Workshop on Building Digital & Precision Agricultural Biotechnology Capacity for Sustainable Agriculture and Food Security

APEC High Level Policy Dialogue on Agricultural Biotechnology

December 2025

Asia-Pacific
Economic Cooperation

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Produced by
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I. Introduction

Global challenges—including extreme weather events and natural disasters, population growth, declining arable land, and emerging plant diseases—pose serious threats to sustainable agriculture and food security in the Asia–Pacific region. Agricultural biotechnology has increasingly been recognized as a critical tool to address these issues, offering innovative solutions that enhance productivity, improve resilience, and support farmers' livelihoods. Over the past two decades, advances in digital and precision breeding technologies, supported by big data, artificial intelligence, and genome editing, have accelerated the pace of crop research and development. These technologies not only contribute to more efficient breeding pipelines but also provide new opportunities for collaboration and regulatory harmonization across economies. In this context, the APEC High Level Policy Dialogue on Agricultural Biotechnology (HLPDAB) has served as a valuable platform for information exchange, policy discussion, and capacity building. This workshop, held in August 2025 in Jeonju, Korea, was organized as part of the APEC-funded project "Building Digital & Precision Agricultural Biotechnology Capacity for Sustainable Agriculture and Food Security (HLPDAB 101 2024A)". The event was hosted by Korea with the support of twelve co-sponsoring economies—Australia; China; Indonesia; Malaysia; Mexico; Peru; the Philippines; Singapore; Chinese Taipei; Thailand; the United States; and Viet Nam. Bringing together policymakers, scientists, and experts from across APEC economies, the workshop aimed to share the latest knowledge and experiences in digital and precision breeding, regulatory frameworks, and practical applications of biotechnology. The program featured thematic sessions on regulatory harmonization, digital transformation in breeding, and new breeding crop development, as well as a field visit to the Rural Development Administration's state-of-the-art research facilities. Through these activities, participants were able to strengthen their understanding of agricultural biotechnology, exchange insights on policy and research directions, and explore opportunities for international cooperation. The outcomes of this workshop reaffirm the importance of agricultural biotechnology in advancing sustainable agriculture and food security and highlight the need for continued collaboration among APEC economies to achieve the goals of the Putrajaya Vision 2040 and the APEC Food Security Roadmap towards 2030.

II. Workshop Summary

1. Session 1: Big data and AI-Driven Agricultural Biotechnology Research

1.1 Data and AI modeling for crop improvement and production

Scott A, Jackson, Professor, Georgia University

Objective: This presentation aims to outline strategies for advancing crop genetic improvement and enhancing productivity by leveraging Artificial Intelligence (AI) and Big Data technologies.

AI Concepts and Applied Technologies

AI in agriculture is designed to simulate human intelligence, encompassing learning, reasoning, and decision-making. Its core technologies include machine learning, neural networks, large language models (LLMs), and advanced data integration. Key data sources originate from remote sensing platforms such as satellites and drones, vegetation indices, and IoT-based sensors that capture soil, climate, and growth information. In addition, genomic and phenotypic databases such as ZEAMAP, SoyBase, and CropGS-Hub, as well as public databases (FAOStat, USDA, NASS), provide critical inputs for AI applications.

Within agriculture, AI is increasingly applied to optimize resources (sowing, fertilization, irrigation), predict yield and risk, monitor pests, diseases, and abnormal climatic events in real time, and to establish linkages between genotype and phenotype for more effective breeding strategies.

AI-Based Breeding Models

AI-based breeding models aim to shorten generation intervals through the formula $R = h^2S / t$, where h^2 denotes heritability, S represents the selection differential, and t is the generation interval. These models incorporate eQTL analysis to predict gene regulation and assess the effects of non-coding regions on trait expression. Advanced AI tools are also employed, including AlphaFold for protein structure prediction, DeepVariant for SNP detection, and AlphaGenome for identifying DNA regulatory regions. Together, these approaches enhance the precision and efficiency of genetic improvement in crops.

Challenges and Opportunities

Despite significant potential, challenges remain. Data accessibility continues to be a barrier, highlighting the need to mainstream gene-editing technologies such as CRISPR. Data asymmetry also complicates experimental strategies, requiring optimization for balanced and reliable outcomes. Furthermore, model bias limits the accuracy of quantitative predictions, underscoring the importance of refining algorithms to improve prediction reliability and support the design of environment-specific crop varieties.

Conclusion

AI represents a transformative tool for crop genetic design and productivity enhancement. The future of agriculture is expected to shift toward precision, data-driven genetic innovation, where sustainability and resilience are embedded in crop breeding programs. Developing varieties with stronger resilience and sustainability will be essential to address global challenges such as climate change, food security, and resource constraints.

1.2 How can AI Bioinformatics Revolutionize Agriculture Research?

Sun Kim, Professor, Seoul National University

Objective: This presentation aims to outline strategies for advancing crop research through AI and bioinformatics by integrating multi-omics data encompassing genomics, transcriptomics, epigenomics, phenomics, and metabolomics.

Gene-to-Trait Linkage Analysis

Advances in gene-to-trait association studies are exemplified by platforms such as Crop-GPA, which integrate genomic information to identify correlations between genetic variation and phenotypic traits. Temporal response analyses using RNA-seq have provided insights into stress responses such as drought, while epigenetic studies, including DNA methylation, have revealed functional consequences, for instance, reduced methylation at the *ACT1* locus was associated with enhanced cold tolerance. Moreover, these epigenetic modifications have been shown to demonstrate heritability across generations, underscoring their long-term impact on crop resilience.

Integrated Multi-Omics Analysis System

To strengthen crop development pipelines, the establishment of standardized information systems integrating genomics, transcriptomics, epigenomics, phenomics, and metabolomics data is underway. Such integration ensures consistent data accessibility and enables comprehensive analyses of complex biological traits.

Web-Based Analytical Platforms

Web-based platforms are being developed to support open access and interactive analysis. These platforms incorporate databases including BioSample, Genomics, Metabolomics, and DeepData, and provide versatile analytical functions. Users can: Access genetic mutation information, analyze pathway-level relationships between gene variation and bioactive compound production, quantitatively compare useful metabolites across cultivars, and Conduct visualization-based, interactive analyses.

Application of AI Models

AI models are increasingly being applied to predict functional and safety-related traits. For example, predictive models for isoflavones and saponins achieved performance levels of ROC-AUC 0.6–0.74. In addition, toxicity and side effect predictions are being improved by training with drug toxicity databases such as Fate-tox, MDTR, and ChemNP.

Multi-Objective AI Optimization Strategy

A Pareto optimal search framework has been introduced to balance functionality, yield, and safety. This approach enables the identification of crop varieties optimized under multiple objectives, ensuring both performance and resilience.

Case Studies and Future Expansion

In collaboration with the Gyeonggi-do Agricultural Research & Extension Services, an AI-based early disease detection system was developed by integrating transcriptomic and phenotypic data. Future directions include expanding this framework to incorporate proteomics, epigenomics, and other omics layers, thereby enhancing the robustness of multi-omics AI applications in crop development.

Conclusion

AI-driven bioinformatics is emerging as a transformative platform for crop innovation. By combining functionality with safety, it enables the development of future-oriented crops designed to meet the dual challenges of sustainability and resilience.

1.3 Agriculture utilizing artificial intelligence and big data

Young Hae Do, Professor, Kyungpook National University

Objective: This presentation aims to demonstrate approaches for extracting quantitative phenotypic traits from crop growth image data through AI and Big Data, and for analyzing growth characteristics and building predictive models by integrating mathematical modeling.

Mathematics-Based AI Application Framework

A mathematics-driven AI application framework has been introduced to enhance the interpretation of crop growth phenomena. Traditional approaches typically follow a sequence of theory, modeling, and simulation. In contrast, the data-driven approach infers governing equations directly from experimental or observational data. Key methods include Sparse Identification of Nonlinear Dynamics (SINDy), which enables the inference of nonlinear dynamic systems, and compressed sensing, which extracts essential signals from high-dimensional data.

Crop Image Data Analysis

The framework was applied to image-based datasets collected from 97 soybean cultivars, with four samples per cultivar and 60 time-series images captured at two-day intervals. From these datasets, RGB color values were extracted, and temporal changes in color were tracked to characterize growth dynamics.

Feature Extraction and Analysis

A structured process was employed to extract and analyze features: Feature Definition: Twelve quantitative features were defined, including maximum, minimum, and standard deviation values at different growth stages.

Feature Refinement: Correlation analyses were conducted to eliminate redundancy.
Cluster Analysis: K-means clustering, Principal Component Analysis (PCA), and the Kruskal–Wallis test were applied for grouping cultivars.
Evaluation Metrics: The quality of clustering was assessed using silhouette scores.

Analytical Methods and Integration Strategy

By combining mathematical dynamic models with AI techniques such as Reservoir Computing, an integrated strategy was developed. This strategy automates feature extraction, enables data-driven classification, and supports the expansion of models for cultivar classification and growth prediction.

Conclusion

Mathematics-based AI analysis demonstrates strong potential as a key tool for crop growth analysis, cultivar classification, and predictive modeling. The integration of image-based quantitative analysis with model-driven interpretation highlights new opportunities for automation and innovation in agriculture.

Session 2: New breeding research utilizing agricultural biotechnology techniques

2.1 Predictive breeding: How companies are using new breeding tools to deliver sustainable agriculture

Michael Leader, Director, Bayer Regulatory Policy & Stakeholder Engagement

Objective: This presentation aims to explore the ways in which companies apply new breeding technologies to advance sustainable agricultural practices.

Bayer's Agricultural Biotechnology Strategy

As a global leader, Bayer integrates conventional breeding, genetically modified (GM) crops, and genome editing technologies into its agricultural biotechnology portfolio. As of 2024, Bayer reported revenues of EUR 22.3 billion, invested EUR 2.6 billion in research and development, and operates across 143 economies worldwide.

Advances in Precision Breeding

Bayer has significantly advanced precision breeding through the integration of artificial intelligence, unmanned aerial vehicles (UAVs/drones), precision image analysis, and genomic sequencing. These innovations have drastically reduced breeding timelines, which traditionally required up to 60 months.

Application of Genome Editing

Genome editing technologies that do not involve the insertion of foreign DNA are often categorized as non-regulated. A notable example is genome-edited soybean developed through Agrobacterium-mediated techniques, which was classified as non-regulated by the USDA.

Challenges in the Regulatory Environment

Despite technological progress, regulatory barriers remain. Currently, many genome-edited crops are classified as GMOs, delaying commercialization and broader adoption. Bayer emphasizes the urgent need for international harmonization of evaluation and regulatory standards to enable innovation and global market access.

Conclusion

Governments should accelerate agricultural innovation by improving regulatory frameworks and establishing mutual recognition systems. Bayer continues to position itself at the forefront of next-generation crop development by fostering open innovation, advancing sustainability, and engaging in diverse global partnerships.

2.2 Research on cisgenesis and targeted mutations for plant breeding in the EU: A personal perspective

Henk J. Schouten, Senior Researcher, Wageningen University and Research Center

Objective: This presentation aims to examine the progress of crop breeding research in the European Union (EU) utilizing new genomic techniques (NGTs), while underscoring the necessity of future policy improvements informed by scientific soundness and ethical perspectives.

Types of New Genomic Techniques (NGTs)

NGTs encompass several approaches with distinct features. Cisgenesis involves the introduction of genes exclusively from within the same gene pool. While similar to conventional breeding, this method is faster and more precise, with successful applications such as late blight-resistant potatoes and scab-resistant apples. Targeted mutagenesis, including CRISPR-Cas–based genome editing, enables precise modifications by disabling susceptibility (S) genes, thereby enhancing disease resistance.

Regulatory Developments and Social Acceptance in Europe

Initially, NGTs were categorized under GMO regulations, which created significant obstacles to commercialization (1999–2018). Since 2018, however, the European Union has moved toward establishing distinct regulatory frameworks for cisgenesis and targeted mutagenesis, aiming to reflect scientific advances and foster public acceptance.

Application Cases of NGTs

Practical applications of NGTs demonstrate their potential to accelerate breeding timelines and reduce agrochemical inputs. In potatoes, the insertion of late blight resistance (R) genes has been used to reduce fungicide dependency. In apples, the incorporation of the Vf gene for resistance to apple scab produced a cisgenic ‘Gala’ variety, reducing breeding time by approximately 40 years compared to conventional methods. Carnation breeding has also benefited, with simultaneous editing of genes conferring Fusarium resistance and altered pigmentation.

Conclusion

Evidence indicates that cisgenesis produces outcomes equivalent to conventional breeding and poses minimal ecological risks. Therefore, regulatory approaches for NGT crops should be grounded in science and focus on risk-based assessments. For Korea, it is recommended that regulatory systems be urgently revised to distinguish between cisgenesis and targeted mutagenesis, thereby fostering innovation while maintaining safety and public trust.

2.3 New breeding innovation: from lab to greenhouse to field

Ju Kyung Yu, Professor, Chungbuk National University

Objective: To introduce next-generation strategies for crop breeding innovation and to comprehensively present the innovative elements of the breeding pipeline from the laboratory stage through greenhouse trials to field applications.

The ultimate goal of breeding is to achieve genetic gain

This is determined by four key elements: Time (T): shortening generation intervals, Accuracy (A): improving selection precision, Intensity (I): strengthening selection pressure, and Genetic Variability (G): maintaining sufficient genetic diversity. Maximizing these elements is possible through precise data collection, advanced interpretation, and the integration of digital breeding strategies.

Breeding innovation lies in data-driven decision-making

The integration of AI-based analyses, genomic and phenotypic platforms, and big-data systems across the entire breeding process enables optimal allocation of resources and enhances the accuracy of decision-making.

Conclusion

It is crucial to establish a next-generation breeding system that integrates diverse technologies into a unified framework. The development of an end-to-end innovative platform—encompassing digital breeding management and AI-based analyses—will be a key task for advancing future breeding pipelines.

2.4 Smart breeding platform to innovate crop breeding

Hiromoto Yamakawa, Manager, NARO Division of Crop Design Research

Objective: To emphasize the importance and implications of establishing a smart breeding platform.

The Need for Smart Breeding

The agricultural sector faces complex challenges, including climate change, a shrinking agricultural workforce, and the growing demand for food. These conditions call for breeding strategies that go beyond experience-based approaches and instead rely on precise, rapid, and data-driven methods for crop improvement.

Core Elements of a Smart Breeding Platform (under development by NARO)

Genetic Resources: Establishment of a representative set based on more than 42,000 rice accessions, enabling the quantification of genetic diversity in various crops and the systematic development of breeding materials.

Data Integration: Incorporation of pedigree information, phenotypic data, and genomic data, integrating both historical and current datasets.

Systems and Tools: Application of simulation-based prediction of crossing combinations and trait performance, supporting a data-driven decision-making framework that can simultaneously enhance yield and quality. In Japan, this approach has already been applied to more than 70% of crossing decisions in actual breeding programs, producing tangible outcomes.

Conclusion

Korea possesses extensive resources in terms of genetic materials, phenotypic information, and climate/cultivation environment data. By integrating AI technologies, Korea can accelerate the development of crop varieties resilient to environmental stresses such as heat, drought, and pests. Moreover, cooperation among APEC member economies should be pursued to establish shared platforms for genetic and phenotypic data. Ultimately, smart breeding platforms represent a key solution for ensuring food security and responding effectively to the climate crisis.

2.5 New breeding Technology development program (NBT research center): goals and current achievements

Jae Sung Shim, Vice Director, NBT research center

Objective: To present the outcomes of Korea's first domestic genome editing crop R&D program, led by the Rural Development Administration (RDA) from 2020 to 2026, implemented through a collaborative public–private research framework.

Establishment of a Genome Editing Platform

The program has successfully developed and established a comprehensive platform for genome editing, including: Advanced technologies to improve tissue culture and transformation efficiency, a guide RNA database for mutant resources, DNA-free genome delivery methods, and Operation of a transformation service center to support research and breeding activities.

Development of Genome-Edited Crops

Genome editing has been applied to develop crops targeting global markets, improved resistance to diseases and abiotic stress, enhanced productivity, and higher added value. Notable examples include: Low-phytate soybean, Male-sterile rice, and tomato with modified fruit ripening and maturation period.

Multi-Trait Combination and Crop Design

In addition to single-trait improvements, the program has advanced methods for multi-trait integration. This includes the development of gene combination simulation techniques and precision micro-adjustment strategies to optimize crop characteristics for targeted breeding objectives.

Conclusion

The Korean experience demonstrates the feasibility and benefits of building genome editing platforms through public–private partnerships. Looking ahead, the establishment of joint breeding infrastructure and policy alignment within APEC economies will be essential. This requires international cooperation in regulatory frameworks, technology transfer, and data-sharing mechanisms to maximize the benefits of genome editing for sustainable agriculture

Session 3: Regulatory harmonization and policies for agricultural biotechnology products

3.1 Trends in global genome editing policy and implication for R&D and product development

John McMurdy, Vice President, Croplife International Plant Biotechnology

Objective: To review global research and development trends, as well as regulatory and policy developments, related to genome-edited organisms (GEOs).

Common Position of the International Seed Industry on GEOs

The global seed industry has emphasized that, if genome-edited crops are indistinguishable from products of conventional breeding, they should not be subject to differential regulation. Exemption from GMO regulatory frameworks is typically proposed under the following conditions: No novel combination of genetic material is introduced, Only stable insertions derived from crossable species are included, and Mutagenesis is involved in the modification process.

Trends Across Major Economies

Regulatory approaches to GEOs vary worldwide. In the European Union, the regulatory status remains undecided, whereas Latin America has pursued alignment at the regional bloc level. Economies such as Japan and Thailand have adopted more practical and rational approaches in applying regulations. However, there remains a lack of consistency across economies in terms of exemption criteria and regulatory procedures.

General Concerns Regarding GEO Regulation

Several issues have been raised in relation to GEO regulation. Additional production requirements or post-market conditions could act as barriers to global distribution. It is also essential to clarify whether regulatory decisions apply to progeny derived from genome-edited crops. Furthermore, data collection should serve primarily for classification within regulatory systems rather than for full-scale risk assessment, provided no novel risks are introduced.

Trade-Related Considerations

The exemption and approval systems for GEOs in practice often mirror those for GMOs. However, discrepancies in definitions and exemption criteria, the rapid pace of technological advances, and current limitations in detection methods contribute to regulatory complexity. These factors may reduce transparency, delay product launches, and shift research investment toward smaller, less-regulated markets.

Conclusion

GEO regulation must account for the diversity of editing techniques, including gene knockouts and epigenetic modifications. To maximize the benefits of genome editing technologies, there is a pressing need for predictable, transparent, and consistent global policy harmonization.

3.2 Gene Editing Regulation: APAC's uneven Terrain

<u>Teck Wah KOH, President, Asia Pacific Seed Association (ASPSA)</u>

Objective: To review the regulatory status and policy directions of genome editing in the Asia–Pacific region.

Overview of APSA

APSA is a regional seed association that supports the production and trade of high-quality seeds for sustainable agriculture. As of 2024, APSA comprises 641 member companies, with major participation from China; India; Japan; Korea; and Pakistan.

Regulatory Status of Genome Editing in the Asia–Pacific Region

Regulatory approaches differ significantly across economies. Some emphasize evaluation of the final product rather than the technology used, while others determine applicability of GMO regulations based on the presence or absence of foreign DNA.

China; Korea: Adopt a "GMO-light" approach (SDN-1, no foreign DNA), with pilot regulations in operation. Japan: If no foreign DNA is present, GMO regulations do not apply; several products have been commercialized. Thailand: SDN-1 is exempt; SDN-2/3 may be exempt case-by-case if no foreign DNA is introduced. The Philippines; Singapore: Products without foreign DNA may be exempted from GMO regulation on a case-by-case basis.

India; Bangladesh: SDN-1/2 products are exempt from GMO regulation, with guidelines and SOPs under development. Indonesia: Some microbial products have been exempted; plant regulations are under review. Australia; New Zealand: Food products without foreign DNA are proposed to be excluded from regulation.

Conclusion

Many Economies in the region are adopting science-based evaluation frameworks, and those with clear policies are well-positioned to advance the application of genome editing technologies. Regional policy harmonization will be critical for facilitating trade, while transparent communication with stakeholders and securing public acceptance remain essential for policy success. APSA, through regional dialogue, is expected to play a central role in developing and promoting long-term, consistent policies.

3.3 Biosafety of agro-biotechnology in Latin America: understanding the dynamics on the other side of the pacific

Alejandra Ferenczi, Biosafety manager, General Directorate of Biosafety and Food Safety

Objective: To review the regulatory and policy frameworks for genome-edited organisms (GEOs) in South America, with a focus on Uruguay, Argentina, and Brazil.

Overview of Uruguay's Agricultural Sector

Agriculture plays a central role in Uruguay's economy, accounting for 14–16% of GDP, 13% of employment, and 48% of exports, while covering 90% of Uruguay's territory as agricultural land. The economy is advancing a sustainable bioeconomy strategy, notably through the Bio-Input Plan 42/25 enacted in 2025. Agriculture and forestry contribute 57% of Uruguay's greenhouse gas emissions, representing only about 0.03% of global emissions.

Core Elements of Biosafety Regulation and GMO Governance

Uruguay's biosafety and GMO regulatory framework emphasizes six principles: (1) balancing innovation and regulation, (2) building institutional capacity, (3) science-based decision-making, (4) consistency with international agreements, (5) communication to build public trust, and (6) strengthening regional cooperation.

GMO risk assessment and management are coordinated by the Ministry of Agriculture (MGAP), the Ministry of Environment, and seven other institutions, supported by a network of 37 expert evaluators across nine agencies.

For new breeding techniques, Law 084/024 (2024) provides the legal basis to determine whether existing GMO regulations apply, following the principle of "Same Product – Same Regulation."

International and Regional Cooperation in South America
Uruguay is a party to major international agreements, including the Cartagena Protocol, the Nagoya Protocol, WTO frameworks, and UPOV. Within MERCOSUR (Brazil, Argentina, Paraguay, Uruguay), mechanisms have been developed to reduce the risks associated with low-level presence (LLP) of GMOs. Furthermore, ABRE-Bio is being promoted as a multilateral cooperation framework among biosafety authorities within MERCOSUR.

Conclusion
Regulation and innovation can coexist, provided that clear and predictable systems are in place. Such frameworks not only encourage private investment but also enhance social acceptance and public trust through active communication. Strengthened cooperation and knowledge sharing between South America and the Asia–Pacific region will contribute significantly to the advancement of global biotechnology and biosafety governance.

3.4 New Genomic Techniques Plant Policy Development progress in EU

Nancy Podevin, Lead, Corteva Agriscience

Objective: To review the regulatory and policy framework for New Genomic Techniques (NGTs) in the European Union (EU).

Key Developments
In 2021, the EU initiated stakeholder consultations, impact assessments, and preparatory work for legislation on NGTs. In July 2023, the European Commission published a draft legislative proposal, which is currently (2024–2025) under negotiation by the European Parliament and the Council of the EU.

Definition and Scope of NGTs

NGT plants are defined as those developed through targeted mutagenesis or cisgenesis without the integration of foreign genetic material. This definition also includes cases in which foreign DNA was temporarily introduced during the editing process but subsequently removed in the final product.

Categorization of NGTs

Category 1 (Conventional-like): Plants with genetic alterations comparable to conventional breeding outcomes. These are exempt from GMO regulation, and requirements for GMO traceability, labeling, and coexistence rules do not apply. Instead, varieties must be registered in a public database, with labeling limited to seed packaging.

Category 2: Plants requiring an EFSA risk assessment and subject to GMO regulation, though with certain regulatory requirements eased relative to conventional GMOs.

Regulatory Issues and Considerations

A central challenge is the technical difficulty of distinguishing NGT-derived plants from conventionally bred varieties, as current analytical methods cannot reliably differentiate them. The proposed legislation introduces a proportional, risk-based regulatory approach. Other considerations include intellectual property, sustainability, labeling, and the exclusion of NGT crops from organic farming standards, which will require further discussion.

Conclusion

The EU is in the process of establishing a tailored regulatory framework for NGT crops, with legislative adoption possible by 2025. For Category 1 NGTs, regulatory relief from GMO-specific requirements is expected to create a more favorable environment for research, development, and commercialization.

3.5 US regulatory framework for GE product and global experience of a small company

Dan Jenkins, Vice President, Pairwise Ltd. Regulatory and Government Affairs

Objective: To review the regulatory framework for genome-edited (GE) crops in the United States and to present the current status and strategic directions of Pairwise's research and development activities.

Overview of Pairwise

Pairwise is a biotechnology company specializing in CRISPR-based crop development, with research and development projects spanning 14 crops. The company has pioneered the commercialization of genome-edited products such as the world's first seedless blackberry and mustard greens with the pungent flavor removed. Major projects and achievements include collaborations with the International Institute of Tropical Agriculture (IITA) and the Bill & Melinda Gates Foundation to improve yam varieties in Nigeria, and with CIMMYT and CGIAR to apply genome editing to major crops in Asia and Africa. Pairwise has developed Fusarium-resistant wheat, Asian Soy Rust-resistant soybean, and consumer-oriented traits such as improved texture and seedlessness in blackberries. Its first commercial product—pungency-removed mustard greens—was licensed to Bayer's vegetable seeds division.

GE Crop Regulatory Framework in the United States

USDA: GE crops are exempt from regulation if they contain no foreign DNA and are not derived from plant pests. EPA: Plant-incorporated protectants (PIPs) without toxicity or with substantially equivalent characteristics may be exempt, subject to notification. FDA: Pre-market consultation and voluntary disclosure of food safety information are encouraged.

Pairwise's Global Regulatory Strategy for GE Crops

Pairwise has secured 38 "non-GMO" determinations across seven economies, including Canada; Chile; and the United States. The company establishes crop- and trait-specific regulatory strategies to ensure early product release and testing. However, barriers remain: requirements such as isolation distances, labeling, and pollen flow control increase testing costs by 3–12 times. For companies focusing on specialty crops, navigating complex regulatory requirements poses particular challenges, underscoring the need for streamlined systems.

Conclusion

The successful commercialization of GE crops depends on simplified regulatory frameworks and science-based early decision-making processes. To accelerate market access, it is essential to establish regulatory strategies tailored to specific crops and target traits in the economies where commercialization is pursued.

4. Field Trip

Workshop participants visited the National Agricultural Science Museum and the National Agrobiodiversity Center under the Rural Development Administration (RDA).

The National Agricultural Science Museum presented Korea's agricultural heritage and the development of agricultural science. It showcased fundamental studies such as crop physiology and soil science, while also demonstrating applications of AI, big data, and smart farming technologies, highlighting the transition of agriculture from traditional practices to science-based innovation. The National Agrobiodiversity Center introduced Korea's system for the long-term preservation and characterization of crops, microorganisms, and insects. It also highlighted its support for breeding and biotechnology research, as well as international cooperation for the safe exchange of genetic resources, emphasizing its critical role in food security and global research.

Overall, the study visits provided participants with a clear understanding of Korea's research and education infrastructure in agricultural biotechnology and its genetic resource management system, while also identifying opportunities to expand APEC-wide cooperation and joint research.

III. Overall Conclusion

This workshop provided an important platform to discuss how agricultural biotechnology can contribute to addressing extreme weather events and natural disasters, and strengthening food security through the use of artificial intelligence (AI), big data, new breeding techniques (NBTs), and harmonized regulatory frameworks. Across three sessions and thirteen presentations, the following key conclusions were drawn.

First, AI- and data-driven precision breeding has emerged as a core technology for addressing climate challenges and ensuring food security. The standardization of genomic and phenomic data, together with the advancement of big data-based predictive models, enables innovation throughout the entire breeding cycle—from trait prediction to gene discovery, gene editing/design, and phenotypic selection. To achieve this, high-quality data collection, field validation of predictive models, and multidisciplinary data-sharing collaboration are essential.

Second, applications of new breeding technologies were highlighted as practical tools to realize sustainable agriculture. Accurate data collection and interpretation, combined with digital breeding strategies, can maximize efficiency in crop improvement. In particular, big data analytics can provide robust decision-making support by integrating scientific validity with breeding trial outcomes, thereby strengthening the link between research and policy.

Third, regulatory and policy perspectives emphasized that divergent approaches among economies significantly affect the commercialization and international trade of agricultural biotechnology. Establishing a predictable and consistent regulatory environment requires science-based decision-making, streamlined procedures, strengthened institutional capacity, transparent communication to build public trust, and enhanced global cooperation.

In conclusion, innovation in agricultural biotechnology should advance around the three main pillars of "AI and big data-based precision breeding – utilization of new breeding technologies – harmonized global regulatory policies." Together, these will contribute to achieving the shared goals of climate resilience and global food security. Strengthened public–private collaboration, improved data sharing, and enhanced international cooperation will further ensure that agricultural biotechnology serves as a sustainable solution to future agricultural and food security challenges.

IV. Annexes

1. AGENDA

Day 1. 5 August 2025

Time	Presentation/Activity	Presenter/Lead
09:00-10:00	Registration	
10:00-10:20	Opening	
Session 1. Big data and AI-Driven Agricultural Biotechnology Research		
10:20-10:45	Data and AI modeling for crop improvement and production	Scott A, Jackson Georgia Univ Professor
10:45:11:10	How can AI Bioinformatics Revolutionize Agriculture Research?	Sun Kim Seoul National Univ Professor
11:10-11:35	Agriculture utilizing artificial intelligence and big data	Young Hae Do Kyungpook National Univ
11:35-12:00	Panel Discussion	Tae Ho Lee Rural Development Administration Director
12:00-14:00	Lunch	
Session 2. New breeding research utilizing agricultural biotechnology techniques		
14:00-14:25	Predictive breeding: how companies are using new breeding tools to deliver sustainable agriculture	Michael Leader Bayer Regulatory Policy & Stakeholder Engagement Director
14:25-14:50	Research on cisgenesis and targeted mutations for plant breeding in the EU. A personal perspective.	Henk J. Schouten Wageningen Univ and Research Center Senior Researcher
14:50-15:15	New breeding innovation: from lab to greenhouse to field	Ju Kyung Yu Chungbuk National Univ Professor
15:15-15:35	Tea break	

15:35-16:00	Smart breeding platform to innovate crop breeding	Hiromoto Yamakawa NARO Division of Crop Design Research Manager
16:00-16:25	New breeding Technology development program (NBT research center): goals and current achievements	Jae Sung Shim NBT research center Vice Director
16:25-16:55	Panel Discussion	Tae Jin Yang Seoul National Univ Professor
16:55-17:00	Closing	
18:00-20:00	Welcome Dinner	

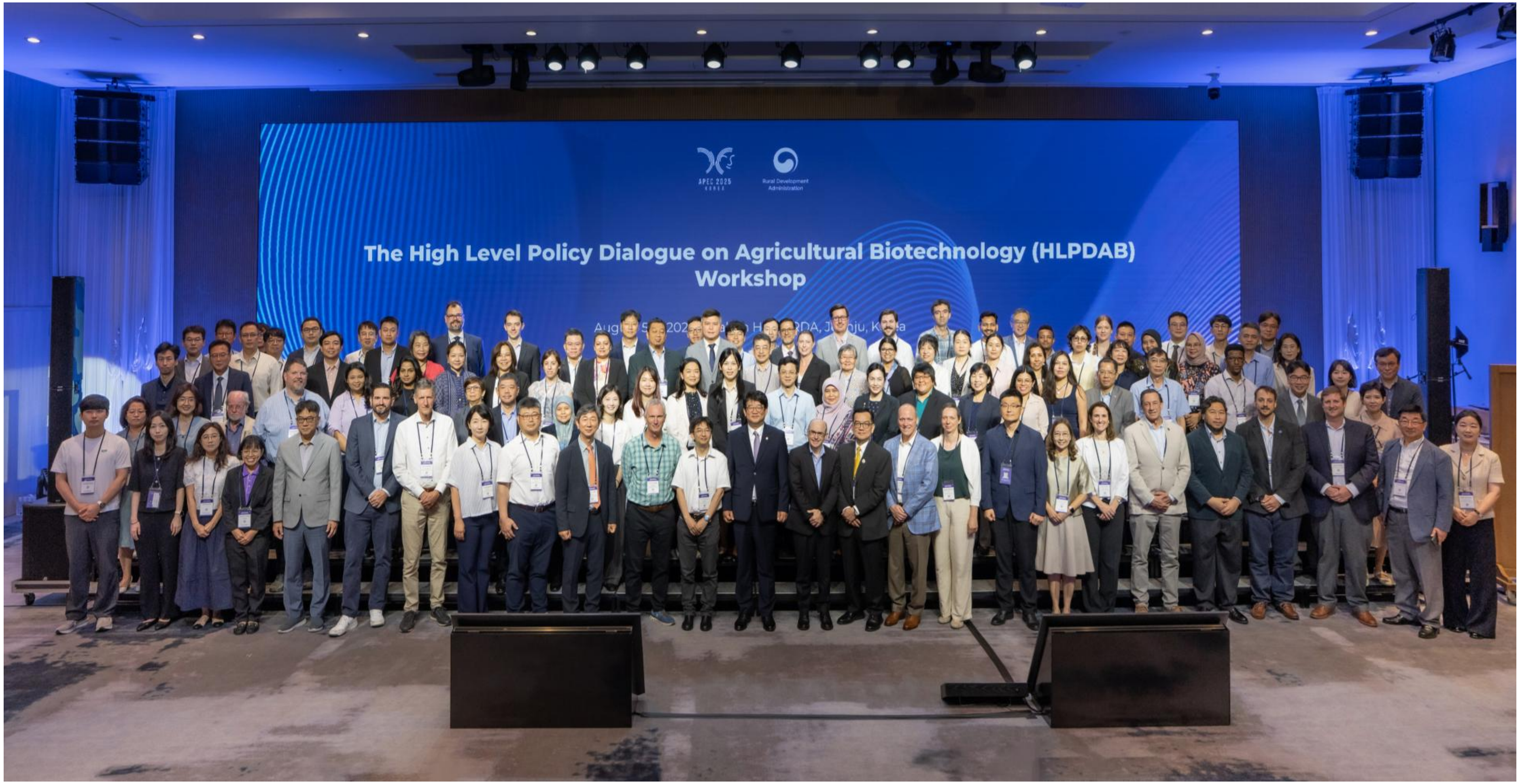
Day 2. 6 August 2025

Time	Presentation/Activity	Presenter/Lead
08:00-09:00	Registration	
09:00-09:10	Opening	
Session 3. Regulatory harmonization and policies for agricultural biotechnology products		
09:10-09:35	Trends in global genome editing policy and implication for R&D and product development	John McMurdy Croplife International Plant Biotechnology Vice President
09:35:10:00	Gene Editing Regulation: APAC's uneven Terrain	Teck Wah KOH Asia Pacific Seed Association President
10:00-10:25	Biosafety of agro-biotechnology in Latin America: understanding the dynamics on the other side of the Pacific	Alejandra Ferenczi General Directorate of Biosafety and Food Safety biosafety manager
10:25-10:50	New Genomic Techniques Plant Policy Development progress in EU	Nancy Podevin Corteva Agriscience Lead
10:50-11:15	US regulatory framework for GE product and global experience of a small company	Dan Jenkins Pairwise Ltd. Regulatory and

		Government Affairs Vice President
11:15-11:45	Panel Discussion	Gi Cheol Kim Korea Biosafety Clearing House Director
11:45-12:00	Closing	
12:00-13:00	Lunch	
13:00-13:40	Lahan hotel → RDA	
13:40-14:50	Field Trip (Rural Development Administration, RDA)	

2. Photo

Workshop



Field Trip


농촌진흥청
APEC 2025 FSMM related Meetings and Event
The High Level Policy Dialogue on Agricultural Biotechnology (HLPDAB)
Field Trip
August 6, 2025 | Rural Development Administration