

Building Bridges of Understanding: Enhancing Communication Strategy on Genome Editing in Nigeria

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Abstract. Genome editing (GE) has been mired in confusion and low public understanding. The inadequacy of information and the society's comprehension capacity (especially in Africa) has created a thread across this important field. This paper explores the critical need for effective communication strategies to disseminate genome editing technologies in Africa, using Nigeria as a case study. GE represents a transformative approach to addressing significant challenges in agriculture, healthcare, and environmental sustainability. However, the successful adoption of GE hinges on society's understanding and acceptance of its implications. This study assesses the readiness of selected African countries, existing communication practices and identifies gaps that hinder effective stakeholder engagement. Through a comprehensive review of the literature, an assessment of the policy framework, and stakeholder mapping, we propose a structured communication framework to navigate Nigeria's socio-cultural context. The novel, tailor-made framework emphasises transparency, public engagement, and the integration of diverse communication channels to enhance awareness and understanding of genome editing. The framework focused on adopting a product-based communication strategy. By fostering dialogue among scientists, policymakers, and the general public, this paper contributes to developing inclusive policies that leverage the full potential of genome-editing technologies for socio-economic advancement in Nigeria and beyond.

Keywords: Genome Editing; Effective Communication Strategies; Policy frameworks Environment; Effective Stakeholder Engagement and Product-based Communication Strategy.

INTRODUCTION

Genome editing (GE) represents a revolutionary advancement in biotechnology, enabling modifications to deoxyribonucleic acid (DNA) in living

organisms. This transformative technology offers significant potential across diverse sectors, including healthcare, agriculture, environmental conservation, and industrial production [1]. GE

is increasingly recognised as a vital tool for addressing pressing challenges in agriculture and healthcare, particularly in regions such as Africa, where food security and disease burdens remain critical [2]. However, the adoption of genome-editing technologies necessitates robust ethical and regulatory frameworks, along with a targeted communication strategy that accounts for public understanding and acceptance [3]. The primary objective of any communication effort is to increase GEd's degree of acceptance, which is built on increasing knowledge and education among all stakeholders. Communication efforts are essential to ensuring the adoption of genome-editing technology and innovations. These communication efforts should emphasise greater transparency, discuss the ethical implications, and positively influence public perception of the technology. The authors' research [1] found that customised communication that connects scientific discoveries to the public is of great importance. Also, communicating clearly and concisely across the breadth of stakeholders – legislators, regulators, and the public – is an essential part of effective science communication [4].

One way to advance genome editing across various African countries, including Ethiopia, Ghana, and Nigeria, is to implement a national stakeholder awareness campaign [5]. These efforts will not only increase awareness and acceptance of this technique but also help alleviate societal concerns about genome editing [1]. Authors [1] emphasised the importance of case studies or success stories, in addition to broad stakeholder engagement, to build trust in genome editing, while ensuring regulators and policymakers have access to credible resources to create informed and effective regulatory processes.

Given these circumstances, effective communication is critical to advancing genome-editing technologies. These methods should emphasise ethical issues, address public concerns, and foster social acceptance. To realise the transformative potential of genome editing in addressing global challenges, it is necessary to combine science communication with regulatory frameworks and stakeholder engagement, as the authors [1] explain. This study provides new perspectives to augment knowledge and social acceptability of genome editing (GEd) in Nigeria. By examining institutional capacity, infrastructure, and regulatory frameworks—including GEd-specific biosafety laws and policies—it evaluates the enabling environment for GEd in a handful of African

countries. The study specifically addresses research and policy needs related to crops such as rice in Burkina Faso and Cassava in Nigeria. It assesses the interactions among senior institutions, parent ministries, GEd initiatives, and the public.

Additionally, the study takes up the challenge of bridging the communication gap around genome editing, as identified by AUDA-NEPAD, by applying lessons learned from their initial assessment and incorporating inputs from NABDA. This paper, entitled "Building Bridges on Understanding: Enabling Communication Strategy on Genome Editing in Nigeria," emphasises the need for broad dissemination of the complexities of genome editing and for facilitating dialogue among stakeholder groups. The study seeks to contribute to an all-inclusive, transparent communication strategy grounded in globally accepted models and tailored to the Nigerian context. This communication structure will be established through an assessment of current communication practices, identification of gaps, evidence-based recommendations, and targeted stakeholder mapping to customise content for various socio-economic segments.

Frameworks For Developing Genome Editing National Communication Strategy

1) Overview. As one of the leading African countries in genome-editing technology, Nigeria has undertaken a genome-editing sensitisation workshop organised by the National Biotechnology Development Agency (NABDA) in partnership with the AUDA-NEPAD Centre of Excellence in Science, Technology and Innovation (CoE-STI). In Nigeria, as in other African countries, GEd presents immense potential to address pressing challenges essential to accelerating socio-economic development and improving the quality of life. Specific benefits of genome editing include advantages in green (agriculture), red (healthcare), and white (industrial production) biotechnology. The economic potential of genome editing technology in agriculture can be harnessed to enhance resistance to diseases, pests, and environmental stresses, thereby improving yield and nutritional quality in key crops such as cowpea, yam, and Cassava [6]. Increasing agricultural efficiency through ongoing research and development in genome editing is a prerequisite for achieving food sufficiency and advancing agro-processing objectives [2, 5]. At the same time, red biotechnology portends advantages,

such as adaptive bacterial immunity [7]. In addition, white biotechnology derives from the cumulative benefits of agriculture by accelerating growth in agro-processing and industrial production.

As part of total quality management, continuous improvement in genome editing will be driven by benchmarking against global best practices and international guidelines regarding scientific protocols, new findings, emerging risks, and ethical, policy, and regulatory standards [8]. Furthermore, effectively communicating the benefits of genome editing is critical for bridging information and knowledge gaps related to potential misuse, safety, suitability, and sustainability. As a

tool for public engagement, robust communication is essential to framing science, technology, and innovation policies that align genome-editing initiatives with societal values and ethical considerations, thereby supporting inclusive policy design [1]. Additionally, leveraging stakeholder mapping and grassroots communication strategies can further enhance public understanding and acceptance of genome editing, ensuring that its benefits are widely disseminated and aligned with national development priorities [10].

2) Synopsis of technical papers reviewed. We presented these papers to collate lessons from various African countries and develop a standard communication strategy for GEd in Nigeria.

Table 1 – Synopsis of technical papers presented at the workshop, with relevant contributions made by selected papers to the development of the communication strategy

Authors	Contribution to the communication strategy	Brief discussion
[6]	Justifications for building human capacity, infrastructure, technological and funding for GEd research in Nigeria; this will promote the use of Cassava – the Green Gold for Africa's Food Security and Economic development. It concluded that effective communication, stakeholders' engagement and multifaceted capacity are germane to sustainable cassava production.	The paper demonstrated opportunities to improve cassava production and utilisation to tackle diseases and pests, improve nutritional content, mitigate post-harvest deterioration, and fast-track breeding timelines. The progress made in Cassava GEd technology infusion at the Coordinator, Biotechnology research department, National Root Crops Research Institute. Umudike, Nigeria, was demonstrated.
[11]	This paper clearly shows that Africa has the regional capacity to deploy GEd. It should embrace technology to mitigate hunger and poverty by developing disease-resistant crops with enhanced nutritional quality. Researchers in Africa have deployed GEd on over 12 plant species, including yams and rice, to address climate change, population growth, reliance on fertilisers and pesticides, and the need for improved organic farming. However, Africa needs an array of interventions to enable regulatory policies, stress-resilient and nutritionally enriched crop varieties, and sustainable intensification practices.	The paper assessed the GEd regulatory landscape in Africa and reported that Nigeria has published a national Biosafety guideline for the regulation of GEd. Kenya has developed and published genome editing guidelines, while Malawi, Ghana, and Ethiopia are at different stages of drafting and passing relevant laws and guidelines. The likes of Burkina Faso, eSwatini, Zimbabwe, and Senegal are considering developing GEd policies. At the same time, existing GM regulations in South Africa covered GED. The presentation submitted that there is a need to coordinate regulatory approaches across the continent and that communication cannot be overdone!
[12]	The paper provided the much-needed foundation for participants to draft a suitable communication strategy for the Nigerian team.	It made clear AUDA-NEPAD's role as an observer, while emphasising the Nigerian people's ownership of the document. The result of the appraisal conducted by AUDA-NEPAD served as evidence to demonstrate that Nigeria has the capacity required to develop and implement a product-based Ged communication strategy.
[13]	The paper allayed stakeholders' concerns by clarifying that the advantages inherent in adopting the Ged do not apply to Africa. The paper comprehensively captured available	The discussion briefly examined the concept of GEd, emphasising its benefits to the agricultural and biotechnological fields. The need to balance innovation and caution, without overhyping or

Authors	Contribution to the communication strategy	Brief discussion
	toolboxes, patents, products, and groundbreaking, relevant research clusters. The paper helped provide the key terminology used in developing the draft GEd communication strategy for Nigeria.	overestimating either, was outlined. The paper proposed a sustainable funding mechanism to strengthen (basic) R&D in genome editing to secure the technology's benefits. Although GEd has provided disease-resistant crops, a case-by-case analysis of both the risks and benefits of GEd remains necessary, as the traits it can confer are highly diverse. The risks associated with these traits vary widely. The paper clearly showed that new breeding techniques enable precise, swift trait insertion compared to conventional methods. CRISPR/Cas9 genome editing is a breakthrough technique with applications in crop improvement, enhancing yield, nutritional value, disease resistance, and other traits.
[9]	The authors used the knowledge gained from this paper to develop a communication strategy that considers all biosafety rules and regulations governing GEd research and innovation in Nigeria.	Genome editing offers promising solutions to numerous 21st-century challenges across the medical, health, food, and agricultural sectors. Nigeria's Biosafety regulatory system has paved the way for the development of various economically viable crops, contributing to national growth. The NBMA is well-equipped to manage gene editing safely and effectively, ensuring compliance with safety standards in this field.

3) Importance of effective communication. The importance of an effective communication strategy revolves around creating and providing accurate information to specific stakeholder groups. Stakeholders' reviews of public perceptions of genome editing report conflicting views across subgroups of the general public. In contrast, awareness is a key determinant in the acceptance of respective technologies [14].

METHODOLOGY

The methodology employed in this study is tailored to creating an effective communication strategy for GEd in Nigeria. The methodology focused on designing a communication strategy to bridge the gap between scientific advancements and public understanding. The discussion strongly emphasised that all stakeholders should be informed and engaged in conversations about GEd technologies. The procedural framework achieves its goals of increasing awareness, understanding, and acceptance of genome editing systematically through communication.

1) Appraisal Criteria of Selected African Countries. The appraisal of the GEd capability is grounded in an in-depth comparative analysis of

six African countries that have successfully integrated GEd technology into their agricultural and healthcare systems. The rationale for this appraisal is based on several key criteria as presented.

The evaluation of the adoption/integration of Genome Editing (GEd) technologies requires a systematic framework that accounts for policy factors, institutional systems, and capabilities. The systematic framework was deemed adequate for capturing the complex regulatory environment and was based on the author's work. A step included in this appraisal of existing policies, with the intent to identify those that enable or inhibit the adoption of GEd technologies, consistent with national development priorities. This paper improves upon the method by the authors [8] by providing a detailed account of the skills, resources, and capabilities within institutions needed to realise GEd objectives fully.

Furthermore, the discussion points about GEd in green biotechnology indicate potential for sustainable agriculture and recognise food security and environmental sustainability; this has, in fact, built on the work of [5], thereby forming a robust

framework for integrating GEd technologies into national development strategies.

2) Criteria for Evaluation of Institutions with Biotechnology/Genome Editing Courses. Institutions offering genome editing (GEd) curricula were assessed using a systematic framework that highlighted several important dimensions. The authors used multiple sources to assess the existence and scope of curricula, especially in undergraduate and graduate programs, as well as the quality and impact of GEd programs at research institutes, colleges, and universities. They also evaluated institutional research output in terms of volume and quality, particularly publications, patents, and collaborative genome-editing projects.

Similarly, the Africa-Originated Scientific Publications with a biotechnology/GED Focus were also analysed. The analysis extended to African-origin scientific publications on biotechnology and genome editing. The authors analysed the volume and quality of these publications to evaluate their compliance with internationally recognised standards. This review and the following analysis capture the current status of GEd curricula and research output in Africa.

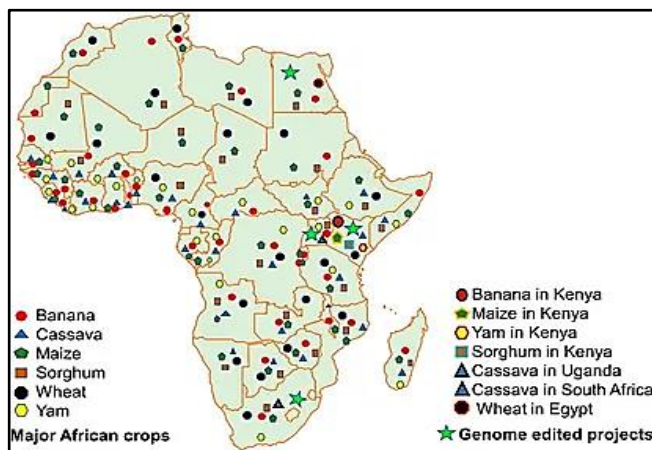


Figure 1 – Status of Innovation in Genome Editing in Africa as an additional Dimension when Assessing Biotechnology/Genome Editing techniques [5]

The authors evaluated national policies, regulatory institutions, and guidelines for biotechnology and genome editing in the selected African countries. The evaluation produced findings that illuminate the key public-sector organisations leading genome-editing initiatives in the respective African countries. These organisations play important roles in policy development and implementation. The evaluation of national policy

guidelines revealed varying levels of development in national guidance documentation, with some countries having developed solid guidelines, whereas others have none. A benchmarking exercise was completed to assess alignment with international best-practice principles and to showcase areas of convergence or divergence with national practice and principles.

The appraisal process in the six selected African countries focused on the multifaceted dimensions of institutions offering a biotechnology (genome editing) curriculum, drawing on a range of information sources from Integrating Policy, Science, and Practice for Sustainable Development. The appraisal and mapping aimed to identify perceived gaps and to develop the capability to support the GEd policy design, with a focus on sustainability. Figure 2 presents a symbiotic relationship among science, policy, and practice. It argues that cross-industrial partnerships are key influencers of society's mindset towards the acceptance or rejection of GEd technology.

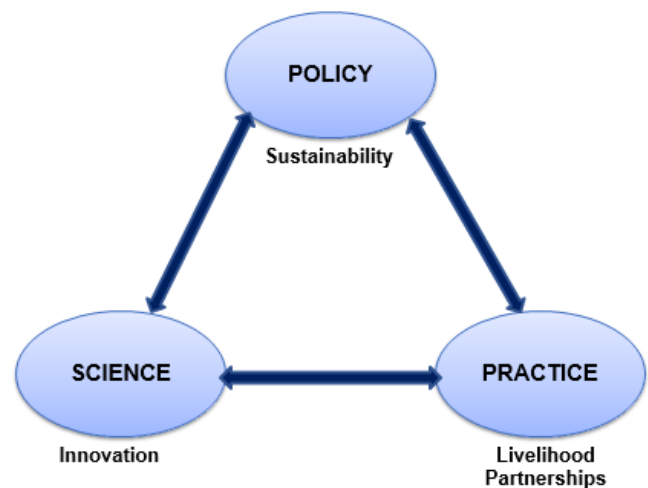


Figure 2 – Integrating Policy, Science, and Practice for Sustainable Development [15]

RESULTS AND DISCUSSION

Table 2 provides a summary of the status assessment and the enabling environment for practising GEd across selected African countries: Burkina Faso, Ghana, Ethiopia, Zambia, eSwatini, and Nigeria. This assessment, conducted by AUDA-NEPAD, highlights the readiness of these nations to adopt and implement GEd technologies. The findings from the study are presented under four thematic areas: the results of Infrastructure and Institutional Capacity, Policy and Regulatory Frameworks, the component of the

results revealed Leading Institutions and Parent Ministries, and the aspect of Crop-Specific Focus.

1) Infrastructure and Institutional Capacity. All six countries have important foundational components needed to support genome editing: research institutions; colleges and universities with diverse biotechnology programs; scientific journals published in and from Africa; and other forms of formal publication. This illustrates a strong research and academic base to foster innovation and capacity building in genome editing technologies. The availability of public information and expert lists establishes a more solid framework for further knowledge sharing and skill development.

2) Policy and Regulatory Frameworks. There is a notable disparity among countries in the development and adoption of GEd guidelines. Nigeria is the only country to have GED guidelines, showing a higher level of regulatory readiness and systematic commitment to genome editing. Ghana and Ethiopia have draft guidelines, which are a

very positive step toward adopting GEd, but these countries will need to continue finalising and operationalising them. Burkina Faso, Zambia and eSwatini have no specific GEd guidelines to adopt, which may limit their ability to regulate and operationalise genome editing. All six countries have biosafety acts in place, which signals a general understanding of the importance of safety and ethics in biotechnology.

3) Leading Institutions and Parent Ministries. All countries have selected a lead institution and its parent ministry to manage genome editing activities. Lead institutions such as INERA in Burkina Faso and NABDA in Nigeria will be key in managing genome-editing initiatives, complying with biosafety laws, and informing the public about ongoing initiatives. Moreover, having parent ministries linked to research and innovation illustrates the high priority attached to biotechnology within the national policy framework.

4) Crop-Specific Focus. Table 2 shows the diversity of genome editing research foci by country.

Table 2 – Status Assessment and Readiness for Genome Editing in Selected African Countries: A Summary of AUDA-NEPAD Findings

Parameter	Burkina Faso	Ghana	Ethiopia	Zambia	eSwatini	Nigeria
Research Institute	Yes	Yes	Yes	Yes	Yes	Yes
Colleges and Universities with distinct biotechnology	Yes	Yes	Yes	Yes	Yes	Yes
Africa-originated Scientific publications	Yes	Yes	Yes	Yes	Yes	Yes
Existing Africa-based publications of public information on biotechnology	Yes	Yes	Yes	Yes	Yes	Yes
Expert list	Yes	Yes	Yes	Yes	Yes	Yes
Policy-related national public institutions	Yes	Yes	Yes	Yes	Yes	Yes
GEd Guideline	No	Draft	Draft	No	No	Yes
Biosafety Acts	Yes	Yes	Yes	Yes	Yes	Yes
Leading Institution	INERA	CSIR	BETIn	DTI	RSP	NABDA
Parent Ministry	IRSAT	MESTI	MinT	MTI	ICT	MSTI
GEd Crop	Rice(CFT)	Sweetpotatoes (Lab)	Brassica carinata (Lab)	No	No	Cassava (Lab)

5) Implications for Genome Editing in Africa. The AUDA-NEPAD evaluation demonstrates encouraging progress towards establishing an enabling environment for GEd in six African case study countries: Burkina Faso, Ghana, Ethiopia, Zambia, eSwatini, and Nigeria. Adequate institutional frameworks, scientific capacity, and regulatory

foundations exist in all these countries; however, there are unacceptable gaps in formulating and operationalising guidelines that specifically address GEd, which create impediments to the intended implementation and integration of genome editing technologies.

All the assessed countries have already established research institutes and are investing in biotechnology development programs. Research institutes play an important role in a developing GEd ecosystem by creating innovative research and closing the gap between research and application in agriculture and health. Examples of crop-specific genome editing in Burkina Faso (rice) and Ghana and Nigeria (sweet potatoes and Cassava, respectively) demonstrate the interest and willingness of these countries to use biotechnology applications for food security and economic development [16].

The lack of formal GEd guidelines in Burkina Faso, Zambia, and eSwatini restricts their capacities to monitor and regulate GEd processes. Nigeria is more advanced than many in the policy process, with developed GED guidelines and serves as a model for other countries.

Also, the countries' parent ministries and leadership institutions affiliated with Bitech illustrate how governments are prioritising GEd in their national development strategies. African countries also need to harmonise the ordinary movement of national policies to avoid fragmentation and support fostering collaboration in the region. Platforms promoting collaborative opportunities, such as the work in Nigeria to develop biosafety acts, stakeholder engagement, and the sharing of best practices, would be beneficial [17].

The table seeks to clarify the lack of active GEd crop development in Zambia and eSwatini and the need for research investment and capacity building. Including GEd research publicly within the national agricultural framework could catalyse innovation to strengthen food system resiliency. Nonetheless, most African countries are multi-ethnic and will have a cultural sensitivity strategy to inform a communication strategy, as acknowledging ethical issues, public trust, and community agreement on the applications of genome editing will not be without challenges [18]. If the opportunity for genome editing in Africa is well supported scientifically and institutionally, countries will have to build their regulatory frameworks, resource targeted research initiatives, and articulate opportunities for regional collaborations to unlock that opportunity. Ultimately, to ensure GEd technologies are developed sustainably and in support of wider goals around food security, sustainability, and economic development on the continent.

6) The Significance of a Communication Strategy and Society. The value of a clearly defined communication strategy for genome editing (GEd) lies in its potential to improve public knowledge and understanding through both empirical and theoretical approaches. In developing effective messages, the theory of framing allows one to use thematic aspects of genome editing, i.e. metaphors and analogies, to communicate scientific information across heterogeneous groups of stakeholders, using basic science, reviews of the benefits and risks, and ethical aspects of the possible outcomes to allow understanding and a sense of inclusion.

The communication cycle ensures information follows a transparent path from producer to stakeholder. It recognises the importance of stakeholders' concerns, as the public will help shape the development of these technologies [1].

Utilising several communication strategies, such as print and social media, can provide access to diverse socio-economic groups. Engaging journalists through press briefings and specialised media training for scientists can also ensure accurate and responsible reporting, which is a critical factor in building and maintaining public trust and transparency [19]. Strategic communication also includes public-facing engagement activities to build partnerships with community leaders and influencers through workshops and public lectures, bringing genome editing into the public conversation and stimulating a sense of ownership.

Moreover, science communication workshops and training programs for researchers are particularly important for building capacity and creating interfaces between scientists and policymakers that could enable deliberations on proposed applications relevant to a given context.

In a multi-ethnic environment such as Nigeria, this approach is key to promoting public acceptance and responsible use of genome editing technologies. Identifying target groups based on literacy, norms, and habits provides opportunities to engage them with messaging aligned with their interests. [20]. Common elements of an effective communication strategy include repeated evaluations and modifications of communication and dissemination strategies to improve engagement. Effective strategies may also include making connections with successful international instances, simulating real-world applications, and using various communication channels to

engage stakeholders and support discussion. Typical communication strategies for the scientific community include precise, evidence-based communication that fosters mutual understanding among researchers, policymakers, and members of the public [8]. Regulatory bodies will need to provide a standardised, contextually relevant oversight approach that not only maintains alignment with international standards but is also effectively tailored to users' needs [4].

A strong legislative framework is necessary to ensure that the information you share is reliable and accurate, including peer-reviewed evidence and timely peer-to-peer communications; safety and ethical approvals; and governance processes that could bolster public confidence in genome editing technology [3].

CONCLUSIONS

Genome editing (GE) represents potentially revolutionary technologies with productivity potential arising from the ability to modify the DNA

of living organisms, which should be carefully managed with a view to strategic communication across different socioeconomies. With the potential for rapid growth in economically beneficial sectors, genome editing technologies offer a viable option for large-scale development in Nigeria. As is usual with novel technologies such as GE, there is a need for comprehensive ethical, socio-cultural, cost-benefit analyses, expert input, and regulatory considerations, communicated as a strategy through open dialogue platforms for all stakeholder groups: scientists, policy and decision-makers, and the public.

For large-scale and rapid take-up of genome editing technologies, the establishment of a regulator, in the form of a National Bioethics Commission with oversight responsibilities, is necessary to support a range of oversight functions; this will provide for an appropriate governance structure for genome editing and associated technologies through an inclusive governance support mechanism.

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