MANAGEMENT PRACTICE

GROUP PROJECT: BIOCENTIS

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A.Y. 2024/25

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CONTENTS

1. Biocentis's origins, history and governance profile

Biocentis is a biotechnology startup whose mission is to apply innovative genetic editing techniques to mitigate the agriculture and public health problems caused by malignant insects [S1]. To achieve their mission, they implement gene-drive, a technological tool used to control the size of insect populations by selectively reducing fertility [1]. With offices in the UK and Italy and a presence in the US, Biocentis has a diverse and highly qualified team of professionals with unparalleled experience in science and technology from all over Europe [S2][S3].

1.1. Origins & history

Biocentis was founded in 2022 by a group of researchers from the Imperial College London in collaboration with the technology investment group Neurone to create a more effective and sustainable alternative to pesticides [S4].

Since its foundation, Biocentis has embarked on a path of strong growth. In 2023, it was ranked first in a call for funding by the Italian Fund for Applied Sciences of the Ministry of Universities and Research. The project had a value of over 3 million euros and aimed to explore new genetic targets for biocontrol, especially in the case of the mosquito *Aegypti*, carrier of diseases such as dengue and yellow fever [S5][2].

Another important project which received additional EU funding was *PesTwin*, whose aim was to create an AI-based predictive model of how parasites interact with their surroundings, specifically in the case of the invasive pest of soft-shelled fruits *Drosophila suzukii* [S6][3]. The business grew its workforce in 2024 by adding professionals from the field like Dr. Kevin Gorman who was named Head of Development, with over 30 years of expertise as a public health and agriculture specialist. In addition, Biocentis has presented its cutting-edge genetic

solutions to a global audience at international gatherings like the World Agri-Tech Innovation Summit and the NOAH Conference in Zurich.

1.2. Governance profile

The founders of Biocentis are a group of people with different but complementary backgrounds, who combine business strategies and scientific knowledge. The following make up the leadership team [S2][S7]:

- Giorgio Rocca, Co-founder and CEO: he graduated from the University of Genoa with a degree in mechanical engineering. After that he obtained an MBA from the Collège des Ingenieurs and INSEAD. After more than five years as a healthcare-focused strategic consultant at the Boston Consulting Group he joined Biocentis. His background in strategy and entrepreneurship helps the business reach its objectives for innovation and growth.
- Kyros Kyrou, specialist in genetic control: he has accumulated BSc and PhD degrees in Biochemistry and Biotechnology from the University of Thessaly and Imperial College London. Before joining Biocentis, he spent many years working on malaria control solutions, using his scientific expertise to innovate biocontrol.
- Andrew Hammond, molecular biologist: he has over ten years of experience in genetic control and serves as co-founder and Head of R&D. The basis of Biocentis' technology is due to his contributing to the development of the most advanced gene drive systems. Having earned a PhD in Cell and Molecular Biology, he has held positions at esteemed academic institutions like Imperial College and Johns Hopkins. His research was also published in international journals such as Nature.
- Teodoro D'Ambrosio, Co-Founder and Executive Chairman: he has established himself as a successful entrepreneur by starting and overseeing many startups, including Prima Assicurazioni and Hotelscan, all of which have been acquired by big players in the industry.

Its companies have received over €500 million in funding. His background in securing funding and overseeing high-impact initiatives significantly contributes to Biocentis' growth and financial support.

- Federico Guelpa, Strategic Consultant for Oliver Wyman: he is a Bocconi University graduate with a Bachelor in Economics and Social Sciences who focuses on big financial institutions. His expertise in strategic planning and management of complex projects is crucial to the success of the company.
- Kevin Gorman, Head of Development: he has developed sustainable technologies for the agricultural and public health sectors for more than 30 years. Previously, he was Chief Development Officer at OXitec, where he headed international projects in North America, Latin America and Asia. Biocentis is better positioned in the global market thanks to its innovative technologies and leadership in biocontrol.

The team at Biocentis is also strengthened by scientists and experts with strong scientific backgrounds such as Alice Santi, Giulia Morselli, Dario Meacci and Matteo Rucco, who help in the research and development of the company's advanced technologies.

2. Product/service offerings

During Slush 2023, the most founder-focused event on earth delivering actionable company-building advice, Giorgio Rocca, CEO and Co-Founder of Biocentis, described the motivation behind Biocentis in clear terms [S8]:

> "Insects are the costliest animal group to society. Every year, they destroy 25% of global crops and cause 20% of all infectious diseases, leading to over $500 billion in damages."

Biocentis' technology reduces insect target species' fertility to decrease populations over time - no chemicals needed. They work in 3 main areas:

1. Fighting disease-carrying mosquitoes (especially *Aedes aegypti,* spreading dengue and Zika);
2. Managing agricultural pests like the invasive *Drosophila suzukii* fruit fly that damages crops;
3. Protecting ecosystems from invasive species [S9].

In describing the company's innovative strategy, Giorgio Rocca explained [S8]:

> "At Biocentis we propose a paradigm shift: rather than killing insects with toxic substances, we prevent their birth using advanced genetics. Engineered males mate with wild females but only pass on traits that suppress reproduction — leading to population collapse over multiple cycles."

So, their approach offers a targeted alternative to chemical pesticides, cutting environmental impact and health risks. The company's innovative genetic methods provide sustainable solutions where traditional pest control falls short.

2.1. Technologies used

Biocentis uses a proprietary CRISPR-Cas9-based gene editing platform to introduce specific and targeted genetic modifications in target insects [S9]. As stated by Giorgio Rocca [S8]:

> "Our platform is based on gene drive technology pioneered in 2003 and perfected by our team. We were the first to develop both a CRISPR-based gene drive and a working suppression drive — a milestone now powering major global malaria eradication efforts."

The goal is to reduce the fertility of the target population through a self-limiting modification, that is, one designed not to persist over time and disappear after a few generations. This approach substantially reduces the ecological risks associated with more invasive genetic strategies, such as permanent gene drives. The use of CRISPR-Cas9 technology achieves high genetic precision by acting only on essential biological traits of the target species without altering the DNA of other coexisting species in the ecosystem. The operation of the platform was described in the following steps:

1. Genetic modification of males of the target species to include traits related to female sterility or early lethality of females.
2. Environmental release of these modified males, which naturally mate with wild females.
3. Transmission of the modification: females born from mating do not reach reproductive age, while males survive and transmit the modification for only a few generations.
4. Gradual reduction of the population of the target species and extinction of genetic modification over time if releases cease.

Confirming the radical nature of the innovation, Biocentis is distinguished by a biological approach to controlling invasive fauna that is completely alternative to pesticides and chemical technologies, breaking with existing paradigms in pest control and presenting itself as a European pioneer of so-called "genetic biocontrol" [S9].

The technological maturity of the product is at the pre-commercial testing stage: Biocentis has already completed laboratory studies and initiated pilot projects to test efficacy and safety in semi-controlled environments. Currently, a commercial product is not yet available, but the company has received public and private funding, including grants specifically for *Aedes aegypti* mosquito control, and is actively involved in regulatory and scientific validation of its model.

In addition, Biocentis integrates advanced computational models and artificial intelligence to simulate the seasonal distribution of target species, improving release planning. As previously mentioned, a relevant example is *PesTwin*, a project developed in collaboration with the University of Pavia, which creates "digital twins" of ecosystems in order to test alternative scenarios before actual implementation [3]. This approach makes it possible to strengthen efficiency, reduce risk and extend the predictive value of Biocentis solutions.

Biocentis was established as a spin-off of Imperial College London and actively collaborates with numerous academic institutions and research centers to analyze the ecological, ethical and regulatory efficacy of its technologies [S4]. The scientific team has more than two decades of experience in insect genetic control, which is also documented by patents pending and peer-reviewed publications.

2.2. Technological advantages and competitive positioning

Compared with traditional methods of insect control, Biocentis' technology offers significant advantages that make it a radical innovation in the field of bioengineering applied to ecology.

- **Specificity:** the genetic modifications introduced are designed to act exclusively on the target species, minimizing side effects on other populations and ensuring a controlled ecological impact.
- **Sustainability:** the system drastically reduces the use of chemical pesticides, helping to protect the environment and human health. Unlike conventional insecticides, it leaves no toxic residues, does not affect pollinators or cause the emergence of resistance in pests.
- **Self-limiting:** genetic modifications are designed to be temporary, disappearing after a limited number of generations. This provides safer and more reversible control than other genetic approaches such as permanent gene drives, which are often criticized for their irreversibility and long-term ecological risks.
- **Adaptability:** the technology platform is modular and can be applied to different species of strategic interest, such as the mosquito *Aedes aegypti* or the fruit fly *Drosophila suzukii*, proving useful in both agricultural and health care settings.
- **Accuracy and efficiency:** the use of CRISPR-Cas9 technology ensures high accuracy in genetic editing. In addition, Biocentis is one of the few companies to combine genetic

editing with predictive computational models to simulate the distribution and impact of treatment in advance [S8]. One example is the *PesTwin* project [3].

2.3. Comparison with alternative solutions

A number of companies with similar missions exist on the international scene, including Oxitec (UK) and Agragene (US).

- Oxitec has developed male *Aedes aegypti* mosquitoes genetically modified not to produce female offspring, but its system is not self-limiting: males must be released continuously, and the genetic material may persist over time.
- Agragene focuses on controlling agricultural pests, such as *Drosophila suzukii*, by sterilizing males. However, its approach does not currently include environmental predictive models, nor is the degree of reversibility of the changes introduced clear.

Biocentis is differentiated by an integrated, multidisciplinary approach that combines:

1. Self-limiting, highly specific and controllable genetic technologies.
2. Integration with AI and environmental simulations for optimizing release strategies.
3. Strong scientific collaborations and a transparent focus on ethics, sustainability and traceability of its solutions.

These elements reinforce Biocentis' positioning as a European pioneer in the field of genetics applied to public health and agri-environmental protection.

3. Business model

The business model of an organization incorporates its entire strategy for generating, allocating and obtaining value. Any business must understand this idea since it clarifies how to make money and how a company engages with its environment to create a lasting impact. Customer channels,

customer relationships, revenue streams, key resources, key activities, primary partners cost structure and value propositions are the nine essential components of the business model [4]. These blocks, if well integrated, provide a clear and functional strategic framework, which is essential for an innovative company like Biocentis. A business model is more than just a description of how a company operates, it is a representation of the dynamics by which a company creates and distributes value [4]. In order to address health and agricultural concerns related to harmful insects, Biocentis uses innovative genetic editing techniques such as gene drive in the biocontrol industry to create value. Along with meeting consumer demands, these solutions support the UNs Sustainable Development Goals (SDGs) and enhance public health and the environment.

A solid business plan is essential to the expansion of any organization but it's very important for startups like Biocentis that aim to solve global problems in a unique way. With a clear business plan a company can leverage public and private partnerships, research and development and strategic alliances to generate value in a responsible and scalable manner in a competitive and fast-changing environment where sustainable solutions are becoming more and more necessary [4]. Given that the company is dealing with pressing global issues like the spread of insect-borne diseases and the overuse of pesticides the applicability of this model for Biocentis becomes even clearer. By providing scalable and eco-friendly solutions, Biocentis' creative and sustainable approach aims to revolutionize the biocontrol industry rather than just meet consumer demand.

Along with outlining the company's financial operations, Biocentis' business model offers a strategic vision that combines partnerships, resources and capacities to produce long-lasting positive effects. This model becomes a vehicle through which Biocentis can grow sustainably, contributing to the social, environmental and health well-being of the communities in which it operates. The business model is shown below in Figure 1.

The Business Model Canvas

Designed for: **Biocentis**

Designed by: **Altavilla Vincenzo, Di Stefano Giuseppe, Manzo Vincenzo**

Key Partnerships

- Imperial College London (official spin-off).
- Research funding agencies (UKRI, EIC, etc.).
- International health organizations and foundations.
- Univerisities and other technology partners for simulation and implementation (e.g., AI-based predictive tools).

Key Activities

- Development and testing of genetically modified insects for biological control.
- Scientific research and validation on the field.
- Field trials in collaboration with local and global partners.
- Management of regulatory and bioethical relationships with national and international bodies.

Key Resources

- Highly qualified scientific team with expertise in biology, genetics, AI and bioethical regulation.
- Patents on gene drive technology.
- Partnerships with universities, research centers and global health organizations.
- Infrastructures for genetic testing and bioinformatics simulations.

Value Propositions

- Gene drive technology that is safer, more controllable, and reversible compared to previous ones.
- Targeted control of harmful insect populations without the use of pesticides.
- Aligning with environmental sustainability and public health goals.
- Combining biotechnology and AI simulation to optimize field outcomes.

Customer Relationships

- Collaborative relationships with public entities and regulators.
- Co-development of solutions with clients (e.g., customized simulations for specific regions).
- Strong scientific transparency to build trust in this sensitive sector.

Channels

- Direct collaborations with global health institutions.
- Participation in research programs, scientific conferences and peer-reviewed publications.
- Communication via website and LinkedIn.

Customer Segments

- Public and international health agencies (e.g., WHO, ministries of health).
- Non-governmental organizations and foundations fighting vector-borne diseases (e.g., malaria, dengue).
- Governments and tropical regions vulnerable to mosquito-borne epidemics.
- Private companies involved in pest control or organic agricultural protection.

Cost Structure

- Research and development (laboratories, scientific personnel, experimentation).
- Costs related to regulations, approvals, and bioethics.
- Scientific communication and participation in competitive grant programs.
- Operational expenses related to partnerships, international project management, and logistics.

Revenue Streams

- Public and private funding and grants for R&D (already obtained from UKRI, EIC, etc.).
- Commercial agreements with health agencies or companies for field implementation.
- Licensing or sublicensing model of the gene technology to industrial partners or target countries.
- Potential SaaS offering or consulting for AI-based predictive simulations.

Figure 1 - Biocentis' business model canva.

3.1. Value creation

Value creation is the first fundamental step in Biocentis' business model, where the company generates innovative value through the application of advanced gene drive technologies for insect biocontrol. Biocentis solutions are unique in that they employ genetic editing methods, specifically CRISPR-Cas9, to alter insect DNA and lower fertility which aids in managing populations of dangerous species like the *Aedes aegypti* mosquito [5].

With the ability to transfer self-limiting genetic traits to offspring, gene drive gradually lowers the target insect population without the need for chemical pesticides [1]. Even though this strategy is radical it has many benefits over conventional techniques including being safe, scalable and environmentally friendly. Additionally gene drive is intended to be transient meaning that genetic modification ceases to exist after a few generations reducing ecological risks over the long term [1]. By fusing cutting-edge scientific knowledge with environmentally friendly methods, Biocentis is leading the way in biotechnology applications to agriculture and public health. Through strategic partnerships with academic and scientific institutions like Imperial College London (from which it grew as a spin-off), the company not only creates biological control solutions but also implements them in actual settings. Additionally, cooperation with academic institutions and research eases the development and validation of Biocentis technologies, guaranteeing that the solutions are both socially and scientifically responsible.

The company uses AI-based predictive models as part of its strategy to maximize the release of genetically modified insects and boost the effectiveness of biological control which goes beyond simple technological advancement. An example of this is the previously mentioned *PesTwin* project, developed in collaboration with the University of Pavia. This innovation is at the core

of Biocentis' value proposition which aims to improve society, the environment and health over the long run in addition to addressing important global issues [3].

3.2. Value delivery

According to Biocentis' business model, value is delivered through a network of strategic channels that allow the company to effectively distribute its technologies and guarantee that the appropriate people receive biocontrol solutions. Technologies are distributed through a variety of channels including direct channels and collaborations with both public and private entities.

Biocentis distributes its technologies mainly through licensing agreements and partnerships with government agencies, agricultural companies and international organizations concerned with public health [S2]. The company adopts a business model that is not limited to the direct sale of solutions, but promotes a licensing strategy for the use of its innovations, as gene drive, to institutions wishing to implement biocontrol technologies in agricultural or health environments. By doing this Biocentis can swiftly expand its solutions throughout various regions and modify them to meet the unique requirements of regional markets. Developing strategic alliances is another essential component of providing value. Biocentis has partnered with government organizations and academic institutions including London's Imperial College to test and validate its solutions in practical environments [S4]. These collaborations help Biocentis secure grants and public funding for its technological innovation initiatives in addition to offering the support required for research and development. To carry out its projects in areas with little funding and combat endemic illnesses like malaria, the company also collaborates with NGOs and global organizations like the OMS.

Finally, Biocentis uses digital channels and scientific publications to educate and inform the public and policy makers about the benefits of biocontrol technologies. Awareness campaigns

aim not only to strengthen the company's image, but also to build public consensus in favour of adopting new biological technologies such as gene drives [1].

3.3. Value capture

The process through which Biocentis maximizes the impact of its biocontrol solutions ensures long-term growth and generates sustainable revenues from its technological innovations is central to the company's business models value capture. This process is articulated through a diversified revenue strategy, which includes licensing, grants and research contracts.

Licenses to use Biocentis gene drive technologies are one of the company's primary sources of income. Agricultural health organizations and governments that wish to employ biocontrol techniques to reduce the population of harmful insects such as disease-carrying mosquitoes are granted these licenses. The license allows Biocentis to monetize its technologies and at the same time spread sustainable solutions on a large scale, without having to directly manage the implementation in each individual market.

In addition, Biocentis receives public grants and research funding from government agencies and international organizations such as the European Union and the Ministry of Universities and Research [S5]. Without depending entirely on licensing fees this funding enables the business to expand its innovation capabilities and carry out more sophisticated research projects. Projects supported are often oriented towards the optimisation of technologies and the expansion of applications in the agricultural and health sectors.

In addition to licenses and grants, Biocentis has developed strategies to monetize its biotechnological solutions through strategic collaborations with farms and public institutions. These collaborations result in research contracts that can generate revenue from joint projects and field trials, as well as giving the company the opportunity to collect data which further refine its solutions [S6].

Another important aspect of monetization is the application of technology to multiple sectors. Although the company started with public health and agriculture, the potential for gene drive application in other areas, such as protecting ecosystems from invasive species, could generate new sources of revenue in the future. The modular approach of Biocentis' solutions allows the company to expand into new markets, such as environmental protection, through innovative applications.

Biocentis' operating cost structure includes expenses for the research and development of genetic solutions, which represent a significant part of the company's budget. Along with the costs of producing and delivering solutions globally the business also has to pay for the certifications and laws that guarantee its technologies are secure and acceptable for use in various markets.

Institutional investors, government grants and the assistance of strategic partners have all contributed to Biocentis strong financial structure. The business has raised money to help with its expansion including through biotechnology and innovation-focused venture capital rounds. These funds are utilized to scale production, advance research and raise Biocentis profile internationally.

3.4. Conclusions

Biocentis' commitment to sustainability and technological innovation forms the foundation of its distinctive business strategy. Value creation through sustainable and scalable technologies that address pressing health and agricultural needs is the model's primary strength. Because of its extensive network of strategic partnerships with academic and governmental organizations, Biocentis is able to profit from its inventions through grants and licensing. With this strategy it can increase its impact on a global scale and its solutions scalable model allows it to adjust to various markets and situations. Despite these benefits, the company can still improve by

expanding its distribution networks, boosting investment in education and communication to raise public awareness of its innovative solutions and diversifying its revenue streams to fortify the model.

To summarize, Biocentis has a strong business plan that emphasizes sustainability and innovation. It also has lots of room to grow and optimize in order to maintain its position as the industry leader.

4. Social purposes and sustainable needs

Biocentis can be clearly seen as a company driven by a social purpose. By combining technological effectiveness with an ethical and environmental responsibility and through an approach based on precision, safety and sustainability, the company is setting the way for a new generation of scalable interventions that simultaneously address health and agricultural needs.

From a social point of view, Biocentis' mission focuses particularly on three key factors: the fight against vector-borne diseases, the promotion of a more sustainable agricultural production and the protection of ecosystems and biodiversity. According to the World Health Organization (WHO), vector-borne diseases such as malaria, dengue, chikungunya and Zika virus are responsible for more than 700,000 deaths annually and pose an increasing global threat due to climate change and globalization[1]. These three challenges are fully aligned with the United Nations Sustainable Development Goals (SDGs)[2] and the UN Vision 2050, which aims for a healthier and more resilient global future. The genetic solutions promoted by Biocentis against mosquitoes and agricultural pests make a concrete contribution to the realization of these objectives. Having said that, Biocentis shows itself as a company capable of transforming biotechnology into tools with a positive impact and with a vision that integrates scientific innovation and collective benefit.

[1] https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases
[2] https://sdgs.un.org/goals

4.1. Combatting vector-borne diseases (SDG 3)

A significant global health emergency is the spread of some known diseases such as dengue, Zika and chikungunya, all of them transmitted by the *Aedes aegypti* mosquito. [5] With its next-generation genetic control technology based on engineering male mosquitoes with a self-limiting gene, this technology contributes directly to the achievement of SDG 3 (Good health and Well-being), which involves reducing communicable diseases and enhancing epidemic response capacities. The first main advantage is that this is an approach which is non-chemical but also particularly suitable for low-income countries, in which conventional insecticides are often inaccessible. Biocentis thus offers a scalable, safe and environmentally perfect solution which reduces the health burden and improves the quality of life for affected communities.

4.2. Enhancing agricultural sustainability (SDG 2 and SDG 12)

In the agriculture sector, the main problem Biocentis deals with is the growing issue of invasive insect pests, above all of them, the *Drosophila suzukii*, which damages fruits making timely chemical intervention difficult and therefore causing severe economic losses. Pesticides that are currently in use to try to stop this phenomenon also harm pollinators and other beneficial organisms, so they are half-effective. Moreover, pests are also rapidly evolving resistance.

Biocentis' idea of applying the same self-limiting genetic technology to this species produces a targeted reduction in the pest population without impacting other species and without using pesticides, thus contributing to a cleaner and longer production. This technology supports the achievement of SDG 2 (Zero Hunger) by improving agricultural yields, and SDG 12 (Responsible Production and Consumption) by supporting sustainable cropping practices and reducing soil and water pollution [6].

4.3. Environmental protection and biodiversity (SDG 13 and SDG 15)

Conventional insect control methods often carry significant ecological impacts: insecticides can persist in the environment, accumulate in food chains and affect even beneficial insects such as bees and butterflies. As previously said, Biocentis' technologies offer a non-permanent, species-specific and reversible alternative [6]. Reversible because if the release of the modified insects stops, the wild population recovers, as reported in the graph shown in Figure 2.

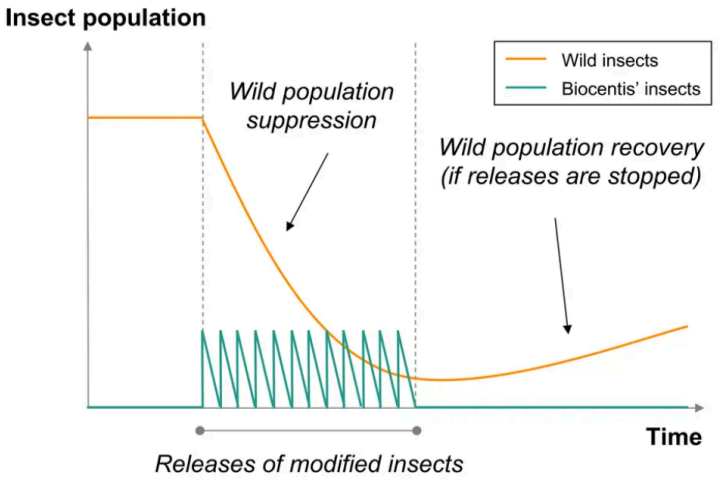

Figure 2 - Illustrative dynamics of the reversibility of the Biocentis' gene-drive process. Image taken by "Biocentis: a mix of molecular biology and data science", Matteo Rucco & Andrea De Antoni, 11th December 2023[3].

Mosquitoes and modified insects leave no lasting genetic alteration in the environment, as the self-limiting genes die out in a few generations. Biocentis' CEO Giorgio Rocca emphasized this point in his talk at the NOAH Conference in London in 2024 [S10]:

> "Our system is scalable, reversible and designed for field deployment. Instead of shipping tons of adult insects, we distribute eggs. Our expected cost is under $50 per hectare per year, a fraction of what chemical insecticides cost. We offer one of the greenest pest control technologies ever conceived — without needing to charge a green premium."

[3] https://www.slideshare.net/slideshow/how-does-biocentis-model-simulate-and-optimize-the-release-of-genedrive-insects/264722271

This particularity totally contributes to the protection of biodiversity, safeguarding local ecosystems and therefore satisfying SDG 15 (Life on land). Additionally, by reducing the dependence on oil derived chemical agents, Biocentis helps stop indirect greenhouse gas emissions, in line with SDG 13 (Combating Climate Change) goals. All of this allows a more efficient ground management and also a good prevention of deforestation and environmental degradation. This all agrees with the UN 2050 vision for a regenerative and productive agriculture that respects natural balances.

4.4. Scalability, ethics and scientific collaboration

The technologies developed by Biocentis can be extended to various pest species in both medical and agricultural settings. A significant element of their work is the previously mentioned collaboration with the University of Pavia for the development of advanced predictive models and simulative tools for the control of the *Drosophila suzukii* midge [3]. This project is a concrete example of synergy between academic research and biotechnology enterprise. The integration of biotechnology and AI enables more targeted, effective and sustainable interventions, helping to reduce pesticide use and protect agricultural productivity.

The reversible and self-regulated approach adopted by Biocentis helps to overcome one of the main public concerns about genetically modified organisms: the fear of permanent effects on the environment. Through safety, transparency and ethics-oriented design, Biocentis presents itself as a reliable player in sustainable biotechnology, potentially acceptable even in very restrictive regulatory environments.

5. Potential risks and ideas for future business development

Significant growth prospects and intricate problems requiring strategic vision are constant challenges for Biocentis. Working at the core of environmental ethics, public health and biotechnology, the company must proactively manage risks while identifying opportunities for responsible and sustainable growth. Using a long-term impact and resilience perspective, the following is a critical analysis of specific risks and future development opportunities for the company, based on current scientific literature and best practices from the real world.

5.1. Opportunity: early engagement with local communities

According to a 2022 study by Pare Toe et al. published in *Malaria Journal*, community engagement (when conducted by time and with a culturally sensitive approach) plays a critical role in increasing social acceptance of gene drive interventions [7]. The experience of the Target Malaria consortium demonstrates that engaging local communities through participatory workshops, transparent communication and co-development activities fosters trust and mitigates resistance [7].

This could be relevant for Biocentis, whose field applications may involve areas in South America or South Asia, regions where historical mistrust of western biotechnologies may still persist. By investing in structured community engagement strategies, Biocentis could not only reduce future opposition and delays in field trials but also differentiate itself from competitors by demonstrating a commitment to ethical deployment.

Biocentis should integrate local stakeholder mapping and participatory planning in its operations, thereby ensuring long-term acceptance and minimizing implementation risks.

5.2. Risk: potential unintended consequences of gene-drive applications

One of the primary risks facing Biocentis lies in the inherent unpredictability of gene-drive systems when released into natural environments. Despite advances in control and reversibility, gene drives are designed to spread genetic modifications through wild populations, and their long-term ecological impacts remain only partially understood [8]. There are in fact some possible outcomes such as off-target genetic effects, the disruption of ecological networks or the suppression of non-target species. Moreover, natural selection may favor mutations that allow target populations to evolve resistance to the gene drive over time, which could compromise the technology's effectiveness and generate unpredictable dynamics [8]. This presents a double challenge for Biocentis: firstly, these ecological consequences could lead to reputational damage and regulatory restrictions; secondly, technical failure could weaken the future product's commercial viability.

To mitigate both ecological and societal risks, Biocentis should adopt a strategy that combines both technical research and robust community engagement, as previously said. This includes intensifying efforts on resistance-proof gene drive architectures (such as multiplexing or threshold-dependent systems), expanding ecological simulation models and collaborating with evolutionary biologists and ecologists. At the same time, establishing a structured framework for community engagement, with early consultation, will help build social legitimacy, facilitate implementation and position Biocentis as an ethical leader in this emerging field.

References

[1] Gantz, V. M., et al. (2015). Engineered gene drives. *Nature*, *523*(7565), 1–7.

[2] Ang, J. et al. (2025). Synthetic homing endonuclease gene drives to revolutionise *Aedes aegypti* biocontrol – Game changer or pipe dream? *Current Opinion in Insect Science*, 101373.

[3] Fenton, B., et al. (2021). PesTwin: Advanced predictive models for pest control. *Journal of Agricultural Technology*, *12*(4), 200–210.

[4] Osterwalder, A., & Pigneur, Y. (2010). *Business model generation: A handbook for visionaries, game changers, and challengers*.

[5] Reitmayer, C. M. et al. (2023). Mimicking superinfection exclusion disrupts alphavirus infection and transmission in the yellow fever mosquito Aedes aegypti. *Proceedings of the National Academy of Sciences*, *120*(37), e2303080120.

[6] Jones, M. S., & Brown, Z. S. (2023). Food for thought: Assessing the consumer welfare impacts of deploying irreversible, landscape-scale biotechnologies. *Food Policy*, 121, 102529.

[7] Pare Toe, L. et al (2022). Operationalizing stakeholder engagement for gene drive research in malaria elimination in Africa—translating guidance into practice. *Malar J* 21, 225.

[8] Champer, J et al. (2016). Cheating evolution: engineering gene drives to manipulate the fate of wild populations. *Nature Reviews Genetics, 17*(3), 146–159.

Sitography

[S1] Biocentis. (n.d.). *Official Website*. Retrieved from https://www.biocentis.com/

[S2] Biocentis. (n.d.). *Biocentis – Company*. Retrieved from https://www.biocentis.com/company

[S3] Crunchbase. (n.d.). *Biocentis Company Profile*. Retrieved from https://www.crunchbase.com/organization/biocentis

[S4] Imperial College London. (2023). *Imperial startup Biocentis to develop genetic tech for controlling harmful insects*. Retrieved from https://www.imperial.ac.uk/news/242793/imperial-startup-biocentis-develop-genetic-tech/

[S5] Biocentis. (n.d.). *Biocentis – News: Biocentis ranked first in a grant call to develop genetic control technologies for Aedes aegypti mosquito*. Retrieved from https://www.biocentis.com/news/biocentis-ranked-first-in-a-grant-call-to-develop-genetic-control-technologies-for-aedes-aegypti-mosquito

[S6] Biocentis. (n.d.). *Biocentis – News: Biocentis has been awarded a grant to pioneer the development of AI-based simulation tools to predict the seasonal distribution of harmful insects*. Retrieved from https://www.biocentis.com/news/biocentis-has-been-awarded-a-grant-to-pioneer-the-development-of-ai-based-simulation-tools-to-predict-the-seasonal-distribution-of-harmful-insects

[S7] Biocentis. (n.d.). *LinkedIn Page*. Retrieved from https://www.linkedin.com/company/biocentis/

[S8] Biocentis. (n.d.). *YouTube interview with Giorgio Rocca [Video]*. Retrieved from https://www.youtube.com/watch?v=6es08Bg2wGE

[S9] Biocentis. (n.d.). *Biocentis – Science and Technology*. Retrieved from https://www.biocentis.com/science-and-technology

[S10] Biocentis. (n.d.). *YouTube interview – Additional [Video]*. Retrieved from https://www.youtube.com/watch?v=kQ6dkXunocQ