Policy Landscape for Accelerated Rice Breeding

Dr. Pedro Naso

Accelerated Crop Breeding for Climate Resilience in Rice:
Challenges and Opportunities

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Introduction

Why prepare a policy landscape?

A policy landscape helps us understand how the institutional environment shapes innovation, diffusion, and adoption of a technology.

- It identifies the main constraints and bottlenecks.
- It shows how incentives affect investment and technology use.
- It helps explain cross-country differences in diffusion and uptake.
- It supports more realistic and better targeted policy recommendations.

How can public policy make countries adopt new technologies?

Public policy can change three things:

1. **Costs**
   public funding, shared infrastructure, and training can lower the fixed costs of adoption
2. **Uncertainty**
   clear and predictable rules make it easier for researchers and firms to invest
3. **Coordination**
   common standards and public platforms help connect research, testing, release, and delivery

Example: if gene-edited plants are not automatically treated as GMOs, breeders face lower compliance costs and less uncertainty, which makes adoption more likely.

Rice Breeding Systems in ASEAN

Rice Breeding Systems in ASEAN

What are the factors that shape the productivity and complexity of rice breeding systems in the region?

1. **Scale of the rice economy**
   Larger rice sectors usually create stronger incentives to invest in breeding and to upgrade breeding systems.

2. **Whether a country is a persistent net exporter or importer**
   Exporters tend to emphasize grain quality and market performance, while importers place more weight on stable yields, affordability, and food security.

3. **Agroecological diversity**
   Different stress environments, such as drought, flooding, salinity, and heat, shape which traits breeders prioritize.

4. **Investment in Agricultural R&D**
   Higher investment makes more breeding methods feasible and increases the capacity to develop and release new varieties.

$\Rightarrow$ Countries with larger rice sectors and stronger R&D systems tend to have more developed rice breeding systems, while trade orientation and stress environments shape which traits they prioritize.

Accelerated Rice Breeding

Accelerated rice breeding in ASEAN: A framework

⇒ **This is a problem of technology development, diffusion, and adoption**

What factors must align?

This is about producing new breeding tools and whether national systems can turn them into farmer-ready varieties.

1. **Breeding capacity**
   labs, data systems, controlled environments, skilled staff
2. **Testing and seed systems**
   multi-location trials, formal release, seed multiplication, distribution
3. **Demand and incentives**
   target traits, government priorities, market demand, farmer uptake

$\Rightarrow$ Countries with stronger breeding capacity, smoother testing and seed systems, and clearer demand tend to adopt more easily accelerated methods and convert them into released varieties.

Where does policy enter?

Policy shapes the incentives that determine whether breeding technologies are developed, diffuse across systems, and reach farmers.

- It shapes whether breeding tools can be **used**.
- It shapes whether new lines can be **tested and released**.
- It shapes whether varieties can be **multiplied, distributed, and adopted**.

The policy landscape covers four broad areas:

1. testing, registration and release
2. regulation for genome and DNA editing
3. germplasm access and exchange
4. funding and institutional capacity

Policy Landscape

Variety testing, registration, and release: what most countries share

1. **Candidate Development & Pre-release trials**
   e.g., run by national research institutes
2. **Official Performance testing**
   often multi-location and sometimes multi-season
3. **Administrative approval**
   entry into an official list or formal recognition before seed can be marketed

$\Rightarrow$ As breeding gets faster, the bottleneck can shift from line development to testing and release.

Variety testing, registration, and release: where countries differ

- **Testing requirements and flexibility**
  some systems require formal DUS and performance evidence; others rely more on government-run or committee-managed trials
- **Recognition mode**
  some countries rely mainly on one recognition step, while others split approval across several certificates, lists, or licensing steps
- **Extra review for modern biotechnology**
  in some systems, varieties developed with newer methods may face additional review requirements

$\Rightarrow$ More steps, less flexibility, and extra review can lengthen timelines, raise administrative burden, and reduce the time gains from accelerated breeding.

Regulation of genome and DNA editing: what countries share

Most systems regulate **products and risky activities**, not breeding methods directly.

Four common features appear in most systems:

1. **Risk assessment and risk management**
2. **Approval for lab or greenhouse work under containment**
3. **Controls on cross-border movement**
4. **Food and feed rules**
   including thresholds and labelling

Regulation of genome and DNA editing: where countries differ

1. **How gene-edited products are classified**
   Some systems keep them under GMO rules; others exempt some products without foreign DNA; others use a gateway decision first.

2. **Where the main regulatory pressure point lies**
   In some countries, the main burden appears early, at research, trials, or environmental release. In others, it appears later, at food approval or market entry.

$\Rightarrow$ Heavier classification rules and earlier regulatory pressure can lengthen timelines and raise costs. When gene-edited products are classified as GMOs, breeders usually face higher compliance costs, longer timelines, and more legal uncertainty.

Germplasm access and exchange: what countries share

1. **National control over genetic resources**
   governments can set conditions for access, exchange, and use
2. **Breeding use is often more open than commercial use**
   protected varieties can often still be used in breeding, even if commercialization is more restricted
3. **Cross-border exchange often depends on contracts**
   material transfer agreements help govern use, sharing, and re-transfer

⇒ Accelerated breeding depends on timely access to diverse germplasm. When access and exchange are predictable, breeders can assemble populations and trait donors more easily.

Germplasm access and exchange: where countries differ

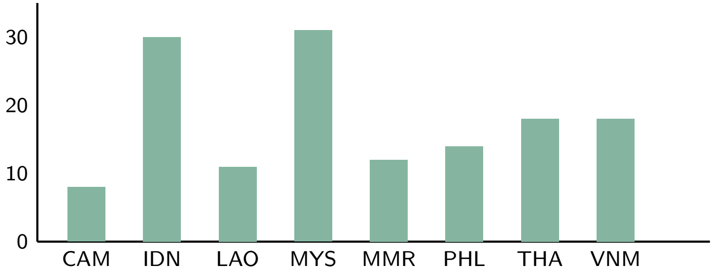
1. **Domestic access procedures**
   some countries have clear permit-and-contract pathways; others have more fragmented or less consolidated implementation

2. **Intellectual-property model**
   some systems focus mainly on breeders' rights, while others also require origin disclosure or benefit-sharing for germplasm used in breeding

$\Rightarrow$ More complex access rules and tighter conditions on use or sharing can slow collaboration, make cross-border exchange harder, and reduce the speed gains from accelerated breeding.

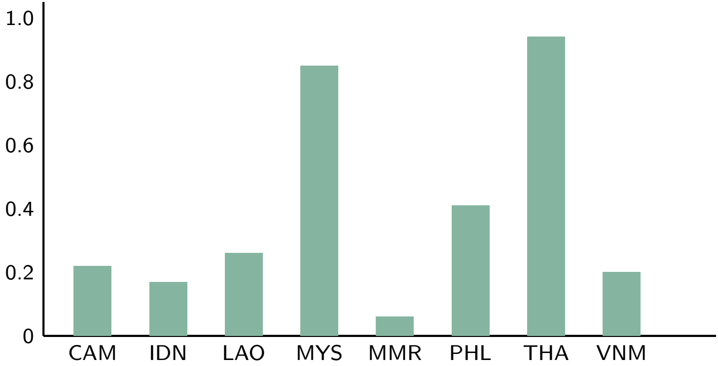
Funding and human capital

PhD-qualified agricultural researchers (%) (Stads et al. 2020)



Funding and human capital

Public agricultural R&D intensity (% of AgGDP) (Stads et al. 2020)



We expect accelerated breeding to be more viable where agricultural R&D investment is higher and the research workforce is more highly trained.

Infrastructure and institutional capacity

- Advanced infrastructure and data systems are unevenly distributed across countries.
- Within country: Capacity is often concentrated in a few public institutions.
- Attracting and retaining qualified staff: recruitment restrictions, low public-sector salaries, and promotion based on seniority rather than merit.

$\Rightarrow$ Accelerated breeding is easier to sustain where institutions can pool infrastructure, coordinate effectively, and keep highly qualified staff.

Taking Stock

Across the four policy areas, the overall picture is mixed:

- The region already has important building blocks for accelerated breeding.
- But these building blocks are unevenly distributed across countries.
- The main barriers are not only technical, but also regulatory and institutional.
- Accelerated breeding works best when the four policy areas reinforce each other.

What does an enabling system look like?

1. **Testing, registration, and release**
   faster, more predictable, and less burdensome
2. **Genome and DNA editing regulation**
   clear, science-based, and proportionate to risk
3. **Germplasm access and exchange**
   timely, predictable, and supportive of collaboration
4. **Funding and institutional capacity**
   stable resources, shared infrastructure, and qualified staff

Recommendations

How the priorities were developed

The priorities presented here combine three sources of evidence:

1. recommendations proposed in the country presentations
2. issues raised in the focus group discussions and Poll Everywhere exercise
3. findings from our own policy analysis

We use these three inputs to identify the main priorities for strengthening accelerated rice breeding in ASEAN.

Strategic Priorities I

- **Build shared breeding infrastructure.**
  Establish regional or national facilities for speed breeding, rapid generation advance, genotyping, phenotyping, and breeding data management.
  - Expand this idea to shared regional services, including outsourced genotyping, cloud computing, and common decision-support tools.
  - Use common platforms where duplication is too costly for individual institutions.
- **Invest in human capital for modern breeding.**
  Train breeders and technicians in genomic selection, marker-assisted breeding, digital phenotyping and controlled-environment protocols.
  - Emphasize continuous practical training, not one-off workshops.
  - Extend training to technicians, data analysts, and other staff involved in the breeding pipeline.

Strategic Priorities II

- **Integrate tools into one breeding pipeline.**
  Combine off-season nurseries, molecular tools, phenotyping, and data systems so that breeding cycles become faster and more predictable.
  - Support common data platforms and G$\times$E tools so breeders can evaluate adaptation more efficiently across environments.
- **Create stable multi-year funding for breeding pipelines.**
  Align public funding with the real time horizon of breeding, including trials, maintenance, and operating costs.

Strategic Priorities III

- **Streamline regulation and variety release.**
  Simplify testing and approval procedures, clarify rules for gene-edited materials, and reduce delays between breeding results and official release.
  - Reduce unnecessary duplication, committee delays, and administrative burden in multi-location testing and release.
  - Develop faster, more science-based, and more proportionate pathways for gene-edited materials.
- **Strengthen partnerships and seed delivery.**
  Link public breeding programs, private seed companies, and extension services so that improved varieties are multiplied, distributed, and adopted more quickly.
  - Strengthen local seed multiplication and distribution so new varieties reach farmers more reliably.
  - Build stronger links between breeders, seed multipliers, and extension systems.

Strategic Priorities IV

- **Target climate-resilient and market-relevant traits.**
  Prioritize traits such as drought, salinity, flood, heat, and pest tolerance, while also protecting grain quality, farmer demand, and consumer preferences.
  - Use shared germplasm and regional testing to address common climate and disease problems across countries.
- **Simplify germplasm exchange.**
  Make research-use germplasm transfer faster, more predictable, and more trusted across countries and institutions.

Strategic Priorities V

- **Strengthen regional collaboration around common breeding goals.**
  Support joint testing, shared breeding agendas, and collaboration across countries facing similar climate and disease problems.
- **Use IRRI as a regional hub.**
  Expand IRRI's role in coordination, training, germplasm exchange, and shared technical services across ASEAN.
- **Promote trusted regional sharing mechanisms.**
  Use common platforms for exchanging germplasm, data, and know-how in ways that reduce suspicion, lower transaction costs, and accelerate diffusion.

How to choose across these?

Policymakers should prioritize interventions with the highest expected return, taking into account both cost and the probability of successful implementation.

Potential Choices:

- **Invest in human capital and practical training.**
  High payoff, relatively low cost, and likely to strengthen many parts of the breeding pipeline at once.

- **Build shared regional services and common platforms.**
  More cost-effective than duplicating expensive infrastructure across many institutions and countries.

- **Simplify germplasm exchange and strengthen IRRI's hub role.**
  Potentially large regional gains at relatively modest cost, especially where countries face similar breeding problems.

Discussion