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South Asia Biosafety Program

BANGLADESH

The Story of Pod Borer Resistant Cowpea: How It Became the First Approved Genetically Engineered Food Crop in Nigeria

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Cowpea pods and beans.

Cowpea (*Vigna unguiculata* L. Walp.) is one of the most important legume food crops in Sub-Saharan Africa, where it is an important source of protein for more than 200 million people. Nigeria is the biggest producer and consumer of cowpea in the world. Cowpea is a low-cost staple to rural and urban people and an important cash crop to the small, household farmers. Apart from the beans, the green leaves and pods are edible and serve as an excellent food source for mitigating hunger. Besides, it is also a good source of quality fodder for livestock.

Cowpea is a resilient legume that is drought tolerant, adapted to harsh soils, and can fix soil nitrogen. However, cowpea farmers are burdened with low productivity and yield due to the infestation of many pests at different stages of the plant's lifecycle. To overcome this barrier, farmers need to apply multiple insecticides several times per season in their fields. The most significant catastrophic damage to the cowpeas may be attributed to the lepidopteran insect called maruca pod borer (*Maruca vitrata*), which can cause 80–90% yield loss for farmers. The damage intensifies due to the lack of proper and effective insecticides against these pests, and high costs often force the farmers to use detrimental non-specific insecticides.

The first approach to overcome the horrifying pest was to develop an improved cowpea variety through conventional breeding that would be resistant to maruca pod borer. More than 15,000 cowpea varieties in the International Institute of Tropical Agriculture (IITA) germplasm bank were evaluated. A gene from one of the wild relatives called *Vigna vexillata* was identified to be resistant. However, attempts to cross this gene into cowpea proved unsuccessful.

Biotechnological interventions came up as the final resort when conventional approaches failed to provide a sustainable solution to the devastating pest problem. The research involved the transfer of an insecticidal gene (*Cry1Ab*) from the well-known soil bacterium *Bacillus thuringiensis* (Bt) to develop Genetically Engineered (GE) Pod Borer Resistant (PBR) cowpea. This bacterium has been used by humans in organic farming as an insecticide spray to control insect pests for over

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BIOSAFETY DISCOURSES

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80 years and some of its insecticidal genes have been successfully incorporated in several GE crops growing worldwide. The research was led by Nigerian scientists at the Institute for Agricultural Research (IAR), Ahmadu Bello University, in collaboration with various international partners under the coordination of the African Agricultural Technology Foundation (AATF), to which Bayer provided the gene on a humanitarian basis. As we all know, GE plants developed in the laboratory need to go through regulatory processes before farmers are able to cultivate them. The developed event, AAT709A, underwent Confined Field Trials (CFT) and biosafety assessments at the IAR in Nigeria.

Applications for CFT of GE PBR cowpea were approved by the National Biosafety Management Agency (NBMA) in 2009 and 2018. The trial process took ten years and was comprised of both single and multilocational trials. In October 2018, IAR submitted the application for general release to the NBMA with the necessary documents on biosafety studies. The application primarily incorporated information relating to the donor and recipient organisms, the vector used to introduce the gene, the nature of the genetic modification, and characteristics of the resulting modified organism. Additionally, information relating to the condition for release and the receiving environment was stated in the application.

The story of GE PBR cowpea [...] demonstrated the ability and functionality of the regulatory authorities to make decisions, independently and impartially, based on evidence and credible science.

The regulatory review of any GE plant addresses two areas, namely environmental safety and food and feed safety. Environmental safety is evaluated through an internationally recognized and already established process called Environmental Risk Assessment (ERA). ERA is performed in the context of providing very specific, relevant, and realistic information about the potential risks of introducing the GE organism into the environment. Most importantly, it serves as an aid to decision making rather than focusing on generating new scientific knowledge. ERA of GE PBR cowpea was therefore performed with an emphasis on potential interactions between the GE plant and the surrounding environment. Necessarily, the focus was on three components–gene flow to wild relatives, potential effects on non-target organisms, and potential for generating insect resistance. Characteristics and factors affecting survival, multiplication, gene expression, and dissemination of the introduced gene were rigorously evaluated. The food and feed safety assessments were required because cowpea is intended to be used as food. In the case of GE PBR cowpea, the history of safe use of the gene and organisms served as the primary basis to provide sufficient evidence on the safety aspects. Potentials for allergenicity and toxicity were evaluated through similarity searches and laboratory studies. A compositional analysis was done to find out substantial equivalence to the conventional non-GE counterpart. Nutritional equivalence and absence of anti-nutritional factors were evaluated through nutritional studies. All the study findings and information were incorporated in the application.

Finally, the application included the risk management procedures, such as information on monitoring, control, and emergency response plans, which would be coherent with NBMA guidelines. But, it is worth mentioning that, as the GE PBR cowpea does not differ from traditional cowpea except for resistance to the pod borer, the management procedures are well established.

On January 22, 2019, taking into consideration the advice of the National Biosafety Committee, National Biosafety Technical Subcommittee, and the risk assessment and risk management report provided by the applicant, the NBMA issued a permit for commercial release of the GE PBR cowpea event AAT709A, in accordance with the *NBMA Act 2015* that guides the regulation of the practice of modern biotechnology, development, handling, and use of GE organisms in

Flower of the cowpea Vigna unguiculata.

Nigeria. On December 12, 2019, approval was granted by the National Committee on Naming, Registration, and Release of Crop Varieties at its 28th meeting. Finally, the Federal Government of Nigeria approved the registration, naming, and release of the GE PBR cowpea variety, Sampea 20-T for commercial cultivation on December 15, 2019. This approval makes the GE PBR cowpea the second approved GE crop following Bt cotton, and the first GE food crop approved in Nigeria. According to the developers, the farmers will benefit as the variety is early maturing, high yielding, and resistant to two notorious parasitic weeds–Striga and Alectra. It is estimated that, by reducing loss due to maruca pod borer, this crop will enable a revenue increase of more than US$132 million annually from cowpea. It will also help to significantly reduce the frequency of insecticidal sprays from eight times to only two times per cropping season. The country is expected to be self-sufficient in cowpea production, eradicate hunger, and may lead the other African countries in adopting sustainable solutions. Currently, farmers in the major cowpea production zones of Nigeria have completed the on-farm demonstrations and are cultivating this GE PBR cowpea.

The story of GE PBR cowpea is noteworthy in several aspects. The overall process dignifies the contribution of local researchers who completed significant portions of the research, development, and biosafety assessments in their own country. This shows the capacity of researchers from a developing country to improve their important food crops while at the same time maintaining good compliance with the biosafety requirements. Moreover, it demonstrated the ability and functionality of the regulatory authorities to make decisions, independently and impartially, based on evidence and credible science. There is much scope for learning from this effort for both researchers and regulators around the world.

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CALL FOR SUBMISSIONS

Student Showcase Articles

The editorial staff would like to invite students residing in South Asia to submit articles for publication in the *SABP Newsletter*. The newly launched "Student Showcase" section presents a unique opportunity to share written works, gain exposure, and engage with the wider biosafety community. To be considered for publication, submissions must conform with the guidelines below and show relevance to biosafety research, environmental or food safety assessment of genetically engineered (GE) organisms, or the regulation of GE plants, animals, arthropods, or microorganisms.

Submission Guidelines:

As with all articles published in the *SABP Newsletter*, submissions should:

- Be written in English and at least 500 words long.
- Include a clear and descriptive title, the names and institutional/academic affiliations of all authors, and an email address where the corresponding author may be contacted.
- Have a clear connection to the mission of SABP. Below are examples of potential topics:
  - research or recent scientific developments in the field of biotechnology, provided that there is a clear description of the purpose of the project, why it is relevant to the region, and includes a brief statement about how the author(s) came to be working on the project and why they have chosen to apply biotechnology to their research project.
  - environmental safety or food safety of GE organisms
  - biosafety regulation
  - policy developments
  - capacity building activities/events
- Relate to a country (or countries) in South Asia. Articles describing events or developments outside of the region will be considered as long as the author provides context explaining why the development is or will be meaningful to South Asia.
- Describe developments or events that have occurred recently, preferably within three months of publication of the newsletter, but never more than a year prior without exceptional cause. Older research or information may be referenced, provided it is relevant to a recent event or topic.

Any article that is promotional in nature or is principally technology advocacy will not be considered.

Submissions may be sent to: **sahmed@southasiabiosafety.org**.

BANGLADESH

Development and Implementation of the Biosafety Regime in Nigeria

Amrin Islam Razna and Eera Ashrafy Anonna, Brac University

STUDENT SHOWCASE

To encourage written discourse on topics related to biosafety and biotechnology among the younger generation, the *SABP Newsletter* dedicates space in select issues to spotlight pieces written by students residing in South Asia. Since articles with the "Student Showcase" tag are meant to reflect the actual views and capabilities of the author(s), they are not revised for content and only lightly edited to conform with the newsletter's style guide.

Nigeria, a developing country from West Africa is the most populous country on the continent. The need to increase its crop production to ensure food security cannot be over emphasized. To reduce the gap and achieve sustainable development, Nigeria has adopted modern biotechnology to address challenges, like malnutrition and food insecurity, that have been difficult to resolve using conventional methods. However, as modern biotechnology approaches are considered to have potential risks to the environment and human health, Nigeria started to adopt precautionary safety measures for biosafety since the 1990s. Initially, these biosafety activities were confined to the development of guidelines.

Nigeria developed their first Biosafety Guidelines in 1994, way before the drafting of the Cartagena Protocol on Biosafety (CPB). It was developed by the Federal Ministry of Agriculture and aimed at agricultural aspects of biotechnology. Nigeria signed the Cartagena Protocol on Biosafety (CPB) in 2000 and ratified it in 2003. This was followed by the updating of the National Biosafety Guidelines and development of the National Biosafety Framework (NBF). The NBF has the power to implement Nigeria's Biosafety Bill and Biosafety Policy. Nigeria has domesticated the Cartagena Protocol by developing the National Biosafety Bill.

The story of the development and implementation of the biosafety system in Nigeria is very encouraging for developing countries, including Bangladesh.

Presently, the Federal Ministry of Environment acts as the National Focal Point and the Competent National Authority (CNA) of Nigeria and is responsible for implementing the CPB. A specialized agency, the Biosafety Unit, has been established under this ministry to regulate the biosafety procedures. In addition to this, there is the National Biosafety Committee (NBC) that reviews the applications on GE organisms. The committee also provides suggestions to the Ministry. The National Biosafety Technical Sub-committees (NBTS), which reviews in detail the scientific data in applications, gives feedback to the NBC on technical issues. At the institutional level, Institutional Biosafety Committees (IBC) deal with biosafety procedures and aid in the research and development of GE organisms.

As per the Nigerian regulatory system, from inception of research through every step of development, biosafety assessment and approval is required. The NBC and NBTS conduct detailed review of each application and generate feedback. The feedback is forwarded to the Federal Ministry of Environment and the Honorable Minister finally takes the decision on the applications. As per the system, the decision is then communicated to the applicants and duly updated on the Nigerian Biosafety Clearing House (BCH).

Together with the development of the biosafety regime, Nigeria has made progress in research in crop biotechnology. Recently, Nigeria approved and released their first GE food crop, Bt cowpea, which was developed by local scientists. This research was part of a project of the Institute for Agricultural Research (IAR)–African Agricultural Technology Foundation (AATF) pod-borer resistance PBR-Cowpea project. This transgenic cowpea was produced through a collaboration between the Commonwealth Scientific and Industrial Research Organization (CSIRO) and African Agricultural Technology Foundation (AATF), and supported by USAID and IAR. After 10 years of intensive research, Nigeria developed this pod borer resistant Bt cowpea–Sampea 20-T. NBMA gave a permit to IAR, that developed the transgenic cowpea, to openly cultivate the transgenic variety in January 2019. The variety was named and commercially released by the National Committee on Naming, Registration, and Release of Crop Varieties in December 2019.

The story of the development and implementation of the biosafety system in Nigeria is very encouraging for developing countries, including Bangladesh. There are many similarities among the regulatory committees, their function, and the processing of applications with other developing countries. There are differences in the size of these committees and member expertise. Nevertheless, Bangladesh has already approved a GE food crop. This means that implementation of the regulatory procedure has already taken place once. Therefore, it has set the path to take advantage of modern biotechnology and its products. Research on many GE crops is going on at various research and educational institutes in Bangladesh. Few biosafety applications are on the table for approval. Following the previous example, Bangladesh can lead Asia in safety assessment of GE food crops through a transparent and efficient implementation of the biosafety regulatory system.

Sprouts of the cowpea Vigna unguiculata.

Contained Trial of Transgenic 3R-gene Potato Starts at the Bangladesh Agricultural Research Institute

Dr. Md. Kamrul Hasan, Bangladesh Agricultural Research Institute

3R-gene potato contained trial at the greenhouse of the Biotechnology Division, BARI, Gazipur (from left to right): Dr. Md. Tariqul Islam, Director (Research), BARI, Dr. Md. Jahangir Hossain, Country Coordinator, FtFBPP 3R-gene Potato Project, Dr. Shaikh Mohammad Bokhtiar, Executive Chairman, BARC, Dr. Md. Nazirul Islam, Director General, BARI, Dr. M. A. Yousuf Akhond, CSO, Biotechnology Division, BARI, and Dr. Most. Mahbuba Begum, PSO, TCRC, BARI.

Bangladesh ranks seventh among the potato producing countries in the world, producing about 10 million tons per year. The country's potato farmers spray fungicide amounting to Tk৳100 crores per year to save their potato crop from late blight, a devastating disease of the crop. These fungicides cause environmental pollution and increase risk to farmers' health. Late blight is a common disease of potato, which is favored by dense fog, limited sunlight, and cold temperatures, and may cause up to 100% yield loss at the early growth stage of potato plants. Bangladesh Agricultural Research Institute (BARI) has been working to develop a resistant variety against late blight disease of potato using conventional breeding methods.

Transgenic technology is a good alternative for the development of crops with desirable traits. In this regard, collaborative research between BARI and Michigan State University (MSU) was initiated under the *Feed the Future Biotechnology Potato Partnership* project, which is funded by the United States Agency for International Development (USAID). The JR Simplot Company has carried out the transformation work for MSU. Late blight resistant lines of Diamant, a popular variety in Bangladesh, have been developed by inserting three Late Blight Resistance (LBR) genes derived from three wild potato species. These are the *Rpi-blb2* gene of Mexican origin *Solanum bulbocastanum*, the *Rpi-vnt1* gene of Argentine origin *Solanum venturii* and the *Rpi-mcq1* gene of Peruvian origin *Solanum mochiquense*. With prior permission from the government, BARI imported two selected late blight resistant potato events on January 21, 2021. The imported events with 3 stacked resistance genes (3R-gene) are expected to provide stronger and more durable resistance to the late blight disease.

The first confined field trial is expected to be conducted in the next potato-growing season (2021-22) [...] It is projected that GM potato with the 3R-gene could save about 25-28% of the production cost to farmers.

A contained trial with these two transgenic lines along with a non-transgenic Diamant (control) line was planted at the greenhouse of the Biotechnology Division of BARI on April 12, 2021. Dr. Shaikh Mohammad Bokhtiar, Executive Chairman, Bangladesh Agricultural Research Council (BARC), Dr. Md. Nazirul Islam, Director General, BARI, Dr. Md. Tariqul Islam, Director (Research), BARI, Dr. M. A. Yousuf Akhond, Chief Scientific Officer and Head, Biotechnology Division, BARI, Dr. Md. Jahangir Hossain, Country Coordinator, Feed the Future Biotech Potato Partnership (FtFBPP) 3R-gene Potato Project, and Dr. Most. Mahbuba Begum, Principle Scientific Officer, TCRC, BARI, and other scientists of the Biotechnology Division were present at the occasion for the planting of 3R-gene potato. Germination of the lines was 100% and the initial growth of the plants was found to be satisfactory.

After completion of the contained trial, the first confined field trial is expected to be conducted in the next potato-growing season (2021-22) with the permission of the National Committee on Biosafety (NCB) and the multi-location trials will follow the year after. It is projected that GM potato with the 3R-gene could save about 25-28% of the production cost to farmers. This will protect the potato crop from the devastating late blight disease and improve human and environmental health.

CALENDAR OF EVENTS

EVENT	ORGANIZED BY	DATE	WEBSITE
INDIA			
Web-Talk Series: AI and SDGs	Bavarian-Indian Centre (BayIND), Swissnex India, and DWIH Tokyo	May 18, 2021 Virtual	https://www.icrisat.org/event/web-talk-series-ai-and-sdgs/
International Conference on Sugarcane Research	ICAR-Sugarcane Breeding Institute, Tamil Nadu Agricultural University, and the Society for Sugarcane Research and Development	June 19-22, 2021 Coimbatore	https://sugarcane.icar.gov.in/images/sbi/Canecon_2020/cancon_second_circular.pdf https://tnau.ac.in/wp-content/uploads/2020/10/1601938688.pdf
International e-Conference on Postharvest Disease Management and Value Addition of Horticultural Crops	ICAR-Indian Agricultural Research Institute	August 18-20, 2021 Virtual	http://www.uhsbagalkot.edu.in/
International Horticulture Conference – Next Generation Horticulture (NEXTGEN – HORT)	Tamil Nadu Agricultural University	September 16-19, 2021 Tamil Nadu	https://tnau.ac.in/news-events/
INTERNATIONAL			
11th Session of the ITWG on Animal Genetic Resources for Food and Agriculture (2021)	Food and Agriculture Organization of the United Nations	May 19-21, 2021 Virtual	http://www.fao.org/animal-genetics/events/events-detail/en/c/1369166/
Hands-on Course: CRISPR/Cas9 Genome Editing: A New Approach for Therapeutics	ICGEB	September 6-8, 2021 Cairo, Egypt	https://www.icgeb.org/activities/meeting-and-courses/
Workshop: Genome Editing to Generate Cellular and Animal Models of Human Diseases	ICGEB	September 7-10, 2021 Cape Town, South Africa	https://www.icgeb.org/activities/meeting-and-courses/
Workshop: Fall Armyworm Control - Challenges and Opportunities for the Use of Biopesticides	ICGEB	November 16-18, 2021 Cape Town, South Africa	https://www.icgeb.org/activities/meeting-and-courses/
10th Meeting of the Conference of the Parties Serving as the Meeting of the Parties to the Cartagena Protocol on Biosafety	Secretariat of the Convention on Biological Diversity (SCBD)	October 11-24, 2021 Kunming, China (tentative dates)	https://bch.cbd.int/protocol/#tab=2
16th ISBR Symposium (ISBR 2022)	International Society for Biosafety Research	April 10-14, 2022 St. Louis, MO, USA	https://isbr.info/news?news_id=136

The South Asia Biosafety Program (SABP) is an international development program implemented in India and Bangladesh with support from the United States Agency for International Development (USAID). SABP aims to work with national governmental agencies and other public sector partners to facilitate the implementation of transparent, efficient, and responsive regulatory frameworks for products of modern biotechnology that meet national goals as regards the safety of novel foods and feeds, and environmental protection.

SOUTH ASIA BIOSAFETY PROGRAM

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