# Enhancing biosecurity for genetically modified organisms import and distribution in Indonesian agriculture

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**Abstract.** This research focuses on developing robust biosecurity protocols for the import and distribution of Genetically Modified Organisms (GMOs) in Indonesian agriculture. Through stakeholder perspectives and surveys, critical biosecurity indicators were identified, including regulatory compliance, environmental impact, public health and safety, industry best practices, and transparency/accountability. The findings reveal a strong emphasis on regulatory compliance and environmental protection, reflecting stakeholders' awareness of legal complexities and environmental risks associated with GMOs. While stakeholders express overall satisfaction with current protocols, areas for improvement include enhanced collaboration, training programs, clear guidelines, streamlined processes, and improved communication channels. Recommendations for future action include fostering collaboration between stakeholders and regulatory bodies, investing in training and capacity building, promoting transparency and public awareness, and enhancing trust in GMO technology. This research contributes to strengthening Indonesia's biosecurity framework, ensuring safe GMO importation and distribution for sustainable agriculture and environmental conservation.

## 1 Introduction

The responsible import and distribution of Genetically Modified Organisms (GMOs) for food production has become a significant point of contention and discussion within Indonesia's agricultural landscape. The focus lies specifically on the port and shipping management program, which plays a crucial role in the transfer, distribution, and management of biotechnology products [1]. This research endeavours to address the pressing need for robust biosecurity protocols to ensure public safety and environmental protection amidst the evolving GMO debate in Indonesia. The urgency of this research stems from the growing importance of GMOs in modern agriculture and the need for clear guidelines on their import and distribution. With Indonesia's diverse ecosystems and regulatory framework, establishing context-specific biosecurity protocols becomes paramount. The lack of such

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protocols can lead to potential risks to public health and environmental integrity, underscoring the critical nature of this research.

The novelty of this research lies in its potential to develop a comprehensive framework for biosecurity protocols tailored to Indonesia's unique context [2,3]. By analysing stakeholder perspectives, including experts in biology, sustainable management, food and nutrition, agricultural management, and port and shipping industry professionals, this research aims to create protocols that not only meet regulatory standards but also incorporate practical insights and industry best practices [4,5]. The objectives of this research are twofold: first, to design biosecurity protocols that effectively manage the import and distribution of GMOs for food production; and second, to foster public trust in GMO technology through transparent and well-defined protocols [6,7]. This research recognises the importance of engaging stakeholders at every stage to ensure that the protocols developed are not only robust but also acceptable and practical within the Indonesian agricultural context.

The gap analysis in this research highlights the current deficiencies in biosecurity protocols for GMOs in Indonesia. Existing protocols often lack specificity and fail to account for the diverse challenges posed by GMO importation and distribution [8,9]. By addressing these gaps, this research aims to contribute significantly to the advancement of biosecurity practices in Indonesian agriculture, ultimately facilitating informed decision-making regarding GMO use and enhancing food production sustainability. This research serves as a critical step towards establishing effective biosecurity protocols for GMOs in Indonesia. By leveraging interdisciplinary expertise and stakeholder engagement, this study aims to bridge the gap between regulatory requirements and practical implementation, ultimately fostering a safer and more sustainable approach to importation and distribution in the Indonesian agricultural sector [7,10,11].

## 2 Method

The research method employed in this study aligns with the interdisciplinary nature of the topic, focusing on developing biosecurity protocols for the import and distribution of Genetically Modified Organisms (GMOs) for food production in Indonesia. Given the complexity of this subject, a multi-faceted approach was adopted to ensure comprehensive data collection, analysis, and protocol development [12,13]. To begin with, a thorough literature review was conducted to establish a solid foundation of existing knowledge and practices related to GMO biosecurity protocols. This step was crucial in understanding global trends, regulatory frameworks, best practices, and potential challenges associated with GMO importation and distribution. The literature review also helped identify gaps in current protocols, which served as a basis for the research's objectives and focus areas.

Following the literature review, qualitative research methods were employed to gather insights from key stakeholders. This included conducting interviews, focus group discussions, and surveys with experts in various fields relevant to GMO biosecurity. These experts included professionals in biology, sustainable management, food and nutrition, agricultural management, and individuals from the port and shipping industry. Their diverse perspectives provided valuable insights into the practical challenges, regulatory requirements, and industry standards related to GMO import and distribution. Additionally, case studies were analysed to understand real-world scenarios and learn from past experiences in GMO importation and distribution. These case studies, drawn from both domestic and international contexts, offered valuable lessons and best practices that could be adapted to Indonesia's unique agricultural landscape.

Data analysis was a crucial component of the research method, involving qualitative techniques such as thematic analysis and content analysis [14,15]. The data collected from

interviews, focus groups, surveys, and case studies were systematically analysed to identify recurring themes, patterns, and key findings. This analysis not only helped in understanding stakeholder perspectives but also informed the development of context-specific biosecurity protocols. The research method also included a participatory approach, where stakeholders were actively engaged throughout the research process. Their input and feedback were sought at various stages, from protocol design to validation, ensuring that the developed protocols were practical, feasible, and aligned with industry expectations.

Furthermore, the research method emphasised collaboration and knowledge sharing among researchers and stakeholders. Workshops, seminars, and collaborative meetings were organised to facilitate dialogue, exchange ideas, and co-create solutions to biosecurity challenges related to GMO importation and distribution. The research method employed a combination of literature review, qualitative research techniques, case studies, data analysis, participatory approaches, and collaboration to develop robust and context-specific biosecurity protocols for GMOs in Indonesia. This methodological approach ensured that the research outcomes were grounded in empirical evidence, reflective of stakeholder perspectives, and capable of addressing the urgent need for enhanced biosecurity in GMO-related activities.

## 3 Result

The results of the research on building biosecurity protocols for the import and distribution of Genetically Modified Organisms (GMOs) for food production in Indonesia are presented here comprehensively, with academic rigour and effective data presentation including tables to aid in understanding and interpreting the findings.

**Table 1.** Stakeholder Perspectives on Biosecurity Indicators

| Indicator | Value of Intensity of Importance (1-5) | Score (1-100) | Percentage (%) |
|---|---|---|---|
| Regulatory Compliance | 4 | 80 | 80% |
| Environmental Impact | 5 | 100 | 100% |
| Public Health and Safety | 4 | 80 | 80% |
| Industry Best Practices | 3 | 60 | 60% |
| Transparency and Accountability | 5 | 100 | 100% |

The data from stakeholder perspectives were analysed using a structured approach to determine the intensity of importance for each biosecurity indicator. Table 1 summarises these findings, showcasing the level of significance attributed to various aspects of biosecurity by stakeholders. Regulatory compliance emerged as a top priority, with an intensity of importance score of 4 out of 5 (80%) indicating a strong emphasis on adhering to regulatory frameworks and guidelines. This underscores the stakeholders' recognition of the legal and regulatory complexities surrounding GMO importation and distribution.

Environmental impact also received a high intensity of importance score of 5 (100%), highlighting stakeholders' concern for mitigating potential environmental risks associated with GMOs. This includes considerations for biodiversity, ecosystem resilience, and long-term sustainability. Public health and safety, another critical aspect, garnered a score of 4 (80%), indicating a significant focus on ensuring that GMOs do not pose risks to human health or food safety. This includes rigorous testing, monitoring, and traceability measures throughout the supply chain.

Industry best practices and transparency/accountability were rated slightly lower, with scores of 3 (60%) and 5 (100%) respectively. While stakeholders recognised the importance of adhering to industry standards and promoting transparency in GMO-related activities, there were areas identified for improvement, such as enhancing collaboration with regulatory bodies and ensuring clear guidelines on GMO labelling. Additionally, a stakeholder survey was conducted to gauge overall satisfaction and identify areas for improvement in biosecurity protocols. Table 2 summarises the survey results, showcasing the satisfaction levels across different stakeholder groups and highlighting key areas for enhancement.

**Table 2.** Summary of Stakeholder Survey Results

| Stakeholder Group | Overall Satisfaction (1-10) | Areas of Improvement |
|---|---|---|
| Biology Experts | 8 | Enhanced collaboration with regulatory bodies |
| Sustainable Management Professionals | 7 | More training and awareness programs |
| Food and Nutrition Academics | 9 | Clearer guidelines on GMO labelling |
| Agricultural Management Experts | 6 | Streamlined approval processes |
| Port and Shipping Industry Professionals | 7 | Improved communication channels |

Biology experts expressed a high level of satisfaction (8 out of 10) with biosecurity protocols, with a particular emphasis on improved collaboration with regulatory bodies. Sustainable management professionals rated their satisfaction at 7, indicating a need for more training and awareness programs to enhance biosecurity practices. Food and nutrition academics reported the highest satisfaction level (9 out of 10), underscoring the effectiveness of current protocols in addressing their concerns. However, they noted a need for clearer guidelines on GMO labelling to enhance consumer awareness.

Agricultural management experts and port and shipping industry professionals expressed moderate satisfaction levels (6 and 7 respectively) and highlighted areas such as streamlined approval processes and improved communication channels as crucial for enhancing biosecurity protocols. The survey results provide valuable insights into stakeholder satisfaction and areas for improvement, which can guide the refinement and implementation of biosecurity protocols in the import and distribution of GMOs for food production in Indonesia.

## 4 Discussion

The discussion of the research findings on building biosecurity protocols for the import and distribution of Genetically Modified Organisms (GMOs) for food production in Indonesia delves into the implications, challenges, and recommendations based on the results obtained from stakeholder perspectives and surveys. Firstly, the research identified key biosecurity indicators that stakeholders deemed critical in ensuring the safe and responsible import and distribution of GMOs. Regulatory compliance emerged as a top priority, reflecting stakeholders' awareness of the legal and regulatory complexities surrounding GMOs. This finding aligns with global trends where regulatory frameworks for GMOs vary widely, necessitating clear guidelines and adherence to local regulations to mitigate risks and ensure compliance with international standards. The high intensity of importance assigned to environmental impact underscores stakeholders' concern for biodiversity conservation, ecosystem resilience, and sustainable agricultural practices [16,17]. This aligns with

Indonesia's rich biodiversity and fragile ecosystems, highlighting the need for biosecurity protocols that minimise environmental risks associated with GMOs.

Public health and safety also received significant attention, reflecting stakeholders' recognition of the potential risks GMOs may pose to human health and food safety. This emphasises the importance of rigorous testing, monitoring, and traceability measures throughout the GMO supply chain to ensure consumer protection and confidence. Industry best practices and transparency/accountability were identified as areas for improvement, indicating a need for enhanced collaboration with regulatory bodies, clearer guidelines on GMO labelling, and increased transparency in GMO-related activities. This finding highlights the importance of fostering a culture of accountability, transparency, and continuous improvement in biosecurity practices within the GMO industry.

The stakeholder survey results provided valuable insights into overall satisfaction levels and areas for improvement in biosecurity protocols. Biology experts expressed a high level of satisfaction, suggesting that current protocols effectively address their concerns. However, sustainable management professionals identified the need for more training and awareness programs, indicating a gap in knowledge and understanding of biosecurity practices among certain stakeholder groups. Food and nutrition academics reported the highest satisfaction level, reflecting the effectiveness of current protocols in addressing their specific concerns. Nonetheless, they highlighted the importance of clearer guidelines on GMO labelling to enhance consumer awareness and informed decision-making.

Agricultural management experts and port and shipping industry professionals expressed moderate satisfaction levels and identified streamlined approval processes and improved communication channels as key areas for enhancing biosecurity protocols. This indicates the need for streamlined procedures and effective communication mechanisms to facilitate smoother GMO importation and distribution processes [8,9]. The discussion of research findings underscores the multifaceted nature of GMO biosecurity, requiring a holistic approach that addresses regulatory compliance, environmental impact, public health and safety, industry best practices, and transparency/accountability. It is imperative to engage stakeholders collaboratively throughout the protocol development and implementation process to ensure practicality, feasibility, and acceptance within the Indonesian agricultural context.

Challenges such as regulatory complexities, varying stakeholder priorities, and limited resources may pose hurdles in implementing robust biosecurity protocols. Therefore, a phased approach with clear milestones, continuous monitoring, and evaluation mechanisms is recommended to track progress, address challenges, and adapt protocols as needed. Moving forward, recommendations include enhancing collaboration between industry stakeholders and regulatory bodies, investing in training and capacity building programs, promoting transparency and accountability in GMO-related activities, and fostering public awareness and trust through clear communication and education initiatives.

The discussion highlights the importance of evidence-based decision-making, stakeholder engagement, continuous improvement, and adaptive management in developing and implementing effective biosecurity protocols for GMOs in Indonesia. By addressing the identified challenges and leveraging opportunities for improvement, Indonesia can strengthen its biosecurity framework, enhance food production sustainability, and foster innovation in agricultural biotechnology for the benefit of society and the environment.

## 5 Conclusion

The research on building biosecurity protocols for the import and distribution of Genetically Modified Organisms (GMOs) for food production in Indonesia highlights the importance of a comprehensive and context-specific approach to address the diverse challenges and

complexities associated with GMOs. The findings underscore the critical need for robust biosecurity protocols that ensure regulatory compliance, mitigate environmental risks, protect public health and safety, adhere to industry best practices, and promote transparency and accountability. Stakeholder perspectives and survey results provide valuable insights into the priorities, concerns, and satisfaction levels regarding current biosecurity protocols. While there is a general satisfaction with the effectiveness of existing protocols, there are clear areas for improvement, such as enhancing collaboration, improving training and awareness, clarifying guidelines, streamlining processes, and enhancing communication channels. Moving forward, it is essential to leverage these findings to refine and implement biosecurity protocols that are practical, feasible, and acceptable within the Indonesian agricultural context. This includes strengthening collaboration between stakeholders and regulatory bodies, investing in capacity building and education programs, promoting transparency and accountability, and fostering public awareness and trust in GMO technology. By addressing these recommendations, Indonesia can establish itself as a leader in biosecurity practices, ensuring the safe and responsible import and distribution of GMOs for sustainable food production and environmental conservation.

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