and lakes will also be included in these urban centers and thus most likely become polluted, endangering fish populations. This means the loss of yet another food resource for the megacities. The growth in population combined with waning regional food resources will make these new cities as dependent on large-scale food imports and transports as under the current system.

2.5 It Intensifies Causes of Flight

Small-scale farming forms the economic backbone of the southern countries, ensuring income and employment, accounting for 80 percent of all jobs. Small-scale farming provides women with livelihoods and ensures food for their children. Restructuring these countries according to the industrial model would only be possible at the expense of small-scale farmers who would be ousted, with their livelihoods destroyed, and their families forced to move to the cities where they would add to the urban proletariat. Given the lack of jobs in the industrial sector, famine and hardship are likely to increase with these additional landless masses, causing more people to seek refuge in the EU. This developmental model is not fit for the Global South.

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7 IPCC, Working Group III: Mitigation, 3.6 Agriculture and Energy Cropping 3.6.1 Introduction, source: http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=115
8 http://www.fao.org/news/story/en/item/216137/icode/
9 http://www.fao.org/news/story/en/item/216137/icode/
10 The drainage of peatlands to cultivate oil palm in Southeast Asia, the ploughing of grassland, and the conversion of natural landscapes into production space also result in a massive release of greenhouse gasses.
11 FAO, ibid.
12 United Nations, Convention to Combat Desertification. 2017, The Global Land Outlook, first edition. Bonn, Germany
13 https://www.umweltbundesamt.de/en/press/pressinformation/ten-million-hectares-of-arable-land-worldwide-are
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16 David Pimentel * and Michael Burgess, Soil Erosion Threatens Food Production, College of Agriculture and Life Sciences, Cornell University, Ithaca, source: https://www.bmbf.de/files/agriculture-03-00443.pdf
17 http://www.fewresources.org/soil-science-and-society-were-running-out-of-dirt.html
18 NASA, Global Groundwater Basins in Distress, 2015 Link: https://visibleearth.nasa.gov/view.php?id=86263
19 http://www.wri.org/resources/charts-graphs/water-stress-country

20 https://www.umweltbundesamt.de/en/press/pressinformation/too-much-fertiliser-drinking-water-could-become (June 9, 2017)
21 http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0185809
22 https://www.zeit.de/wissen/umwelt/2017-05/voegel-bestand-landwirtschaft-gifte-kiebitz-braunkehlchen-uferschnepfe-feldlerche
23 https://www.mdr.de/wissen/feldhase-104.html
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25 https://www.boell.de/de/konzernatlas
26 Ibid. min. 129.
27 FAO, Drivers, Dynamics and Epidemiology of Antimicrobial Resistance in Animal Production, 2016
28 Ibid , p. 2.
29 https://www.arte.tv/de/videos/064368-000-A/armes-schwein-fettes-geschaeft/(from min. 105 on).
30 FAO, Drivers, Dynamics and Epidemiology of Antimicrobial Resistance in Animal Production, 2016, p. 1.
31 http://www.stockholmresilience.org/research/planetary-boundaries.html
32 Further boundaries identified by the scientists include stratospheric ozone depletion, land-system change, freshwater use, ocean acidification, phosphorus flow from freshwater systems into the ocean and from fertilizers to erodible soils, atmospheric aerosol loading, and pollution through chemicals.
33 https://www.ecologyandsociety.org/vol14/iss2/art32/
34 https://www.pik-potsdam.de/news/press-releases/four-of-nine-planetary-boundaries-now-crossed?set_language=en
35 Australian Wheat Board (2004), Financial Times (September 18, 2013 & March 3, 2014).
36 https://akehir.com/files/publications/Ochsenbein_Raphael_RiceInJapan.pdf
37 http://www.fao.org/countryprofiles/lifdc/en/
38 http://www.fao.org/3/a-i5222e.pdf
39 Up to 40 percent.
40 https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf
41 Bommert, Wilfried, Landzettel, Marianne, Verbrannte Mandeln, wie der Klimawandel unseren Teller erreicht, Munich 2017, p. 194.
42 Wolfram Schlenker und Michael J. Robers, Nonlinear Temperature Effects Indicate Severe Damages to U.S. Crop Yields Under Climate Change, Proceedings of the National Academy of Science of the United States, 2009, Vol. 106.

3. Why Ecological Farming Can Succeed

In 2008 the World Agriculture Report declared "the need for an agroecological evolution in agriculture, food production, and consumption." [43] This call has gained urgency over the past ten years. Scientific surveys acknowledge that an agroecological evolution can lead the way out of the deadlock of industrial agriculture. The World Agriculture Report uses a term denoting an agricultural practice as old as the origins of agriculture itself. [44] For thousands of years it focused on adapting to changing natural conditions. However, this adaptability was lost to agriculture in the past 100 years. Fossil energy sources, the introduction of complex machinery, and modern agricultural chemistry have rendered the necessity to adapt to natural conditions obsolete and have led to a practice that exploits natural habitats and unravels regional agricultural and food systems. Agroecology opposes this disastrous development with a new model.

3.1 Agroecology as a Holistic Concept

The concept of agroecology encompasses what is generally discussed as organic farming but also reaches significantly further. Not only the ecological value of farming practices and their impact on the environment are subject to close scrutiny here, but also agriculture's interactions with nature, the people, and their cultures. "Its strength lies in the connection of ecology, biology, and agricultural sciences, as well as dietetics, medicine, and social sciences." [45] Agroecological practice is based on traditional and local knowledge. It works with what is available on location: the sun, water and soil, biodiversity, and the specific knowledge the respective people and communities have accumulated about their coexistence with nature. Next to practical technologies, agroecology counts on the knowledge of everyone involved.[46]

3.2 … and as a Diversified Practice

Agroecological farming systems place value on diversified crop rotations that help further soil vitality and fertility. They support humus formation and thus the absorption of greenhouse gasses in the soil.[47] By keeping the ground covered constantly, they furthermore prevent erosion and increase soil water storage capacities. This helps reduce vulnerabilities to heat waves and droughts. Additionally, agroecological farming systems lead to better water and air quality, more biodiversity in cultural and natural landscapes, and stable microclimates. In total, the agroecological system ensures higher resistance to extreme climate conditions[48] and helps promote a varied diet rich in plant-based foods for farmers and consumers through its diversified cultivation, as well as preserve a vibrant diversity of regional cuisines. However, it is important to point out that in contrast to "ecological agriculture" the term "agroecology" has not yet been formally

defined and as a consequence is broadly misused to semantically ennoble 'ecological' practices in industrial agriculture, as is the case e.g. in France.

3.3 But Are there Enough Yields?

When discussing the advantages of ecological production methods, it is important to note that their yields per hectare are currently 10 to 25 percent lower than those of conventional farming. [49] Lower yields are considered a principle disadvantage of the ecological cultivation system. However, such a narrow comparison, based only on one criterion, can hardly result in a fundamental assessment of the over-all system's productivity. For this reason, John Reganold and Jonathan Wachter apply twelve criteria in their analysis "Organic Agriculture in the Twenty-First Century"[50] which arrives at an entirely different conclusion. Regarding the criterion of yields, the conventional system remains in first place here. However, the organic system is on the same level with respect to the quality of nutrients, employment of workers, as well as total costs, and clearly proves superior with regard to soil quality, energy use, biodiversity, water pollution, profitability, ecosystem services, health hazards through exposure to pesticides for workers, and pesticide residues in the environment.

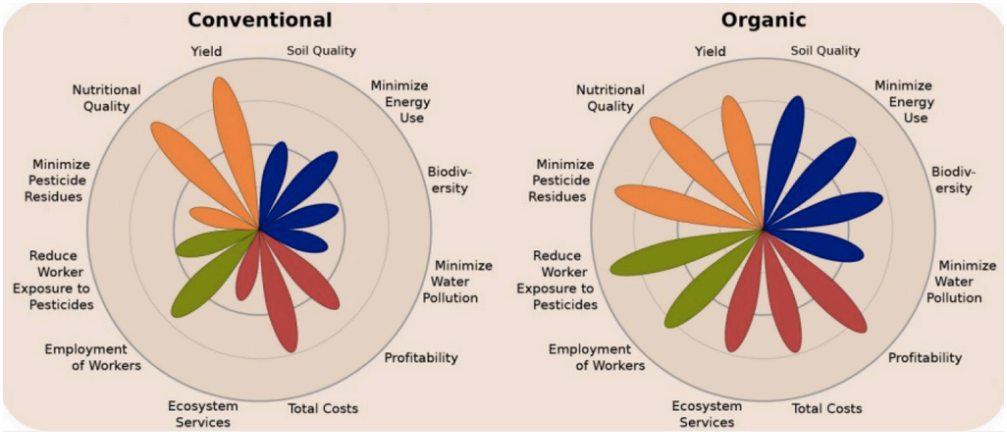

Illustration from: Reganold, John P., Wachter, Jonathan M., Organic Agriculture in the Twenty-First Century, Nature Plants , Vol. 2, 2/2016, p. 4

The comparative diagram does not list either system's impact on the climate, however, this is taken into consideration in the survey itself, according to which the ecological system uses up to 27 percent less fossil fuels, mainly due to its renunciation of synthetic nitrogen. This in return reduces the impact of greenhouse gasses by 14 percent. [51] Furthermore, the active formation of humus contributes to the long-term absorption of greenhouse gasses in the soil, which are thus prevented from entering the atmosphere. [52] The survey's findings have been corroborated by more recent field studies in Germany between 2008 and 2014. [53]

In total, ecological agriculture also reaches virtually the same levels as conventional agriculture with respect to yields and potential yield increases, if one looks more closely at the region where larger yields will be of crucial importance in the future: the Global South.

Large yield increases can be achieved particularly in cases where small-scale farmers have received little training so far, where low-yielding plant varieties and hardly any machines or means for irrigation are used, and where there is a lack of applied research and consulting services. In 2016, the International Panel of Experts on Sustainable Food Systems (IPES-Food) stated that the conversion to organic agriculture resulted in yield increases of up to 80 percent in the Global South.[54] As early as 2011, the United Nations Special Rapporteur on the Right to Food, Olivier De Schutter, concluded in his report on the success of agroecological projects in 57 countries that considerable yield increases up to double the original amount were possible, particularly in African countries.[55] These results were based solely on improved cultivation techniques, not taking into consideration the further potentials that could be unleashed with the help of research and development.

Moreover, there are significant global saving potentials with regard to land use. Considering that one third of all food ends up on garbage dumps, that the supplies for a morbid diet of overeating affecting 2 billion people use up approximately 100 million hectares,[56] that the industrial countries' meat consumption already occupies more than half of the world's entire agricultural areas, and that the production of agrofuels currently requires 40 million hectares, it becomes obvious that even if yields were to be lower after a conversion to ecological farming, shortages do not have to become a reality.[57]

It is possible to produce enough food agroecologically even for a growing world population. Recent model calculations by ETH Zurich and FiBL Switzerland[58] support this proposition, indicating sufficient leeway for an ecological conversion of world food, especially since the potentials of agroecological systems have only been rudimentarily researched so far.

3.4 The Range of Ecological Farming

There is a large variety of ecological systems in world agriculture significantly exceeding the amount of farmlands certified and cultivated according to the criteria of organic farming associations. Strictly regulated organic farmlands only amount to 1 percent of all agricultural land worldwide.[59] However, if uncertified farmlands that are cultivated without synthetic fertilizers and pesticides but use crop rotation systems, thus supporting biodiversity and soil fertility, are included, the over-all amount of ecologically cultivated farmlands is substantially larger. Today, these systems, which also characterized the German countryside up to the 1950s, are applied mainly by farmers in the countries of the Global South, albeit with considerable yield deficits for the time being. Nonetheless, they open up a

much larger spectrum of ecological cultivation methods than what is represented by the criteria of organic farming associations in the industrial countries. [60]

What is already being tested in the Global South's countries can be connected to transitional and interim ecological practices in the industrialized countries, applied here under names such as "agroforestry" or "permaculture," amongst others. [61] On a global level, ecological food change can thus build on—and extend—a wide range of ecologically oriented cultivation methods and operating modes.

43 https://www.globalagriculture.org/report-topics/agroecology.html
44 https://ftp.gwdg.de/pub/tropentag/proceedings/2001/full%20papers/1-production%20system/1_8_Mallinkrodt.pdf
45 Ibid.
46 Ibid.
47 Ibid.
48 http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf, p. 31.
49 Ibid., p. 8.
50 Reganold, John P. , Wachter, Jonathan M. , Organic Agriculture in the Twenty-First Century, Nature Plants, Vol. 2, 2/2016.
51 Ibid., p. 6.
52 Ibid., p. 3.
53 https://www.thuenen.de/de/ol/projekte/systeme-der-rinderhaltung/klimawirkungen-und-nachhaltigkeit-in-der-milcherzeugung/
54 http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf, p. 31.
55 http://www.srfood.org/images/stories/pdf/press_releases/20110308_agroecology-report-pr_en.pdf
56 Bommert, Wilfried, Bodenrausch, die globale Jagd nach den Äckern der Welt, Cologne 2012, p. 309.
57 J.Popp et al, The Effect of Bioenergy Expansion: Food, Energy, and Environment, Renewable and Sustainable Energy Reviews Volume 32, April 2014, pp. 559–578.
58 Adrian Muller et al.,Strategies for Feeding the World more Sustainably with Organic Agriculture, Nature Communications 2017.
59 Willer , Lermoud, The World of Organic Agriculture Statistics and Emerging Trends, FiBL – IFOAM 2015.
60 Reganold, John P. , Wachter, Jonathan M. , Organic Agriculture in the Twenty-First Century, Nature Plants , Vol. 2, 2/2016, p. 1.
61 http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf, p. 14.

4. Supposed Certainties – Allegations Regarding Ecological Agriculture

4.1 Low Yields Fail to Feed the World Population

Response: The main reason for world hunger is not a lack of food but the fact that so many people are poor, as well as the circumstances of unequal access to food, soil and water, credit, and education. Earth's soils are perfectly capable of producing food for its population—even for 10 billion people and more. This can be achieved if land is cultivated considerately and allowed to regenerate, if its yields are distributed more fairly than today, if the consumption of meat decreases considerably to avoid that up to 50 percent of the current corn, grain, and soy crops are fed to animals, and if significantly less food goes to waste or is destroyed on its way from the field to the table.

It is hence inaccurate to state that the world's growing population can only be fed by intensifying large-scale agriculture with high-performing plants and chemicals.[62] In fact, as chapter 2 points out, this approach is doomed to fail. Furthermore, this kind of intensification would increase world hunger because it would lead to the ousting of millions of small-scale farmers from their land in the Global South, driving them into urban slums instead. If, however, they remain on their land, they will be able to significantly increase their yields on the same acreage with the help of ecological agriculture.[63] Yields can also be improved through the use of adapted species and biodiversity.[64]

4.2 Organic Foods Are too Expensive for Poor People

Response: Here, a distinction needs to be made between the situations of early industrialized countries and countries in the Global South.

Food supplies sold in European healthfood stores are indeed often unaffordable for poorer parts of the population, notably meat, dairy products, and chocolate. One of the main reasons keeping less wealthy people from switching to organic foods is their high meat consumption. Organic foods at discount stores, on the other hand, are often priced at almost the same level, particularly vegetables, grains, and fruit.

People living in financially constrained circumstances usually purchase cheaper products. However, conventionally produced food isn't really cheaper; it is priced significantly lower than its actual costs. The only difference to organic food is that these costs are not tied immediately to the produce—instead, the producers pass them on to society as a whole. This "cost externalizing," as it is called in professional terms, entails climate pollution caused by synthetic fertilizers, groundwater pollution by manure and nitrate, health hazards posed by pesticides, antibiotics, and other harmful substances, an existential threat to bees and thus

fertility, and much more. Consumers have to pay for these costs indirectly, with an increasing risk for their health and with growing fees, taxes, and charges to fight the damages described above. While discount supermarkets do sell cheaper organic products, it is important to note that this form of marketing achieves its competitive price advantages at the expense of the producers, particularly by focusing on 'Fast Moving Consumer Goods' (FMCG) in the organic product range and mixing organic and conventional produce in their calculations. In other words: there is no such thing as cheap food, whether it is produced conventionally or organically.

The Global South's poor rural populations are in a completely different situation. To them, organic farming does not mean a more expensive but an easier way of life in every respect. Chapters 3 and 5 detail this more closely.

4.3 Meat Must Remain Affordable for People with Low Incomes

Response: The problem is: the fact that meat consumption is high especially in precarious households makes the price gap appear particularly large. In the case of a healthy diet high in vegetables and low in meat, however, the differences are far less striking. Meat produced by intensive livestock farming only appears to be cheap—see above. Because its follow-up costs don't show on the bill, they are often overlooked. Eating less meat leads to a healthier and not a worse life.

4.4 Organic Foods Are Not Healthier

Response: In terms of nutrients, organically and conventionally produced foods may reach similarly high levels, and differences may also appear small when it comes to the flavor of fruit and vegetables; nonetheless, organic food has three advantages detailed in chapter 3:

- Ecological farming systems do not pollute the environment with synthetic nitrogen, they support biodiversity in the ecosystem, and preserve and regenerate basic food resources, especially the climate, soil, and water.

- Residues from pesticides and antibiotics and the health risks they pose are substantially lower and often totally absent from organic foods. On the other hand they are richer in valuable plant compounds such as antioxidants. [65,66]

- Organic meat and dairy products in most cases have a more characteristic and rich flavor than conventional products.

4.5 Ecological Farming Is Unnecessary Because Precision Farming and Computer-Based Machines Will Be Able to Fix Current System Damages

Response: Where applicable, "precision farming" can help reduce some of the ecological damages caused by conventional agriculture. Large organic farms in

Europe and the United States also apply precision farming. Nonetheless, conventional agriculture's modern systems perpetuate previous principle mistakes and in some cases even intensify them. Hence, they will not resolve agriculture's fundamental crisis.

1. It furthers climate damage, mainly through the application of synthetic nitrogen. Even though synthetic nitrogen is used more efficiently in precision farming, it remains the wrong choice for fertilizers, as fossil fuels are required for its production and as it emits nitrous oxide when used on the fields, which is significantly more potent.

2. It perpetuates the destruction of soil fertility. Wind and rain-driven erosion is furthered by extensive monocultures—made possible through digital technology and enforced for reasons of profitability—, as well as by extensive tillage, particularly plowing. Insecticides and herbicides damage the irreplaceable functions of living soils.

3. The world's water resources continue to dwindle. High-performing plants—and the irrigation they require in many regions—, as well as animal farming, exhaust water supplies, even if consumption can be reduced through more rational use.

4. Biodiversity loss is increasing. Continued extensive agriculture furthers the loss of numerous species. Agrochemical and seed corporations with their breeding lines geared towards short-term profits, and not least the patenting of crops, further reduce the range of crop species.

5. It destroys small-scale agricultural infrastructures. The application of precision farming practiced in extensive agriculture requires high capital investment and professional management and is hence only feasible in large farms. When this method is superimposed on small-scale farming structures in the Global South, it uproots millions of small-scale farmers, intensifies rural flight, and adds to the overpopulation of the cities, or drives people to migration—and on their way to Europe.

6. Precision farming doesn't change meat production on an industrial scale, which is agriculture's main contributor to green house gas emissions and facilitates antimicrobial resistance due to its rampant use of antibiotics. Antimicrobial-resistant germs, which are spreading as a consequence, are considered a globally growing health risk for the world population, according to the FAO. The situation is particularly alarming in developing countries.

4.6 Hunger Is Best Ended Through Technological Progress

Response: Famines require immediate aid. On a long-term basis, hunger can be overcome if people affected are empowered to feed themselves and have earned incomes or, alternatively, access to land, water and organic cultivation methods,

microcredits, and education. Industrial progress, as it is sought by intensive agriculture, depends on capital which is available in wealthy countries but missing sorely in the cases of those starving.

4.7 Agricultural Exports from Developing Countries Are the Key to Development and Fighting Poverty

Response: Agricultural products are exported mostly by large farms. In the majority of cases they belong to international corporations and contribute little to nothing to the local population's self-sufficiency and development.

4.8 We Need Large Farms to Feed the World

Response: Especially in Asia and Africa many people continue to live and work in the countryside and subsist on the yields of small-scale farms. World hunger will decrease if they in particular are introduced to the advantages of organic agriculture. Wherever large farms in the aforementioned regions of the world proliferate, small-scale farmers are ousted from their land and driven into urban slums or to migration—predominantly to Europe.

4.9 Increases in Productivity Remain Key in Fighting Hunger and Malnutrition

Response: It depends on who benefits from an increase in productivity. An increase of yields for farms and farmers due to biological research and applied experience would be highly welcome. If, however, increased productivity mainly serves intensive agriculture's profits, people suffering from hunger benefit little or not at all. Their lot will improve if subsistence and small-scale farms are empowered to generate higher yields with the help of organic agriculture, which also improves their position in the market.

[62] Although this understanding was challenged by a survey recently conducted by the University of Göttingen (Meemken, E.-M / Qaim, M. (2018), Organic Agriculture, Food Security and the Environment. Annual Review of Resource Economics Vol. 10) it does remain the state of knowledge. The survey's conclusion that ecological production is not capable of feeding the world population because it requires substantially more acreage than conventional agriculture, which would come at the expense of forests and other natural habitats, is based on two contestable premises. Firstly, the need for 'substantially more' land is quantified according to the current eating habits in industrialized countries, which are dominated by meat consumption, where one third of all food does not make it to the table but ends up on garbage dumps instead, and where a rampant habit of overeating consumes an increasing amount of foods. 'Substantially more' is thus tied to patterns of consumption which cannot be continued in a sustainable food system. If diets become measured and healthy again, sufficient amounts of farmlands and meadows are in fact available. Secondly, the survey considers industrial agriculture superior due to its yield levels which, however, are only achieved in northern states and in moderate climate. Industrial agriculture's yields decline under extreme weather conditions as they prevail e.g. in Africa or Australia, as does its competitiveness with ecological agricultural systems.

Organic farming on average achieves better and more stable yields especially under difficult weather conditions. This particularly applies for climate change. Organically farmed lands display higher resilience which will have positive effects for ecological agriculture in extreme weather events.

63 Fanzo, Jessica (2017), From Big to Small: the Significance of Smallholder Farms in the Global Food System**.** In: The Lancet 1/2017, #15 f.; Herrero, Mario (u.a.) (2017, Farming and the Geography of Nutrient Production for Human Use: a Transdisciplinary Analysis. In: The Lancet 1/2017, p. 33–42.

64 Reganold, John P./Wachter, J.M. (2016), Organic Agriculture in the Twenty-First Century. Nature Plants 2016, 2, 15221; Niggli, Urs (2015), Sustainability of Organic Food Production: Challenges and Innovations. Proc. Nutr. Soc. 2015, pp. 74, 83–88.

65 https://www.wiwo.de/technologie/green/studie-zeigt-biolebensmittel-sind-gesuender/13549684.html

66 Smith-Spangler et al. (2012), Are Organic Foods Safer or Healthier Than Conventional Alternatives? In: Ann Intern Med.157:348–366; Holzman, David C. (2012), Organic Food Conclusions Don't Tell the Whole Story. In: Environmental Health Perspectives 4/2012; Stiftung Warentest (2015), Die Bio-Bilanz. test 12/2015.

5. How Organic Agriculture Has to Change to Fulfill its Global Tasks

5.1 Become Aware of its Range

There is a great diversity of organic farming systems in global agriculture, much larger than the amount of farmlands certified and cultivated according to the criteria of organic farming associations. Models can be found throughout the world, we would like to introduce four examples.

5.1.1 "The System of Rice Intensification"

One of the most significant systems is known as the "System of Rice Intensification." It was developed in rice cultivation and meets almost all the criteria of ecological agriculture. It dispenses with synthetic nitrogen and pesticides, improves soil quality, only uses half the amount of water conventionally required and contributes to relieving the climate by largely skipping the traditional practice of flooding which produces methane. Its success is based on widely spacing the plants for better root development and more growth of tillers. In this way, yields per hectare increase by 2 to 8 tons on average. Because they plant less seedlings, the farmers also only require one tenth of the usual amount of seeds. [67]

The System of Rice Intensification was developed in Madagascar and has been adopted by around 50 million farmers in more than 50 countries in Asia, Africa, and Latin America. In China and India it is officially promoted by the authorities.[68] The system has also successfully been applied to other cereal crops such as wheat, corn, and millet and is known here under the term "System of Crop Intensification."[69]

5.1.2 "Push and Pull"

Another agroecological system, "Push and Pull," is practiced successfully in Africa where it helps protect maize crops from their natural enemies. [70] Desmodium, which absorbs nitrogen from the air, is planted as an intercrop between the maize or millet. Its smell repels the stemborer moths (Push) while the plant also improves the ability of the soil to absorb and retain moisture. Additionally, nitrogen is fixed and soil fertility is thus improved. Napier grass or brachiaria is planted as a border crop, drawing insect pests (moths) away from the field (Pull). The moth larvae then perish on the sticky milk produced by the leaves. The system has additional benefits: napier grass, brachiaria, and desmodium are healthy fodder for the farmers' animals. The push-pull method was developed at ICIPE, the International Centre for Insect Physiology and Ecology in Nairobi, and is practiced by over 130,000 farmers in East Africa. [71]

5.1.3 "Agroforestry" and "Permaculture"

Agroforestry and permaculture are two further precursors of agroecological systems with long histories of practical experience, especially in India.[72] Agroforestry, which combines crops and trees, represents the traditional form of organic farming in the Indian uplands. The system revolves around a tree, an acacia species, which fixes nitrogen from the atmosphere in its roots and thus provides other plants with nutrients. A pond helps collect rainwater and serves as a habitat for ducks and fish, while also ensuring sufficient water supplies throughout the year. The system has proven highly productive. According to calculations by Indian researchers, it has an internal rate of return of 33 percent during a ten-year period.[73] A historical form of permaculture evolved around the French city of Rennes. It was in fact a proper agricultural system with a regional breed of chicken, the Coucou de Rennes, at its center. The chickens were kept on the meadows and fed on seeds and worms, with cows grazing nearby. Old apple trees gave shade. This permaculture provided the city with butter, eggs, cider, chicken meat, and beef. The long hedges lining the meadows were trimmed every nine years and provided fuel. According to a survey on "Local Food Systems in Europe," this tradition continues to thrive and remains an official element of urban development in Rennes.[74]

These examples show that civil societies around the world already have a wide range of successful ecological systems at their disposal. They form the critical mass which can help model an ecologically diverse system change.

5.2 Be Applicable also in Large-Scale Settings, Especially to Ensure the Sustenance of Metropolises

Ensuring sufficient and healthy food for cities with more than one million inhabitants poses a challenge to any food system. This holds especially true in the case of metropolises as they are currently forming in Africa, Asia, and Latin America. And it particularly applies for organic farming which is chiefly organized in small-scale structures in named regions. How can the quantities necessary for these masses of people be produced and brought to the various markets? To meet these challenges, a number of different and intertwining production and distribution methods are taken into consideration as foundations of food provision.

5.2.1 Argentina's "Programa de Agricultura Urbana"

To begin with, residential areas can produce more food, both proactively and with municipal support for subsistence farms, as well as via commercially run enterprises. In the city of Rosario, Argentina, the municipality created a program to support landless farm workers, who had been ousted from the back country, as well as poor city dwellers. The idea was for them to cultivate their own vegetables on unused plots of land in the city in order to be self-sufficient. The initiative became known under the name "Programa de Agricultura Urbana" (PAU). It led to

a boom in urban farming, resulting in the development of new local markets and processing facilities which today make money by selling organically cultivated fruit and vegetables as well as processed products to more wealthy urban dwellers. [75]

5.2.2 Brazil's "Zero Hunger Program"

The second key component is initiatives by associations and groups or by governments which have already taken important steps towards regional self-sufficiency in recent years. In Brazil, for example, the Lula government's Zero Hunger Program focuses on small-scale farmers in urban centers. The goal is to promote organic and thus cost-efficient production methods and to supply the poorer parts of large cities' populations with food in doing so. Today, 4.3 million Brazilian small-scale farmers apply organic cultivation principles in the country's major cities and their surroundings.

5.2.3 Urban Agriculture in Cuba

The example of Havana, Cuba, also demonstrates how a city can increase self-sufficiency. After the collapse of the Soviet Union, Cuba was forced to reorganize its food supply system. Unused plots of land and green spaces throughout the cities were turned into gardens. Today, they are an element of food provision. Cultivation is based on organic principles and organized in cooperatives. Produce is sold to immediate neighbors. 30,000 hectares are farmed in this way in Havana, covering more than 60 percent of the demand for fruit and vegetables. [76]

5.2.4 New Distribution Channels for Megacities

The third and presumably vital pillar is yet to be developed. Its concern is directed at the introduction of trade chains which bring together small- and medium-scaled farms as producers or collectives, standardize their products as needed, transport them into the metropolitan areas via general distribution channels or through their own channels, and either bring them to market themselves or deliver the goods to vendors to do so. Such a trade network can, if the distribution channels allow for it, extend its sphere of action and also include more remote producers. It provides the prospect of overcoming poverty for those currently affected, as well as helping them reach a modest degree of prosperity, and could prove a both commercially and socially stabilizing force in entire regions.

The measures introduced here provide insights and impulses for the ecological provision of foods for megacities, however, they do not represent a failsafe strategy. Nonetheless, the resourcefulness and determination which can be observed here give reason to hope that organic farming will provide sufficient and healthy foods for future megacities; especially, since considerable yield increases are to be expected for this region in the wake of intensified ecological research and practice. This contrasts with industrial agriculture which will destroy what it intends to build.

5.3 Create Regionally Focused Education and Advisory Systems

Agricultural education in industrialized countries as well as in developing countries is focused mainly on supporting the agro-industrial system. Germany serves as an example for this lopsidedness. Only a small number of training centers teach the principles of an agroecological future. Merely 8 out of 117 professional schools for agriculture in the country offer training in organic farming. [77]

5.3.1 Extensive Education

The full implementation of ecological agriculture is only viable, however, if its basic principles inform the curricula of all relevant educational institutions. This applies for Germany and for Europe, but especially for the Global South where food supplies for the megacities also depend on whether small-scale farmers can achieve considerably higher yields. Currently, they receive no support from educational or advisory systems, a circumstance the donor countries, including Germany, have contributed to by massively reducing their aid. [78]

To boost local agricultures' productivity once more, the reconstruction and further development of these structures, based on agroecological principles, will be of the essence. One example of how this can be done are the green innovation centers for the agriculture and food sector (GIAE) in Africa and India, realized by The Federal Ministry for Economic Cooperation and Development (BMZ) in cooperation with The International Federation of Organic Agriculture Movements IFOAM – Organics International, the Research Institute of Organic Agriculture (FiBL), and the Naturland Association for Organic Agriculture.

5.4 Intensify Research: in Principle, Regionally and Multi-Culturally

Organic agricultural research is widely neglected in the industrialized countries' agricultural research funding programs. In Germany, for example, it is allocated only 6 percent[79] of the over-all federal agricultural research budget. [80] Only one of 14 federal research institutes focuses on ecological agriculture. [81]

5.4.1 Massively Extend Funding for Research

Agroecology's low status in the fields of research and teaching reflects the lack of political interest in organic farming. This will have to change fundamentally. The allocation of public research funds must be increased dramatically in order to provide the necessary foundation for the comprehensive implementation of organic farming.

5.4.2 Prioritize Ecology

At the same time, there is a need for re-prioritization in research. In a 2017 memorandum addressed at the German federal government, leading associations demanded new focus areas in research funding, [82] calling for research directed

towards the basic requirements for sustainable, ecological, and stable agriculture as well as the consumer-oriented provision of diverse and healthy foods to be prioritized. Its aim must be climate neutrality by 2050 and it must work towards strengthening small-scale farming and the necessary agroecological prerequisites on a global level, as well as preserving and improving its natural production basis: fertile soil, water availability, bio diversity, and climate stability. In the same way, research must promote urban and peri-urban organic farming as a contribution to food security in growing cities and facilitate the return of the global agricultural and food system to local and regional cycles.

Results achieved by research conducted in this manner must be such that they empower producers and consumers to make independent decisions. Furthermore, research has to bring to light the prevailing power structures in the agricultural and food markets, including upstream industries, and attempt to find strategies for their restriction and transformation. Stronger involvement of those directly affected as well as of relevant organizations from civil society in transdisciplinary research is indispensable.

International research is united in the global agricultural research partnership Consultative Group on International Agricultural Research (CGIAR); this group's funding has also been drastically cut back and must be increased, as does funding on a national and European level, in order to meet the great challenge of transforming the food system.[83]

67 Norman Uphoff, Systems Thinking on Intensification and Sustainability: Systems Boundaries, Processes and Dimensions, 1877–3435/# 2014 Elsevier, http://dx.doi.org/10.1016/j.cosust.2014.10.010
68 https://www.globalagriculture.org/flagship-projects/system-of-rice-intensification.html
69 Ibid., Current Opinion in Environmental Sustainability 2014, 8:89–100.
70 https://www.biovision.ch/en/projects/sub-saharan-africa/push-pull-east-africa/
71 https://www.globalagriculture.org/flagship-projects/push-pull-in-ethiopia.html
72 http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf, p. 14.
73 http://www.kiran.nic.in/pdf/agri-info/jhum%20cultivation/Multifunctional.pdf
74 FAAN:, Local Food Systems in Europe., Graz 2010.
75 Wilfried Bommert, Brot und Backstein, wer ernährt die Städte der Zukunft, Munich 2014, p. 207.
76 Sinan Koont, Sustainable Agriculture in Cuba, Gainsville, FL: University Press of Florida, 2011
77 https://www.bildungsserveragrar.de/fortbildung/fachschulverzeichnis
78 From 20 percent to below 5 percent between 1985 and 2005.
79 Budget proposal 2017: https://m.proplanta.de/Agrar-Nachrichten/Agrarpolitik/Agrarhaushalt-2017-betraegt-5-9-Milliarden-Euro_article1467798771.html
80 Approx. 278 Million Euros (2017).
81 http://www.forschung-oekolandbau.info/de/strukturen/deutschland/forschungseinrichtungen.html
82 IWE, Memorandum für eine Forschungsförderung zur Sicherung der Welternährung, Berlin 2016, https://germanwatch.org/de/download/17259.pdf.
83 CGIAR: Financial Report 2006.

6. Impediments to Change – Illustrated by the Example of Germany

The two elementary objectives in preventative policy are the protection of life and limb and of food. While security policy enjoys high levels of attention and is discussed and negotiated intensely, food policy has appeared to be of secondary importance thus far. Most people consider food security a given and tend to take it for granted. For this reason it has held a subordinate position in the federal political agenda. Elections aren't or are not yet decided on the subject of food. And although scandals arise in the context of industrial practices time and again, they will not result in a principle change of mind as long as political measures such as animal welfare labeling dampen the outrage and promise improvements. For this reason, the current model of food policies, which was shaped in the 1950s, continues to predominate.

6.1 The Industrial Model

In Germany, the concept of industrial agriculture, based on the U.S. model, developed after World War II. It was intended to transfer industrial principles to agriculture. The mission was to massively increase productivity with the aid of technology, chemicals, high-performance breeding, and specialization. On the one hand, this was supposed to fight hunger which prevailed in the post-war years, on the other to set free labor force which, no longer needed in agriculture, could be moved to the booming industries, and, finally, to lower prices for bread, milk, and meat and to thus spur the population's purchasing power for fridges, TVs, and cars.

6.2 The Agro-Industrial Coalition

The success of this strategy, which evolved from close interactions between agricultural associations, upstream and downstream industries, politics, and administrations, contributed to what has historically become known as the German "Wirtschaftswunder." This agro-industrial coalition is still in place today and continues to pursue its objective of comprehensively industrializing the agricultural and food sectors—despite public resistance which is forming in movements such as "Wir haben es satt" ('We're fed up with it'). The food industry coalition also campaigned against the ecologization of agricultural practices in Germany and continues to create ever-growing mono structures on the fields and in the stables via its agricultural policies on a European level.

6.3 Monopolization of the Agricultural Industry

Its influence can be ascribed to corporations in particular, which have grown into economic power complexes now extending to a global level. Bayer, for example,

became one of the world's largest producers of seeds and agricultural chemicals after taking over United States company Monsanto. Alongside agrochemical corporation BASF, circa one third of the world market for industrial agriculture is now covered from Germany. Four corporations command global trade with agricultural commodities. In the food manufacturing industry, Nestlé, Unilever, and Danone control the market.[84] This rapid process of concentration is driven by international financial investors who capitalize on a globally oriented agro-industry. None of them have the slightest interest in transforming the food system.

6.4 The Agro-Industrial Lobby

This concentration of economic power is linked to the increasing political influence of a diverse political lobby which secures and defends the concept of intensive implementation of agrochemicals, high-performing plants and animals, global trade, and industrial food processing on a EU level. The German Farmers' Association is one of the pillars supporting this system, with members on the supervisory boards of agricultural corporations. As board members they advocate the corporations' policies and are biased regarding any political change of direction. The German Farmers' Association belongs to the lobby of a system that has succeeded in advancing even into the parliamentary committees of the German Bundestag.

6.5 The German Bundestag Committee on Food and Agriculture

As a parliamentary expert committee, the Committee on Food and Agriculture at the German Bundestag has great influence on legislation. Even more so, since the Bundestag only has a very small number of agricultural experts. In 2017, out of the 17 CDU/CSU members of the Committee on Food and Agriculture, 13 were representatives of agrarian associations or had close ties to the industry.[85] The same situation applies on a European level.[86]

6.6 Misinvestments by Farmers

A further impediment for the departure from the dominating model can be traced back to the farmers themselves and their investments. Driven by association politics and their representatives, who likened globalized dairy and cattle markets to promises of salvation, they invested in buildings and equipment. These investments amount to billions of Euros, the repayment of which can take years and thus obstructs or prevents any decision to choose a new path. This particularly affects dairy farmers who have lost all financial leeway due to the low-pricing policies of recent years.

6.7 Disappearing Farm Structures

Ongoing structural change represents a further stumbling block to transformation. The fact that an increasing number of farmers are giving up business leads to a redistribution of land, as well as lesser and larger farms. The digitization of agriculture will further accelerate structural change. Robert Habeck, the new head of the German Green Party, estimated that three quarters of German farms could fall by the way-side in the wake of "Smart Farming". [87] Released land is increasingly taken over by corporations dedicated to the production of energy on the one hand, and the industrial model of dairy and pork exports to China, amongst others, on the other, displaying little readiness for ecological change.

6.8 The Corporations' Claim of Entitlement

The current debate about the future of global food, which is dominated by the agricultural corporations, is another factor preventing a change of thinking. Their assertion that only further intensification of production can feed a growing world population supports their own position of power. Because their claim of sole expertise is acted upon in agricultural and development policies, precedents are created, as in the case of the "New Alliance for Food Security and Nutrition," supported by the G7 industrial countries and the global agricultural corporations. In Tanzania, for example, it led to the designation of a special agricultural zone named SAGCOT (The Southern Agricultural Growth Corridor of Tanzania) in which projects for the industrial development of agriculture are enforced at the expense of small-scale farmers. [88]

Given this background of concentrated power and interests in an industrial agricultural system, is there even a chance for change and an ecologically and regionally oriented food supply scenario? Chapter 7 is dedicated to this question.

84 https://www.boell.de/en/2017/10/26/agrifood-atlas-facts-and-figures-about-corporations-control-what-we-eat
85 http://docplayer.org/36181937-Man-kennt-sich-man-schaetzt-sich-man-schuetzt-sich.html
86 https://www.lobbycontrol.de/produkt/lobby-planet-bruessel/
87 http://www.robert-habeck.de/texte/blog/ei-ist-nicht-mehr-gleich-ei/
88 https://www.agrarkoordination.de/uploads/media/Praesentation_Lanje.pdf

7. What Needs to be Done

The fundamental ecologization of the agricultural and food system on this continent is a pan-European project. The groundwork must be laid in Brussels, the impulses, however, have to come from the union's member states and their citizens. The great transformation of the food system begins in regional Europe.

7.1 Civil Society Takes the First Step

Given politics' lack of flexibility, civil society will have to induce the necessary system change. It can promote and emphasize the importance of the following propositions. Germany's energy policy turnaround can serve as an illustration of what needs to be done: set examples, provide models, develop markets, forge political coalitions, readjust public funding, and declare agroecology the gold standard of agriculture, as recommended by the German Council for Sustainable Development in 2011.

7.2 Public Funding Only for Ecological Benefits

At the same time, the course must be set new in European agricultural and trade policies. The goal: not to spend a single Euro before maintaining its ecological impact; not to sign any new contract without taking into consideration its consequences for human food supplies first. Among the political measures required by the European Union to initiate the transformation of the food system, the redirection of payments to farmers needs to take top priority. They should only be paid for ecological services. Wherever ecological damage is caused, as well as in the cases of already existing obligations regarding fertilization and the protection of water, sanctions must be applied resolutely. As these changes are already being demanded, we provide six proposals currently not at the center of the EU reform debate, which we, however, consider highly effective in the process of agricultural transformation.

7.3 Six Proposals Complement the Turnaround

7.3.1 Withdraw from Risks – Divestment from Agricultural Industry Stocks

Investing money in the agricultural and food industry means taking high risks which will increase even more in the future. Following the example of divestment from coal, we plead for phasing out agricultural corporations' stocks. The target groups here are large pension schemes, life insurers, corporate pension plans, and pension funds.

7.3.2 Create Models – Ecologically Consolidate Lease Agreements

As large landowners, churches and municipalities must lead the way with respect to agricultural transformation. Their arable land should only be leased to tenants working ecologically and serving local markets.

7.3.3 Initiate a Federal Program – Regional, Organic, Fair

Regional food concepts are to be developed for all German cities. The creation of institutions such as food councils, concepts such as edible cities, community-supported agriculture, ecological model regions is to be expedited via a federal program. National/European competition will contribute to their proliferation.

Collaboration with individual states is also possible here. They are to install exemplary ecological model regions (Öko-Modellregionen) like those already in place today in southern Germany, in all states.

7.3.4 Radically Fight Multi-Resistant Organisms – Ban Antibiotics in Animal Husbandry

As means against life-threatening diseases, antibiotics are increasingly losing effectiveness. Antibiotic resistance is on the rise. The risk of infection with or death by multi-resistant organisms is also growing. These organisms are created, amongst others, through the massive use of antibiotics in intensive livestock farming, increasingly also reserve antibiotics which must be set aside for human medicine only. To protect the population, a general ban on antibiotics in animal farming is needed.

7.3.5 Save Insects – Outlaw Pesticides

In 2017 we learned that 75 percent of all insects in German agricultural landscapes have died out. Their extinction shows how massively our ecosystem is already impaired. Pesticides are considered the main cause. Licenses should hence be subject to general revision and immediately revoked in any case of doubt. A first step in this direction is to ban glyphosate from all fields in the Federal Republic of Germany and from all properties owned by Deutsche Bahn.

7.3.6 Reimburse Farmers for Misinvestments

Farmers should be compensated for misinvestments in industrial agriculture following the standard practice already in place in the energy sector. Rather than the farmers, German and European agricultural policies, which promoted faulty models for decades, are to be held accountable for these misguided decisions. Only financial relief from this burden will allow farmers to escape the “business as usual” forced upon them, and to invest into an ecological new beginning.