The SEED Framework:

Advancing gender equity in Southeast Asia agriculture for sustainable and resilient biosecurity

By Dominique Anne S. Aluquin, Jo Yi Chow, & P.T. Nhean

Dominique Anne S. Aluquin (Philippines), SingHealth Duke-NUS Global Health Institute, National University of Singapore, Singapore
Jo Yi Chow (Malaysia), Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore
P.T. Nhean (Cambodia), Independent Biosecurity Researcher, Cambodia

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Executive Summary

Southeast Asia (SEA) is a region of critical biosecurity concern due to its rich biodiversity, dense human populations, tropical climates, and porous borders—all of which facilitate the emergence and spread of infectious diseases. Agriculture is a key economic sector, employing a large portion of the population and contributing significantly to most national gross domestic products (GDPs). Southeast Asia is also one of the top three regions in the world most prone to agro-terrorism and agro-crime, next to the Middle East and North Africa. Gender-specific disparities in risk are evident due to the varying activities engaged in by men and women. Women are pivotal in agriculture, being accountable for more than half of the world's food production. Although that makes them the majority of frontline responders, vulnerable to deliberate biological risks, they're also the key to reducing such catastrophic risks coming from agriculture.

Despite their significant roles, women often lack access to proper training and are underrepresented in decision-making platforms, limiting their capacity to implement effective biosecurity measures. To address these challenges, biosecurity investments in Southeast Asia must be needs-based, integrating financial support with meaningful participation and sociocultural understanding. This can lead to a cultural shift wherein women are intentionally involved, adequately informed of the biorisks, and educated on biosecurity prevention and response strategies in the agricultural sector. The framework focuses on strengthening capacity building of female farmers in Southeast Asia, given their shared role in the fields, responsibility for livestock, and household activities.

By taking on a gender-sensitive approach, capacity-building programs can address training and education inequities of female farmers. This recommendation proposes a framework called **Sustainable Empowerment and Equity for Disease Prevention (SEED)**, that advocates for empowering women through gender-earmarked funds, meaningful inclusion, and sociocultural understanding, while acknowledging the connectedness of animal, environment, and human health. This will not only help bridge the gender gap but also foster security and resilience in agricultural practices.

Background

Globally, the deliberate and accidental misuse of biological sciences and disease spillover between species pose significant biological risks to humans, animals, and plants. However, biological threats vary by country.[1] SEA is a hotspot for zoonotic spillover,[2] driven by climate change, land-use change, interactions with diverse animal species, and the trade and consumption of wild animal meat.[3] With agriculture as a primary economic driver in the region,[4] it is notable that 74 percent of the increased infectious disease risk for humans comes from agricultural land-use.[5] In 2018, The World Organisation for Animal Health (OIE), the Food and Agriculture Organization of the United Nations (FAO), and the International Criminal Police Organization (INTERPOL) identified SEA as one of the top three regions most vulnerable to agro-terrorism and agro-crime, and, if production were disrupted, it could devastate the food chain in the global market.[6] As a response, an initiative led by Indonesia, known as ASEAN One Health Joint Plan of Action, called for collaboration across human, animal, plant, and environmental health among the ASEAN member states.[7] It is clear that SEA has acknowledged the importance of biosecurity practices through early

planning efforts, especially with the United Nations Interregional Crime and Justice Research Institute (UNICRI).[8] Combined with recent naturally occurring disease outbreaks in SEA, including Nipah (Malaysia 1999), SARS (2003), H1N1 (2009), and SARS-CoV-2 (2019), this makes SEA a unique regional intersection between agriculture, security, and defense.

Women are integral to agriculture, responsible for up to 80 percent of global food production.[9] Although agriculture was traditionally seen as men's work in SEA, the Feminisation of Agriculture (FoA) has become prominent in recent years.[10] Despite this trend, systemic gender inequities persist, where a study from 2019 revealed that women are often not recognized as farmers by their peers and are excluded from capacity development initiatives, even as they are expected to adapt to agricultural innovations.[11] Beyond agriculture, SEA women are involved in caregiving[12] and community health care.[13] Gender inequity exacerbates their vulnerability to biological risks because women would likely comprise most frontline responders to biological threats. Research shows that women frequently lack access to biosecurity training, resources, and decision making on broad biological threats reduction platforms.[14] A study on African Swine Fever (ASF) in Uganda found that typical gender assumptions in biosecurity negatively impact the implementation of biosecurity measures that manage biological risks to human, animal, and plants health.[15] This exclusion not only undermines the effectiveness of biosecurity measures but also exacerbates already existing gender inequalities.

Women who receive support in training, knowledge sharing, and emotional encouragement succeed and often move into decision-making and leadership roles.[16] However, empowerment efforts must also consider SEA's diverse priorities, ecosystems, cultures, and religions. According to Emma Alegi, a Gender Specialist at the United Nations' FAO, meaningful participation requires communication and empathy grounded in cultural understanding. For instance, although American approaches to women's empowerment in agriculture emphasize strong leadership and ownership,[17] SEA might benefit more from needs-oriented initiatives focusing on current necessities (e.g., women's involvement in a Muslim-dominated country like Indonesia, where women either are refrained from or chose not to participate in biosecurity implementation).

Thus, we propose a needs-based biosecurity investment strategy for Southeast Asian women that ties financial investment with meaningful participation and sociocultural understanding. We believe that this strategy is not only a foundation to bridging the gender gap in biosecurity measures in SEA, but also reinforces One Health while ensuring that women are equipped and empowered to contribute effectively to minimize risks from deliberate and accidental misuse through agricultural framing.

Discussion

Agriculture as a Neglected Dimension in National Security

Despite the critical role of agriculture in national stability and its historical targeting by bioterrorism, national security strategies often prioritize human-centric threats like terrorism and geopolitical tensions.[18] These focuses overshadow agricultural concerns, which are seen more as economic or developmental issues rather than integral components of national security. Consequently, the risks posed by biothreats to agriculture, which can destabilize nations by undermining both their economics and the health of their populations, are often overlooked. This issue is particularly pronounced in SEA, which relies heavily on agriculture for both local consumption[19] and international export markets.[20] This oversight was evident in the delayed responses and underfunded preventive measures for controlling ASF's spread in the region.[21] Despite the severe impact on pork production—an economic staple in the region[22]—initial responses lacked coordinated efforts that are typically reserved for threats perceived as directly impacting human safety or economic stability.

The agricultural industry, being an interface of human, animal, plant, and environmental components, is uniquely positioned to act as a sentinel and barrier against biological threats. Given that 80 percent of pathogens with bioterrorism potential are zoonotic (e.g., Yersinia pestis [plague] or Bacillus anthracis [anthrax]),[23] and that SEA is particularly vulnerable to agro-terrorism, integrating One Health strategies (e.g., ASEAN One Health Joint Plan of Action) into national security to enhance agricultural biosecurity is paramount. Developing joint response mechanisms between the national defense and agricultural sectors can rapidly mobilize resources during an agro-biosecurity threat, ensuring that the agricultural sector is not isolated in its response by enabling it to quickly draw upon broader governmental and military support, thus enhancing the effectiveness of response strategies.

Challenges and Dual Roles of Women in SEA Agriculture: Impacts on Biosecurity

Agriculture in SEA predominantly features smallholder farms, many managed by women,[24] who represent 26.7 percent of the agricultural workforce—considerably higher than the 3.5 percent observed in OECD countries.[25] FoA in SEA challenges traditional gender roles, with women increasingly becoming primary farm managers and accessing productive resources.[26] However, persistent patriarchal cultures, male-favored inheritance practices, and gender-insensitive land policies undermine true autonomy of SEA female farmers, leading to land registration under men's names[27] and agricultural training programs frequently catered toward men.[28] Consequently, women's roles in SEA agriculture are not given the appropriate weight, limiting their long-term control over the farms.

Women in SEA also frequently serve as primary familial caregivers.[29] Their dual responsibilities in agriculture and family care increase their risk of contracting **and** transmitting zoonotic diseases.[30] The region's porous borders amplify these biological risks,[31] potentially escalating local outbreaks into broader public health emergencies. Recurrent natural disasters and chronic food insecurity further strain resources,[32] diverting attention from long-term biological risk reduction planning.

Despite their pivotal roles, SEA female farmers still face barriers in accessing agricultural training and are underrepresented in decision making,[33] impairing their capacity to adopt effective biosecurity measures. Key barriers include prioritizing men in existing training initiatives, the absence of culturally adapted training materials, and sociocultural constraints that limit women's participation.[34] Women also disproportionately receive only 7 percent of agricultural investments, despite comprising a significant portion of the industry.[35]

Leveraging Gender Equity in Agriculture for Enhanced Disease Control and Prevention

However, targeted investments in female farmers' education to manage biological and biosecurity risks have enhanced agricultural practices in other regions. For example, the FAO's gender-focused communication strategies in Africa have reduced animal disease outbreaks by targeting women,[36] the primary caretakers of livestock. Female farmers are also more likely to engage in sustainable practices[37] and produce higher-quality crops[38] than their male counterparts, reducing the need for deforestation, which typically compounds zoonotic risks due to increased contact with disease reservoirs.[39] Furthermore, investing in their learning not only strengthens a crucial segment of the SEA agricultural community but paves the way for generational knowledge transfer about best practices in agricultural biological threat reduction.[40] Women's extensive involvement in both agriculture and childcare uniquely positions them to educate the next generation from an early age, fostering a culture of awareness and preparedness. Thus, addressing gender disparities in biosecurity becomes not merely a matter of fairness, but also one of effectiveness. On the other hand, uneven access to information exacerbates gendered exposure risks,[41] exemplified by the Ebola outbreak where the exclusion of women from education and response meetings contributed to the disease's spread, highlighting the implications of withholding crucial information from vulnerable groups.

The momentum for empowering women is growing through female-specific programs advocating for gender-equitable farming subsidies,[42] increased ownership of farming equipment, and greater educational involvement.[43] These programs could enhance biosecurity discussions by leveraging women's social capital and networks to build bridges across divided communities, thereby improving pathogen surveillance, detection, and containment, bolstering the overall biological threat reduction network. Studies from Sudan[44] and India[45] demonstrate the effectiveness of leveraging women as hubs in social networks for vaccine advocacy, leading to increases in vaccination rates and benefiting entire communities.

Investments into Female Farmers' Participation Creates Positive Feedback for Sustainability of Global Biosecurity Capacity Building

At the community level, tailoring capacity-building programs to address the specific challenges women face in agriculture equips them with opportunities to overcome their unique obstacles. These programs can enhance women's agricultural skills, offering a step into meaningful participation in agricultural decision making that impacts biosecurity, such as crop selection and animal vaccination. Additionally, these programs can educate women about land rights and develop their advocacy skills for equitable ownership, initiating positive feedback loops of community mobilization that boosts women's confidence to assert their rights and assume

leadership roles,[46] thereby improving their capacity to lead biosecurity and biological risk reduction measures on their managed farms. Although capacity-building workshops are not a silver bullet, they are crucial in a broader strategy for sociocultural change and policy reform aimed at helping SEA female farmers overcome barriers like lack of financing and information, and discriminatory norms.[47]

Women's active involvement in biosecurity also brings perspectives that might otherwise be overlooked.[48] Currently, numerous existing global initiatives are aimed at promoting women's equity in agriculture by enhancing their access to resources,[49] with frameworks emphasizing the importance of gender equality across sectors.[50] However, these initiatives can be further leveraged by incorporating a biosecurity perspective. Providing a model for agricultural ministries to develop gender-sensitive agricultural biosecurity policies ensures women's voices are heard, fool-proofing biosecurity policies by filling unseen gaps.[51]

In governance, policy development is the key mechanism for promoting gender equity in agricultural biosecurity efforts. For example, the Philippines' Gender and Development Budget Policy mandates that a portion of government budgets be allocated to gender equality programs.[52] These funds could support participatory programs for women, developing culturally sensitive agricultural biosecurity policies. Given the demonstrated effectiveness of socially sensitive policies in enhancing compliance across health systems and other sectors,[53] agricultural biosecurity policies that actively engage women and integrate their insights are likely to be more effective.[54] Such inclusion not only improves immediate response efficacy, but also builds resilience within agricultural communities, establishing robust defenses against biosecurity threats.

By empowering female farmers with the right tools and knowledge, their capacity to prevent and respond effectively to these threats can be significantly enhanced, thereby reinforcing the agricultural sector's role in national security. This approach not only fortifies biosecurity measures but also ensures that women's contributions are recognized and integrated into the broader security framework, enhancing the resilience and responsiveness of health and defense strategies at the national and regional levels.

Recommendations

Although financial support can spur equity-focused activities, meaningful inclusion and addressing sociocultural needs encourage organizations and governments to move beyond tokenistic initiatives. To sustainably address inequities, activities must foster a cultural shift that intentionally includes women, especially in agricultural communities, and provides them with necessary resources for improved disease mitigation.

This framework acknowledges the cyclical relationship between policy and practice, where each informs and strengthens the other. Such initiatives enable women to better address health security risks through enhanced disease control, surveillance efforts, and knowledge of better environmental agriculture practices, thereby reducing biological risks.

The Sustainable Empowerment and Equity for Disease Prevention (SEED) Framework (see Figure 1) advocates for sustainable investments in women's empowerment within the agriculture sector

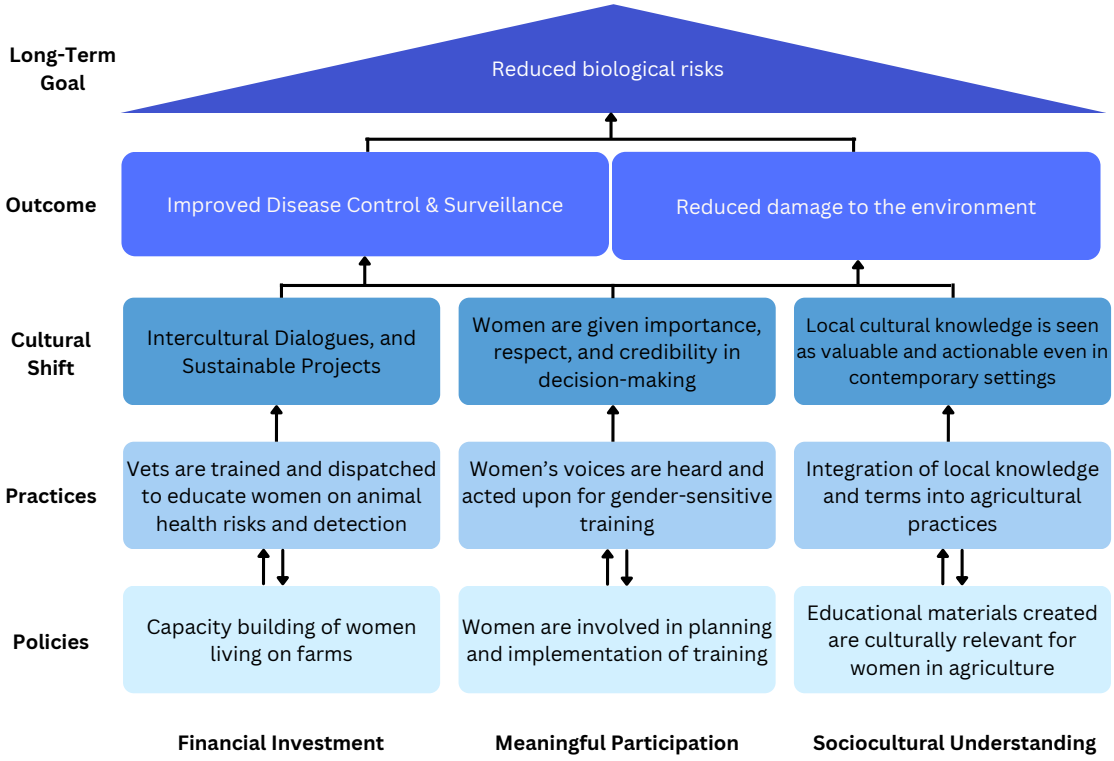


***Figure 1**. SEED Framework*

1. Financial Investment

In SEA, the Japan-ASEAN Women Empowerment Fund (JAWEF), managed by BlueOrchard, pools private investments to strengthen Japan-ASEAN relations through women's empowerment.[55] A cost-benefit analysis revealed that a gender-transformative approach in education and addressing gender inequalities yields a 410 percent return on investment (ROI), compared to 270 percent for addressing the gender gap alone, and 30 percent for a control group.[56]

The framework proposes establishing a **Women for Biosecurity (W4B)** group under JAWEF. This group would focus on capacity building and consist of experts, advocates, representatives, and trainers. They would implement frameworks, provide training, raise awareness, and oversee activities related to deliberate biological risks and public health emergency preparedness for women. For instance, **W4B would ensure that veterinarians are trained and dispatched to educate women on animal health risks and detection.**

To maximize W4B's potential, we suggest a multi-layered funding approach, either as an alternative or complementary source:

- **Donors:** private, non-governmental, and philanthropic organizations like Open Philanthropy, Global Partnerships, and the Bill and Melinda Gates Foundation.
- **Governmental Partners:** grants from health ministries within implementing countries, FAO partnership.
- **Regional Partners:** annual contributions from ASEAN member states and women-focused intergovernmental organizations such as UN Women for SEA.
- **Women as Donors:** encourage middle- to high-income women to donate 10 percent of their income.

2. Meaningful Inclusion

This involves both ensuring diverse representation and valuing diverse perspectives. Adapting the Lundy Model of Participation,[57] key aspects include space, voice, audience, and influence. Space ensures inclusion in discussions, voice provides a platform for their opinions, audience involves attentive stakeholders with decision-making power, and influence ensures needs are addressed. For women in SEA agriculture, this means sharing their lived experiences, having leadership positions, and implementing programs to improve their quality of life.

In most ASEAN countries, women in agriculture earn less than men, discouraging women from engaging in employment.[58] Women are often excluded from high-level decision-making positions, with only 6 percent serving as ministers in environment-related ministries, including agriculture.[59] Female leadership reduces tokenistic participation and ensures equitable gender-sensitive investments. The SEED Framework ensures that women in agriculture will have all the tools and policies in place to support their decision making in biosecurity interventions around SEA.

This is reflected in the framework through the following activities:

- **Space:** forums and workshops are held for local female farmers facilitated by a group of W4B members and local government agents (mayor, agricultural minister, Agroecology Learning Alliance in SEA representative).
- **Voice:** biosecurity advisory committee for sub-national and national levels with female representatives led by ASEAN Women's Network for Biosafety and Biosecurity.
- **Audience:** W4B works to ensure attentive audiences are gathered from ASEAN Women's Network for Biosafety and Biosecurity, agricultural ministry, mayor, and/or donors.
- **Influence:** executive officials and local governments of ASEAN implement gender-sensitive, culturally sound policies that address the barriers for women to participate in biosecurity interventions.

3. Sociocultural Understanding

Addressing animal health and biosecurity risks in SEA requires communication through a cultural lens to foster local trust and cooperation. A study on raising H5N1 awareness in Cambodia highlighted the difficulty of using technical rationale over approaches aligned with farmers' sociocultural beliefs.[60] This underscores the importance of local taxonomy because conflicting terms hinder behavioral change.[61]

This framework recommends W4B to partner with the ASEAN Women's Network for Biosafety and Biosecurity to support establishing local community leaders who will be responsible for community sociocultural needs assessment pre- and post-training, and equitable distribution of resources (e.g., manuals, PPE, testing kits, disinfectants, access to information and technology). The needs assessment will serve as a basis to guide trainers on capacity-building methods, and modules relevant to each local group.
Additionally, to foster sociocultural understanding beyond local levels, the ASEAN Women Entrepreneurs Network should provide a platform for women representatives from rural provinces and smallholder farms to advocate for their specific needs and showcase their activities in biosecurity interventions.[62]

Suggested metrics for finance, meaningful inclusion, and sociocultural understanding recommendations can be found in Appendix B.

4. SEED Framework Application in Thailand

Given that Thailand is a leader in SEA for health security and gender equality based on the GHS Index and Global Gender Gap Report (see Appendix C), it provides a good backdrop to issues surrounding the role of women in agriculture and how the framework could be used in their context. Thailand's 12.7 million smallholder farmers account for 18 percent of the total population and contribute to 6.2 percent of the country's agricultural GDP.[63] On a national level, 27 percent of employment in agriculture is female,[64] but one study reported that this percentage can be as high as 60 percent in some provinces.[65] This statistic does not include informal or unpaid work by women who spend 3.5 times more time on these activities than their partners.[66]

Along the border of Thailand, there is an equal men-to-women ratio involved in raising poultry.[67] Poultry farms, especially small ones with fewer disease prevention measures, have a high risk of avian influenza. Female farmers mainly raise poultry and help men with manual tasks, food preparation, and processing.[68] Despite their significant contribution, women's access to resources and training related to livestock are minimal.[69] This might be due to a lack of gender awareness in families, communities, and government, which maintains traditional beliefs that undervalue women's roles in agriculture.[70] The lack of attention to gender leads to men being the main or only target group for agricultural development.[71]

Female farmers face health risks and lack training, highlighting a gap in capacity building. This is reflected in a study done by FAO in Thailand on gender roles in the agricultural sector, rural women specifically expressed wanting to learn how to improve the management of poultry and small livestock diseases.[72] In relation to the proposed financial policy and practice, Thailand would

benefit from educating women on deliberate and naturally occurring animal health risks through trained local veterinarians and greater funding being dedicated to such endeavours.

Although women in Thailand are members of agricultural and non-agricultural organizations, they do not have prominent leadership roles.[73] Research found that generally Thai women participated less in village groups, poorer and less-educated women faced barriers to joining women's group, and the selection process for trainings favored men.[74] The call for meaningful participation of women holds true in this country because women should not only be heard but also take part in decision making for initiatives that affect them and their communities. Despite some positive steps taken toward equitable investment, more needs to be done in Thailand and other parts of Southeast Asia.

Sociocultural understanding in the context of Thailand takes into consideration the cultural gender roles that exist within a household. Women are taught to obey rather than express their views, especially village women, so they lack the confidence to attend training courses outside their villages, contact government officials, or express their perspectives.[75] Taking this into account, when establishing a training program, it would be imperative to have this take place within villages, to limit the presence of government officials, and create a safe space for the women to share their experiences and thoughts. The participation of local women in the planning and implementation of such a program is essential to tailoring the training for female farmers in these provinces and allow for aspects of women empowerment to be embedded in these activities.

Some societies like Thailand and the Philippines are predominantly matrilineal, whereas others like Indonesia have a large Muslim population where religion plays a key role in women's mobility and communication between the sexes.[76] Given these differences in sociopolitical values, religion, family systems, and culture, women's role in agriculture in SEA differs and requires greater scrutiny at a community level.

Conclusion

Uplifting women in Southeast Asia's agriculture industry is not just about equity; it is essential for strengthening biosecurity interventions, reinforcing One Health, and building a society resilient to biorisks. Despite composing a large segment of the SEA agricultural community, female farmers are often marginalized and lack access to biosecurity training and resources. This gap heightens their vulnerability and cripples our collective ability to manage biosecurity risks effectively, particularly on smallholder farms with fewer disease prevention measures. If left unchecked, the porous borders of SEA could exacerbate the spread of infectious diseases from deliberate or accidental biorisk of agriculture, posing a global threat. However, actively enhancing the participation and leadership of SEA's marginalized female farmers at the intersection of agriculture, security, and defense can fortify one of the most vulnerable sectors in this high-risk region.

Strategic investments in female farmers not only benefit the women involved but also enhance community outcomes. Given women's dual roles, these investments are able to empower a crucial segment of the agricultural workforce and aid in generational knowledge transfer about best biosecurity practices. Utilizing women's unique perspectives and networks can also significantly improve pathogen surveillance, detection, and containment. However, many existing programs

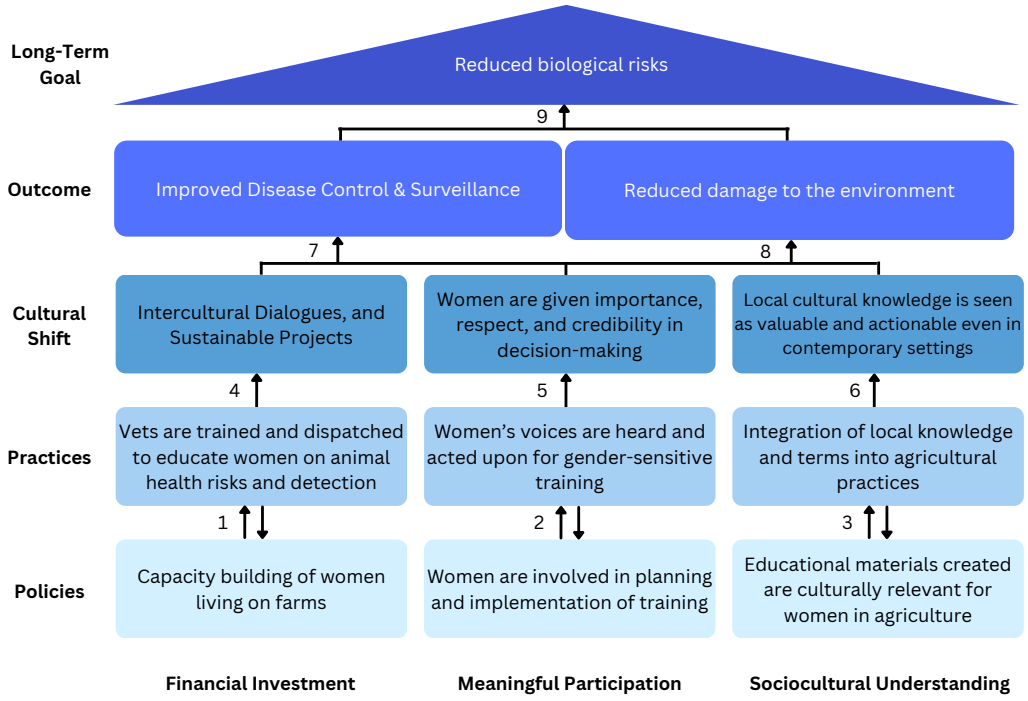
supporting women in agriculture currently lack biosecurity components, highlighting the untapped potential of weaving biosecurity understanding into women-focused agricultural initiatives. This offers a strategy to strengthen both local and global biosecurity frameworks by empowering a large, marginalized segment of SEA's agricultural workforce.

Given this, the proposed SEED Framework offers a comprehensive blueprint for change, advocating for equitable investments through targeted financing, meaningful inclusion, and a deep understanding of the sociocultural dynamics at play. Incorporating these into policy and practices can catalyse a cultural shift that leads to improvement in both human-animal disease control and environmental damage, thereby supporting the joint plan of action for One Health and resulting in an overall reduction of biosecurity risks. This framework is contextualized using Thailand as a case study, showing the need and current initiatives dedicated to the intersection of gender, agriculture, and biosecurity in the region.

To conclude, ensuring that women have equitable opportunities to contribute to and lead in agriculture biosecurity efforts is **more than just an ethical imperative**—it is a **strategic necessity**. By empowering female farmers, we not only address ingrained inequalities but also strengthen our collective ability to manage biorisks. This investment in women is an investment in the future of global food chain security and community health, moving us closer to a world where gender equity is a reality, and empowered female farmers lead in creating healthy, prosperous, and biosecure communities.

Appendix

Appendix A. Supplementary Information on the SEED Framework with Corresponding Assumptions and Confidence Levels



Flow No.	Assumptions or Evidence	Confidence
1	Studies and research will be enough to convince local governments to take actions.	Low – 35%
2 & 3	Female representatives are willing enough to dedicate their time in training and open enough to allow new education materials to be integrated in their culture/communities.	Medium – 45%
4 & 5	Distribution of knowledge and information is successful and women are open to further strengthening the effort.	Medium – 65%
7 & 8	Women who are supported with resources, encouragement, and have the space to be involved are more likely to take on leadership roles and make more decisions.[77]	High – 98%
9	Improving disease control and surveillance systems greatly reduces the biological risk.[78] Reducing damage to the environment also reduces the damage of climate change, thereby leading to a reduced risk of infectious diseases.[79]	High – 95%

Appendix B. Summary of Potential Metrics for Recommendations

Financial

Indicator	*Metric*	*Reasoning*
Return on Investment	(Cost saved from reduced family medical bills + Increased earnings from better animal husbandry practices). Estimated cost of training female farmers.	Proposed ROI calculation based on perceived benefits that female farmers will attain from participating in training.

Meaningful Inclusion

Indicator	*Metric*	*Reasoning*
Proportion of women in senior and middle management positions	15 percent increase in the percentage of women in leadership positions as reported by the International Labor Organization.	Current trends show less than 10 percent increase per year[80]in the proportion of women in SEA in leadership positions, setting a goal of 15 percent increase pushes the boundaries of this trend and strives to encourage nations to do more to place women in leadership roles.
Proportion of women in parliamentary positions	50 percent increase in the percentage of women in political leadership positions as reported by the Inter-Parliamentary Union.	Current trends show that the Philippines has the highest percentage of women in parliament at an average of 28 percent for lower and upper chamber whereas Malaysia had the lower proportion at 13.6 percent.[81] Setting a goal of a 50 percent increase pushes the envelope on what political gender inclusion currently looks like.
Proportion of women senior management positions in agricultural organizations	50 percent increase in the percentage of women in senior management positions in agricultural organizations as reported by SEA nations.	By specifying leadership in agricultural organizations, this metric directly measures the gender ratio in this field.

Sociocultural Understanding

Indicator	*Metric*	*Reasoning*
Participation of local women	At least 50 percent of the planning and implementation team are women from the local community.	Including women from the local community provides space for their knowledge to be integrated in programs targeting them.
Local women leaders	At least one local woman leader in every program impacting them.	Placing local women in positions of leadership for programs that impact them ensures that their voices are heard and prioritized.

Appendix C. Performance Metrics for Biosecurity, Biosafety, and Public Health Response from the Global Health Security (GHS) Index

Performance metrics for biosecurity, biosafety, and public health response from the GHS Index,[82] alongside gender gap index from the World Economic Forum (WEF)[83] for each SEA country. GHS scores range from 0–100, with higher values indicating better performance. The average score is derived from the adjacent metrics. The WEF Gender Gap Index ranges from 0–1, with higher scores reflecting better gender parity in economic participation, educational attainment, health, survival, and political empowerment.

	(1.2) Zoonotic Disease	(1.3) Biosecurity	(1.4) Biosafety	(1.6) Immunization	(2.4) Surveillance data accessibility and transparency	(5.2) Cross-border agreements on public health and animal health emergency response	(5.5) Financing	(6.2) Socio-economic resilience	(6.4) Environmental risks	Average score across used GHS metrics	Gender Gap Index (2023)
Thailand	64.1	69.3	50	75	86.7	50	75	63.1	60.4	65.96	0.711
Singapore	19.7	28	100	75	66.7	0	50	77.6	52.7	52.19	0.739
Malaysia	23.9	44	0	75	60	50	50	83.2	67.5	50.40	0.682
Vietnam	26.1	24	50	75	43.3	50	50	54	66	48.71	0.711
Brunei	18.4	4	0	100	43.3	50	66.7	49.9	65	44.14	0.693
Myanmar	26.3	4	0	75	43.3	50	75	65.7	42.3	42.40	0.65
Philippines	17.3	24	0	50	53.3	50	50	77.4	46	40.89	0.791
Indonesia	42	24	0	50	20	50	62.5	67.1	47.5	40.34	0.697
Cambodia	40.6	0	0	75	60	50	41.7	44.3	29.3	37.88	0.695
Lao PDR	8	4	0	50	40	50	41.7	47.6	46.1	31.93	0.733
Timor-Leste	0	0	0	25	10	0	54.2	61.6	57.6	23.16	0.693

Appendix D. List of Experts Consulted

Anemone Franz, Fellow, Emerging Leaders in Biosecurity (ELBI)
Ayelet Berman, Associate Professor (Visiting) at NUS Saw Swee Hock School of Public Health
Lead, Law & Governance at NUS Asia Centre for Health Security; Lead, Global Health Law at NUS Centre for International Law
Emma Alegi, Gender Specialist, Joint Centre for Zoonoses and Antimicrobial Resistance, Food and Agriculture Organization (FAO) Headquarters

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