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How Do Policy Environments Influence Technology Adoption?

Insights from Nigeria's Pod Borer Resistant (PBR) Cowpea Experience

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Overview and study objectives

Policymakers are increasingly considering the promise of modern biotechnology, including genetically modified organisms (GMOs) to help solve development problems in health, agriculture, and other fields (Zambrano et al., 2022). However, debates persist around health and environmental implications (National Academies of Sciences, 2016; Raman, 2017; Smyth et al., 2021). The regulation of GMOs varies globally, with some countries implementing outright bans or imposing stringent controls (Sarkar et al., 2021; Yali, 2022). A recent study examines the Nigerian policy environment for Pod Borer Resistant (PBR) cowpea, which has been genetically engineered to resist the legume pod borer (*Maruca vitrata*) [Mockshell et al., (unpublished)]. Legume pod borers significantly reduce cowpea yield and quality, with losses of up to 80% reported (Andam et al., 2024; Mockshell et al., 2024). This policy note summarizes the findings of the paper, providing insights to guide policy development around the adoption of biotech food crops in Nigeria and other countries in Africa South of the Sahara (SSA). The primary research question is: Is there an enabling policy environment for PBR cowpea and what factors contribute to it?

Brief Background on Nigeria's Pod-Borer Resistant (PBR) Cowpea Variety

PBR cowpea confined field trials began in 2009 at the Institute for Agricultural Research (IAR), Zaria, leading to environmental release approval in Nigeria by 2019, following seven to eight years of development and regulatory trials. This was under the support of policies such as the National

Biosafety Management Agency (NBMA) Act (2015) (NBMA, 2024; Phillip et al., 2019). Figure 1 highlights the key milestones in biotechnology regulation under NBMA, emphasizing the structured regulatory framework that facilitated PBR cowpea's development and approval process.

Figure 1: NBMA's Biotechnology Regulatory Milestones

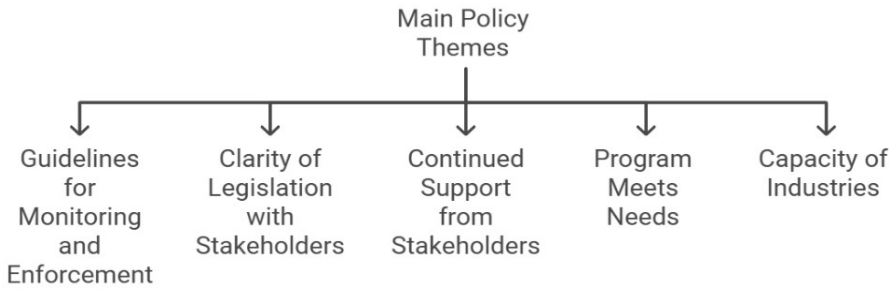
Source: Authors' illustration

Although some groups have raised safety concerns, support for PBR cowpea is expanding as a solution to food and nutrition security challenges (Horn et al., 2022). Given that the PBR cowpea seed shows improved yields, it has the potential to increase productivity and positively affect food security in Nigeria and Africa (Ba et al., 2018; Phillip et al., 2019). Nigeria, the top cowpea producer globally, struggles to meet its national demand, producing less than needed, and consequently resorting to imports and limiting exports (Benson et al., 2020; Nwagboso et al., 2024). Factors such as climate change and pest pressure necessitate heavy reliance on costly pesticides (Ma et al., 2021; Hatzenbuehler et al., 2023). PBR cowpea offers a promising alternative (Addae et al., 2021). Given PBR cowpea's extensive development process and potential impact, understanding the policy environment is essential to support its adoption and food security benefits.

Major policy themes identified by factor principal component analysis

The study identified major policy themes through a factor principal component analysis (factor loadings of absolute values above 0.30), based on correlation patterns between various enabling environment indicators. These factors are based on a total of thirty (30) in-depth interviews with stakeholders(government agencies, researchers, development partners, civil society organizations, media agents, health professionals, and private sector actors)[1]. Each theme reflects distinct yet interrelated aspects of PBR cowpea's policy environment. The five main policy themes identified are highlighted in figure 2.

Figure 2: Main policy themes identified through factor principal component analysis



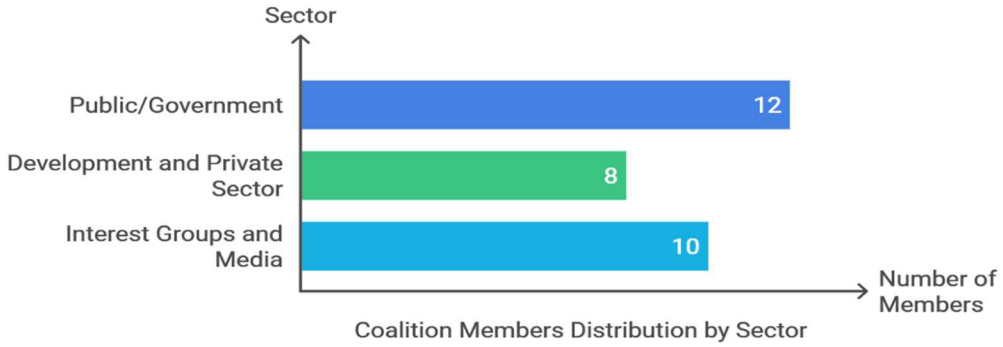
Source: Authors' illustration

Note: These themes summarize the primary policy areas driving the effectiveness of regulatory and support structures within the policy environment for PBR cowpea.

Participants in the discourse coalitions identified in the cluster analysis

Based on shared policy themes, three major clusters in discourse coalitions were identified through a two-step cluster analysis[2], namely public/government, private sector and development partners, and interest groups and media (Figure 3). The government/public sector is the most prominent group in the stakeholder landscape. This – in addition to their involvement in other coalitions – indicates a prominent level of involvement by policymakers/regulators in PBR cowpea's policy environment. Furthermore, the role of the media and interest groups in disseminating information and shaping public opinion cannot be understated. Private sector actors, particularly seed companies involved in distributing the PBR cowpea variety, engage with both the public sector and development partners, reflecting a collaborative effort to invest in the development, promotion, and commercialization of PBR cowpea. Additionally, development partners contribute to the discourse across various coalitions, highlighting their multifaceted role in supporting PBR cowpea development and adoption.

Figure 3: Participants in the discourse coalitions identified in the cluster analysis



Source: Authors' illustration

[2] The cluster membership was determined and cross-tabulated with a policy actor identification variable.

The factors that enable or hinder the environment for PBR cowpea are summarized based on participant narratives within discourse coalitions, organized around policy themes identified through factor analysis.

Enabling factors influencing PBR cowpea's policy environment

- **PBR cowpea meets needs**: PBR cowpea's resistance to pests, coupled to the variety's existing shorter growth time, with a reduction in the need of insect-specific pesticides, can lead to increased productivity, improved health of farmers (through reduction in pesticide sprays), cost savings, better time allocation, and improved food and nutrition security.

- **Continued support in capacity building and promotion**: Continued support from stakeholders, including development partners, research institutes, media, and government bodies, is a driving force behind PBR cowpea policy. These stakeholders play instrumental roles in development, promotion and awareness creation, and information dissemination.

- **Clarity of legislation:** Well-defined and transparent legislation, coupled with ongoing stakeholder support, fosters an enabling policy environment. Mechanisms, such as public notices and feedback systems, enhance policy transparency and credibility.

Constraining factors influencing PBR cowpea's policy environment

- **Scarcity of the PBR cowpea seeds and low market uptake**: Respondents noted that Nigerians often resort to saving conventional cowpea seeds for planting. It was also widely agreed that there is a high demand for the PBR cowpea seed among farmers who know of its benefits, and it is scarce. Considering that PBR cowpea is in its initial stages of dissemination and adoption, it is important for the seeds to be made available by the private sector to interested farmers, while more awareness should be created by the media and interest groups among farmers who are not aware of its benefits.

- **Limited industry capacity**: It is expected that the capacity of the private sector (seed companies), which is currently underdeveloped (according to respondents), should be advanced to increase the capacity and quality of seed production companies. This could involve providing training and technical assistance to seed companies on improved production methods, quality control, and distribution logistics. Facilitating access to credit and financing would enable investments in better infrastructure, equipment, and resources.

- **Post-harvest and storage losses:** Although PBR cowpea addresses Nigeria's cowpea production shortfall, it does not solve post-harvest and storage issues.

Table 1: Summary of enabling and constraining factors influencing PBR cowpea's policy environment

Theme	Enabling Factors	Challenges	Actors on enabling side	Actors on disabling side
Guidelines for monitoring and enforcement	Structured regulatory framework that supports the commercialization and quality control of PBR cowpea seeds	PBR cowpea grains are not labeled for consumers	Government, development partners	Government
Clarity of legislation with stakeholders	Legislation is clear and accessible	Most farmers rely on saved cowpea seeds instead of certified seeds	Government, media, interest groups	Farmers
Continued support from stakeholders	Stakeholders support development, awareness creation, and dissemination of PBR cowpea	Some seed companies insist that they receive limited support from the government	Development partners, research organizations, interest groups, media	Government
Capacity of industries	Investment by private seed companies, government support	Limited industry capacity and low market uptake	Private seed companies, farmers, government entities	Some private seed companies
PBR Cowpea Meets Needs	Product meets agricultural needs	High post-harvest and storage losses	Farmers, seed companies, government agencies	

Source: Summarized from in-depth interviews conducted from January to July 2023

Conclusions and policy recommendations

The insights summarized in this policy note can inform future policy decisions related to the adoption of biotechnology for crop development in Nigeria and elsewhere in Africa to fully realize the potential benefits for improved food and nutrition security and poverty reduction. These lessons underscore the importance of stakeholder engagement, transparency, and clarity in legislation, as well as public awareness and education, capacity building, addressing market challenges, and a comprehensive approach to foster understanding of biotechnology among the population. Transparent and predictable regulatory frameworks, along with mechanisms for accountability and public input, can contribute to public trust in the regulatory process. In addition to these, we provide the following policy recommendations:

1. Address challenges related to seed distribution, market awareness, and post-harvest storage to enable successful PBR cowpea adoption.
2. Build the capacity of private seed companies through training, access to finance, and infrastructure support to enhance their ability to produce and distribute quality PBR cowpea seeds.

3. Strengthen enforcement of labeling regulations to allow consumers to differentiate PBR cowpea from conventional varieties, while balancing costs and preferences.
4. Continue stakeholder engagement, public awareness campaigns, and collaborative governance to foster trust and understanding of PBR cowpea technology.

These strategies can help maximize the benefits of PBR cowpea and offer valuable lessons for other African countries that are considering the development of biotech food crops.

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