

Forum: International Bioethics Committee

Topic: Addressing the Ethical and Environmental Implications of Insect Gene Drive Technologies for Food Security in Sub-Saharan Africa

President

Introduction

Twenty-seven African countries are currently experiencing acute food crisis. Contributing to some of the highest levels of hunger and malnutrition in the world during the 21st century. Among the many threats facing the region are agricultural pests. These pests pose a significant risk as they destroy crops and reduce food production. When crops fail, the impact is immediate, especially for the millions of people whose livelihoods and daily meals depend on farming. Additionally, about 45% of farms across Africa are facing drought, meaning communities face an even steeper crisis in achieving lasting food security and basic economic steadiness.

One of the most destructive agricultural pests is the Fall Armyworm, an invasive crop eating pest that continues to spread across Africa at an alarming rate. The first case of fall armyworm was reported on the continent in early 2016 and today it has infested more than 40 African countries. This pest attacks and destroys mainly maize, in addition to rice, wheat and sorghum. Placing additional pressure on food security and threatens the livelihoods of millions of people who depend on agriculture.

As these challenges continue to increase, researchers have explored new technologies that could help address both agricultural and public health issues. During the 2010s, scientists began investigating the use of Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-based gene drive technology in mosquitoes. After a remarkable breakthrough occurred in 2015 when a successful CRISPR-Cas9 gene drive was demonstrated in insects, it was then proposed for use in Africa as a way to reduce malaria, particularly through the Target Malaria initiative by genetically modifying mosquitoes by genetically modifying mosquito populations to reduce their ability to reproduce or transmit malaria.

Despite its potential benefits, the use of insect gene drives has raised significant ethical and environmental concerns. Many argue that gene drive organisms could have unintended consequences on ecosystems and national borders, making their effects difficult to contain., cause unintended ecological and social consequences due to their unknown outcomes. The technology also sparked important bioethical disputes regarding safety,

informed consent, justice, governance, and whether the potential benefits outweigh the possible risks, particularly when decisions made today could affect future generations and ecosystems.

This issue connects to this year's AMMUN theme "Moderating Morality" as it explores the challenge of balancing scientific innovation with ethical responsibility. Insect gene drives have the potential to improve food security in Sub-Saharan Africa by decreasing the spread of agricultural pests and disease-carrying insects. However, their use also raises critical moral questions regarding environmental protection, public consent, justice, and the long-term consequences of altering ecosystems. Moderating morality makes it necessary for governments, scientists, and international organizations to carefully consider whether the humanitarian benefits of gene drive technology outweigh its potential risks.

Definition of Key Terms

Gene Drive

Gene drive is a genetic mechanism that biases inheritance and increases the probability that a particular gene or trait will be transferred to the offspring. As a result, the selected trait can spread rapidly throughout a population over numerous generations.

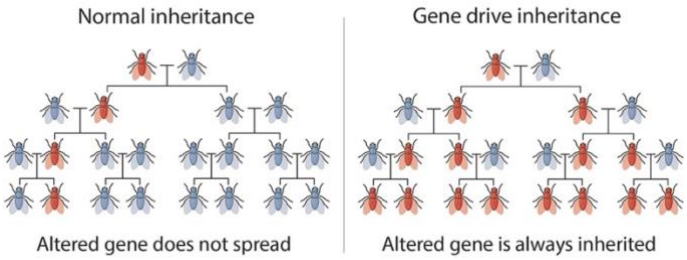


Figure 1- gene drive compared to normal inheritance

CRISPR (clustered regularly interspaced short palindromic repeats)

Clustered Regularly Interspaced Short Palindromic Repeats is a gene editing technology scientists use to make changes to the DNA of living organisms it was adapted for laboratory use from the immune system in bacteria.

CRISPR-Cas9

CRISPR-Cas9 is a genome editing tool that enables geneticists and medical researchers to edit parts of a genome by removing, adding or altering sections of the DNA sequence. It works by using an enzyme called Cas9 to cut both strands of the DNA at a specific location which allows genetic material to be inserted, removed or modified. The cell then repairs the DNA resulting in the desired genetic change.

Food Security

Food security refers to a condition in which all people, at all times, have reliable access to sufficient, nutritious and safe food that meets their dietary needs and food preferences to achieve a healthy and active life.

Biodiversity

Biodiversity is the variety of life on Earth, including animals, plants fungi and microorganisms such as bacteria, which all together form the natural world and contribute to the functioning of ecosystems.

Ecosystem

An ecosystem is a community of living organisms and their physical environment interacting together in a specific area. The living organisms and the environment are linked together through nutrient cycles and energy flows

Bioethics

Bioethics is the study of the moral and ethical questions that arise from developments in biology, medicine, and biotechnology. It examines how scientific advancements should be used responsibly by considering their impact on individuals, society and the environment, and guides ethical design making in these fields.

Environmental Risk Assessment (ERA)

Environmental Risk Assessment is a structured tool used in environmental decision making to identify, evaluate and manage potential risks to ecosystems and human health. It provides a systematic and measurable framework for understanding the probability and impact of environmental hazards, thereby enabling responsible policy and management decisions

Genetic Modification

Genetic modification, also known as genetic engineering, is the process of altering or transferring a gene from one species to another. It is a complex scientific process used to incorporate desired traits into an organism by changing its genetic material

Biosafety

Biosafety refers to the practices, regulations and containment measures used to safely handle biological materials especially infectious agents. It aims to prevent accidental exposure, the release of harmful microorganisms and the misuse of biological substances while ensuring safe and responsible laboratory work.

General Overview

Beginnings and Background of the Issue

Food security has remained one of the most pressing challenges facing Sub-Saharan Africa for decades due to the combination of climate change, population growth, conflict, limited agricultural infrastructure, and the increasing spread of invasive pests. Agriculture is the primary source of livelihood for a large proportion of the region's population, with millions of farmers relying on crop production for both income, and food supply. However, these farmers continue to experience significant agricultural losses due to insects that damage essential crops such as maize, sorghum, millet, and cassava. According to the Food and Agriculture Organization (FAO), plant pests destroy up to 40% of global crop production, which results in economic losses exceeding US$220 billion annually.

As climate change destabilizes temperatures and rainfall patterns, many invasive pests are entering into new regions. This makes traditional pest management strategies increasingly ineffective, placing additional pressure on already vulnerable food systems. These growing challenges have motivated governments, scientists, and international organizations to explore innovative technologies that can protect agricultural production, as well as supporting long-term food security.

One of the most significant agricultural pests that continue to threaten Sub-Saharan Africa is the Fall Armyworm, also known as Spodoptera frugiperda, which is an invasive insect native to the Americas that was first detected in West Africa in 2016 before rapidly spreading across the continent. Since its detection, the pest has been reported in more than 40 African countries. It feeds on over 80 plant species; however it causes its most severe damage to maize which is one of the region's most vital crops.

Maize is a key crop for the region, as it is used to feed livestock, used for human consumption, and utilised in industrial applications and generates an estimated US$1 billion annually across Sub-Saharan Africa, but this sector has seen a downtrend due to invasive pests. The rapid spread of the Fall Armyworm has demonstrated the limitations of conventional pest control methods like chemical pesticides and biological control. These methods are often difficult to implement consistently and lose effectiveness as insects develop resistance. For many farmers, the repeated pest outbreaks convert into lower crop yield, reduced household incomes, and increased vulnerability to hunger and poverty, which further highlights the need for more sustainable and long-term approaches.

Advances in biotechnology have led researchers to investigate insect gene drive technologies as a potential solution to these agricultural challenges. Gene drives are genetic systems designed to increase the likelihood that a specific gene trait will be inherited by future generations. As a result, the selected traits can spread rapidly throughout a population over numerous generations. The development of the CRISPR-Cas 9 gene-editing system in 2012 made gene drives significantly more precise and practical as it enables scientists to explore their use in suppressing pest populations or altering insects so they can no longer damage crops.

Unlike traditional genetic modification, gene drives are intended to spread beyond individual organisms into entire populations. This means that their effects may extend across ecosystems and national borders. This unique characteristic has transformed insect gene drives from a purely scientific innovation into an issue of bioethics, environmental governance and global cooperation. Which has sparked discussions within organizations such as the Convention on Biological Diversity (CBD), the African Union (AU), and the World Health Organization (WHO) on how to ensure their safe and responsible development before any environmental release.

Ethical and Environmental Implications of Insect Gene Drive Technologies

Although insect gene drive technologies have the potential to improve food security by reducing populations of destructive agricultural pests, they also raise significant ethical and environmental concerns that have become the focus of international debate. Once the gene-edited pests are released into the environment, a gene drive may continue to spread for multiple generations, making it extremely difficult and in some cases impossible to reverse its effects. This has led scientists and policymakers to question whether sufficient scientific knowledge currently exists to predict the long-term ecological consequences of releasing a gene drive into natural ecosystems. Since insects play important roles in food chains and pollination, reducing or even eliminating an entire species could unintentionally affect predators and overall ecosystem stability. Furthermore, insects do not recognize political borders, meaning that when a gene drive is released in one country, they could also spread into neighbouring nations without their consent. This increases complex legal and diplomatic challenges that require international cooperation.

Beyond environmental concerns, insect gene drives raise fundamental ethical questions regarding governance, public participation, fairness and justice. Because the technology has the potential to affect entire ecosystems and future generations, many experts argue that decisions regarding its development and release should not be made solely by scientists or national governments. This introduced a major ethical challenge regarding how to balance the inclusion of affected populations with highly technical nature of risk assessment.

This ongoing debate reflects the importance of diplomatic dialogue and inclusion, while also highlighting border bioethical principles of transparency, informed participation, justice, and respect for communities. There are also concerns that unequal access to biotechnology could widen scientific and economic differences between developed and developing countries if research and funding remain concentrated in wealthier nations. While many countries in Sub-Saharan Africa could benefit from improved pest control, they may also face greater environmental risks. If sufficient biosafety and long-term monitoring are not in place before implementation.

It becomes vital for international organisations to recognize both the potential benefits and uncertainties of gene drive technologies. As a result, these international organizations have increasingly focused on developing governance frameworks that balance scientific innovation with environmental safety. Although no agricultural insect gene drive has yet been approved for environmental release, ongoing international discussions continue to emphasize that ethical responsibility and regional cooperation must remain central to any future decision regarding the

use of gene drive technologies.

Major Parties Involved

Tanzania

Tanzania faces significant challenges to food security due to agricultural pests, particularly the Fall Armyworm. The Fall Armyworm was first detected in the country in 2017 and has endangered maize production and crop harvests. Tanzania has responded to this crisis by integrating pest management strategies, including biological control methods and farmer support programs, to reduce agricultural losses. As CRISPR gene-edited organisms are rising in popularity and are researched internationally as a potential tool to control insect populations, Tanzania has not approved of their use, due to their unknown outcomes. The country supports responsible biotechnology development while prioritising biosafety assessments, environmental protection and ethical considerations before adopting emerging genetic technologies

Uganda

Uganda is an agriculture-based country where food security and substantiable farming remain key national priorities. Uganda has supported biotechnology research while additionally establishing biosafety frameworks through the Cartagena Protocol on Biosafety and the National Biosafety Act (2020). Although Uganda has not approved insect gene-drive applications it still recognises the potential of genetic technologies to improve food security and control pests. While also ensuring that ecosystems and communities are protected by using the ERAs before introducing new biotechnology applications.

African Union (AU)

The African Union (AU) is a continental organisation which consists of 55 African member states which promotes cooperation and regional development and stability across the continent. The AU supports responsible scientific innovation in addressing biotechnology and food security while ensuring environmental protection. Through frameworks such as the African Model Law on Biosafety, the AU stresses the need for careful regulation on genetic technologies. It also

emphasizes the importance of using ERAs to balance the potential agricultural benefits with ethical considerations and the protection of Africa's ecosystems.

Food and Agriculture Organisation (FAO)

The Food and Agriculture Organisation (FAO) is a specialised United Nations agency that works to improve food security, sustainable agriculture and the management of natural resources worldwide. The FAO persistently encourages exploring new and innovative technologies that can address pest and agricultural challenges. Regarding gene drive technologies, the organisation acknowledges their potential in reducing pests and improving food systems. The FAO emphasizes responsible research, ethical considerations, and the protection of biodiversity. Through its programmes and partnerships, the FAO supports balancing agricultural innovations and the needs of local communities.

Convention on Biological Diversity (CBD)

The Convention of Biological Diversity (CBD) is an international agreement established to conserve biodiversity and promote the sustainable use of natural resources while ensuring that the fair sharing of benefits from genetic resources. The CBD plays a key role in all discussions surrounding insect gene-drive technologies due to their potential impacts on ecosystems and biological diversity. Through frameworks such as the Cartagena Protocol on Biosafety, the CBD highlights precaution and scientific assessment. Its approach encourages countries to consider both the potential benefits of gene drives for food security and the possible risks to ecosystems.

The United States of America (US)

The United States of America (US) is a leading actor in biotechnology research and genetic innovation and contributes significantly to the development of technologies such as CRISPR-Cas9 gene editing. The US supports scientific advancements that can improve agriculture and food security, including research into gene-drive technologies to control pests and disease-carrying insects. However, the US stresses the need for responsible innovation and regulatory oversight to address potential ecological and ethical concerns.

Timeline of Events

Date	Event
1992 / 6 / 5	The CBD was adopted and established international commitments to protect biodiversity.
2000 / 1 / 29	The Cartagena Protocol on Biosafety was adopted under the CBD. It created international rules for safe handling, transportation, releasing and use of living modified organisms (LMOs)
2003 / 9 / 11	The Cartagena Protocol entered into force and required member states that ratified the agreement to establish national biosafety frameworks and ERAs before releasing genetically modified organisms into ecosystems
2012 / 6 / 28	Scientists Jennifer Doudna and Emmanuelle Charpentier developed the CRISPR-Cas 9 gene editing system which make genome editing faster and more precise.
2014 / 7 / 17	Researchers first proposed using CRISPR-Cas 9 to create gene drives which shifted the perspective of gene editing by allowing engineered genes to spread rapidly through wild ecosystems.
2015 / 12 / 1	Scientists successfully developed one of the first CRISPR-Cas 9 gene drives in fruit flies.
2018 / 11 / 29	At the CBD COP14, Parties reaffirmed that

ERA, public consent and scientific evidence should guide any future discussions regarding gene drive organism

2022 / 12 / 19

At the CBD COP15, Parties took into place Kunming-Montreal Global Biodiversity Framework. While also continuing discussions on governance, consent, risk assessment and oversight of emerging technologies such as gene drives.

Attempts to solve the issue

Synthetic biology (2022/12/19-7)(CBD/COP/DEC/15/31)

This resolution was submitted by the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD), where it was officially adopted on 19 December 2022. It focused on synthetic biology and the need to carefully monitor new scientific developments, so they do not harm biodiversity. It created a process where scientists, governments, and Indigenous Peoples could share information and study both the benefits and risks of synthetic biology. This resolution also supported the idea of precaution, as these technologies, such as engineered gene drives, could have uncertain effects on the environment.

Synthetic biology (2018/11/17-29)(CBD/COP/DEC/14/19)

This is a landmark agreement adopted at the 2018 UN CBD conference, where it was officially adopted on 27 November 2018. It asked countries to work together on synthetic biology and to carefully assess new technologies so they would not harm biodiversity or the communities that depend on it. The resolution supported the idea that governments should share information, monitor developments and ensure precautionary approaches before allowing new applications to spread. This helped encourage international cooperation and awareness;

however it did not force countries to take the same actions, meaning that the impact of this resolution depended on how governments chose to respond.

Programme of work of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2022/12/7-19)(CBD/COP/DEC/15/19)

This resolution was adopted by the COP to the CBD, where it was officially adopted on 19 December 2022. It asked for countries to work together on the Kunming-Montreal Global Biodiversity Framework (GBF), which set goals to protect nature, restore degraded ecosystems and strengthen biodiversity financing by 2030. The resolution supported the idea that governments should act together to reduce biodiversity loss, improve dialogue and use nature more sustainably. This helped encourage international cooperation and set global targets.

Possible Solutions

One possible solution to address the ethical and environmental implications of insect gene drive technologies would be strengthening international and national biosafety frameworks and research capacity. Organizations such as the CBD, AU and national governments should establish clear regulations regarding the research, testing and potential release of gene drive organisms. These frameworks must incorporate strict ethical evaluations, environmental risk assessments, and controlled testing protocols alongside consistent environmental monitor before large-scale application. Additionally, regional scientific cooperation through institutions like the AU can allow developing nations to share expertise and independently. This approach protects national sovereignty while balancing agricultural progress with environmental safety.

Another possible solution involved prioritising local engagement and ethical awareness in the decision-making processes involving insect gene drive technologies. Communities, farmers, scientists and policymakers impacted by these technologies should have the opportunity to participate in dialogue and decision-making. Before participating in formal decision making, stakeholders should be provided with targeted briefing and workshops covering the fundamentals, potential applications and biosecurity risks of gene editing.

Providing these educational resources ensure that local design makers are fully informed before taking action or making formal decisions. This transparent process helps address public concerns and eliminate misconceptions. Ultimately, it builds crucial trust within local communities making the decisions making process far more ethical.

Finally, cross border environmental monitoring and ongoing tracking systems should be established prior to the release of gene drive organisms. Because insect populations naturally migrate across national borders, releasing gene drive technologies in one country could cause unintended environmental impacts in neighbouring Sub-Saharan nations. Regional organisations, such as the AU, should coordinate shared monitoring systems to track biodiversity and evaluate potential consequences on non-target species across borders. Furthermore, regional mechanisms must be considered to respond effectively in uninvited ecological impacts occur. This collaborate approach is critical for protecting shared ecosystems and ensuring long-term food security across the region.

Guiding Questions

1. How does your country view the use of gene-drive technology in agriculture and public health?
2. Does your country have any national biotechnology, genetic engineering, or gene drive regulations or ethical review processes in place?
3. Has your country ever supported or opposed international negotiations around gene drive technologies in nature at the UN or CBD or IBC?
4. Does your country rely on agriculture which may be impacted by insect pests? Could gene drives benefit or harm that sector?
5. What are the primary ethical considerations with releasing gene-drive insects into the environment?
6. What environmental concerns might gene drive technologies pose to biodiversity, ecosystems and non-target species?
7. Who should determine whether to release gene drive organisms: national governments, scientists, local communities or international organizations?
8. Should communities affected by gene-drive releases be entitled to free, prior and informed

consent?

9. How can governments ensure that gene drive research is safe, transparent and accountable?
10. Should gene-drive technology be restricted to laboratory research until stricter international regulations are established?
11. How can gene-drive technologies be utilized to improve food security while avoiding unjust or negative consequences?

Appendix

- Ethical Considerations for Gene Drive: Challenges of Balancing Inclusion, Power and Perspectives: https://pmc.ncbi.nlm.nih.gov/articles/PMC8814439/
- Ethical, legal and social issues of genetically modifying insect vectors for public health: https://www.sciencedirect.com/science/article/abs/pii/S0965174805000639
- Gene drives, mosquitoes, and ecosystems: an interdisciplinary approach to emerging ethical concerns: https://www.frontiersin.org/journals/environmental-science/articles/10.3389/fenvs.2023.1254219/full
- Ugandan stakeholder hopes and concerns about gene drive mosquitoes for malaria control: new directions for gene drive risk governance: https://pmc.ncbi.nlm.nih.gov/articles/PMC7968178/
- Identifying Priorities for Risk Assessment of Gene Drive Mosquito: https://foodsystems.org/what-we-do/era/genedrives/
- Genetic Modification in Integrated Pest Management: https://afropolitanjournals.com/index.php/ajasfr/article/view/1268
- Gene drive strategies of pest control in agricultural systems: Challenges and opportunities: https://onlinelibrary.wiley.com/doi/10.1111/eva.13285
- United Nations Hits the Brakes on Gene Drives:

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