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Organic Agriculture and Modern Biotechnology: Conflicts and Challenges

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Abstract

Organic farming emphasises a broader range of farming practices while avoiding the use of fertilizers and pesticides. As a result, it may positively impact local environmental preservation and biodiversity. On the other hand, organic farming produces lower yields than conventional farming. Therefore, more land is required to produce the high-quality food, and more organic farming might result in agricultural land growth. According to new research examining Europe's Farm to Fork Strategy and its commitment to biotechnology and organic farming, the concept of organic farming along with gene editing by using modern biotechnology as well as advanced plant breeding approaches might be a great match for each other, resulting in greater local and global agricultural sustainability. However, it is a challenge for emerging agricultural scientists to work upon.

Keywords: Biotechnology, Farming, GMOs, Organic Agriculture

Introduction

According to an international research team led by scientists from Wageningen University & Research situated in the Netherlands, Europe's Farm to Fork strategy will likely fail to deliver on its promise of moving towards the sustainable development goals (SDGs) unless the European Union (EU) allows novel breeding techniques and gene editing approaches in organic agriculture (AGDAILY, 2022). The authors of research published in

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Trends in Plant Science make a strong case for combining these two agricultural systems, claiming that organic farming and modern biotechnology both have unique characteristics in contributing to the SDGs (Purnhagen et al., 2021). The SDGs, such as zero hunger perspectives, climate change action, and life on land, were established in 2015 by the worldwide community to solve the global concerns (AGDAILY, 2022). The European Commission (EC) has committed to these objectives, which must be met by 2030 (Purnhagen et al., 2021).

By executing its Farm to Fork policy, the EC hopes to accelerate the growth of EU organic farming to achieve 25% of total lands under organic cultivation by 2030 (AGDAILY, 2022). This rise, however, will not ensure increased sustainability if present European prohibitions on the continuing use of innovative breeding techniques in agriculture (Purnhagen et al., 2021). This strategy is not new, especially outside the United States, where organic farming is not as well-funded (Rural 21, 2022). The utilisation of current biotechnology and genetic engineering techniques was perhaps the most controversial issue in establishing organic standards in the 1990s (Purnhagen et al., 2021). Attempts to bring genetically modified organisms (GMOs) and their products into organic agriculture and food systems across the world were initially met with scepticism (Rural 21, 2022). The topic was widely disputed in the United States by the then National Organic Standards Board (NOSB), which ended up recommending that the technology cannot be accepted (AGDAILY, 2022). The US Department of Agriculture (USDA) suggested legalising particular applications of genetic engineering in 1997 and sought public feedback. In reaction, the public largely rejected permitting recombinant DNA technology and the introduction of genetically modified organisms (GMOs) on organic farms (Organic Farmer, 2022; Rural 21, 2022). Organic farming and gene editing might be a great match for each other, resulting in greater local and global sustainability (Purnhagen et al., 2021).

Organic farming combined with advanced breeding strategies and biotechnological tools may offer a way to attain more sustainable agriculture. EU regulations should be altered to enable gene editing in organic farming for greater global sustainability (AGDAILY, 2022; Rural 21, 2022). As a result, it may positively impact local environmental preservation and biodiversity. More robust plants may be generated using new molecular tools that provide large yields while using less fertilizer (Organic Farmer, 2022). In addition, gene editing is being utilised to develop fungus-resistant plants that can be grown organically without copper-based

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insecticides. Copper is highly hazardous to soil and aquatic creatures; however, it is nevertheless allowed in organic farming to control fungus (AGDAILY, 2022. The application of genetic engineering and advance molecular breeding approach in organic farming, on the other hand, necessitates regulatory modifications. There is currently no political consensus in favour of this idea, since many people view biotechnology with scepticism (Purnhagen et al., 2021).

Global organic statistics show ongoing engagement with transparency in the organic sector.

Organic farmland expanded by 1.1 million hectares, while organic retail sales continued to climb, according to the latest FIBL report on organic agriculture worldwide, including data from 187 nations. The 22nd edition of FIBL and IFOAM – Organics International's research "The World of Organic Agriculture" reveals a continuation of the good trend witnessed in previous years. In 2019, the worldwide organic food industry was worth 106 billion euros (FIBL, 2022) and the largest market identified in the United States (44.7 billion euros), followed by Germany (12.0 billion euros) and France (10.0 billion euros) (FIBL, 2022).

Many large markets continued to develop strongly in 2019, with the French market, for example, increasing by more than 13% (FIBL, 2022). Consumers in Denmark and Switzerland paid the most on organic food (344 and 338 euros per capita, respectively) (FIBL, 2022). With 12.1 per cent of the entire food market, Denmark has the largest organic market share. 3.1 million Organic growers were recorded in 2019 (FIBL, 2022). India continues to have the most producer after Uganda and Ethiopia. At the end of 2019, there were 72.3 million hectares of organically managed land. The greatest organic agricultural area is in Australia (35.7 million hectares), followed by Argentina (3.7 million hectares) and Spain (2.5 million hectares). Oceania accounts for half of the world's organic agricultural land due to Australia's enormous amount of organic farming (36.0 million hectares) (FIBL, 2022).

In comparison to 2018, organic farmland grew on all continents except Asia and Oceania (FIBL, 2022). Only 1.5 per cent of agriculture in the world is organic. Many countries, on the other hand, have far greater percentages. Liechtenstein (41.0 per cent), Austria (26.1 per cent), and So Tomé and Principe (24.9 per cent) have the highest organic share of their total cropland (FIBL, 2022). In the next years, certain Indian states will be or want to be 100 per cent organic. Global organic statistics have proven valuable for international development

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cooperation programmes and supporting organic agricultural and market strategies, and they are critical for assessing the impact of these initiatives (FIBL, 2022). Table 1 explains the world organic agricultural statistics 2019 according to the FIBL survey, 2021.

Use of advanced transgenic approaches

Both organic agriculture and biotechnology have progressed in recent years. New approaches for manipulating genetic information have been created and marketed. Rather than transmitting genetic information from one species to another, the method of "transgenics" involves changing the species' genetic structure. Editing, deletion, multiplication, or modification of genomic sequences and novel mutation-inducing methods are among them (Organic Farmer, 2022; Rural 21, 2022). Gene editing proponents claim that the technique is more precise than the previously used genetic alteration methods. CRISPR, which stands for "Clustered Regularly Interspaced Short Palindromic Repeats," is one of the new approaches that has gotten much attention (AGDAILY, 2022; Rural 21, 2022).

The CRISPR-associated protein 9 (Cas9) is an enzyme that can recognise, cut, and splice sequences into distinct parts of a cell's genome (AGDAILY, 2022). Genes can also be silenced, deleted, or duplicated using this technology. However, because the procedure does not entail the transfer of genetic material across species, scientists argue that the identical alterations might occur spontaneously through random mutation (Purnhagen et al., 2021; Rural 21, 2022). TALEN, which stands for Transcription activator-like Effector Nucleases, is another genome editing approach. Even though commercial applications are restricted, the technologies are attracting a lot of interest, financing, and investment in academic and industrial contexts due to the potential for the new technology to replace traditional breeding procedures.

The debate has arisen in the organic community that gene-editing technology may be used in ways that are consistent with organic agricultural practices (AGDAILY, 2022). Several gene editing and targeted genetic modification approaches, including CRISPR-Cas, zinc finger nuclease (ZFN) mutagenesis, and oligonucleotide-directed mutagenesis (ODM), were ruled to be prohibited methods by the USDA's National Organic Standards Board (NOSB) in April 2016 (Organic Farmer, 2022). The NOSB's findings and recommendations also included gene silencing, reverse breeding, synthetic biology, cloned animals and progeny, and plastid transformation. In November 2017, the NOSB added cisgenesis, intragenesis, and agro-infiltration to the list of banned technologies (Organic Farmer, 2022; AGDAILY, 2022). The

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NOSB received universal public agreement for adding these three approaches to the prohibited procedures.

In 2013, the USDA used a similar approach to cell fusion technology (Rural 21, 2022). The USDA has also proposed required bioengineered food labeling laws (Purnhagen et al., 2021). Gene editing provides significant benefits over earlier recombinant DNA (rDNA) approaches, including accuracy and predictability. Various farmers, seed firms, and others participating in the organic community, on the other hand, are unaware of such benefits. Companies who pioneered previous approaches made similar promises that, at least in some situations, proved out to be false (Purnhagen et al., 2021; AGDAILY, 2022). While some organic farmers believe that there may be benefits in the future, no known applications have been accepted.

Use of precision tools in plant breeding

The use of marker-assisted breeding is one exception. In selecting cultivars appropriate for organic farming, traditional plant breeders believe gene mapping to be a beneficial technique. It might be feasible to speed up the production of varieties compatible with organic farming systems by having a better grasp of plant genomes and employing traditional breeding methods. Therefore, marker-assisted selection should not be deemed an excluded approach, according to the NOSB (Organic Farmer, 2022). Gene drives, which employ gene-editing techniques to eliminate functioning genes and manage a wild population to carry single allele, are another new technology established (Purnhagen et al., 2021). The method might introduce insect pests or weeds that produce sterile or otherwise non-viable offspring or seed, replacing the local population after a few generations. The fear is that gene drive technology changes natural systems permanently and irrevocably (AGDAILY, 2022). A gene drive organism can no longer be controlled once unleashed, and it has the potential to become a pest or weed. Organic producers are afraid that gene drive organisms will spread to organic fields, threatening stable pest and weed control methods (Organic Farmer, 2022; Rural 21, 2022).

Table 1. World organic agricultural statistics 2019 (Source: FIBL, 2022)

Particulars	World figures	Figures of top three countries

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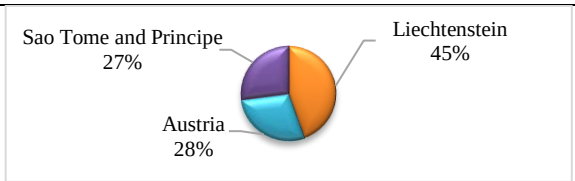
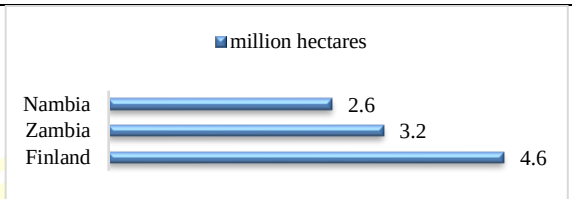
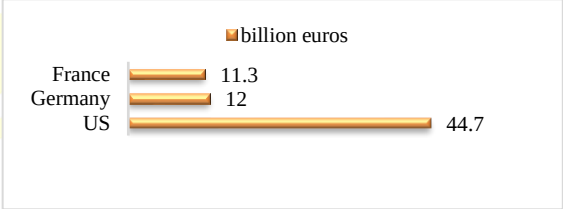
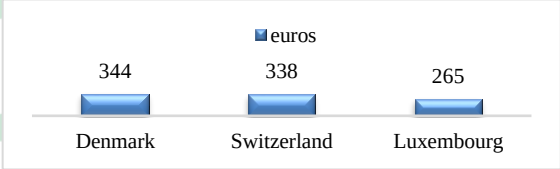
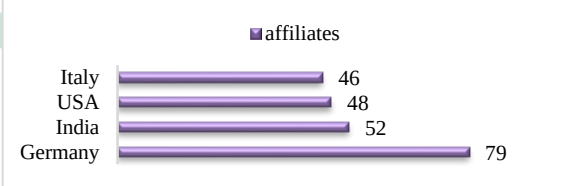
Land devoted to organic agriculture	72.3 million hectares	
Share of organic farming from total land	1.5%	
Wild collection areas	35.1 million hectares	
Organic producers	3.1 million	
Organic market	106.4 billion euros	
Consumption (Per capita)	14 euros	
Affiliates to IFOAM	719 affiliates	
Organic activities performing countries: 187 number of countries		
Organic regulation: 108 number of countries		

Conclusion

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Scientists are already voicing concerns about the new biotechnology's long-term and larger ecological effects. Biotechnology approaches are based on reductionist methodologies, while organic agriculture is holistic. As an example, while single-gene resistance is employed when the pathogen evolves to defeat plant's defence, breeding for vertical resistance and total immunity based on a single gene fails. Although multi-gene or horizontal resistance does not guarantee total protection, the resistant variety will be more resistant to subsequent mutations and the emergence of disease strains happen that defeat the plant's immune system. Another factor that is not well known is the impact of the new technology on the soil biome. Proponents of the technology recognise hazards but suggested that, they are minor and that control is unnecessary.

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