Unlocking the commercial pathway for technical breakthrough in climate-smart, highly productive rice cultivation by smallholder farmers across ASEAN

Final report

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BEANSTALK

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Abbreviations

FCDO	–	Foreign, Commonwealth & Development Office
GHG	–	Greenhouse Gas
IP	–	Intellectual Property
IRRI	–	International Rice Research Institute
NDC	–	National Determined Contribution
NUE	–	Nitrogen Use-Efficiency
R&D	–	Research and Development
SAM	–	Serviceable Available Market
SDG	–	Sustainable Development Goals
SOM	–	Serviceable Obtainable Market
TAM	–	Total Addressable Market
TRL	–	Technology Readiness Level
UVP	–	Unique Value Proposition

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Executive Summary

The project team explored the development and potential commercialization of a gene-editing solution to enhance Nitrogen Use Efficiency (NUE) in rice crops. This project addressed critical issues plaguing Southeast Asia's agricultural sector, including stagnant rice yields, limited access to high-quality inputs for smallholder farmers, and the environmental consequences associated with inefficient fertilizer use. By employing a collaborative approach that leveraged IRRI's scientific expertise and Beanstalk's commercialization experience, the project aimed to bridge the gap between scientific innovation and market realities in the region.

The project unfolded in two distinct stages. The initial stage focused on defining and validating the solution's unique value proposition for targeted customer segments within the agricultural sector. This phase heavily relied on workshops and stakeholder engagement to comprehensively identify the value proposition for these specific groups. The subsequent stage built upon the groundwork laid in the first stage and concentrated on refining a commercially viable model for large-scale adoption of the NUE technology across Southeast Asia.

Stage 1 yielded two promising commercialization pathways: a product-centric model that entailed offering NUE seeds directly to farmers, and a service-oriented model that leveraged IRRI's expertise by providing collaborative R&D and trait integration services to partner organizations. Furthermore, the project meticulously mapped the competitive landscape within the ASEAN region, identifying key players with whom potential collaboration could be established. However, a crucial insight emerged from further analysis – the territories initially scoped for the project might not be commercially viable, particularly for the envisioned spin-off scenario. This led to the identification of India as a potential near-term market, with Vietnam considered for future expansion plans.

Following the selection of commercially viable markets, the project team conducted a comprehensive analysis of potential challenges and opportunities within the target regions. This analysis particularly focused on the following aspects: the regulatory uncertainty surrounding genetically engineered (GE) crops; public skepticism towards gene editing in certain countries; the challenge of reaching smallholder farmers, the dominant agricultural demographic in ASEAN, which necessitated the development of efficient seed delivery and extension services; the need for farmers to adjust their fertilizer application practices to maximize the benefits of the NUE technology; and finally, achieving a balance between seed cost and the increased yield or reduced fertilizer use, ensuring a clear economic benefit for farmers. Additionally, detailed customer profiles were formulated for seed companies, the target customer group, along with corresponding profiles outlining the relevant decision-maker personas within these organizations.

The development and commercialization pathway structured, employing Technology Readiness Levels (TRLs) to outline the development process for crop varieties. This segmentation offered facilitated the mapping of expected timeframes and resource requirements for each stage. Following the successful demonstration of the technology's efficacy, key commercialization next steps included securing intellectual property (IP) protection through patent applications encompassing various crops beyond rice, establishing partnerships with national seed companies to gain market access and facilitate technology dissemination, and selecting from a range of commercialization paths such as selling patents, co-developing NUE rice varieties, or establishing long-term R&D partnerships for portfolio development.

Financial models were constructed based on factors such as resource requirements, the chosen commercial pathway, and market forecasts. A sensitivity analysis was conducted to assess the impact of varying factors such as royalty fees, market penetration, and technology access costs. This analysis informed the identification of potential funding partners beyond just customers and strategic partners, with the specific funding options depending on the chosen commercialization pathway.

The project holds significant potential to revolutionize agriculture across Southeast Asia, with its impact extending far beyond the immediate beneficiaries. The technology's potential success has the potential to inspire increased investment in climate-smart and sustainable agricultural solutions across the region. It can also foster a culture of knowledge-sharing and collaboration among diverse

stakeholders, including public research institutions and private companies, ultimately leading to the creation of a more robust regional innovation ecosystem. Furthermore, by promoting more efficient fertilizer use, the project tackles the hidden cost of nitrogen fertilizer and its associated environmental burden. The technology's contribution to reducing nitrous oxide emissions positions it as a crucial tool in combating climate change, aligning perfectly with the region's growing focus on environmentally sustainable agricultural practices. While research on NUE gene-editing continues, the project's findings on commercialization pathways offer valuable insights for future endeavors. The project underscores the crucial role of the public sector in scaling up agricultural innovations. Governments can act as catalysts by establishing enabling regulatory frameworks, fostering public trust through educational outreach, and investing in infrastructure and knowledge sharing platforms that empower smallholder farmers. Additionally, public institutions can engage in co-development opportunities with private partners to accelerate the impact of these innovations. The project acknowledged the importance of a balanced approach to collaboration with other research institutions. While open communication and knowledge sharing were recognized as essential, the project team was mindful of potential risks associated with premature technology dissemination. To mitigate these risks, strategies such as staged disclosure and carefully crafted collaboration agreements were employed to ensure both knowledge transfer and the protection of commercially valuable aspects of the technology.

I. Introduction

Problem statement

In the dynamic landscape of Southeast Asian agriculture, the project's chosen focus area is agriculture, intricately interlinked with climate adaptation and resilience. This strategic emphasis stems from the recognition of agriculture's centrality in the region, with rice cultivation standing as a staple food source and contributing a substantial 26% to the world's rice harvest[1]. However, recent years have posed formidable challenges, with rice farmers in Southeast Asia confronting a pronounced yield stagnation, indicating a looming crisis against the backdrop of an anticipated 18% surge in demand by 2050 due to population growth[2].

The landscape is further complicated by a widening agricultural technology gap. The increasing privatization and consolidation of larger agribusinesses, coupled with the inaccessibility of 'premium' input products, exacerbate the exclusion of smallholder farmers from reaping the benefits of technological advancements. The financial constraints faced by these farmers hinder their ability to embrace genetically modified rice crops with 'premium traits,' a significant portion of their budget (20-35%) being allocated to purchasing fertilizers. Within these inputs, nitrogen is critical to the global food system, but only 15% of nitrogen applied in fertilizers is used by crops, with the rest of it leeching to soils and water.

In parallel, the governments of the region are pivoting towards climate adaptation and resilience. Initiatives such as Indonesia's National Determined Contribution (NDC) and Vietnam's ambitious plans for cultivating low-carbon, high-quality rice underscore a regional commitment to sustainable agriculture. However, these aspirations face a critical bottleneck – almost half of the agricultural emissions in Southeast Asia stem from rice cultivation, with a significant proportion attributed to fertilizers. The inefficiency of nitrogen use in rice crops not only jeopardizes food security but also poses environmental threats through water pollution and the release of nitrous oxide, a potent greenhouse gas.

In response to these multifaceted challenges, the project aimed to position itself as a catalyst for change, seeking to assess and advance the commercial feasibility of a groundbreaking rice crop solution developed by the International Rice Research Institute (IRRI). At the heart of this solution is gene editing, a technological marvel employed to enhance Nitrogen Use Efficiency (NUE) in rice crops. This innovative approach through a genetic pathway promises a significant reduction of up to 50% in nitrogen application, a consequent decrease in greenhouse gas (GHG) emissions, and a substantial improvement in smallholder farmer income by reducing fertilizer costs by up to $90 per hectare.

Despite the promising initial results from field studies, IRRI faced a capacity and experience gap in evaluating the relevant commercial pathways for gene-edited traits. This project assumed the role of a bridge, endeavoring to fill this gap and unlock the full potential of scaling the technology in collaboration with the private sector across ASEAN regions. The overarching objective is clear – propel IRRI's breakthrough gene-editing solution from the realms of research to the bustling markets, making it not only sustainable but also accessible to the smallholder farmers whose livelihoods are intricately tied to the success of such innovations. The project's strategic approach involved the identification of a unique value proposition (UVP), an in-depth assessment of the market dynamics, and the formulation of a commercially viable model, all contributing to the realization of sustainable and climate-smart agriculture in the critical rice markets of Indonesia, Vietnam, and The Philippines.

[1] USDA, Foreign Agricultural Service, *Production, Supply and Distribution* database.

[2] World Economic Forum. "Rice is both a victim and a villain in terms of the climate crisis". *Agriculture, Food and Beverage*. June 6, 2023

The technology

At IRRI, the team chanced upon a nitrogen remobilization-related function of a gene associated with a catabolism process existing in all living organisms. The Figure below illustrates that silencing the gene coding for the enzyme X may lead to the accumulation of the products B and C of the enzymatic reaction catalyzed by enzyme X.

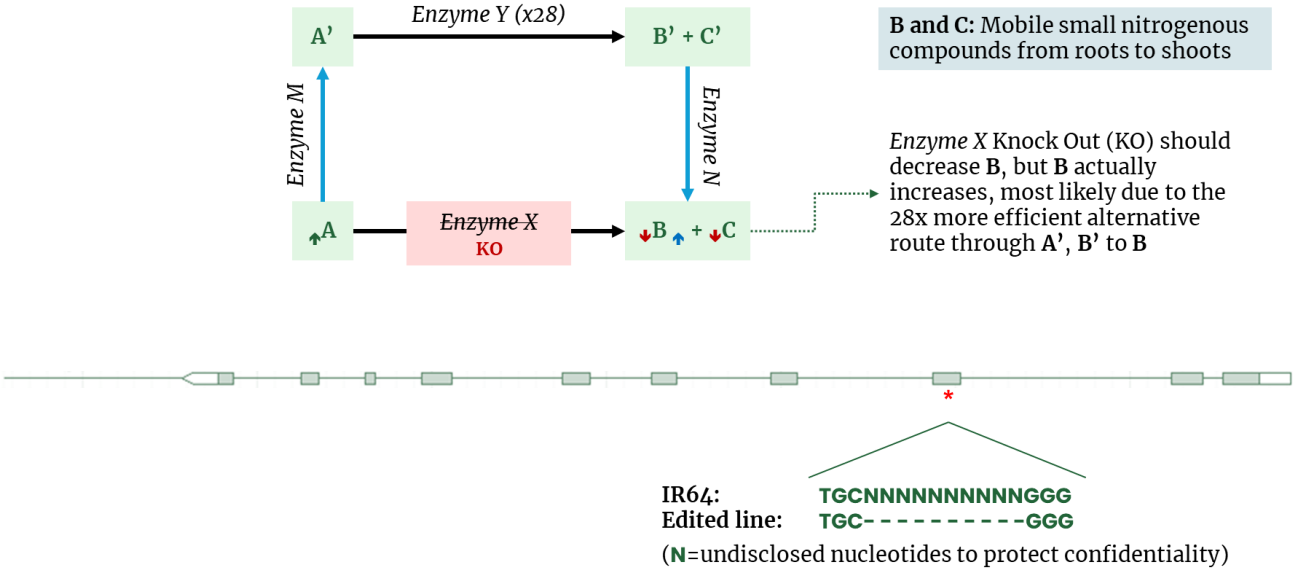

Figure 1: Metabolic pathway involved in gene editing process

The mechanism of accumulation of B & C is a metabolic shunt which is assumed to be functional in rice as it has been shown in Arabidopsis through the involvement of a 28x more active enzyme Y. The moieties B&C are small, mobile, nitrogenous compounds. Their excess presence leads to higher yield. This hypothesis can be checked if some accessions in the 3000 genomes show a dysfunctional gene for Enzyme X. Such accessions should accumulate more of B&C and should not suffer yield loss under reduced nitrogen. Four such lines were identified and subjected to field testing under less nitrogen along with other selected lines. Initial results from two field studies support the hypothesis. To test the hypothesis further, the lines are being grown under hydroponics with reduced nitrogen to discount the variability in soil Nitrogen.

The gene editing process aims to silence this gene in lines known to have an active version of the enzyme and show no effect of reducing nitrogen on yield and other physiological parameters.

II. Project overview

Project objectives

The primary objective of this project was to validate the commercial feasibility and scalability of a groundbreaking technology aimed at enhancing NUE in rice, with potential applications in other cereal crops. By leveraging the innovative genetic pathway developed by IRRI, the project sought to address key Sustainable Development Goals (SDGs). Specifically, it showed alignment with SDG 2, targeting the end of hunger, achievement of food security, and improvement of nutrition through sustainable agriculture (2.3, 2.4, and 2.a). Additionally, the project aimed to contribute to SDG 12 by striving to ensure sustainable consumption and production patterns, focusing on goals 12.2 and 12.4. Moreover, it addresses SDG 13 by taking urgent action to combat climate change and its impacts.

The envisioned impact of a commercially-viable product utilizing the IRRI-developed genetic pathway is multifaceted. At the smallholder farming level in ASEAN and beyond, the project aims for significant and sustained gains in agricultural productivity. This includes enhancing nitrogen utilization even

under constraints related to income and access. Furthermore, the project anticipates a reduction in emissions of nitrous oxide, a greenhouse gas over 250 times more potent than carbon dioxide. This reduction is expected through optimizing nitrogen application, allowing existing or newly-applied nitrogen in the soil to be more efficiently absorbed by cereal crops.

However, the pursuit of a smallholder-inclusive commercial pathway is not without its challenges. Previous experiences with high-quality technological traits in low-and-middle-income country contexts have demonstrated potential pitfalls. Such traits often struggle to reach smallholder farmers due to economic constraints or distribution rights issues. In the context of this project's technological innovation facilitated through gene editing, regulatory requirements, dynamically evolving across the region, are anticipated to play a pivotal role in determining commercial viability and shaping attitudes towards partnership.

The essence of this project lies in the comprehensive elaboration, assessment, and proof-of-concept for two crucial components: a UVP and a viable commercial model. These elements are fundamental to extending the impact of the innovation at scale and in an inclusive manner. The project team commits to delivering a series of outputs, including inception, progress, draft final, and final reports, providing evidence behind the development of these materials.

Critical outputs, addressing intellectual and commercial gaps identified, encompass:

- A clear understanding of profiles for the top 2-3 customer segments across the region, emphasizing the 'right to serve' each from the perspective of high-NUE biotech;
- Elaboration of the competitive landscape, including current and aspirational competitive advantages in target markets, with a specific focus on Indonesia, Vietnam, and The Philippines;
- Alignment of IRRI and partner leadership on the 'right' (viable, strategic, and inclusive) commercial model to pursue and establish;
- Clear short- to medium-term strategies, spanning the improvement of commercial foundations, refinement of the technical roadmap, and the go-to-market approach;

Preparation of IRRI, in the context of this project and beyond, to enhance its ability to deliver value to farmers through innovative partnerships with private sector agribusinesses, capital markets, and other technical and commercial collaborators. The shortest-term focus involves addressing an existing funding gap to fulfill the full technical proof-of-technology and lay the foundation for commercial product development.

Project scope and methodology

The chosen methodology leveraged the synergies between Beanstalk and IRRI, combining their individual strengths. Beanstalk, with its extensive commercial relationships across ASEAN and proven expertise in crafting, developing, and executing commercial strategies for agricultural innovation, collaborated with IRRI's extensive history of introducing groundbreaking innovations to smallholder markets and robust technical networks in crop breeding and genetics.

The methodology drew insights from relevant literature and references in agricultural innovation, commercialization, and genetic trait manipulation, including studies on successful commercialization models for novel agricultural technologies and frameworks for defining unique value propositions. However, stakeholder engagement was central to the methodology. The project included discussions with IRRI on commercializable assets, target customer segments, hypothesized competitive advantages, and success criteria for the feasibility assessment. Additionally, one-on-one discussions with customers and key stakeholders across ASEAN, who were identified and engaged in the initial stage of the project, were integral for understanding needs, mapping market landscapes, and defining the 'right to win' in the context of the project. For this purpose, the team utilized collaborative tools for virtual workshops and document sharing, including video conferencing platforms, collaborative document editing tools, and project management software.

The agricultural and gene-editing landscape in the region is dynamic, with ongoing advancements and innovations shaping the field. Recognizing the importance of staying current with the latest developments, our project methodology incorporated a continuous review of research and development in the agricultural sector. This proactive approach ensured that each step of the project, particularly the definition and validation of the UVP, was informed by the latest and most relevant knowledge.

Based on its objectives, this project encompassed the delivery of core outputs through two stages to comply with the requirements established by the FCDO:

Project stage	Outputs produced	Key activities
1. Definition and validation of UVP	• Output 1: Inception Report • Output 2: Progress Report	• Kick-Off Workshop • Customer Needs Assessment • Competitive & Market Landscape • Workshop on Defining UVP & Roadmap to Strengthen
2. Clarification of viable commercial model	• Output 3: Draft Final Report • Output 4: Final Report	• Commercial Pathway Mapping and Evaluation • Commercial Strategy Workshop • Prep and Presentation of Final Report

Stage 1: Definition and validation of UVP

1.1 **Kick-off Workshop:** The project officially commenced with a half-day workshop involving the IRRI team and select external partners. This session aimed to build upon the insights gathered in the inception report, focusing on commercializable assets, target customer segments, hypothesized competitive advantages, and success criteria for the feasibility assessment.

1.2 **Customer Needs Assessment:** Desk research and one-on-one discussions with potential customers and key players within priority segments across target markets were conducted to identify the 'right to win' and critical components of a competitive commercial solution, mapping the key challenges and goals of decision-makers among target customer groups.

1.3 **Market Landscaping & Assessment:** Desk research and discussions were undertaken to map the landscape of potential customers, competitors, and partners within the ASEAN region, aligning with the 'right to win' framework.

1.4 **UVP Definition & Roadmap Workshop:** A collaborative workshop was convened with the IRRI team and selected external partners to clarify the current, potential, and path-to-strengthen UVP for commercializable assets in priority customer segments.

Stage 2: Clarification of viable commercial model

2.1. **Commercial Pathway Mapping and Evaluation:** A desk-driven population and evaluation of a long-list of fit-for-customer/UVP business models were conducted to identify viable commercial pathways aligned to the capabilities and mission of IRRI. While focusing on assessing the trade-offs in returns, risks, required resources, strategic fit, and return to IRRI-at-large, the team collaboratively forecast and played forward commercial and operational scenarios under various models to pressure-test pathways and establish clear 'right to win' factors and investments..

2.2. **Commercial Strategy Workshop:** The team convened in an in-person, half-day workshop to define the key elements to consider in the integration of a clear Go-To-Market (GTM) roadmap, covering commercial structure, team composition, customer engagement targets, R&D, IP strategy, geographic focus, and fundraising strategy. Special focus was given to models that could internalize and embed commercial capability within IRRI to advance prospects for future

innovations within the current research pipeline. Broader learnings for commercialization and private sector engagement strategy were considered, including opportunities to amplify support for the NUE innovation and identify similar opportunities across the IRRI portfolio.

2.3. **Preparation and Presentation of Final Report:** The working team, in collaboration with critical partners at IRRI, have authored and will present a final report to the FCDO and key stakeholders in a virtual session on June 21st, 2024. This will include a clear demonstration of the 'proof-of-concept' for IRRI's NUE-enhancing genetics from the standpoint of assessed and refined commercial feasibility. Substantial consideration have been given to the implications of the innovation and its commercial deployment across Southeast Asia. A translation of the commercial feasibility assessment to 'next steps' in confirming further sustainability of the innovation's development have been consolidated in an inventory of commercial engagement materials (which include a 'pitch deck' for potential commercial and strategic engagements).

III. Implementation

Results of the project

Identifying commercializable assets

The kick-off workshop marked the inception of the project's journey towards identifying and analyzing potential customer segments for IRRI's NUE gene-editing solution. Collaborating closely with the technical and technology-transfer teams, the project team delved into the intricate details of the solution's functionality and underlying technology. Guided by the project's overarching goal, the team adopted the Value Proposition Canvas[3] as the central framework for their analysis. This framework facilitated the visualization of customer value creation by delineating the "who, what, and how" of customer needs and IRRI's technology offerings (see Appendix 1: Kick-off workshop outputs).

Using the Value Proposition Canvas as a guide, the team embarked on a rigorous process of identifying IRRI's assets deemed "commercializable" within the context of the NUE gene-editing solution. Through this analysis, two primary commercialization approaches emerged: a product-centric approach focused on tangible products like market-ready NUE trait or hybrid seeds, and a service-oriented approach leveraging IRRI's expertise to offer a solution portfolio services such as trait integration assistance, application of synergistic technologies, or collaborative R&D efforts. These approaches formed the basis for further exploration through primary and secondary research, aiming to gather insights from successful case studies to inform future strategies.

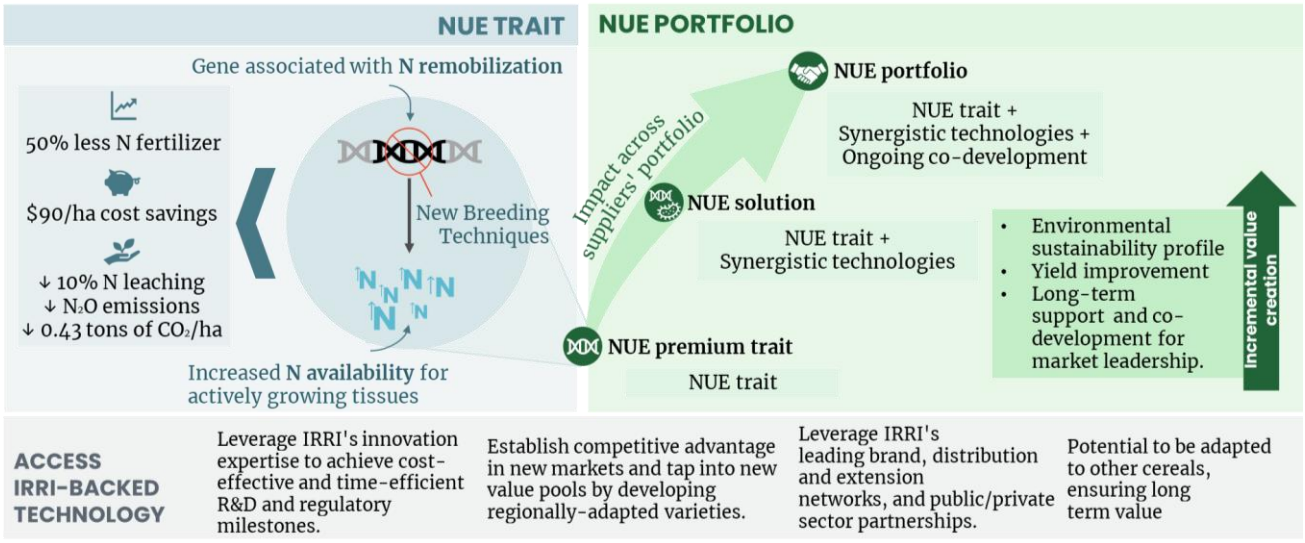

Figure 2: Primary commercialization approaches

With commercializable assets identified, the project shifted its attention to pinpointing potential target customer segments (including global seed companies, seed SMEs, seed distributors, public entities, and private R&D companies). The objective was to ensure a strong alignment between customer needs and IRRI's value proposition. This phase laid the groundwork for a comprehensive customer analysis, establishing a solid foundation for understanding both the solution's capabilities and the potential customer landscape.

[3] Osterwalder, Alexander, Alan Smith, Yves Pigneur, Greg Bernarda & Trish Papadakos. "Value Proposition Design"

Mapping the market landscape

Understanding the market landscape surrounding IRRI's NUE gene-editing solution is crucial for identifying potential clients, partners, and competitors.

In the initial phase of the market analysis, an extensive market landscaping matrix was created, encompassing various segments including global seed companies, SME seed companies, private biotechnology and R&D companies, government and public R&D entities, universities, and alternatives to nitrogen fertilizers. Relevant actors for inclusion in the matrix were identified through extensive desk research using market reports and keyword searches covering gene editing technologies, nitrogen use efficiency, alternatives to nitrogen fertilizers, new breeding technologies, rice research, and nitrogen reduction research.

Despite encountering difficulties in classifying certain entities in this matrix, such as some seed companies also offering alternatives to nitrogen fertilizers, the main challenge lay in the vast amount of information collected and the consequent difficulty in presenting it in a simple and concise manner. After exploring various presentation approaches, a common thread emerged among all the actors on the list: their involvement in the seed business, their efforts to reduce nitrogen fertilizers, and/or their advances in new breeding technologies. Although companies tended to specialize in different sectors, the analysis revealed innovation efforts and leading companies located at the intersections of these sectors. Consequently, a decision was made to devise a diagram delineating the three primary sectors alongside their intersections, showcasing the respective players engaged within each domain.

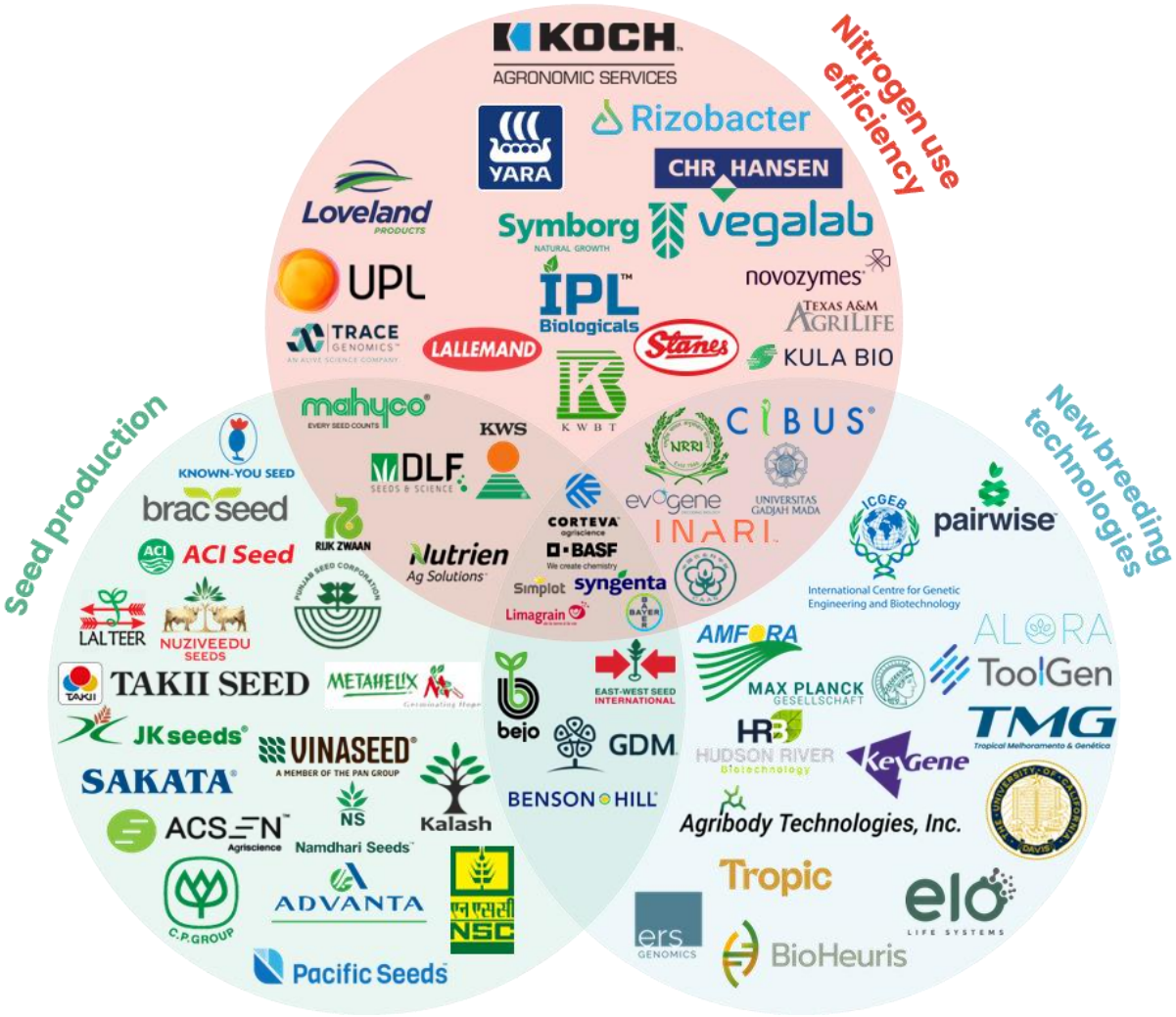

Figure 3: Landscape map

Within this scope, the landscape can be visualized as a dynamic ecosystem comprised of three key market sectors:

1. **Seed production:** This sector encompasses the companies responsible for developing, producing, and distributing seeds for various crops. These companies play a vital role in ensuring a stable and high-quality seed supply for farmers around the world.
2. **New breeding technologies:** This sector focuses on the development and application of innovative tools and techniques for crop improvement. These encompass a wide range of technologies, including gene editing, marker-assisted selection, and genetic modification.
3. **NUE:** This sector is comprised by companies or research institutions focused on NUE research or developing complementary technologies

While companies often specialize in a specific market sector, the landscape is not entirely siloed. Innovation thrives at the intersection of these sectors, where companies collaborate to leverage expertise from different areas. By thoroughly understanding the market dynamics, including the major players, their areas of specialization, and the potential for collaboration across sectors, IRRI can:

- Identify potential clients by recognizing market players seeking to NUE technologies to enhance their product offerings
- Pinpoint collaboration opportunities or partnerships to further develop and commercialize the solution
- Navigate the competitive landscape, understanding the competitive environment within the NUE space and developing strategies to differentiate their solution
- Uncover emerging opportunities for new applications arising from the convergence of different market sectors

Creating prospective customer/partner profiles

In refining the initial customer segments identified during the kick-off workshop, the project team recognized the need to reassess the segmentation criteria, as certain characteristics previously used for segmentation, such as company size, location in the value chain, and other factors, did not consistently align with the key differences between segments as perceived from the insights gathered through interviews with industry experts and the information collected from various sources.

As a result, the team adopted a more nuanced approach, focusing on attributes directly relevant to the adoption and utilization of the NUE technology rather than broad categorizations like company size or industry sector. This approach allowed them to identify customer segments based on factors such as internal R&D capabilities, adaptability to new technologies, and alignment with IRRI's value proposition.

Through this process, the team discovered that characteristics such as innovation mindset, technological readiness, and strategic focus were more indicative of a company's potential as a customer or partner for IRRI's solution than traditional segmentation factors alone. This realization led to the emergence of five distinctive customer segments that better reflected the diverse landscape of potential adopters (see Appendix 2: Customer segment profiles):

1. Established innovators (e.g. Bayer, Syngenta, Corteva): Seed corporations with in-house GE/Biotech R&D capabilities
2. Agile adapters (e.g. ACI Seed, KLF): Seed companies lacking internal GE/Biotech R&D
3. Specialized partners (e.g. Evogene, Pairwise): Private GE/Biotech R&D companies focused on trait development
4. Complementary innovators (e.g. Phosphogypsum Consortium): Companies exploring alternative technologies for NUE improvement
5. Public research powerhouses: Public institutes with expertise in agricultural research and development

This refined segmentation approach was informed by a two-pronged strategy in two significant ways:

- **Alignment with Market Players:** The first prong focused on ensuring alignment between the identified customer segments and the relevant market players previously mapped within the seed production, new breeding technologies, and NUE sectors. By aligning the segmentation strategy with these market players, the team ensured that their approach targeted companies most suited to benefit from IRRI's NUE gene-editing solution. This alignment helped narrow down the focus to those organizations actively involved in sectors relevant to IRRI's technology, enhancing the precision of the segmentation.
- **Correlation with Value Proposition:** The second prong involved establishing a clear correlation between the distinct characteristics of each customer segment and the value proposition offered by IRRI's NUE gene-editing solution. By understanding the unique needs, challenges, and priorities of each segment, the team could tailor the value proposition to resonate specifically with those characteristics. This targeted approach would allow for the development of communication and engagement strategies that effectively address the specific concerns and interests of each segment, thereby increasing the likelihood of successful adoption of IRRI's technology.

The following table summarizes the key findings on each of the segments' identified pains, gains, and recommended approach:

	Seed corporations with GE/Biotech R&D capabilities	Seed companies without GE/Biotech R&D capabilities	Private GE/Biotech R&D companies	Alternative technology companies	Public GE/Biotech R&D institutes
Pains	• High R&D costs strain profitability and limit resources for commercialization • Collaborative innovation is less agile than in-house R&D, and limited by trait, applications, and/or crops (short-term) • Limited market understanding due to centralized R&D capabilities (limited feedback loop/customer engagement – Asia not a priority for global strategy) leads to missed sales and market share • Regulatory delays hinder product launches and revenue growth, as technology evolves faster than regulations	• Difficulty of competing with larger seed companies who have global reach and advanced R&D capabilities. • Long delays in bringing gene-edited crops to market due to regulatory hurdles prevent companies from capitalizing on potential yield improvements and associated revenue growth. • Heavy reliance on overseas R&D leads to duplication of efforts and limits access to technologies specifically tailored to regional needs, potentially delaying market entry of potentially profitable seed varieties. • Farmer perception of lower grain quality in hybrid varieties compared to inbreds can lead to lower market prices and reduced profitability.	• Significant financial resources are needed for research, development, and regulatory approval of gene editing technologies. • Complex and evolving regulatory environment. • Competition from other private GE/Biotech companies and established seed corporations with in-house R&D capabilities. • Lengthy process of developing, testing, and gaining regulatory approval for new gene editing applications.	• Competition with established market share and lower upfront costs of conventional fertilizers • Pricing challenges, as they need to balance the value proposition of their products with the need to be price-competitive in the fertilizer market • Challenges in ensuring adequate adoption and use of alternative technologies among farmers	• Differing public perceptions and a lack of harmonized regulations across the region create challenges for implementing GE technologies • Limited innovation focus due to government priorities, greatly hindered by the unbalance between short-term political cycles with long-term sustainability goals • High fertilizer use, and its rising cost and environmental impact • Introducing new crops needs careful consideration to avoid unintended consequences on staple food security
Gains	• Increased market access, reduced customer acquisition costs, and ease of 'license to operate' (LTO) through improvement of local/regional reputation • Development of regionally adapted seed varieties to expand product portfolio, potentially increasing sales • Creation and development of strategic partnerships to expand market reach, access new technologies, and reduce R&D costs	• Increased capacity and access to new technologies and/or products to higher yields and increased farmer revenue, translating to greater profit margins. • Building credibility and a better reputation as a regional seed provider can attract additional support from governments (e.g., grants, subsidies) and other third parties. • Focus on regional vulnerabilities can attract premium prices from farmers facing these challenges, leading to increased profitability and client loyalty.	• Being first to market with a novel and effective gene editing solution can lead to significant market share and brand recognition. • Opportunities to establish lucrative partnerships with seed companies • Contributing to solutions for global and national food security challenges	• Capitalizing on the increasing demand for sustainable agricultural practices and environmentally friendly products. • Ability to command premium prices for their technologies from farmers who prioritize soil health and long-term benefits. • Opportunities to partner with seed companies, distributors, or retailers to expand market reach and brand recognition.	• Potential for cost reduction associated to existing government policies (e.g. fertilizer subsidies) • Desire to promote sustainable agricultural practices that improve resource efficiency and reduce environmental pollution • Supporting initiatives that strengthen smallholder farmer communities through cooperatives and knowledge-sharing
Approach as a client	• Tailor message to highlight alignment between proposed solution and current product portfolio and/or R&D priorities • Offer a cost-effective model, considering tiered licensing options catering to different company sizes and needs • Provide scientific data and real-world results to demonstrate credibility and effectiveness • Position as a collaborative partner, open to co-development	• Consider how the solution addresses the vulnerabilities, and challenges in their own markets • Offer comprehensive training and support to ensure the successful adoption and use of the solution • Demonstrate ROI provided in terms of increased yields, improved quality, or reduced costs			• Highlight how the solution contributes to the national and regional goals (e.g. ASEAN guidelines for sustainable agriculture) • Leverage external data sources (e.g. IFPRI) on fertilizer use and pollution to showcase the urgency of adopting sustainable solutions • Develop educational materials (localized languages, visual aids) to explain gene editing and the specific benefits of the NUE solution
Approach as a partner		• Demonstrate complementary expertise, leveraging their own knowledge and network • Develop an agreement highlighting shared resources and risks	• Partner by offering technical expertise to integrate with their existing seed development pipelines • Offer co-development opportunities to further develop NUE technology or target specific traits in combination with other beneficial features • Develop agreements that share profits from jointly developed technologies/products or reward successful completion of development milestones	• Highlight opportunities for combined solutions for a more holistic approach to nutrient management • Explore joint research projects to optimize the compatibility and effectiveness of each other's technologies when used together. • Establish a fair and transparent revenue-sharing agreement to incentivize both partners.	• Partner to quantify the environmental benefits of reduced fertilizer use (e.g., lower nitrogen runoff) • Collaborate with cooperatives to facilitate technology adoption and knowledge sharing among smallholder farmers.
Considerations as a competitor	• Advantage in launching and promoting new products due to strong brand recognition • Due to their established R&D capabilities and resource advantage, these corporations may choose to develop their own NUE gene editing technology in-house. • Possible existing partnerships with other gene editing companies who are working on NUE solutions.	• May have cost advantages by operating locally and focusing on price competition • Possible existing partnerships with research institutions or universities due to reliance on external R&D	• Generally faster and more agile vs. public organizations • Ensure patent protection and/or licensing terms to limit competition and secure market share • Monitor the R&D progress of this segment to adapt strategy and maintain a competitive edge	• Identify and showcase specific benefits of the NUE gene editing solution that go beyond what alternative technologies can offer, sustained by evidence and field-trial data • Monitor competitor activity and applicable regulatory landscape	

Establishing the commercial approach

While customer segmentation provides a valuable framework for understanding distinct needs within the market, the team identified the need to delve into existing commercial models within the market landscape, aiming to identify successful partnerships and dissect the key ingredients for such collaborations. While leveraging insights from both primary and secondary research, the case study analysis served a three-fold purpose: (1) identifying the key factors that contribute to a strong and productive partnership (e.g. shared goals, clear communication channels, well-defined risk and revenue-sharing structure), (2) pinpointing the essential ingredients for successful partnerships within each use case (e.g. specific types of expertise, access to certain resources, commitment to joint research), and (3) understanding potential financial arrangements for IRRI's own collaborations, with revenue models encompassing licensing agreements, co-development revenue sharing, or tiered service subscriptions (see Appendix 3: Exemplary UVPs).

Based on these use cases and the resulting takeaways from the workshops, the team shortlisted the following model alternatives:

	Description	Operating model	Revenue model	What's necessary	Time to market	Reference model
Long-term R&D collaboration	IRRI gets paid to integrate the **NUE trait** into an existing seed portfolio of a global seed company, acting as a knowledge provider	1. IRRI identifies a global seed company to propose the integration of the NUE trait into their portfolio 2. IRRI contributes scientific expertise and conducts joint research activities 3. IRRI receives partial royalties based on sales of seeds containing the NUE trait	• Payment as R&D partner/ service provider (e.g. milestone fees, retainer) • Partial royalties based on sales	• **Pre-developed NUE trait** • Specialized scientific team for collaborative research	Medium	Pairwise + Bayer
'Trait-as-a-Service' model	IRRI offers tiered memberships to mid-sized seed companies for varying access to services leveraging its own **know-how**	1. IRRI establishes different membership tiers offering varying access to expertise and resources related to the incorporation of traits into existing portfolios 2. Mid-sized seed companies subscribe to suitable membership tiers based on their needs 3. IRRI delivers services and support as per the chosen membership tier	• Recurring membership fees	• **Pre-developed NUE trait** • Established platform for knowledge sharing and service delivery • Expertise in diverse areas relevant to NUE development	Long	IRRI + DA PhilRice

	Description	Operating model	Revenue model	What's necessary	Time to market	Reference model
2-stage licensing	IRRI sells a **time-restricted exclusive license** to 1 to 3 seed companies that provide varying contributions to R&D funding to develop a market-ready **NUE trait**	1. IRRI presents the NUE trait, its potential, and R&D plan (budget) to prospective investors/clients 2. IRRI utilizes the upfront payment from selected client to fund further R&D to attain a market-ready solution 3. IRRI provides a time-restricted exclusive license to funding client 4. Once the time restriction is lifted, IRRI will identify and negotiate licensing agreements with other clients	• Upfront payment to fund further portfolio-building and R&D • Royalties based on sales, once opened up	• **Initial data on NUE trait** • Established intellectual property rights (decide level of IP protection) • Defined array of required R&D investments and commercial conditions	Medium	-
Collaborative solution development	IRRI sells access to **gene portfolio** to platform provider in order to co-develop and jointly market NUE traits	1. IRRI identifies and partners with a platform provider, sharing its gene portfolio and expertise in NUE gene-editing 2. IRRI and partner co-develop a market-ready NUE trait 3. IRRI and partner jointly commercialize the NUE trait to seed companies	• Revenue sharing through co-development agreements (e.g. profit sharing, milestone payments)	• **Initial data on NUE trait** • Specialized scientific team for collaborative research	Long	BioConsortia ICGEB + IARI GDM + BioHeuris

Based on the shortlisted business models, the team identified two possible pathways for IRRI two undertake, considering their benefits and trade-offs:

1. A hollistic **NUE portfolio** approach, which would require a spin-off from IRRI due to the executive and commercial implications of this model, as IRRI's geographical and crop focus may hinder the long-term viability of an integrated solution model. While this option involves higher risk and complexity, and requires more capital, it also entails higher long-term earnings and value generation. Early liquidity through the spin-off could also support the strengthening and integration of new capabilities withing IRRI.
2. An **NUE trait commercialization** pathway, for which co-development is a crucial step, which would allow IRRI to share risks and potentially achieve faster market entry, but would entail means less control over IP and potentially lower royalty participation. While this option

represents a more straightforward path, with less capital cost and faster-to-market, it would likely have less value-add/up-sell opportunities, resulting in a potentially less competitive single solution with lower headroom for value creation.

Identifying the market opportunity

After the analysis of the potential business models, along with the solution's value proposition, the team identified the potential of an initial focus on the Asia-Pacific region as an opportunity to leverage IRRI's expertise of 64 years in the regional staple crop, and its mission as a research organization[4]. While the region has a total rice seed market size of US$4.32B, this analysis had focus on the 2030 forecast of the hybrid seed market while identifying the Total Addressable Market (TAM)[5], Serviceable Available Market (SAM)[6], and Serviceable Obtainable Market (SOM)[7].

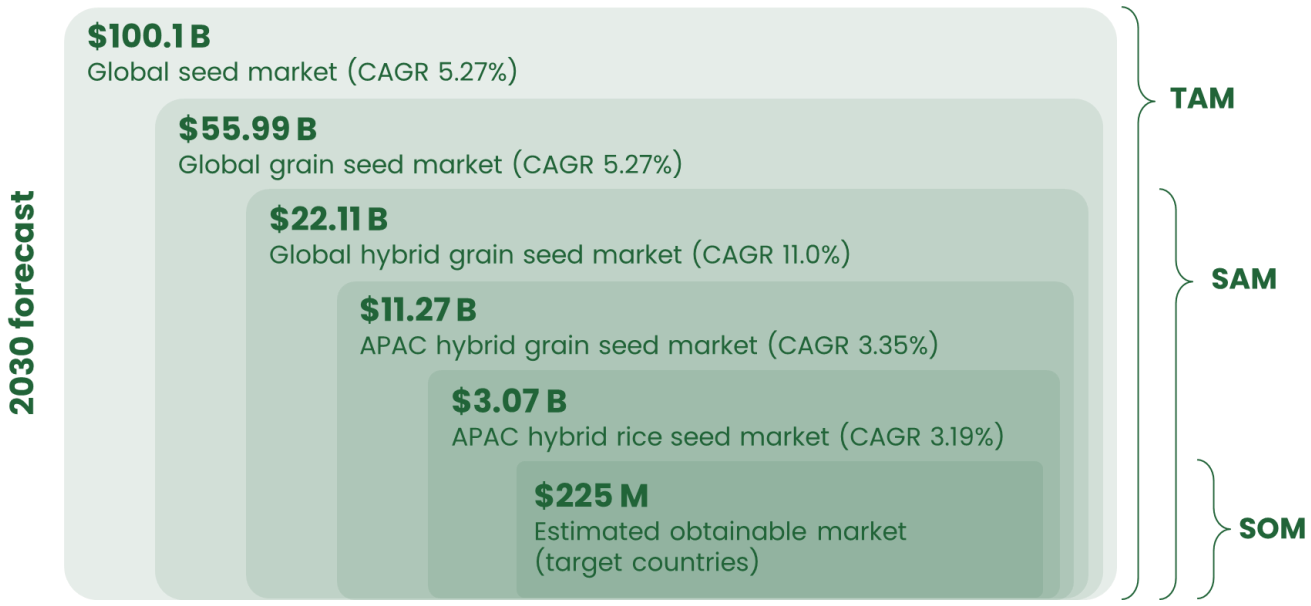

Figure 4: Market TAM, SAM, and SOM

The team then progressed to assessing the potential markets within the target countries set in the scope of this project, evaluating the challenges presented in both a regional and national matter:

Regional challenges

- Regulatory uncertainty as GE-related regulations are still unevenly evolving within the ASEAN region.
- Gene editing for food crops faces public skepticism in some countries, including both the scoped countries and international markets that have trade relationships with them.
- Reaching smallholder farmers, the dominant group in ASEAN, requires efficient seed delivery and extension services, often hindered by the countries' geography.
- Farmers may need to adjust fertilizer application practices to fully benefit from NUE rice.
- The cost of seeds with the new trait needs to be balanced by the increased yield or reduced fertilizer use for farmers to see a clear economic benefit.

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[4] "[...] reducing poverty and hunger through rice science; improving the health and welfare of rice farmers and consumers; and protecting the rice-growing environment for future generations." *IRRI at a Glance*. 2018. https://www.irri.org/irri-glance#:~:text=The%20International%20Rice%20Research%20Institute,growing%20environment%20for%20future%20generations.

[5] The Total Addressable Market (TAM) quantifies the total market for a product

[6] The Serviceable Available Market (SAM) is the portion of the market the organization can acquire based on the business model

[7] The Serviceable Obtainable Market (SOM) is the percentage of SAM that can be realistically captured by the organization.

National challenges and opportunities

- Indonesia
    - **Challenges:** Seed piracy as a concern for investment. Indonesia has a large archipelagic geography, requiring robust seed delivery systems.
    - **Opportunities:** NUE rice can improve food security and reduce current reliance on imports. Government funding and support for agricultural research is significant.
- Philippines
    - **Challenges:** Other traits might be more valuable given frequent typhoons and unpredictable weather (i.e. drought-resistance)
    - **Opportunities:** High public acceptance of agricultural technologies and robust regulatory system. The government actively supports innovation to improve rice yields.
- Vietnam
    - **Challenges:** Strict regulatory environment for GMOs; public awareness about gene editing is low, requiring more effort for acceptance.
    - **Opportunities:** Potential improvement of export competitiveness and government support for agricultural innovation and climate-smart solutions

Taking into consideration the key dimensions, comprised of commercially focused indicators and metrics aligned to IRRI's mission, the results of said analysis indicated that there was not an existing market within the initially scoped territories that could be commercially viable to ensure sustainable growth and development, especially within the spin-off scenario. This conclusion resulted in the consideration of India as a potential near-term market that could support the initial development of the commercially focused endeavor, prior to expanding to other countries, regions, and crops.

Undergoing the same analysis as the previously mentioned markets, India showed the highest potential as a near-term market, while acknowledging Vietnam's potential for future expansion, subject to its development of GE regulation as part of ongoing efforts and discussions.

Prioritisation		Market size [2030]		Regulatory pathway openness	Smallholder-centricity (% of farms)	Emissions from agriculture [$MtCO_2e$]		GHG/ environmental pressure by govt.	IRRI positioning (brand and infrastructure)
		Rice	Other grains			N_2O	Total		
	India	470.4M	4.53B	Guidelines for gene-edited plants (Mar '22) Part of Seeds Without Borders	81.8%	293.73 (39.6%)	741.92	Medium	Strong (Collaboration with ICAR across initiatives)
	Vietnam	231.5M	239.1M	2030 bioindustry project includes GED regulation Part of Seeds Without Borders	94.8%	22.65 (32.2%)	70.27	High	Medium (Collaboration in breeding and capacity-building programs)
	Philippines	47.4M	-	Operational regulatory system for GM and GED crops Part of Seeds Without Borders	68.1%	11.48 (18.7%)	61.44	High	Strong (Close collaboration with DA and agencies)
	Thailand	373.3M	301.8M	Biosafety regulatory system for GM crops, but GED require case-by-case assessment	42.3%	16.83 (24.8%)	67.88	Medium	Medium (Cooperation in breeding programs and climate-focused programs)
	Indonesia	58.3M	-	No existing regulations or guidelines. GED technology is assessed in a case-by-case (only 1 application received)	87.6%	65.56 (42.5%)	154.30	Medium	Low (Existing projects, but last collaborative workplan in 2011)

Table 1: Market prioritisation based on key criteria assessment

Taking into consideration the previously defined customer/partner profiles, along with the two pathways for the business model, the team proceed to consolidate the profile of the target customer, seed companies, within the established markets, along with the 'personas' of relevant decision-makers within these types of organizations. The existing variance between internal R&D capabilities among players in the regional seeds market would represent a need to scope what is accessible to respective customers for respective agreements, but would also allow a more flexible approach towards commercial engagements in different stages of the development process.

Among key decision-makers within this customer group, the team highlighted three potential personas based on the centralized R&D structure of most seed companies: Seed Research & Development Director, Field Crop Seed Portfolio Manager, and Regional Plant Breeding Director (see Appendix)

Seed Companies

Centralized R&D capabilities

Regional/national portfolio strategies

Focus on profitability, efficiency and long-term benefits

Main pains:

- Limited R&D agility
- High in-house R&D costs
- Slowing pace of seed innovation (and erosion of competitive advantage due to diversification of breeding approaches)
- Increased regulatory pressure

Main gains:

- Retention and strengthening of market share
- Development of regionally-adapted varieties
- Improvement of local/regional reputation, and strengthening of sustainability strategy through support of NDCs
- Tap into nutrition value pools
- Opportunity for premium pricing

Established innovators: BASF, Bayer, Corteva agriscience, Mahyco, Advanta, Limagrain, East-West Seed, Syngenta

Agile adapters: Nuziveedu Seeds, ACI, Kaveri Seeds, Enza Zaden, VINASEED, 農友種苗 Known-You Seed, Nirmal Seeds

Due to the variance between R&D capabilities among players in the regional seeds market, there would be a need to scope what is accessible to respective customers for respective agreements

Figure 5: Seed companies' potential customer profile

Table 2: Target customer persona profiles

Role	Main goals	Key challenges	How to approach
Seed Research & Development Director Lead every decision related to seed breeding and trials Establishment and management of relationships with universities, research labs, and other organizations	• Develop and deliver high-performing seed varieties • Build strong grower and customer relationships • Ensure regulatory compliance • Expand research partnerships to leverage expertise and accelerate innovation • Enhance brand image by supporting R&D efforts	• Maintain the innovation pipeline by consistently identifying new and relevant research topics • Translate customer needs into commercially viable seed products • Lead the development and execution of R&D budgets while driving cost efficiencies • Balancing priorities	• Frame NUE technology as a disruptive **innovation with the potential to transform their product portfolio** across multiple crops. • Emphasize how this technology can provide a **long-term competitive edge** through improved yields, market differentiation, and alignment with sustainable agriculture trends. • Present **data showcasing the genetic pathway's potential impact** on NUE yield improvement. • Be prepared to discuss **co-development options**, demonstrating flexibility to meet their strategic needs, while positioning as a potential long-term partner.
Asia Field Crop Seed Portfolio Manager Design and management of crop strategies across the region Ownership of relevant strategic external partner/ collaborator relationships	• Build a leading field crop seed portfolio across the region • Design effective crop strategies for key growth crops, anticipating future grower needs and setting R&D direction • Design seed production plans that balance growth, profitability, and risk management	• Achieve market share growth while maintaining a profitable portfolio • Ensure seamless collaboration between R&D, P&S, Regulatory, and Marketing to deliver a cohesive crop strategy • Anticipate evolving needs and challenges faced by farmers • Effectively analyze and respond to competitor activities	• Emphasize how the NUE pathway can lead to higher yields, reduced fertilizer dependence for farmers, and ultimately, increased profitability for the company, as NUE varieties can attract new customers seeking sustainable solutions and improve brand differentiation, leading to **market share growth**. • Showcase how the NUE technology **aligns with the company's commitment to sustainable agriculture solutions**, emphasizing the urgency of adopting NUE technology due to growing concerns about fertilizer costs and environmental sustainability in Asia. • Present compelling **data from research trials** demonstrating the effectiveness of the NUE pathway in relevant Asian crops
APAC Plant Breeding Director Development and management of breeding projects Collaboration with Research Management Team	• Lead the breeding team to develop and launch new plant varieties • Ensure the efficiency and effectiveness of all breeding programs • Identify and implement cutting-edge breeding methods and technologies to accelerate variety development	• Consistently identify market needs and translate them into commercially viable plant varieties • Optimize limited resources within the breeding program • Navigate complex international projects and navigate cultural differences	• Focus on **practical integration** of the trait to their portfolio. • Present data showcasing the **measurable NUE and yield improvements** achieved. • Emphasize how this technology can accelerate the development of **commercially viable**, high-yielding NUE varieties. • Discuss **potential cost savings** through reduced fertilizer dependence and the resource efficiency of integrating the NUE technology in seed production procedures. • Highlight how this technology helps them deliver on **market demands** for sustainable and fertilizer-efficient crops.

Structuring the development and commercialization pathway

Aiming to provide a structured approach to the development process of crop varieties, the team opted for mapping the comprised key activities within TRL-based stages.

	Stage	Description
Research	1	Observation of candidate metabolic pathway/gene
	2	Hypothesis formulation
	3	Hypothesis validation through R&D with rice varieties with a natural mutation in the target gene
Development	4	Validation of NUE improvement through laboratory gene-editing trials
	5	Greenhouse experiments to validate edited rice plants' agronomic performance under controlled conditions
	6	Field trials to demonstrate the edited rice plants' agronomic performance in various locations under real-world growing conditions
Deployment	7	Development of complete commercialization prototype
	8	Completion of final product
	9	Adoption by target markets

Figure 6: Technology Readiness Levels for crop trait development

This segmentation was then utilized to map the expected timeframes and required resources for each of the stages, aiming to identify the capacity gaps to be considered within the financial model and the fundraising goal for each of the two pathways, along with establishing the generated outputs per stage that could be utilized in commercially oriented engagements with potential customers and/or strategic partners:

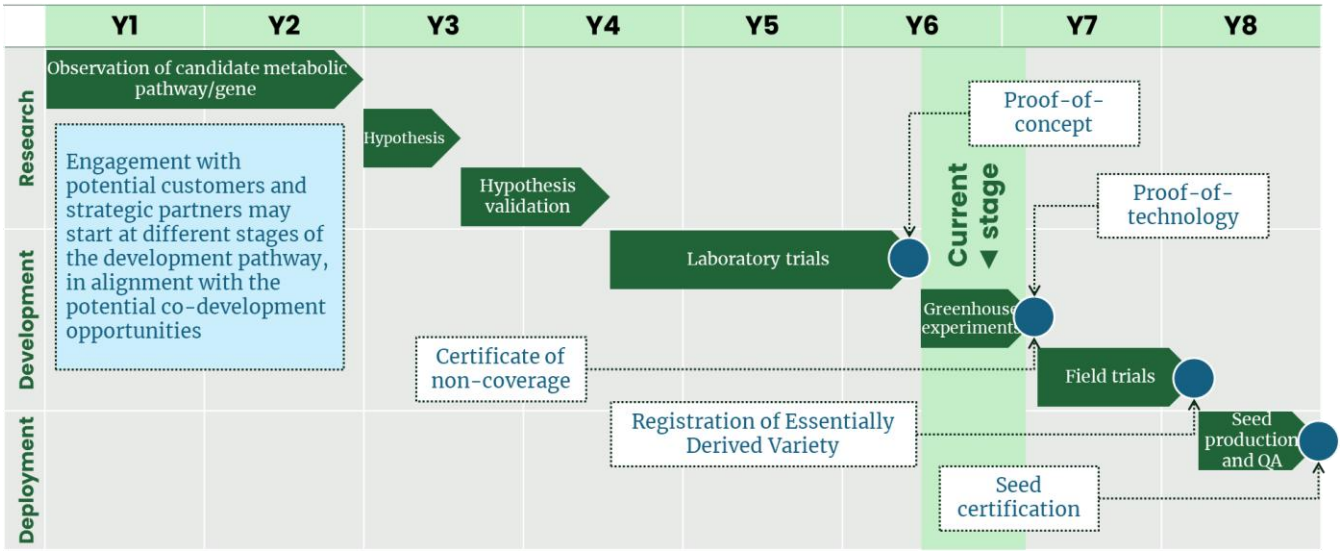


Figure 7: Current development pathway for NUE trait (applicable to both pathways)

While IRRI has leading technical expertise in new breeding technologies, the start of commercially oriented activities would require future recruitment efforts centered on business operations, particularly in the case of a spin-off scenario pursuing an NUE portfolio development. Having established the current capabilities, the team defined the recommended team structure, identifying potential talent sources for the comprised roles.

Figure 8: Recommended team structure

Following this pathway towards deployment of an enhanced NUE variety, this team would require foregoing a series of steps towards commercialization once proof-of technology has been achieved:

1. **Securing IP protection:** Filing of a Patent Cooperation Treaty (PCT) application, including research results and bioinformatics data for other species, and broadening the claims in the application to encompass various crops beyond rice.
2. **Partnering with national seed companies:** Engagement with diverse seed companies, and evaluate offers to select those that align best with goals and offer the most favourable terms for involved parties.
3. **Establish commercialization path(s):** Select one or more commercialization paths, as
    a. **Sell patent for specific crop and/or region**
    b. **Co-development of NUE rice variety**
    c. **Long-term R&D partnership and portfolio development**

    Due to the differing focus between each path, these can be used as a combination. For example, path 'a' could provide initial funding to start path 'c', while path 'b' could remain focused on IRRI's social mission, being supported by the other two.

Building the financial model

Based on the resource requirements, the variability involved in the choice of a commercial pathway, and the SOM forecast for 2033, the team proceeded to create the financial model and define potential scenarios based on key variables and assumptions:

Table 3: Financial summary for both commercial pathways

	Royalty fee from seed sales	Payback period for a client	Proyected revenue by 2033	Required upfront investment	Breakeven point
NUE Portfolio (Spinoff)	2%	3 years	$44.1M	$3.1M	5 years
NUE trait commercialization	1%	3 years	$13.4M	$1M	5 years

Based on the sensitivity analysis, there is a large upside opportunity from increasing royalty fees, deeper market penetration, and/or increased customers' technology access costs. In the case of the NUE Portfolio, doubling royalty fees to 4% will generate an additional $6.5M in profits, while increasing upfront fees payback by 1 year is estimated to generate +$2.5M in profits. On the other hand, in the trait commercialization pathway, doubling royalty fees to 2% will generate an additional $3.4M in profits, while increasing upfront fees payback by 1 year is estimated to generate +$6M in profits.

Fundraising

Based on the scenarios, and the capital requirements, the team has suggested different types of capital partners, in addition to any potential customers and strategic partners, depending on the selected commercialization pathway:

Table 4: Potential funding options per pathway

I. Potential Funding Options	Description	Investment Approach	Engagement Likelihood Portfolio	Trait
Grants	• Funding provided by governments, foundations, or corporations that do not require repayment.	• No exit/ no repayment required but will require to undergo a long application process. • Funds might be allowed to be used only for a specific activity or have other limitations (select geographies, etc.).	HIGH	HIGH
Corporate Venture Capital (CVC)	• Subsidiaries of large corporations that invest strategically in smaller companies. • Investments are often made to gain access to innovative technologies or to form strategic partnerships that are synergistic with the parent company's operations.	• Will seek strategic benefits from the investment. • Most large seed protection/ seed biotech companies do have their own CVCs established and have track record supporting similar startups. • Potential to fully integrate the product into the parent company's product line.	HIGH	LOW
Impact Investors	• Investors who are primarily focused on generating a positive, measurable social and environmental impact alongside a financial return. • Will often accept a lower return for higher impact generated.	• Will focus on understanding the technology's impact potential (social & environmental).	HIGH	LOW
Angel Investors	• Typically high-net-worth individuals who provide capital for startups in exchange for convertible debt or ownership equity. • Usually invest at the very early stages of a company and might provide advisory and strategic support/ serve as Board members.	• Need to identify those who specialize/ tend to invest/ have previous sector experience in AgTech/ biotech.	MID	MID
Venture Capitalists (VCs)	• Professional groups that manage pooled funds from many investors to invest in startups and small businesses with strong growth potential. • Investments are typically in exchange for equity, and VCs actively participate in company decision-making.	• Typically require high growth rates and willing to take high risks for these ventures. • Might be suitable to approach in Pathway #1 at later stages, but generally are not likely to engage.	MID	LOW
Family Offices	• Private wealth management advisory firms that serve ultra-high-net-worth individuals or families. • Unlike VCs, family offices may take a longer-term view on investments, focusing on wealth preservation as well as growth.	• Will be interested in stable, less risky investments with moderate growth. • Good match especially if the family's strategic interests/ existing business relates to the agricultural space, or target geographies for NUE. • Many will value social and environmental impact.	MID	LOW

Potential implications and significance of obtained results

The IRRI project presents a significant opportunity to improve agriculture across the ASEAN region, starting in the focus region of Vietnam, Indonesia, and the Philippines. This initiative goes beyond just benefitting IRRI and its chosen partners. It aims to create a broader environment that fosters innovation and development in agriculture, with the potential to be scaled up across Southeast Asia.

Successful commercialization of the NUE solution in these initial markets would demonstrate the effectiveness of innovative approaches to agricultural challenges in Southeast Asia. This success story could inspire more investment in R&D focused on climate-smart and sustainable solutions across the region. This may involve collaboration among diverse stakeholders in these countries, including public research institutions and private companies. This creates a valuable model for future initiatives by promoting knowledge sharing, resource pooling, and the creation of a stronger regional innovation ecosystem.

While not always explicitly recognized, nitrogen fertilizer represents a major cost for farmers and a significant environmental burden. This IRRI research project tackles this hidden cost through its NUE technology. By enabling crops to utilize nitrogen more efficiently, the project directly reduces fertilizer needs, lowering input costs for farmers and minimizing agricultural pollution. Furthermore, the NUE technology's contribution to reducing nitrous oxide emissions positions it as a crucial tool in combating climate change, aligning perfectly with the region's increasing focus on environmentally friendly agriculture.

The project acknowledges the need for a balanced approach to collaboration with other research institutions. While open communication and knowledge sharing are important, the project team is also mindful of potential risks associated with premature technology dissemination. Strategies like staged disclosure and carefully crafted collaboration agreements will be employed to ensure both knowledge transfer and the protection of commercially valuable aspects of the technology. Recognizing that not all solutions are patentable, the team will continue to explore alternative IP protection strategies, such as licensing agreements, to safeguard its innovations. Ultimately, successful collaboration will hinge on establishing mutually beneficial partnerships with clear terms regarding knowledge sharing and IP ownership across different crops.

The project team has adopted a flexible commercialization strategy that allows for adaptation to different markets within the APAC region. This adaptability, coupled with the learnings and best practices gleaned from the initial focus in Vietnam, Indonesia, and the Philippines, will empower other ASEAN nations to develop and implement their own solutions for agricultural challenges. This knowledge transfer, along with potential future collaborations, can significantly amplify the project's overall impact and contribute to a more food-secure, environmentally responsible, and economically beneficial agricultural future for the entire region. Nonetheless, it is critical to acknowledge the impact of a science-based, predictable regulatory ecosystem in the promotion of further innovation within the NUE and seed production landscape, as functioning and endorsed guidelines and registration processes encourage R&D projects in the region.

Potential scalability

Results

The project's current outcomes hold promising potential for scalability, both in terms of geographic reach and applicability across different crops and regions.

- **Geographic reach:** Although the initial focus is on India, Vietnam, and the Philippines, the results achieved in these countries can serve as a blueprint for similar initiatives in other regions facing comparable agricultural challenges. The scalable nature of gene-editing technology allows for the adaptation of solutions to diverse agroecological conditions and farming systems worldwide. By demonstrating the efficacy of the NUE gene-editing solution in these countries, the project lays the groundwork for broader adoption and implementation in other rice-growing regions globally.
- **Applicability across crops:** While the project currently targets rice cultivation, the underlying gene-editing technology and commercialization models developed can be extended to other crops facing similar nitrogen management issues. This scalability across crops enhances the project's impact and relevance beyond rice, addressing broader agricultural sustainability goals. The success of the project in enhancing nitrogen use efficiency in rice crops can pave the way for similar interventions in maize, wheat, and other staple crops, contributing to global food security and sustainability.

Approach to innovation

The project's approach to innovation exhibits characteristics that enhance its scalability and replicability. Here are key aspects contributing to the scalability of the innovation approach:

- **Collaborative partnerships:** The project emphasizes collaboration between diverse stakeholders, which may incluude research institutions, technology providers, seed companies, and regulatory bodies. This collaborative approach fosters knowledge sharing, resource pooling, and collective problem-solving, enhancing the scalability of innovations by leveraging complementary expertise and resources. By forging strategic partnerships, the project maximizes the impact of its innovation efforts and accelerates the adoption of gene-editing technologies across agricultural value chains.
- **Iterative learning and adaptation:** The project adopts an iterative and adaptive approach to innovation, continuously learning from feedback cycles involving different backgrounds. This iterative learning cycle enables the project to refine its strategies, technologies, and commercialization models over time, improving their scalability and effectiveness. By embracing a culture of continuous improvement and innovation, the project remains agile and responsive to evolving challenges and opportunities in agricultural sustainability.
- **Adoption of emerging technologies:** The project embraces cutting-edge technologies, such as gene editing, to address complex agricultural challenges effectively. By harnessing the power of emerging technologies, the project unlocks new opportunities for sustainable agriculture and resilient food systems. The innovative use of gene editing to enhance nitrogen use efficiency in rice exemplifies the project's commitment to pioneering solutions that have the potential for widespread scalability and transformative impact.

Key factors

As specified throughout this report, there are key internal and external factors that may influence the potential scalability of this and similar endeavors, as high degree of path-dependency means that we need to be mindful of commercial implications tomorrow for R&D decisions today. Among some of these factors, the team has highlighted the following:

- **Crops and varieties:** Seed cost, production volume, variety's market-specificity, alignment with current R&D capabilities, market perception.
- **Target market:** Market share and fragmentation level, regulatory ecosystem, national endorsement of climate-smart initiatives, presence of subsidies, perception of NUE benefits.

- **GE technology:** Licensing costs, R&D times and costs
- **R&D partnerships:** Resource sharing, profit sharing, IP concessions.
- **Commercial partnerships:** Limited exclusivity, seed production capabilities, speed of adoption

Table 5: Market and operational considerations

Category	Factor/ Variable	Market access	Revenue generation	Cost reduction	Risk mitigation	Market share	Capability requirement
Crops and varieties	Seed cost and production volume	●	●			●	
	Market-specificity	●					
	Alignment with current capabilities						●
	Market perception	●					
Target market	Market share/fragmentation				●	●	
	Regulatory ecosystem	●			●		●
	Push for CS initiatives + subsidies	●	●			●	
	Perception of NUE benefits					●	
GE technology	Licensing costs			●			
	R&D times and costs			●			
R&D partnership	Resource sharing			●	●		●
	Profit sharing		●				
	IP concessions				●		
Commercial partnership	(Limited) exclusivity	●	●			●	
	Seed production			●			
	Speed of adoption	●	●			●	

Role of the public sector

Agricultural innovation holds immense potential to address global challenges like food security and climate change. However, translating promising research projects into widespread adoption often requires a robust public sector role. Here's how governments can act as catalysts for scaling up these innovations:

- **Enabling Regulatory Frameworks:** Many agricultural innovations, particularly those involving biotechnologies, face regulatory hurdles. Governments can champion the development of clear, science-based regulations that balance innovation with biosafety. This provides comfort for private companies hesitant to invest in technologies with uncertain regulatory pathways.
- **Building Public Trust:** Public concerns surrounding new agricultural technologies are common. Governments can partner with research institutions and NGOs to develop public outreach programs that educate farmers and consumers. This fosters trust and acceptance, paving the way for wider adoption.
- **Investing in Infrastructure and Knowledge Sharing:** Smallholder farmers often lack access to essential resources and technical expertise. Public investments in extension services, training programs, and rural infrastructure empower these farmers to leverage new technologies effectively. By collaborating with research institutions such as IRRI, governments can establish knowledge-sharing platforms to disseminate best practices and ensure innovations reach those who need them most.
- **Solution Co-Development:** Public institutions can play a critical role in accelerating the impact of these innovations by engaging in co-development opportunities with private partners. By fostering a collaborative environment and clearly defining roles and responsibilities, co-development partnerships can bridge the gap between scientific discovery and real-world impact, ultimately accelerating the delivery of essential agricultural innovations to farmers in need.

By taking a proactive stance in these areas, the public sector can create an enabling environment for agricultural innovations to flourish. This will ultimately contribute to a more productive, sustainable, and equitable agricultural sector.

Pathway to impact

The project's "pathway to impact" outlines the journey from initial research and development to the broader societal, economic, and environmental benefits derived from the project's outcomes.

Overarching objective	Enhance Agricultural Sustainability through NUE Technology Adoption		
Long-term objectives	Increase agricultural productivity and resilience	Promote environmental conservation and climate mitigation	Foster economic prosperity and food security
Intermediary objectives	• Adoption of NUE gene-editing technology by farmers and agricultural stakeholders • Improved crop yields, resilience to environmental stressors, and overall farm productivity	• Reduction in nitrous oxide emissions and nitrogen fertilizer usage in agricultural practices • Preservation of soil health, water quality, and biodiversity through sustainable farming practices	• Increased income and livelihood opportunities for farmers through improved crop yields and resource efficiency • Enhanced food security and economic stability at local and regional levels by ensuring reliable access to nutritious crops

While the project team primarily focuses on executing the innovation and commercialization process, for further stages and overall project success, the engagement of additional stakeholders is crucial. Government agencies, research institutions, farmer cooperatives, and industry partners may play pivotal roles in scaling up production, promoting adoption, and ensuring sustainable impact. Their potential involvement is vital for navigating regulatory landscapes, accessing resources, and fostering an enabling environment for agricultural innovation and adoption. Hence, the project's pathway to impact may rely on the collective efforts of diverse stakeholders beyond the core project team.

Relevance to SDGs

As specified within the project objectives, the project's focus on improving agricultural efficiency, reducing environmental impact, and promoting sustainable development aligns closely with SDGs 2 (Zero Hunger), 12 (Responsible Consumption and Production), and 13 (Climate Action), contributing to a more sustainable and resilient future for agriculture in Southeast Asia.

- **SDG 2 – Zero Hunger:** The project directly contributes to SDG 2 by aiming to improve agricultural practices, specifically focusing on rice cultivation, which is a staple food source for millions of people in Southeast Asia. By enhancing nitrogen use efficiency (NUE) in rice crops through gene editing technology, the project seeks to increase crop yields while reducing the need for excessive fertilizer application. This approach can lead to improved food security by ensuring more efficient use of resources, reducing production costs for farmers, and potentially increasing agricultural productivity. Moreover, by targeting smallholder farmers, the project addresses the needs of vulnerable populations who often bear the brunt of food insecurity.
- **SDG 12 – Responsible Consumption and Production:** The project contributes to SDG 12 by promoting sustainable agricultural practices and responsible production methods. By developing a gene-edited rice crop solution to enhance NUE, the project aims to reduce the environmental impact of agriculture, particularly in terms of nitrogen fertilizer use. Nitrogen fertilizer runoff can lead to water pollution and contribute to greenhouse gas emissions, exacerbating environmental degradation and climate change. By optimizing nitrogen utilization in rice crops, the project seeks to minimize the negative externalities associated with conventional agricultural practices. Additionally, the project's focus on commercialization models that prioritize sustainability and equitable access to technology aligns with the principles of responsible consumption and production.
  SDG 13 – Climate Action: The project addresses SDG 13 by targeting climate change mitigation through innovative agricultural solutions. Nitrous oxide emissions from agricultural activities, including fertilizer use, contribute significantly to greenhouse gas emissions and global warming. By developing a gene-edited rice crop with enhanced NUE, the project aims to reduce nitrogen fertilizer requirements, thereby lowering nitrous oxide emissions from rice fields. This approach aligns with climate action goals by promoting more sustainable agricultural practices that mitigate the impact of agriculture on climate change. Furthermore, the project's emphasis on scaling up climate-smart agricultural technologies across Southeast Asia demonstrates a commitment to broader climate resilience efforts in the region.

IV. Next steps

In alignment with the pathway to impact, the project team identifies the following steps to ensure the continued success and impact of the project beyond the current funding period:

1. Sustainability planning: Develop a sustainability plan to ensure the continuation of project activities beyond the current funding period. This plan should outline strategies for securing additional funding, leveraging partnerships, and generating revenue streams to support ongoing operations.
2. Scaling Opportunities: Explore opportunities for scaling the project's impact beyond its current scope. This could involve expanding into new geographical regions, engaging with additional stakeholders, or adapting the solution to address related challenges in agriculture.

3. Partnership Development: Strengthen partnerships with key stakeholders, including government agencies, private sector companies, research institutions, and non-profit organizations. Collaborate on joint initiatives to further develop and promote the adoption of IRRI's NUE gene-editing solution.
4. Continued Research and Development: Allocate resources for ongoing research and development efforts to enhance the effectiveness and applicability of the NUE technology. This includes staying abreast of advancements in gene editing and agricultural science to remain competitive in the market.
5. Monitoring and Evaluation: Establish robust monitoring and evaluation mechanisms to track the progress and impact of the project over time. Continuously assess key performance indicators and adjust strategies as needed to maximize effectiveness and achieve long-term sustainability.

Appendices

Appendix 1: Kick-off workshop outputs

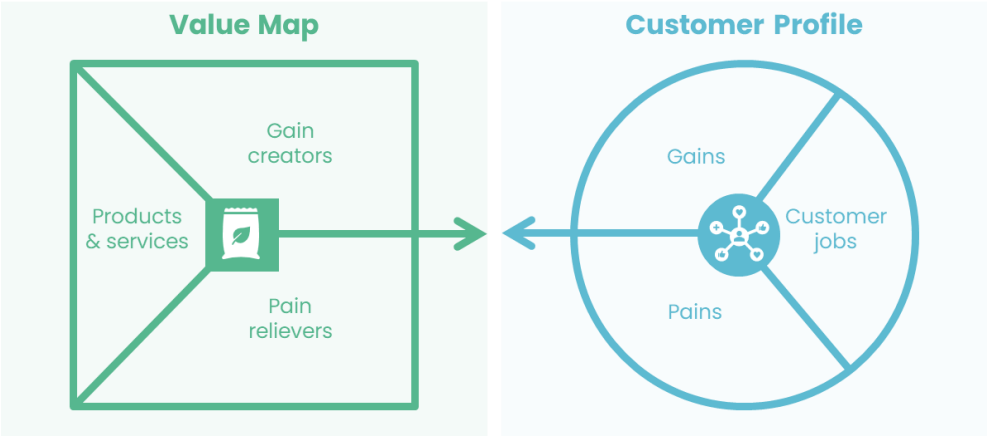


Figure 9: Value Proposition Canvas

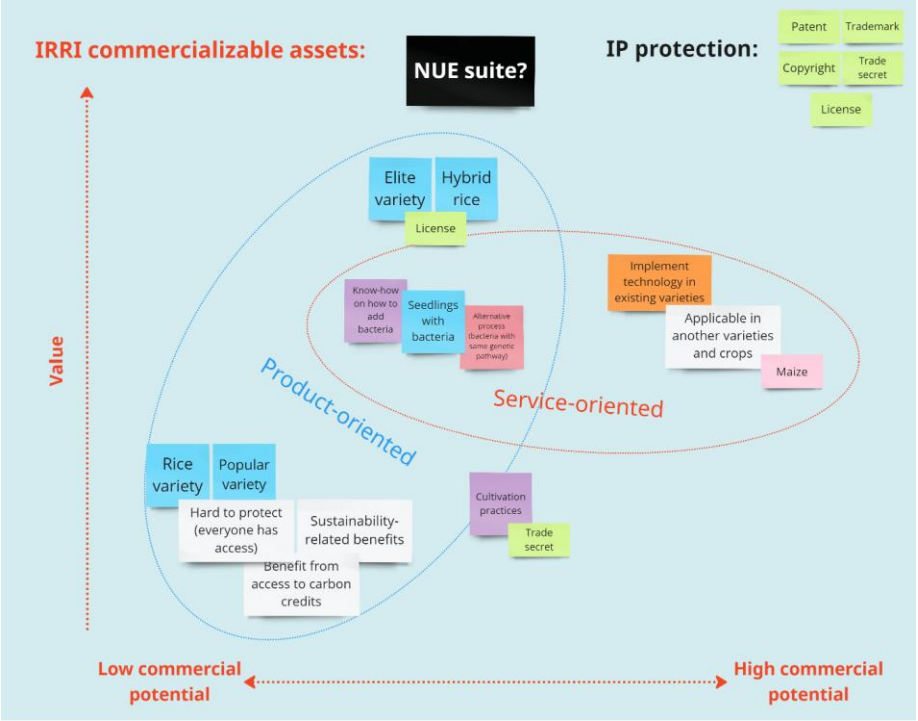


Figure 10: Identification of IRRI commercializable assets

Identifying target customer segments:

- Out of the profiles presented, which 2-3 would have the highest potential as target customer segments?
- Would there be any additional profiles to consider?
- Are there any observation regarding the needs, preferences, challenges, and behaviors/practices of these segments in relation to the project's objectives?
- To understand pain/gains and behaviours, what would we need to know from the target customer segments?

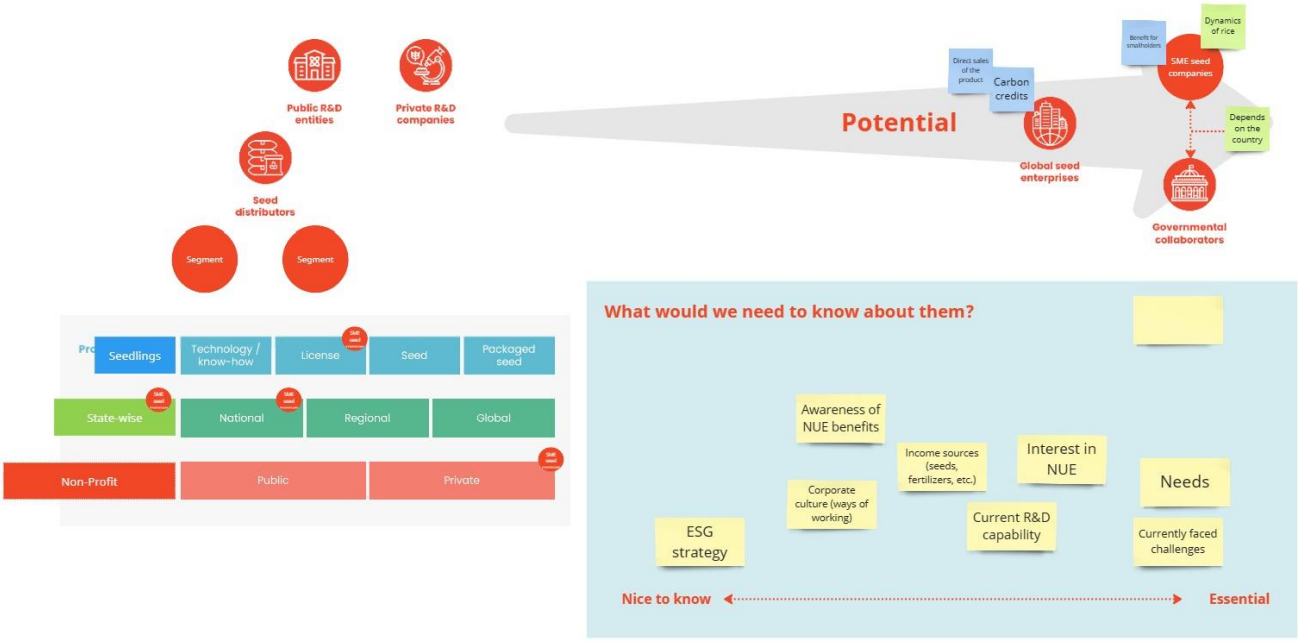
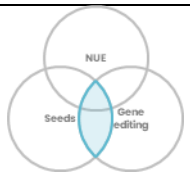


Figure 11: Initial identification of target customer segments

Appendix 2: Customer profiles

Profile #1

Seed corporations with GE/Biotech R&D capabilities



Structure

- Highly concentrated with a few leading corporations dominating the global seed market
- Generally global corporations with overseas HQ and centralized R&D capabilities
- Vertical integration across the value chain

Conduct

- Pre-competitive collaborations with organizations with similar interests
- Country leads responsible for identifying local opportunities and managing commercial relationships
- Collaboration with research institutes for complementary innovation, but core product development remains in-house
- Actively promoting use of GE in the region, and related knowledge in policymakers
- Locally-focused ESG efforts
- Directly mention profit as the main priority

Pains

- High R&D costs strain profitability and limit resources for commercialization
- Collaborative innovation is less agile than in-house R&D, and limited by trait, applications, and/or crops (short-term)
- Limited market understanding due to centralized R&D capabilities (limited feedback loop/customer engagement – Asia not a priority for global strategy) leads to missed sales and market share
- Regulatory delays hinder product launches and revenue growth, as technology evolves faster than regulations

Gains

- Increased market access, reduced customer acquisition costs, and ease of 'license to operate' (LTO) through improvement of local/regional reputation
- Development of regionally adapted seed varieties to expand product portfolio, potentially increasing sales
- Creation and development of strategic partnerships to expand market reach, access new technologies, and reduce R&D costs

Recommended approach as a:

Client

- Tailor message to highlight alignment between proposed solution and current product portfolio and/or R&D priorities
- Offer a cost-effective model, considering tiered licensing options catering to different company sizes and needs
- Provide scientific data and real-world results to demonstrate credibility and effectiveness
- Position as a collaborative partner, open to co-development

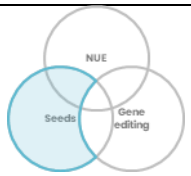
Considerations as a:

Competitor

- Advantage in launching and promoting new products due to strong brand recognition
- Due to their established R&D capabilities, and resource advantage, these corporations may choose to develop their own NUE gene editing technology in-house
- Possible existing partnerships with other gene editing companies who are working on NUE solutions

Profile #2

Seed companies without GE/Biotech R&D capabilities



Structure

- National or regional geographical scope with HQ in the region
- Limited differentiation beyond regional adaptation
- Likely low vertical integration with limited control over seed production and distribution channels
- High reliance on external R&D and potentially limited economies of scale

Conduct

- Focus on price competition due to limited product differentiation
- May emphasize regional adaptation and relationships with local farmers
- Limited in-house innovation due to lack of R&D resources. May rely on partnerships or licensing agreements
- Focus on local markets

Pains

- Difficulty of competing with larger seed companies who have global reach and advanced R&D capabilities.
- Long delays in bringing gene-edited crops to market due to regulatory hurdles prevent companies from capitalizing on potential yield improvements and associated revenue growth.
- Heavy reliance on overseas R&D leads to duplication of efforts and limits access to technologies specifically tailored to regional needs, potentially delaying market entry of potentially profitable seed varieties.
- Farmer perception of lower grain quality in hybrid varieties compared to inbreds can lead to lower market prices and profitability.

Gains

- Increased capacity and access to new technologies and/or products to higher yields and increased farmer revenue, translating to greater profit margins.
- Building credibility and a better reputation as a regional seed provider can attract additional support from governments (e.g., grants, subsidies) and other third parties.
- Focus on regional vulnerabilities can attract premium prices from farmers facing these challenges, leading to increased profitability and client loyalty.

Recommended approach as a:

Client

- Increased capacity and access to new technologies and/or products to higher yields and increased farmer revenue, translating to greater profit margins.
- Building credibility and a better reputation as a regional seed provider can attract additional support from governments (e.g., grants, subsidies) and other third parties.
- Focus on regional vulnerabilities can attract premium prices from farmers facing these challenges, leading to increased profitability and client loyalty.

Partner

- Increased capacity and access to new technologies and/or products to higher yields and increased farmer revenue, translating to greater profit margins.
- Building credibility and a better reputation as a regional seed provider can attract additional support from governments (e.g., grants, subsidies) and other third parties.
- Focus on regional vulnerabilities can attract premium prices from farmers facing these challenges, leading to increased profitability and client loyalty.

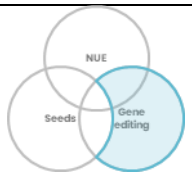
Considerations as a:

Competitor

- May have cost advantages by operating locally and focusing on price competition
- Possible existing partnerships with research institutions or universities due to reliance in external R&D

Profile #3

Seed corporations with GE/Biotech R&D capabilities



Structure

- Moderate market concentration with few leading institutions
- High differentiation based on the specific gene editing technologies and the traits they target
- Vertical integration may vary, with some focusing solely on R&D and others partnering with seed companies or integrating into production
- High R&D costs associated with gene editing tech development

Conduct

- Pricing models can vary depending on the technology, licensing agreements, and potential royalty structures with seed companies
- High levels of R&D investment to develop novel gene editing tools and target new traits in crops

Pains

- Significant financial resources needed for research, development, and regulatory approval of gene editing technologies.
- Complex and evolving regulatory environment.
- Competition from other private GE/Biotech companies and established seed corporations with in-house R&D capabilities.
- Lengthy process of developing, testing, and gaining regulatory approval for new gene editing applications

Gains

- Being first to market with a novel and effective gene editing solution can lead to significant market share and brand recognition.
- Opportunities to establish lucrative partnerships with seed companies
- Contributing to solutions for global and national food security challenges

Recommended approach as a:

Partner

- Partner by offering technical expertise to integrate with their existing seed development pipelines
- Offer co-development opportunities to further develop NUE technology or target specific traits in combination with other beneficial features
- Develop agreements that share profits from jointly developed technologies/products or reward successful completion of development milestones

Considerations as a:

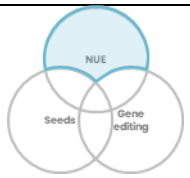
Competitor

- Generally faster and more agile vs. public organizations
- Ensure patent protection and/or licensing terms to limit competition and secure market share
- Monitor R&D progress of this segment to adapt strategy and maintain a competitive edge

Profile #4

Alternative technology companies

Biofertilizers, slow release, etc.



Structure

- Fragmented market concentration with a mix of small and medium-sized companies offering various alternative technologies.
- Moderate differentiation based on the specific type of alternative technology (biofertilizers, slow-release fertilizers, etc.)
- Low to moderate integration

Conduct

- Non-price competition, with emphasis on environmental sustainability, soil health improvement, and organic compatibility to differentiate from conventional fertilizers.
- Pricing strategies may focus on value proposition, highlighting long-term benefits and potential cost savings

Pains

- Competition with established market share and lower upfront costs of conventional fertilizers
- Pricing challenges, as they need to balance the value proposition of their products with the need to be price-competitive in the fertilizer market
- Challenges in ensuring adequate adoption and use of alternative technologies among farmers

Gains

- Capitalizing on the increasing demand for sustainable agricultural practices and environmentally friendly products.
- Ability to command premium prices for their technologies from farmers who prioritize soil health and long-term benefits.
- Opportunities to partner with seed companies, distributors, or retailers to expand market reach and brand recognition.

Recommended approach as a:

Partner

- Highlight opportunity for combined solutions for a more holistic approach to nutrient management
- Explore joint research projects to optimize the compatibility and effectiveness of each other's technologies when used together.
- Establish a fair and transparent revenue-sharing agreement to incentivize both partners.

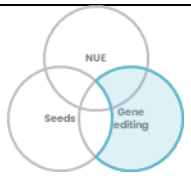
Considerations as a:

Competitor

- Identify and showcase specific benefits of NUE gene editing solution that go beyond what alternative technologies can offer, sustained by evidence and field-trial data
- Monitor competitor activity and applicable regulatory landscape

Profile #5

Public GE/Biotech R&D institutes



Structure

- Policies and programs are tailored to address specific regional agricultural needs and priorities
- High - influence across the agricultural sector, from research and development to production and distribution
- Funding comes from a mix of national budgets, foreign aid, and international grants

Conduct

- Prioritization of solutions with a broader societal impact beyond just commercial gain
- Governments may provide funds to NGOs and research institutes for projects aligned with their development goals

Pains

- Differing public perceptions and a lack of harmonized regulations across the region create challenges for implementing GE technologies
- Limited innovation focus due to government priorities, greatly hindered by the unbalance between short-term political cycles with long-term sustainability goals
- High fertilizer use, and its rising cost and environmental impact
- Introducing new crops needs careful consideration to avoid unintended consequences on staple food security

Gains

- Potential for cost reduction associated to existing government policies (e.g. fertilizer subsidies)
- Desire to promote sustainable agricultural practices that improve resource efficiency and reduce environmental pollution
- Supporting initiatives that strengthen smallholder farmer communities through cooperatives and knowledge sharing

Recommended approach as a:

Client

- Highlight how the solution contributes to the national and regional goals (e.g. ASEAN guidelines for sustainable agriculture)
- Leverage external data sources (e.g. IFPRI) on fertilizer use and pollution to showcase the urgency of adopting sustainable solutions
- Develop educational materials (localized languages, visual aids) to explain gene editing and the specific benefits of NUE solution

Partner

- Partner to quantify the environmental benefits of reduced fertilizer use (e.g., lower nitrogen runoff)
- Collaborate with cooperatives to facilitate technology adoption and knowledge sharing among smallholder farmers.

Appendix 3: Exemplary UVPs

UVP	Exemplary case study	Keys to the partnership	Need-to-haves	Revenue model
Provider of actionable target genes to unlock premium traits for biotech platform players	CPSBB → BetterSeeds Evogene → Monsanto AgriBody Technologies → Benson Hill	Showcase the potential of their target genes to address key challenges in agriculture	Portfolio of genes relevant to target traits Potential for dynamic trait discovery and development	Fee structure based on the provision of each gene. Royalties based on resulting sales. Financial allocations to facilitate R&D activities
Market-ready solution aimed at reducing N fertilizer usage	Symborg → Corteva Cibus → Interoc	Market validation and commercialization success Reputation as a leader in the field	Production- and market-ready off-the-shelf solution	Licensing fees for IP access Royalties based on resulting sales
Gene editing technology platform for the identification and modification of genes to unlock premium traits	Benson Hill → Agribody Technologies Tropic → Corteva BetterSeeds → CPSBB	Showcase the potential of their technology to address key challenges in agriculture	Advanced gene-editing technology or platform	Licensing fees and royalties based on the use of technology or commercialization of the resulting products
Long-term R&D partnerships for crop improvement or sustainable solutions	Pairwise – Bayer Mosaic – BioConsortia ICGEB – IARI GDM - BioHeuris	Track record of success and innovation Previous successful partnerships for credibility	Cutting-edge gene editing or trait discovery technology	Financial allocations to facilitate R&D activities
Provider of R&D, safety assessment, and deployment services for traits tailored to local varieties	IRRI → DA PhilRice	Understanding of local markets and established relationships Global recognition	Advanced scientific infrastructure and facilities Expertise in rice research	Research funding and grants Consulting and training services

Appendix 4: Target customer 'persona' profiles

James

Seed Research & Development Director

Lead every decision related to seed breeding and trials

Establishment and management of relationships with universities, research labs, and other organizations

Background:

- Master's Degree in Agronomy or Biology or related field with a strong knowledge of Plant Breeding
- 15+ years experience
- Product development experience
- 5+ leadership experience

Goals:

- Develop and deliver high-performing seed varieties
- Build strong grower and customer relationships
- Ensure regulatory compliance
- Expand research partnerships to leverage expertise and accelerate innovation
- Enhance brand image by supporting research and product development efforts

Challenges:

- Maintain the innovation pipeline by consistently identifying new and relevant research topics
- Translate customer needs into commercially viable seed products
- Lead the development and execution of R&D budgets while driving cost efficiencies
- Balancing priorities

How to approach:

- Focus on impact and innovation: Frame NUE technology as a disruptive innovation with the potential to transform their product portfolio across multiple crops.
- Emphasize how this technology can provide a long-term competitive edge through improved yields, market differentiation, and alignment with sustainable agriculture trends.
- Present data showcasing the genetic pathway's potential impact on NUE yield improvement.
- Be prepared to discuss co-development options, demonstrating flexibility to meet their strategic needs, while positioning as a potential long-term partner.

Nidhi

APAC Plant Breeding Director

Development and management of breeding projects

Collaboration with Research Management Team

Background:

- Master's Degree in Agronomy or Biology or related field with a strong knowledge of Plant Breeding
- 10+ years experience
- Product development experience
- Management of international projects

Goals:

- Lead the breeding team to develop and launch new plant varieties
- Ensure the efficiency and effectiveness of all breeding programs
- Identify and implement cutting-edge breeding methods and technologies to accelerate variety development

Challenges:

- Consistently identify market needs and translate them into commercially viable plant varieties
- Optimize limited resources within the breeding program
- Navigate complex international projects and navigate cultural differences

How to approach:

- Focus on practical integration:
- Present data showcasing the measurable NUE and yield improvements achieved.
- Emphasize how this technology can accelerate the development of commercially viable, high-yielding NUE varieties.
- Discuss potential cost savings through reduced fertilizer dependence and the resource efficiency of integrating the NUE technology in seed production procedures.
- Highlight how this technology helps them deliver on market demands for sustainable and fertilizer-efficient crops.

Sam

Asia Field Crop Seed Portfolio Manager

Design and management of crop strategies across the region

Ownership of relevant strategic external partner/ collaborator relationships

Background:

- Degree in Agriculture or Business with in-depth knowledge of Seed Industry in Asia
- 5+ years experience in the agribusiness industry
- Technical knowledge on relevant crops
- Can use market research intelligence

Goals:

- Build a leading field crop seed portfolio across the region
- Design effective crop strategies for key growth crops, anticipating future grower needs and setting R&D direction
- Design seed production plans that balance growth, profitability, and risk management

Challenges:

- Achieve market share growth while maintaining a profitable portfolio
- Ensure seamless collaboration between R&D, P&S, Regulatory, and Marketing to deliver a cohesive crop strategy
- Anticipate evolving needs and challenges faced by farmers
- Effectively analyze and respond to competitor activities

How to approach:

- Emphasize how the NUE pathway can lead to higher yields, reduced fertilizer dependence for farmers, and ultimately, increased profitability for the company, as NUE varieties can attract new customers seeking sustainable solutions and improve brand differentiation, leading to market share growth.
- Showcase how the NUE technology aligns with the company's commitment to sustainable agriculture solutions, emphasizing the urgency of adopting NUE technology due to growing concerns about fertilizer costs and environmental sustainability in Asia.
- Present compelling data from research trials demonstrating the effectiveness of the NUE pathway in relevant Asian crops