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Research on GMOs Detailed Analysis of Genetically Modified Corn

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ABSTRACT

The research presents a statistical analysis of genetically modified organisms (GMOs) according to the European Union (EU) Register of GMOs for genetically modified food and feed, with a focus on genetically modified corn. The analysis aims to highlight the current status of indicators recorded in the EU Register and provide the necessary perspective for identifying future directions. The study was conducted based on data provided by the Food and Agriculture Organization (FAO) and interpreted using classical statistical methods. Information from official studies processed from databases such as Clarivate Analytics, Google Scholar, and ResearchGate was accessed for comparative bibliographic documentation. The results showed an increased number of indicators for genetically modified corn. Important aspects were analyzed, including traits such as herbicide tolerance, insect resistance, and other genetic modifications that distinguish GM products from conventional ones.

1. Introduction

In recent decades, research on genetically modified organisms (GMOs) has become a topic of great interest for both the scientific community and the public due to their potential impact on global food security. A particularly relevant example is genetically modified corn, extensively used to improve agricultural production, increase resistance to pests and diseases, and adapt to variable climatic conditions. The European Union (EU), along with international organizations such as the Food and Agriculture Organization (FAO) and the European Food Safety Authority (EFSA), has implemented stringent regulations for the evaluation and monitoring of GMO safety. These regulations are essential for protecting human health and the environment, establishing standardized methods for the detection and quantification of GMOs in food and feed. This study focuses on the importance of disseminating information regarding the use of genetically modified organisms, with an emphasis on genetically modified corn, to contribute to the development of safe and sustainable agricultural practices. This article aims to analyze in detail the EU Register of GMOs for genetically modified food and feed, focusing on genetically modified corn due to its high prevalence in this register. We will explore statistics related to the specific traits of genetically modified corn and the use of these indicators in the EU. Additionally, we will discuss applicable regulations, providing a comprehensive perspective on the current state and future challenges in the field of GMOs.

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The EU Register of GMOs for genetically modified food and feed is an official database containing information about all GMOs approved for use in the European Union. This register is essential for ensuring transparency and for the continuous monitoring of food and environmental safety. Within the EU Register of GMOs, genetically modified corn occupies a central place, with 211 indicators out of a total of 483. This highlights the importance of corn in the context of genetically modified feed. Specific indicators of genetically modified corn include traits such as herbicide tolerance, insect resistance, and other genetic modifications that improve agricultural performance. Other genetically modified crops listed in the EU register include soybeans (59 indicators), cotton (58 indicators), potatoes (45 indicators), and rapeseed (36 indicators). This analysis also included an assessment of the impact of EU regulations on the development and use of genetically modified corn, ensuring compliance with international standards and protecting consumers and the environment.

Statistical information regarding genetically modified food and feed was obtained through access to official data provided by the Food and Agriculture Organization (FAO). Legislative aspects were derived from information provided by national and European public institutions. For documentation, open-access scientific articles from databases such as ResearchGate, Clarivate, SCOPUS, and Google Scholar were used. The collected data were statistically processed and represented in tabular and graphical forms. The results obtained were compared with information from the specialized literature for validation.

2. Literature review

The current state of research on genetically modified corn is characterized by an increased interest in the adoption and implementation of advanced technologies in agriculture to optimize yields and ensure environmental sustainability. Numerous recent studies analyze the economic impact, public perception, and regulatory framework, providing a comprehensive overview of the benefits and risks associated with the use of GMOs. New technologies for the dissemination and communication of agricultural knowledge are vital for agricultural research institutes (Barakabitze et al., 2020). The use of these technologies significantly impacts access to agricultural information for researchers, extension agents, and farmers in southwestern Nigeria (Oladele, 2011).

In another study, Stanciu investigated organic production in Romania, offering perspectives on the European context and highlighting the importance of organic agriculture for sustainable development (Stanciu & Sârbu, 2014). The adoption of GMOs and productivity in Romanian agriculture were analyzed by Popescu and Ionescu, demonstrating increased yields and agricultural efficiency due to GMOs (Popescu & Ionescu, 2018). The risk assessment associated with genetically modified crops in Romania was detailed by Georgescu and Petrescu, emphasizing the safety measures necessary for environmental and public health protection (Georgescu & Petrescu, 2019). Public perception of genetically modified organisms in Romania was studied by Marinescu and Mihai, highlighting Romanian consumers' attitudes and concerns about GMOs (Marinescu & Mihai, 2020). The regulatory frameworks for GMOs in Romania, analyzed by Dumitrescu and Ardelean, underscored the importance of a robust legislative framework for ensuring food and environmental safety (Dumitrescu & Ardelean, 2021). The challenges and opportunities for GMO cultivation in Romania were explored by Vasilescu and Lungu, providing a comprehensive analysis of the Romanian agricultural context and prospects (Vasilescu & Lungu, 2022). Effective dissemination of agricultural information is essential for improving farmers' knowledge and practices.

3. Results

Genetically modified organisms (GMOs) have sparked intense debates regarding their impact on the environment and ecosystems. Research in this field has evolved significantly in recent years, providing a clearer perspective on the potential risks associated with GMOs. An important aspect to consider is the impact on native species. Studies have suggested that GMOs can lead to increased mortality of certain species, either through direct factors or unintended crossbreeding with natural populations. For example, some studies from the USA and the UK have associated GMOs with an increase in insect mortality in areas cultivated with genetically modified plants. However, it is important to emphasize that the issue of GMO impact is complex and nuanced. There are divergent opinions and contradictory research results. A careful analysis of scientific evidence, considering multiple perspectives, is essential to formulate solid conclusions and make informed decisions regarding the responsible use of GMOs.

In addition to potential risks, it is also important to consider the potential benefits of GMOs, such as increased agricultural production, improved nutritional value of food, and reduced dependence on pesticides. A balanced assessment of both aspects, risks, and benefits, is crucial for making well-founded decisions regarding the role of GMOs in our society.

Following the analysis of the EU Register of GMOs for genetically modified food and feed, aspects concerning the number of existing identifiers and genetically modified food and feed were extracted and analyzed. This register is an essential tool that facilitates access to information about GMO safety and promotes a transparent and evidence-based approach to GMO evaluation and regulation. The platform offers significant benefits for consumers, regulatory authorities, researchers, and food safety specialists. Table 1 highlights a significant diversity of genetically modified organisms (GMOs) currently used, with 483 unique identifiers distributed across 31 types of crops. This diversity is reflected in the variable frequency of GMOs, with certain crops predominating significantly. Corn, soybeans, and cotton stand out as the most common GMOs, with 211, 59, and 58 unique identifiers, respectively. This prevalence translates into significant percentages: corn represents 43.7% of all GMOs, soybeans 12.2%, and cotton 12%, together accounting for 68.1% of the total. The dominance of corn, soybeans, and cotton can be attributed to various factors. This trio has a long history of cultivation and considerable economic importance, making them attractive targets for GMO research and development. Additionally, their genetic characteristics make them receptive to various beneficial modifications, such as pest or herbicide resistance. The lower frequency of GMOs in other crops can be explained by several reasons, including genetic complexity, regulatory issues, or consumer concerns. Genetic modification of certain crops may be more difficult or costly, limiting the adoption of GMOs. Some countries may have stricter regulations on GMOs, influencing their market availability. There is significant public reluctance towards GMOs in certain regions, limiting demand and stimulating slower adoption.

Table 1. Ranking of genetically modified foods and feeds by number of identifiers

Foods and Feeds	Number of Identifiers
Corn / Maize	211
Soybean / Soybeans	59
Cotton	58
Potatoes	45
Canola / Oilseed rape / Rape Seed	36
Sugarcane	17

Foods and Feeds	Number of Identifiers
Tomatoes	8
Rice	8
Alfalfa / Lucerne	8
Apple	7
Sorghum	3
Sugar Beet	3
Radicchio	3
Safflower	3
Wheat	2
Plum	2
Vegetable Marrow/ Squash	2
Papayas	2
Cantaloupe	2
Creeping bentgrass / Agrostis stolonifera	1
Bean (common)	1
Flax / Linseed	1
Pineapple	1
Camelina (Camelina sativa (L.) Crantz)	0
Total	483

Source: Authors, using FAO.ORG - EU GMO Register (2024)

The graph in Figure 1 highlights an unequal distribution of GMOs based on the number of unique identifiers from the FAO Register of Genetically Modified Plant-Derived Foods, with corn, soybeans, and cotton dominating the landscape, accounting for 44% and 12% of the total identifiers. These three crops represent 68.1% of all GMOs, demonstrating a clear predominance. Intensive cultivation of GMOs can reduce agricultural biodiversity through crossbreeding with traditional varieties and the elimination of local species adapted to specific environmental conditions, especially in the case of these top three crops where genetically modified varieties are predominant.

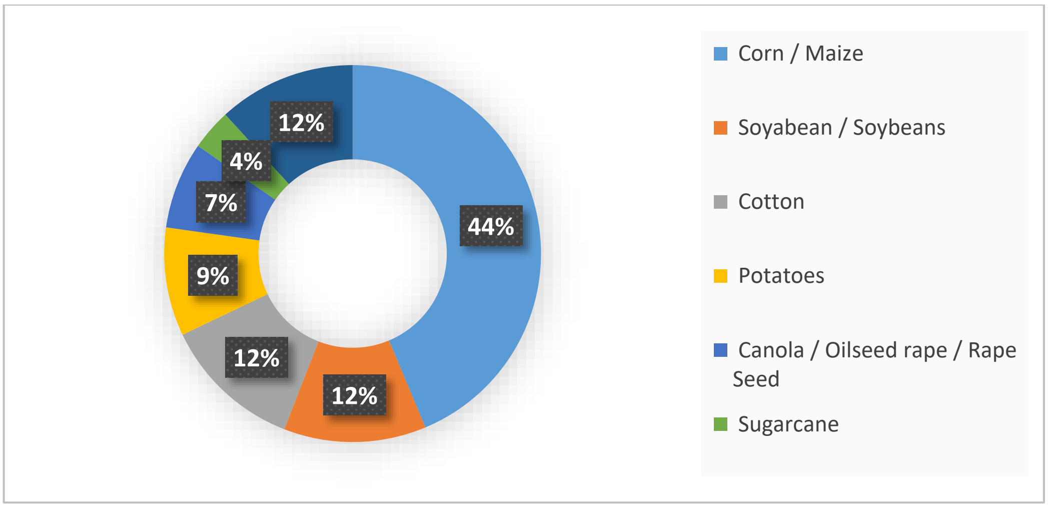

Figure 1. Main genetically modified foods and feeds

Source: Authors, using FAO.ORG - EU GMO Register (2024)

Corn is the most frequently cultivated genetically modified (GM) crop globally, with a significant presence in Table 1 (211 unique identifiers). GM corn has been genetically engineered to confer various advantages, including pest resistance, herbicide tolerance, and nutritional enhancements. GM varieties

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can be resistant to harmful insects, reducing the need for chemical pesticides. Certain types of GM corn tolerate specific herbicides, allowing for efficient weed management and reducing agricultural costs. Some GM varieties have been modified to contain higher levels of essential nutrients, such as vitamin A or proteins. According to existing data, potential risks include environmental impact, health issues, and even ethical and social concerns. There are concerns about the negative impact of pollen from GM corn on native plant and insect species. Some express worries about health risks associated with consuming GM foods, although there is no conclusive scientific evidence to support these claims. The use of GMOs raises complex issues related to seed ownership, biodiversity, and corporate control over the food chain.

Figure 2 graphically represents the distribution of 211 genetically modified (GM) corn varieties based on their specific applications, providing a detailed view of their diversity. Sixty types of corn are registered strictly for combined herbicide and insecticide tolerance. The graph highlights a significant share (32%) of GM corn varieties created for tolerance to specific herbicides, such as glyphosate. This category indicates a concentration of research efforts to reduce costs and facilitate weed management in corn crops. In addition to herbicide tolerance, the graph shows significant diversity in GM varieties intended for other applications, such as insect resistance (21%), nutritional improvement (17%), disease tolerance (8%), and other characteristics (2%). This diversity demonstrates a wide range of objectives pursued through the genetic modification of corn.

It is also noted that a significant proportion (10%) of GM varieties exhibit multiple characteristics, combining, for example, herbicide tolerance with insect resistance or nutritional improvement. This trend suggests a research direction towards more complex and versatile varieties. The predominance of herbicide-tolerant varieties may be influenced by the significant costs associated with weed control in crops. Herbicide tolerance offers an efficient and cost-effective solution for farmers. The diversity of GM varieties reflects market needs and demand for specific corn characteristics. For example, nutritional improvement aims to combat food deficiencies, while insect resistance protects crops from specific pests. The graph highlights an evolution in GM corn research, with a gradual shift from herbicide tolerance to a wider range of applications, such as nutritional improvement and disease resistance.

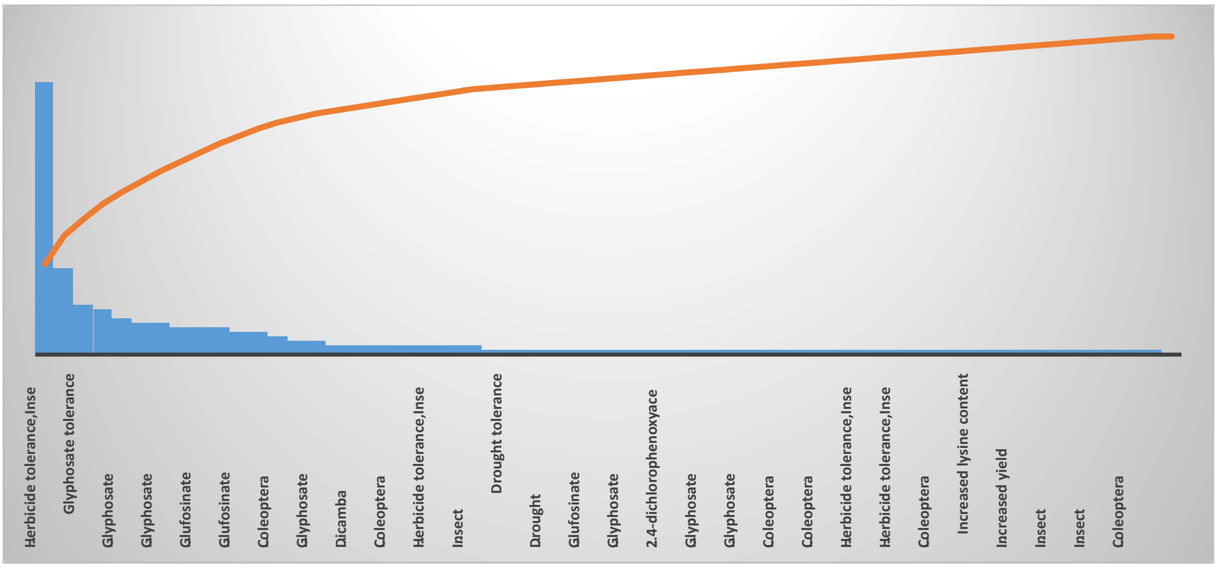

Figure 2. Distribution of GM Corn Varieties by Specific Applications

Source: Authors, using FAO.ORG - EU GMO Register (2024)

The diversity of GMO varieties highlights a wide range of potential benefits but also associated risks. A balanced approach is essential, considering both the economic and agricultural advantages as well as concerns related to the environment, health, and ethics. The presence of GMO varieties with multiple characteristics (herbicide and insect resistance, nutritional enhancement, etc.) raises additional questions about their complex impact on the environment and health. Detailed research is necessary to evaluate the long-term synergistic effects of these genetically modified traits.

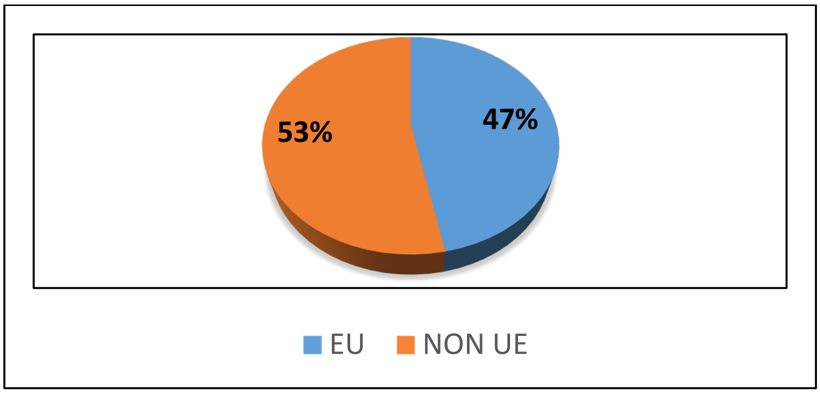

Figure 3. Corn - GMO Statistics on Indicator Usage in the EU

Source: Authors, using FAO.ORG - EU GMO Register (2024)

According to current data, 53% of the types of GM corn cultivated worldwide are used in the EU, while 47% are cultivated outside the EU without presence within the union. The EU has a stricter regulatory framework for GMO approval, involving detailed scientific evaluations and consideration of environmental and health impacts. This slower process can limit the rapid adoption of new GM varieties. Some EU member states have greater public reticence towards GMOs, influenced by social debates and safety concerns. This reticence can affect national policies and GMO adoption. Developing new GM varieties can be costly, and companies may be more reluctant to invest in the EU given the stricter regulations and potentially smaller markets. The EU has a strong agricultural tradition and a diversity of non-GMO crops. Farmers may have access to a wide range of non-GMO alternatives, reducing the necessity of adopting GMOs. Europe has diverse climatic conditions that may require specifically adapted GM varieties. Developing local GM varieties can be expensive and slow, limiting their adoption. Some regions in the EU may face less pest pressure compared to the United States, Brazil, or Mexico, reducing the need for insect-resistant GM varieties. Some EU consumers may prefer non-GMO foods, influencing market demand and agricultural producers' decisions. The smaller share of GM corn in the EU compared to the rest of the world results from a combination of regulatory, economic, geographic, climatic, and cultural factors.

5. Conclusions

Genetically modified (GM) corn holds a significant share in the EU GMO register, with 211 unique identifiers out of 483 (43.7%). This prevalence reflects its economic importance and the diversity of its applications. GM corn varieties exhibit a wide range of genetically modified traits, including herbicide tolerance, insect resistance, nutritional enhancement, disease tolerance, and other characteristics. GMOs offer potential benefits such as increased agricultural production, reduced dependency on pesticides, improved nutritional value of food, and adaptation to variable climatic conditions, in line with the purposes for which these varieties were created.

The use of GMOs raises concerns related to environmental impact (biodiversity, pollination), potential health issues, and ethical and social aspects (seed ownership, corporate control). The EU has a stricter regulatory framework for GMO approval, involving detailed scientific evaluations and increased precautions. This process can limit the rapid adoption of new GM varieties. The effective dissemination of evidence-based scientific information is essential to facilitate a clear public understanding of the potential benefits and risks of GMOs, contributing to informed decision-making regarding their responsible use. This research on GMOs can be useful for a variety of individuals and organizations interested in research, agriculture, industry, or food.

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