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Many "New" Green Revolutions?

– Unearthing the Coexistence of Agrifood Solutions to Malnutrition in the Philippines

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Shun-Nan Chiang

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The Dissertation of Shun-Nan Chiang

is approved:

_____
Professor Julie Guthman, chair

_____
Professor Nancy Chen

_____
Professor Jenny Reardon

_____
Peter Biehl
Vice Provost and Dean of Graduate Studies

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Abstract

Many "New" Green Revolutions? – Unearthing the Coexistence of Agrifood Solutions to Malnutrition in the Philippines

Shun-Nan Chiang

While malnutrition has been recognized as a persisting social problem since the emergence of modern nutrition science, in recent years, the international agricultural development field has made efforts to tackle malnutrition through a range of potentially conflicting innovations, commonly known as nutrition-sensitive agriculture. Yet, development agencies' practice of cataloging solutions has not resolved the internal contentions within agricultural development, nor has it acted as an effective way of tackling malnutrition. Draw on Foucault's discussion on problematization and STS scholars' theorizing of problem-solution coupling, this research studies five coexisting agrifood project for addressing malnutrition in the Philippines to grappling with the complexity beneath the coexistence of agrifood solutions. How and why do particular agrifood solutions coexist? And how do these coexisting solutions attempt to address malnutrition collectively?

These five projects are: 1) The Golden Rice Project, aiming to develop a new type of genetically modified rice for Vitamin A deficiency and carried out by the International Rice Research Institute; 2) The Iron-Premix Rice Project, focusing on developing technologies to mix rice with iron during the post-harvest

processing and researched by the Philippine National Food and Nutrition Research Institute; 3) The Moringa Industry Development Initiative, advocating to institutionalize governmental support for the production of moringa-supplemented products and facilitated by the Moringaling Philippines Foundation Inc.; 4) The government-backed BeRICEponsible Campaign, promoting brown rice consumption nationally and executed by the Philippine Rice Research Institute; 5) The School-plus-Home Gardening Project, utilizing school gardens to supplement the pre-existing school feeding program and devised by a coalition of the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), University of Philippines Los Baños, Department of Education, and six public schools in Laguna Province.

I approach these five solutions from three aspects: the history of problem-solution dynamics, the configuration of each solution, and the shared infrastructure underlying all the solutions. In Chapter Two, I point out that the coexistence of multiple agrifood innovations as solutions to malnutrition is not merely a contemporary phenomenon but has existed throughout history. I developed the concept of problem-solution constellation to demonstrate how different agricultural approaches associated with the five projects in my research have reappeared in history multiple times as solutions to malnutrition. In Chapter Three, I switch from a longitudinal to a horizontal view and center on the contemporary status of these five projects. I analyze how each agrifood project configured an assemblage that rendered technoscience situated. For the Iron-

Premix Rice Project, I argue that the kernel-shaped iron-premix is the key element that brings together the assemblage. In Chapter Four, I highlight three infrastructures embedded in the configuration of all the assemblages. The first is the epistemic infrastructure, which concerns how malnutrition is perceived and understood. The second is the research infrastructure, including public research centers, universities, and international development agencies or research institutes. The third is the mobilization infrastructure, mainly referring to the meetings of development actors.

The problem-solution analytical framework speaks to the practical-critical divide in the scholarly literature on multiple fronts. For practical scholars, the problem-solution constellation analysis highlights the limit of comparative analysis of solutions based on an individualist methodology. For critical scholars, the findings in this research helped steer critical analysis away from focusing on the most contentious technology only and help situate the contentious solution in relation to other coexisting solutions and the targeted problem.

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The journey to pursue the PhD degree in the U.S. began with my encounter with my partner, Ling. She had stood resolute beside me for all this time. Words could not describe my gratitude. Life would be different without her company.

Prologue

It was in a minivan, during a conversation with a Filipino nutritionist, Dr. Leila Africa, where I began to formulate this dissertation research. We were on our way back to the University of Philippines Los Baños (UPLB) along with a group of researchers from a trip to two public schools where these researchers implemented a school gardening project. At that time in 2016, I had just begun my preliminary research for my dissertation. I arrived in the Philippines intending to study the Golden Rice Project, an iconic innovation that utilized genetic modification techniques to increase the vitamin A content in white rice. I saw the Golden Rice Project as the perfect entry point to study the interaction between agricultural development and human health. However, after I visited various agricultural scientists, nutritionists, social scientists, and activists in the Philippines, I realized that very few Filipinos at the time cared about Golden Rice, including Dr. Africa, with whom I had had the conversation in the minivan. Although she worked at UPLB, where the International Rice Research Institute (IRRI) – the institute responsible for the Golden Rice research – was located, she did not pay much attention to the Golden Rice Project. At one point in our conversation, she asked me whether Golden Rice was for vitamin A or iron deficiency. That was when I realized how insignificant the Golden Rice Project might be to the nutritional community in the Philippines. I was also surprised to discover why Dr. Africa felt indifferent about Golden Rice. It was because Golden Rice was still under development while many other agrifood innovations

were already in use and at her disposal. The conversation made me aware that, for particular social problems, there were always alternatives to certain innovations that could be workable solutions. Thereafter, I began to pay attention to a range of agrifood projects considered solutions to malnutrition in the Philippines.

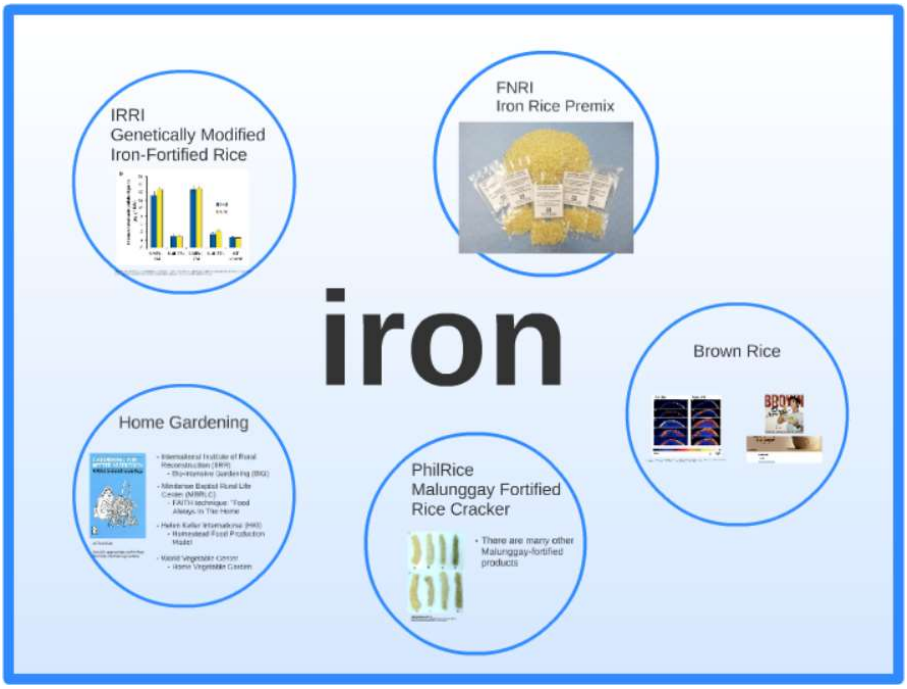

Figure 1: A slide presented in my invited talk in UPLB

By opening my perspective to other agrifood solutions to malnutrition, I exposed myself to the development field[1] regarding agriculture-nutrition linkage

[1] Activities I carried out during this 6-week research trip include attending four conferences (ADB Food Security Forum, FNRI Nutrition Series Seminar, International Conference on Philippines Studies, UPOU Organic Agriculture Course), visiting nine institutes or organizations (IRRI Genetic Transformation Laboratory, an organic farm in Calauan, Farm Farm Away — Nu Wave Farmers, the UPOU Farmers Market, the UPLB Gender Center, Some restaurants and coffee shops, IRRI Rice World Museum, and farmers' group

in the Philippines. The result was fruitful, and this line of thinking also formulated an invited talk at the end of my pre-dissertation research. Figure 1 was one of the slides I presented in the talk. I showcased various agrifood innovations I discovered in the Philippines to address the issue of iron deficiency. These innovations include genetically modified (GM) rice, iron fortification of rice, brown rice consumption, moringa-fortified rice crackers, and home gardening.

Although all these agrifood innovations in Figure 1 were meant to solve iron deficiency, they represent different visions of agricultural development and assume different pathways to solve malnutrition. For example, GM rice for nutrition characterizes the new frontier and goal for the agri-biotechnology industry. By contrast, home gardening usually serves as the cornerstone for alternative food networks that oppose large-scale and industrialized agricultural systems. Furthermore, while food fortification with synthesized nutrients such as iron is closely tied to the food industry practices that produce processed food, supplementing food products with natural ingredients such as moringa leaf powders is influenced by the counter-trend of the natural food movement. Meanwhile, different from all the innovations above, promoting brown rice seemed to move the policy focus away from agricultural production to consumption and resonate with the features of post-industrial society, in which

MASIPAG), numerous discussions with scholars across disciplines (15 scholars from UPLB, IRRI, and other institutions in the discipline of agriculture, nutrition, and social sciences) and collecting secondary materials from UPLB libraries, Ateneo de Manila University Library - Microfilm Collection, the UPLB Gender Center, and several bookstores.

consumers' collective behaviors are deemed to play a more important role in influencing food production models.

While I was struck by diverse and vibrant approaches coexisting in the development field, what was even critical in my discovery were the contradictions underlying these coexisting agrifood solutions. On the one hand, these agrifood innovations seemed to conflict. For example, local farmers' groups and nonprofit organizations opposing the development of genetically modified rice to tackle malnutrition have repeatedly used brown rice and gardening as alternative solutions. Meanwhile, biofortification, an approach that utilizes traditional breeding and genetic modification (GM) techniques to develop crop varieties with high nutrient content, was usually positioned by its supporters as a better substitute for fortification. On the other hand, all these agrifood innovations I discovered not only coexisted in the Philippine policy arena, but all seemed to have certain degrees of involvement from the Philippine government or its related research agencies.

It was this contradiction – that these agrifood solutions seem to conflict with each other while coexisting with a shared source of public support – that transformed my research focus from the interaction between agricultural development and human health into the coexistence of agrifood solutions to malnutrition. With this problematic regarding the dynamics between problems and solutions, I delved into this research.

Chapter One
Introduction: Agriculture as Solution?

1-1 The rise of nutrition-sensitive agriculture as a better version of agricultural development

In the past two decades, international agricultural development has shifted from its long-abiding policy emphasis on increasing production to eradicating malnutrition – popularly known as "nutrition-sensitive agriculture." One milestone was The 2014 Second International Conference on Nutrition (ICN2), co-held by the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO). During the ICN2, the FAO proposed mainstreaming nutrition by including it in each of its five strategic objectives and "maximiz[ing] the impact of food and agricultural systems on nutrition." At the end of ICN2, the FAO, the WHO, and other participants also published the *Rome Declaration on Nutrition* collectively, emphasizing the responsibility of agriculture in tackling malnutrition. Embracing this new policy trend of "nutrition-sensitive agriculture," a wave of new organizations and collaborations across diverse geographies have emerged[2], and so too have supporters from

[2] Examples include Leveraging Agriculture for Nutrition in South Asia (LANSA), New Alliance for Food Security and Nutrition promoted by G8 in Africa (New Alliance), the Global Alliance for Improved Nutrition (GAIN), and Global Panel on Agriculture and Food Systems for Nutrition supported by UKAID and Bill & Melinda Gates Foundation.

academic communities in nutrition and agricultural sciences (Chatterjee 2014; Pinstrup-Andersen 2013).[3]

The development field recognizes nutrition-sensitive agriculture as a key part of its pursuit of a better version of agricultural development. The most important policy indication comes from comparing the United Nations' *Millennium Development Goals* (MDGs) of 2000 and the *Sustainable Development Goals* (SDGs) of 2015. In the MDGs, eradicating hunger was categorized in MDG #1, along with reducing poverty, suggesting that poverty was the main cause of hunger. By contrast, eradicating hunger and reducing poverty were de-coupled as two SDG goals — SDG #2 and SDG #1. Meanwhile, SDG #2 targets not only improving nutrition but also promoting sustainable agriculture[4]. As explained by the UN, "it is time to rethink how we grow, share and consume our food. If done right, agriculture, forestry, and fisheries can provide nutritious food for all and generate decent incomes while supporting people-centered rural development and protecting the environment."[5] The UN's elaboration of SDG #2 shows that the development field considers that the operation of the entire food system plays an important role in improving people's nutrition status.

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[3] The most widely-referred-to scholarly literatures are the 2008 *Lancet Special Series on Maternal and Child Undernutrition* (https://www.thelancet.com/series/maternal-and-child-undernutrition) and the 2013 *Lancet Special Series on Maternal and Child Nutrition* (https://www.thelancet.com/series/maternal-and-child-nutrition).

[4] The entire SDG #2 says, "End hunger, achieve food security and improved nutrition, and promote sustainable agriculture."

[5] See https://sdgacademy.org/goal/zero-hunger/ for details. (Accessed 04/21/2021).

While the trend of nutrition-sensitive agriculture upholds agrifood innovations as solutions to malnutrition, the content of those innovations is disparate. Similar to what I observed in the Philippines, development agencies, academics, and international agricultural research centers propose a certain type of innovation as the best agrifood solution to the issue of malnutrition, and, unsurprisingly, these agrifood innovations are based on diverse and sometimes contending approaches – ranging from ecological farming to biotechnology (Bouis and Welch 2010; Weinberger 2013).

For example, some scientists and development agencies urge the active adaptation of agri-biotechnology to tackle malnutrition (Bouis and Welch 2010; Bouis et al. 2011). They advocate for biofortification as the key approach to reaching people living in rural areas without access to food other than staples. The rationale is that, while this population has a higher prevalence of micronutrient deficiency, they cannot reach fortified food because they live in rural areas with less income. Thus, these agencies argue the only way to reduce the prevalence of micronutrient deficiency among these people is to increase the nutritional values in the staple crop they consume every day (Bouis et al. 2011).

Others contend that various agroecological techniques could better serve the goal of nutrition-sensitive agriculture and express implicit doubts about biotechnology (Weinberger 2013; Gillespie et al. 2015; Guzman, Zamora, and Bernardo 2015; Nagarajan, Bhavani, and Swaminathan 2014; Maluf et al. 2015).

Scientists in the Philippines introduced several local farming systems that could leverage agriculture to improve nutrition, including bio-intensive gardening, homestead food production program, farmer-led sustainable agriculture, and upland food production systems of indigenous peoples (Weinberger 2013; Gillespie et al. 2015; Guzman, Zamora, and Bernardo 2015). Scientists and activists in India have also developed a "farming system for nutrition" approach that focuses on family farming and community vegetable gardens to address malnutrition (Nagarajan, Bhavani, and Swaminathan 2014). In Brazil, when activists and scientists argued how nutrition-sensitive agriculture could enhance food and nutrition sovereignty and security (Maluf et al. 2015), they highlight the possibility of agroecological approaches that diversify food production and protect local seeds and express their suspicions on biofortification in their article.

Surprisingly, when encountering internal contentions across agrifood approaches, development agencies' policy focus is not to decide the most effective solution. Their primary aim is to cultivate "a catalog of solutions." The most comprehensive effort came from the FAO's publication in 2017, titled *Nutrition-sensitive agriculture and food systems in practice* (Uccello et al. 2017). This book provides detailed guidelines for different intervention options based on a food system framework. Figure 2 shows the comprehensive list of innovations compiled in the book that could improve nutrition. As the figure shows, different agrifood innovations across the supply chain *coexist* as potential solutions. Echoing what I discovered in the Philippines, this list of innovations includes

seemingly contrasting approaches, such as biofortification and promoting biodiversity. That is, on the surface, there seem to be two groups of innovations, each representing a particular direction of agricultural development, and they seem to conflict with each other[6]; but ultimately, development agencies such as FAO tend to "collect" all the innovations and compile them in the same catalog. FAO's rationale – similar to the Filipino nutritionist I conversed with in the van – is to get hold of viable and diverse solutions that could tailor to different local contexts.

[6] The basic framing of these two contrasting directions of agricultural development is between industrial and alternative agriculture (Beus & Dunlap 1990). Yet, the binary framing of agricultural development has not only persisted but also been evolving when scholars continue to debate the polarization of future agricultural development with new formations (Kershen 2012; Vanloqueren and Baret 2009). In the contemporary era, one popular framing is between precision agriculture – the combination of technology-based innovations and concentration of capital – and agroecology – technique-based innovations and corresponding small-scale social organizations. The binary framing of agricultural development has also manifested in different policy contexts. For example, in the European policy context, scholars point out the contestations between two divided visions, both associated with the European Union's proposed policy direction of the knowledge-based bioeconomy. One of them is the "Life Sciences vision," based on plant-cell factories to replace fossil fuels as farming input. The other is "Agroecology vision," based on agroecological methods and minimizes external inputs (Levidow et al. 2013; Birth 2016). Even after the term "sustainable agriculture" has become a popular framing and the goal for future agricultural development, the debate associated with the binary framing of agricultural development continued and became: "what is sustainable agriculture" (Janker et al. 2018; Velten et al. 2015).Although the rift was no longer between industrial agriculture and agroecology but between different proposals to replace or reform industrialized agriculture, the new debate resembles the old one. Scholars frame the most typical debate as between sustainable agricultural intensification (SAI) and agroecological intensification (AEI) (Mockshell & Kamanda 2018). While both SAI and AEI claim to be the alternative to conventional or industrialized agriculture, they embrace different approaches. The starkest difference is their attitude towards new technologies. SAI is more open to incorporating digital technology and recognizes genetic modification techniques as potential tools (Haggar et al. 2020; Godfray 2015). In contrast, AEI is more skeptical of digital technology due to its reliance on high capital input and categorically rejects genetic modification techniques (Geertsema et al. 2016). In short, scholars remain to frame the future of agricultural development as between reforming and replacing industrialized agriculture (HLPE 2019).

MAIN FUNCTIONS OF THE FOOD SYSTEM	INTERVENTIONS
Food production	Diversification and sustainable intensification of agricultural production
	Nutrition-sensitive livestock and fisheries
	Biodiversity for food and nutrition
	Biofortification
	Urban and peri-urban agriculture
Food handling, storage and processing	Nutrition-sensitive post-harvest handling, storage and processing
	Food fortification
Food trade and marketing	Trade for nutrition
	Food marketing and advertising practices
	Food price policies for promoting healthy diets
	Food labelling
Consumer demand, food preparation and preferences	Nutrition education and behaviour change communication
	Income generation for nutrition
	Nutrition-sensitive social protection
	School food and nutrition
	Nutrition-sensitive humanitarian food assistance
Cross-cutting issues	Nutrition-sensitive value chains
	Women's empowerment and gender equality
	Food loss and waste: prevention, reduction and management
	Food quality, safety and hygiene

Figure 2: A list of nutrition-sensitive interventions compiled by FAO in a 2017 book

The controversy surrounding the 2021 UN Food Systems Summit sheds further light on the implication of these two opposite tendencies — compiling the catalog of solutions and the internal conflict among agrifood approaches. One debate was about the role of agroecology in the summit. In a reported interview, one organizer argued that "the summit must not [be] bogged down in ideological battles" when being asked about how to handle the presence of "conflicting schools of thought, such as the representatives of agroecology on the one hand and the advocates of a more conventional or technologically oriented agriculture on the other." In an "Editorial" of *Agroecology and Sustainable Food Systems*, the

editors, Steve Gliessman and Maywa de Wit Montenegro (2021), responded to this comment by criticizing that, in the summit, “agroecology appears relegated to being one more tool in a ‘toolbox’ dominated by genetic engineering, digital frameworks, big data, and new technological innovations.” In other words, they rejected the very idea of a toolbox.

The rift between the summit organizer and these agroecology scholars highlights the contention underlying “the catalog of conflicting solutions.” The summit organizer was worried that development actors spent too much energy fighting each other without being practical and making substantive progress toward solving problems. In contrast, these agroecology scholars contended that the approach of the “catalog of solutions” was just an intention to depoliticize the process when development actors debated and decided the direction for future agricultural development. They criticized that it was the idea such as “toolbox” that would delay the progress to achieve what they think is the correct pathway to change. The debate invokes the question of how coexisting solutions come to be and the implications of their coexistence.

Although the coexistence of competing solutions is a common phenomenon in the development field, existing scholarly literature has paid scant attention to it. Nor do scholars provide a satisfying framework to analyze what the coexistence of the solutions reveals about how social problems could be tackled. Similar to the implicit debate between the summit organizer and the agroecology scholars,

scholars tend to employ two opposite *methodological* approaches to studying solutions — what I term "the naively practical" and "the not-so-constructively critical."

Scholars employing the practical approach come from various disciplines used to compare coexisting solutions. Take nutrition-sensitive agriculture as an example. Research in economics, nutrition science, or sustainability studies was tasked to compare and *evaluate* the effectiveness of different agricultural interventions to address malnutrition (Bhutta et al. 2008, 2013; Garbero and Jäckering 2021; Masset et al. 2012; Masters et al. 2014). Among social sciences, economic analysis is particularly influential in this type of analysis because it has a key concept called "opportunity cost." Unlike the basic idea of "cost" that refers to the efforts and consequences of carrying out a certain solution, "opportunity cost" refers to the *benefit* that cannot be fulfilled when policymakers choose a solution rather than an alternative one. In essence, the concept of opportunity cost propels economic analysis to be aware of coexisting solutions and develop comparative analysis across them. However, this kind of comparative analysis usually takes a stance of *methodological* individualism and assumes that each solution is independent without relation to others. This type of analysis is also not attentive to why *these* particular solutions coexist rather than other ones and what the collective pattern of *these* coexisting solutions means. On top of these issues, this type of analysis usually uses realist methodology to consider the relationship

between solutions and the corresponding social problem and take how solutions emerge in relation to the social problem for granted.

By contrast, critical scholars in the development field tend to narrow their focus on the most contentious or seemingly problematic solutions – most of them are technology-centered solutions. These scholars may be concerned with these controversial agrifood solutions' impacts and unintended consequences. They may further point out that these solutions are only a band-aid that fails to address the root cause of the social problem[7]. Some scholars may even unveil the hidden agenda of the solutions and reveal how the promoters of these solutions may reframe the social problem to fit the solution[8]. Yet, while these critical scholars

[7] One well-adopted concept elaborating this argument is "technological fix." Development studies scholars employ the concept to provide cautious tales regarding the use of technology-based solutions in the development context (Bobel 2019; Chang 2017; Lundvall 2017; Markusson et al. 2017; Rosner 2013; Sims 2017; Varma 2002; Wibeck, Hansson, and Anshelm 2015). Scholars argue that technology-based solutions tend to narrow down a social issue to a manageable technical problem for which the society could possibly identify the solution (Scott 2011). This process of narrowing down and redefining an issue may also "factor out the human element" (Scott 2011: 209). Dane Scott suggests that this is why this type of technology-based solution normally "transformed, relocated or delayed problems and generated social side effects and/or additional problems" (Scott 2011: 216). Scott's discussion resonates with Tania Li's conceptualization of "rendering technical" a socio-political issue with a technology-based solution to obfuscate its social solution (Li 2007). Li further points out that the rationale of rendering technical also implies that technology-based solutions are usually more conservative and inclined to "fix" the problem within the pre-existing system (Li 2007). She also ascribes "rendering technical" as the common practice accompanying "the will to improve" and highlights the consequence of "de-politicization" after social problems are rendered technical (Li 2007).

[8] For example, scholars have investigated how nutritional health is incorporated as the new frontier for profit-making. Drawing from the food regime framework, Jane Dixon (2009) analyzes how malnutrition embeds the transformation of different food regimes by problematizing the purpose and use of nutritional knowledge. Dixon critically evaluates the increasing dominance of nutrition science underlying transitions in food regimes, which she refers to as "nutritionalization." She defines nutritionalization as involving "the co-option of nutrition science to extract surplus value and authority relations from food and is most transparent when corporate strategies and public policies are framed in terms of nutritional disease and health and wealth advancement" (Dixon 2009, 322). Dixon borrows from other critical nutrition scholars to analyze how the reductive tendency and quantification of

provide in-depth analysis of a particular solution, they tend to overlook other coexisting solutions. In *Problem-Solving Sociology*, Monica Prasad (2021) suggests this tendency of "critique without construction" as one of the traps for mainstream sociological analysis to move away from proposing genuine solutions. Critical scholars may suggest better alternative solutions in the last chapter of their analysis, but they usually pay less attention to these alternative solutions than the critical analysis they do for the seemingly problematic solution.

One exception across this practical-critical divide is a group of scholars proposing a "pathways approach" to address development issues (Leach et al. 2010). Their analysis begins with the acknowledgment that development problems are full of the binary pathways between capital-intensive and technology-centered solutions and community-based solutions. Yet, they argue that, since "dynamism, complexity, and uncertainty dominate today's world," there should be diverse pathways of solutions to social problems manifesting in

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nutrition science could be manipulated by the capitalistic and industrial food system (Mudry 2010; Scrinis 2008; Nestle 2007). Sharing a similar agenda, Aya Kimura (2008) details how the food industry in Indonesia utilizes cultural values and gendered stereotypes to promote baby formula and interferes with nutritional policymaking for infant malnutrition. Gyorgy Scrinis (2020) further conceptualized food companies' strategies to exploit nutritional knowledge for marketing. He identifies reformulation, fortification, and functionalization as three key strategies increasingly popular in the global south and north. Beyond corporate practices, scholars have also considered how governments and development agencies manipulate the issue of malnutrition for agricultural development. Kimura's (2013) study in Indonesia points out how agricultural policy becomes the main consideration for nutrition policymaking. She argues that the Indonesian government set a specific rule for wheat fortification, which favored local companies and practically stopped wheat import. Sally Brooks (2010) studies how international agricultural research centers collaborate with local partners to develop rice biofortification technologies in the Philippines. She argues that funding is one of the main considerations for these research centers to turn to malnutrition and position agricultural innovations as key to solving malnutrition issues.

the diverse locale. These scholars further point out that there is a tendency for "powerful actors and institutions to 'close down' around particular framings, committing to particular pathways that emphasize maintaining stability and control"(Leach et al. 2010:5). To counter this tendency, these scholars highlight diversity of solutions and inclusiveness of development actors as important factors to "open up" alternative pathways to development. They also develop specific *methodologies* consisting of analytical, policy, and appraisal approaches to evaluate technologies and other solutions involved in development practices. To some extent, these scholars' stance resonates with the call of some sociologists for a more engaged sociology, such as the approach of problem-solving sociology, design sociology, or policy sociology (Graizbord 2019; Lupton 2018; Mahmoud et al. 2018; Prasad 2021). All these research approaches intend to stress the importance of not only developing an in-depth diagnosis of social problems but also developing a sound *methodology* that could help generate constructive solutions to intervene in the policymaking process.

Similar to the pathways approach scholars, I aim to build on the insight of practical and critical approaches to studying solutions to social problems and, at the same time, address their shortfalls. While I uphold the importance of conducting a comparative analysis of coexisting solutions, this research goes beyond methodological individualism by analyzing why *these* particular solutions coexist and what the collective pattern of these coexisting solutions reveals. I also take up critical development scholars' stances to re-examine how solutions are

conceived in relation to problems, but I hope to supplement the singular-solution-based critical analysis by examining coexisting solutions with the same research vigor. Furthermore, different from the pathways approach scholars and solution-proposing sociologists, my goal in this research is not to develop a *methodology* to generate solutions. Instead, I hope to invite more discussion on how we could better assess the existing "catalog of solutions" as the foundation for any solution-generating attempts.

To achieve the goal, in the next section, I draw from STS scholars' and Michel Foucault's theorization on problematization to develop an analytical framework to study the collective pattern of coexisting solutions and how solutions come to coexist in relation to the corresponding problem.

1-2 Problematization: the dynamics between problems and solutions

The theorization of a "problem" in the STS field is long in coming, and it involves two fronts of scholarly efforts. The first is to move beyond the social constructivist understanding of social problems in sociology. Sociologists have long studied all kinds of social problems and theorized the nature of "social problems." In the 1970s U.S., influenced by symbolic interactionist theories and phenomenology, sociologists began to redefine "social problems" from a realist stance toward a social constructivist approach — that is, understanding "social

problems" as processes of claim-making rather than real conditions (Best 2018). Taking a step further from this tradition of sociology of social problems grounded in social constructivism, STS scholars highlight the epistemic nature of "problems." STS scholars consider the focus on claim-making as only one side of the story and go further to study the empirical matter that is the foundation of the claim (Best 2018). Take the problem of malnutrition as an example. While sociologists of social problems would draw on social factors to study how society perceives malnutrition as a social problem that has far-reaching social impacts and anticipates social responses (Vernon 2007), STS scholars would also study the development of nutrition science and how the epistemic nature of malnutrition reshapes the public's attention on certain types of malnutrition.

Studying the epistemic nature of a social problem points to STS scholars' other front of efforts. STS scholars have studied the role of "problem" in natural science since Thomas Kuhn's (1962) theorization of scientific discipline as a paradigm. In Kuhn's theorization, the paradigm predetermines what scientific problems are legitimate — what he terms a "model problem." Based on the premise, the process of scientific knowledge production is to solve the model problem and, subsequently, strengthen the paradigm. Theorizing scientific knowledge production as "problem-solving" activities cracked open STS scholars' potential to treat scientific knowledge production as their research object. Later, STS scholars developed the important methodology of "controversy studies" to study technoscience in the making. In this type of research,

controversies invoked by the construction of facts or artifacts are "problems" without settled agreement among relevant social groups (Jasanoff and Metzler 2020; Barthe et al. 2020). Nonetheless, these earlier studies are more attentive to how controversies are settled or stabilized rather than considering the nature or the emergence of the controversy (Marres 2007).

In recent years, STS scholars have further theorized the problem formation process, especially considering the role of public involvement during this process. Noortje Marres (2007, 2015) provides the most comprehensive theorization of "issue-making" so far. Marres's main concern is the democratic process in techno-politics. Resonating with ANT scholars' insight on "science in action" (Latour 1987), Marres (2007) points out that, similar to the methodology of tracking how the closure of controversies could be reached, STS scholars should also trace how an issue could be formulated into the status of a public problem – or what Barry (2021) terms "politics in action." Bringing in insights from pragmatist philosophers, Marres argues that the process of issue identification assumes that it is a problem that "existing institutions cannot settle" (Marres 2007:770) and, thus, "requires the involvement of political outsiders, the public" (Marres 2007:770). Marres foregrounds the importance of *the public* that emerges with problematization. Meanwhile, Callon and Rabeharisoa (2008) theorize a similar concept termed "concerned groups" when studying how social movement

groups intervene in specific *matters of concern*[9]. Both scholars share a similar insight that new social groups or institutions may emerge along with the process of problematization when an issue becomes a specific problem. In this research, I also take this insight to pay attention to development actors involved in coexisting agrifood projects.

While Marres mainly centers on "the continuous work needed to transform new issues into public problems" (Laurent 2017:22), Callon further develops a problematization framework that addresses the connection between problem and solution. Partly following Marres's theorization of issue formulation and partly building on earlier ANT analysis (Callon 1980, 1986), Callon defines problematization as a threefold process that transforms a particular *issue* (or "matters of concern" in Latour's term) into a network of *problems* that already implicate *solutions*. Callon defines "issues" as "situations of initial shock" that do not have a clear demarcation of political, scientific, or economic aspects[10]. Problematization refers to the process when the issue is differentiated into well-defined problems addressed by specific actions. Callon terms the process "multiform problematization" that "leads to the constitution of a network of problems" (Callon 2009: 543). Callon further argues that the process that

[9] Latour provides an early reflection on the importance to pay attention to "issues." He (2004) differentiates "matters of concern" from "matters of fact" to theorize problems that are not static or given facts but "uncertain, partially known, entangled, contested and in process" (Barry 2021:98).

[10] In Callon's empirical case, "global warming" is such an issue that "defies all attempts to reduce it to a problem that is either strictly … political, economic, or scientific/technical" (Callon 2009: 542.)

transforms an issue into a network of problems and corresponding actions is an ongoing and experimental process that does not belong to and stretches between essentialism and social constructivism. For Callon – and following the typical stance of ANT theory – what is important is not whether these problems are "real" or constructed but what and how these problems come to exist with "new forms of organization and socio-technical agencement" (Callon 2009: 545).

Various other scholars take on Callon's problematization framework or share a similar perspective, and they employ the problematization framework primarily to criticize a certain type of problem-solution coupling[11] concerning a contemporary issue. For example, Neyland and Milyaeva (2016) analyze the rise of market-based interventions as the solution to the problem of online privacy. Collier and Cox (2021) analyze how private insurance companies play a key role in the process of problematization by providing data for formulating the problem of urban resilience. Some other scholars aim to destabilize the problem-solution coupling by comparing multiple problem-solution coupling. For example, Laurent (2017) studies the implementation of nanotechnology as an issue and considers ways of organizing democratic order as the response to public problems incited by nanotechnology. In parallel with this line of inquiry but moving further, Jasanoff and Metzler (2020) compare different countries' policies regarding in vitro

[11] I use "problem-solution coupling" to refer to the result of Callon's theorized process of problematization that produces formulated problems with corresponding actions, responses, or solutions. My use of the term does not have direct connection to French philosopher Gaston Bachelard's use of the same term.

fertilization to unveil the political assumption of the value of lives in each country.[12] Overall, the agenda for most of these STS scholars is to reconsider responses, solutions, or actions associated with certain formulations of problems.

While this problematization framework formulated by Callon (via Marres) holds great potential to study complex issues and emerging technologies of our time, the current formulation of the framework falls short when considering how and why multiple solutions coexist (also see Laurent 2017; Barry 2021). To explore how to theorize solutions' coexistence further, I draw from Foucault's insight to broaden the scholarly understanding of the implication of coexisting solutions.

Foucault foregrounds problematization as a key concept for his thinking and methodology only at a very late stage (Rabinow 2003). His elaboration of the concept mainly comes from his various interviews (Foucault 1984, 1988, 1996), which leaves room for scholars to interpret the significance of this concept in Foucault's academic work and thinking (Osborne 1993; Dean 2010; Rabinow 2003; Bowden 2018; Stengers 2021). In further theorizing Callon's problematization framework, I focus primarily on how Foucault illustrates the relation between problems and a range of solutions.

[12] Although Jasanoff and Metzler (2020) do not directly draw on Callon's concept, their definition of their "comparative problematization" methodology shares a similar perspective. They define problematization as "how an unordered, possibly chaotic set of signals in the world is resolved into problems seen as requiring a governmental response." Here the chaotic set of signals is the issue, and the governmental response (legal framing) is the solution.

In the 1980s, Foucault began to re-interpret his life-long research agenda as studying the "history of thought" and suggested the analysis of problematization at the center of this methodology. There are two kinds of "problematization" involved. As Foucault (1996) explains,

> "for a field of action, a behavior, to enter the domain of thought, it is necessary for a certain number of factors to have made it uncertain, to have made it lose its familiarity, or to have provoked a certain number of difficulties" (421, emphasis added).

What Foucault describes here to "defamiliarize" human behaviors is a common notion of *problematization* in social sciences, which means to call into question social norms or practices that society has taken for granted. However, for Foucault, this is only the beginning of the analysis. As Foucault continues to elaborate,

> "to one single set of difficulties, several responses can be made. And most of the time different responses are actually proposed. But what has to be understood is what makes them simultaneously possible: it is the point in which their simultaneity is rooted; it is the soil that can nourish them in all their diversity and sometimes in spite of their contradictions" (421, emphasis added).

Foucault's elaboration on the second and more important type of problematization corresponds well with what I intend to explain. Similar to my observation on the "catalog of solutions" in the promotion of nutrition-sensitive agriculture, Foucault points out that multiple responses coexist to one set of difficulties, and the task is to explore the "soil" beneath the co-emergence of multiple responses. Foucault argues that the analysis of problematization is

> "to rediscover at the root of these diverse solutions the general form of problématisation that has made them possible—even in their very opposition; or what has made possible the transformations of the difficulties and obstacles of a practice into a general problem for which one proposes diverse practical solutions" (Foucault 1984).

Paul Rabinow's contemporary interpretation of Foucault's problematization methodology is precise and to the point. As Rabinow elaborates, "[f]or Foucault there are always several possible ways of responding to 'the same ensemble of difficulties.' Consequently, the primary task of the analyst is not to proceed directly toward intervention and repair of the situation's discordancy but rather to understand and to put forth a diagnosis of 'what makes these responses simultaneously possible' (Rabinow 2013: 18).

While Callon's problematization framework does not present obvious conflict with Foucault's interpretation of problematization,[13] Foucault foregrounds three aspects that help supplement Callon's problematization framework. First, compared to Callon's problematization framework, Foucault's problematization methodology takes into account the external resources sustaining the network of problematizations – what Foucault terms the "soil" that nourishes multiple coexisting solutions. In my research, other than coexisting solutions, I also identify components that contribute to the development of all the innovation projects. Second, history determines how solutions and problems may evolve and be conditioned. I also refer to Thomas Kuhn's (1964) analysis of the paradigm shift that considers the problem-solution relationship from a historical perspective. Although most of the current problematization-grounded research in the STS does not pay attention to the long-term historical trajectory of the problem-solution coupling, I consider it an important aspect of my research. Finally, different from Callon's conceptualization of a core "issue" that differentiates into a network of problems, Foucault's notion of a set of difficulties enables the consideration of multiple issues that encounter and make impacts simultaneously. I am also inspired by Andrew Barry's (2021) discussion on understanding environmental problems. Following Marres's discussion on issue identification, Barry points out that it is imperative to consider the encounter of

[13] In fact, there are multiple implicit references to Foucault in Callon and other ANT scholar's works. Laurent (2017) further argues that ANT scholars and Foucault share very similar understandings of problematization despite of different research purposes.

multiple issues[14] that constitutes the pre-condition of an environmental problem and trace how the encounter of issues impacts the emergence of multiple responses. In my research, I also identify agricultural development and malnutrition as two distinct issues that have frequently been encountered throughout history and constitute foundational conditions for the coexistence of agrifood solutions to malnutrition.

Building on Foucault's ideas of the multiplicity of possibilities between difficulties and a set of responses, I propose a "problem-solution analytical framework" to understand the development of innovations as solutions to certain problems in the development field. My theorization of the problem-solution analytical framework also follows Ferguson's (1994) theorization of development projects as antipolitics machines. Ferguson argues that even when development projects do not solve the social problem that they set to tackle, they still do something in the process – they help expand and sustain a development industry. While Ferguson mainly refers to development practices as a whole, I consider the "problem-solution analytical framework" to be more attentive to the contemporary period when "STI for development" dominated the development discourse[15].

[14] What Barry conceptualizes "political situations" or what Stengers terms an "event" (Barry 2021).

[15] The idea of "STI for development" indicates that the pursuit and promotion of technology gradually occupy a key role in development practices, as highlighted in the SDGs. Specifically, SDG#9 is about "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" (Matusiak et al. 2020). The main policy focus of "STI

This research aims to develop three aspects of analysis to formulate the problem-solution analytical framework and contribute to the theorizing of Callon's problematization framework. First, to address the lack of historical perspective in the current STS research based on the problematization framework, I analyze how a set of solutions has coexisted over a century to demonstrate how these solutions (re-)emerged in response to various problems of malnutrition and agricultural development. Second, to disentangle the problematization framework's assumed connection between the problem and its corresponding solution and be attentive to the agency of each solution's development, I employ an assemblage perspective to compare how each solution develops into operational projects by mobilizing heterogeneous resources. Third, to address the problematization framework's tendency to overlook external factors sustaining the problem-solution coupling, I draw on Foucault's insight on the "soil" nourishing coexisting solutions and explore underlying infrastructures contributing to the co-emerging of solutions.

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for development" is usually on how governments and development agencies could create "enabling environment" such as providing funds or educational opportunities to nurture and strengthen STI development that could, in turn, contribute to development goals. For example, when the UN emphasized the importance of "Science, Technology, and Innovation for Sustainable Development" in the Third International Conference on Financing for Development of 2015, the official output of the conference, the Addis Ababa Action Agenda, also underscores the key role of the "enabling environment." As the document says, "We recognize the importance of an enabling environment at all levels, including enabling regulatory and governance frameworks, in nurturing science, innovation, the dissemination of technologies, particularly to micro, small and medium-sized enterprises, as well as industrial diversification and value-added to commodities." In particular, the "enabling environment" that the Addis Ababa Action Agenda focuses on is the tertiary education, financing for research, and intellectual property regulations.

By foregrounding the coexistence of multiple solutions, the historical trajectories of these solutions, and factors that support the coexistence of these solutions, the problem-solution analytical framework could also speak to the practical and critical approaches to studying development solutions. To supplement the current type of practical evaluation analysis, this research exemplifies a methodological approach that provides a *thick* analysis of coexisting solutions by considering the historical relations across these solutions, these solutions' varied connections to the targeted social problem, and the shared infrastructure underlying coexisting solutions. Similarly, these three aspects of analysis also contribute to the critical analysis by providing additional explanatory factors to analyze the significance of contentious technology as a solution. Finally, the problem-solution analytical framework resonates with scholars who urge more policy-relevant research. The framework foregrounds the comprehensive analysis of existing *solutions* as the foundation for further problem-solving proposals. This aspect of contribution is even more significant for resource-poor countries such as the Philippines, which does not have a strong research capacity. In the next section, I discuss how I operationalize these three aspects of analysis in my research of coexisting agrifood solutions to malnutrition in the Philippines.

1-3 Studying five coexisting agrifood solutions to malnutrition in the Philippines

Corresponding to the problem-solution analytical framework, I take a historical-comparative perspective to understand how and why the government, development agencies, or local NGOs have developed various agrifood solutions to malnutrition in the Philippines since the early 20th century. I strategically chose five key yet distinctly different and coexisting agrifood projects. They all claimed to be the most suitable solution to malnutrition amidst the current policy landscape of solutions in the Philippines. The five agrifood projects[16] are:

1) **The Golden Rice Project,** aiming to develop a new type of genetically modified rice for Vitamin A deficiency and carried out by the International Rice Research Institute;
2) **The Iron-Premix Rice Project,** focusing on developing technologies to mix rice with iron during the post-harvest processing and researched by the Philippine National Food and Nutrition Research Institute;
3) **The Moringa Industry Development Initiative**, advocating to institutionalize governmental support for the production of moringa-supplemented products and facilitated by the Moringaling Philippines

[16] While it is important that all these innovation projects contain innovations, what is more crucial is that they are "projects." In this dissertation I highlight two key elements of "projects." First, they are more than just technologies or innovations but encompass all the aspects that help mobilize a solution. Second, these projects are limited in its scale and geographical focus and usually serve as the experiment for large-scale policy implementations (Freeman and Schuller 2020; Li 2016).

Foundation Inc.;

4) **The government-backed BeRICEponsible Campaign**, promoting brown rice consumption nationally and executed by the Philippine Rice Research Institute;
5) **The School-plus-Home Gardening Project**, utilizing school gardens to supplement the pre-existing school feeding program and devised by a coalition of the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), University of Philippines Los Baños, Department of Education, and six public schools in Laguna Province.

Three main considerations shape how and why I chose these five projects. First, policymakers and development agencies have long associated malnutrition with multiple layers of causes – from immediate ones to root causes. While these five agrifood projects may claim to address multiple aspects of causes, they all set the immediate cause of *the inadequate intake of nutrients* as the basic problem they intend to tackle. Yet, these five projects represent distinct ways to utilize agrifood practices or products to address the problem. Second, I selected these five specific projects partly because they were the most *visible* projects I encountered during my pre-dissertation research. The *visibility* meant these projects were comparatively "successful" or well-known compared to other similar projects in the Philippines. Third, the reason for studying "five" projects was not a one-off decision but a negotiated result between my research capacity

and the strength of my findings to support my argument. On the one hand, the limit of my research capacity to follow and collect data from multiple projects in one research predetermined that "five" projects may be the maximum number of projects I could study. On the other hand, I made the decision to stick to "five" projects rather than scaling down to four or three projects because the data I collected in the early fieldwork suggested that each of the five projects occupies a unique space in the development field and could provide additional insight into the argument that I aim to develop.

It is worth noting that, since the beginning of my research, I have been aware of other similar projects I could choose to follow. While studying these five projects, there were additional benefits to being surrounded by excessive agrifood innovations for nutrition. For biofortification, the IRRI was also developing another project targeting iron-biofortified rice. For school gardening, there was another active project carried out by the International Institute for Rural Reconstruction (IIRR). For brown rice promotion, the OXFAM Philippines and the FNRI both carried out similar projects during a similar period. After I began the primary research fieldwork, I encountered even more projects that shared similar or contrasting agendas with the projects I studied. For example, I discovered during an interview that UPLB was developing iron-biofortified rice using traditional breeding techniques. During a workshop, I was introduced to a nonprofit that developed centralized kitchens to provide school meals, which starkly contrasted with the approach based on school gardening. This landscape of

solutions constantly reminded me of how ordinary these five projects were and pushed me to pay more attention to the "soil" – in Foucault's term – that allowed these five and much more projects to coexist. Meanwhile, I also put each of these five projects in the landscape of agrifood innovations to evaluate the particular positioning of these projects and assess what more inquiries to pursue while collecting data.

The flourishing of agrifood innovations for improving nutrition demonstrated why the Philippines could be where we gain the most insight into the issue in this research. Since the beginning of the twentieth century, the Philippines has been a site of nutrition and agricultural interventions directed by the government and development agencies. These interventions have made the Philippines one of the local hubs of the international development field. The Philippines houses the headquarters of the Asian Development Bank (ADB), the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), and regional and local branches of several international agencies. It also accommodates the International Rice Research Institute (IRRI), founded by the Rockefeller Foundation and known to be the leading promoter of the Green Revolution in Asia in the 1960s. Even nowadays, because of IRRI and SEARCA, agricultural development in the Philippines frequently serves as an experimental site for Southeast Asia and the entire world. This includes two agricultural innovations I study in the dissertation – the School Gardening project by SEARCA and the Golden Rice Project by IRRI.

When IRRI developed their hybrid rice variety as a part of the Green Revolution, two distinct approaches to agricultural development emerged in the Philippines – one relying on agri-biotechnology facilitated by the government and IRRI; the other characterized by the resistance of conventional agriculture and the alternative focus on organic farming promoted by local farmer organizations (Frossard 2002; Bachman, Cruzada, and Wright 2009; Medina 2002). Since the government passed the Organic Agriculture Act in 2010, some scholars argue that the national agricultural development in the Philippines is standing at the intersection between agri-bioengineering and organic agriculture.

Besides agricultural development, the Philippines has the most active governmental regulations for nutrition in Southeast Asia. As early as 1947, right after WWII and their national independence from the U.S. occupation, the Philippine government established the Institute of Nutrition to collect information regarding malnutrition to devise solutions. The institute was later renamed the Food and Nutrition Research Institute (FNRI) and has remained the primary national research center that utilizes food technology to develop nutritional innovations. Furthermore, FNRI is also responsible for conducting regular national nutritional surveys since the 1970s and just released the results from the 8th National Nutritional Survey in 2018. The 1970s also saw the paradigm shift toward multisectoral nutrition governance in the international development field. The Philippines was recognized as the model by the U.S. and the international nutrition community (Field 1987; Engel and Arnold 1979). With the United States

Agency for International Development's (USAID) facilitation, the Philippine government established a centralized agency, the National Nutrition Council (NNC), to oversee nutrition policies. Even after entering the 21st century, the Philippines has maintained the most extensive regulation and facilitation of food fortification in Southeast Asia, as evidenced by the enactment of the Food Fortification Act in 2000.

Meanwhile, what has been changing is the types of malnutrition prevalent in the Philippines over time – the process that nutritionists conceptualize as "nutrition transition" (Lipoeto, Lin, and Angeles-Agdeppa 2013). Based on different editions of the National Nutrition Survey in recent years, currently, while there is still a significant proportion of malnourished children chronically and accurately, more adults appear to be overweight in the statistical data, particularly women. The themes of the annual National Nutrition Month (NNM), which usually indicate the focus of the nutrition community and the government during that year, also reflect the government's ever-changing attention to different types of malnutrition (See Appendix 2 for the list of themes since 1976). For example, in 2015, the theme of the NNM was "Correct weight through right nutrition and exercise," while in 2016, it was "Nurture your baby's first 1000 days for a healthy future." To some extent, the co-presence of different types of malnutrition underlines the challenge for nutritional policymaking to address all of them simultaneously.

All these contexts – multiple forms of malnutrition and diverse pathways of agricultural development – constitute the background of the five agrifood innovation projects for nutrition in my dissertation research. Consider **the Golden Rice Project**, which was transferred to IRRI by two European scientists in 2000. The project develops a kind of genetically modified (GM) rice, producing more beta-carotene to reduce Vitamin-A deficiency. While this innovation targets a specific micronutrient deficiency, some also positioned it as a milestone for the new era of the biotechnology industry in the Philippines. Also focused on a particular micronutrient, **the Iron Premix Rice Project,** developed by the FNRI in 2010, chose to renovate traditional food fortification techniques and collaborated with the pre-existing milling industry to develop the product. In 2013, the Department of Agriculture launched a national **"BeRICEponsible" campaign** to promote brown rice consumption. Although relying on rice to solve malnutrition, this campaign focuses on consumption and aims to invoke the "responsibility" of consumers to maintain their health and support fellow farmers. In addition to these three rice-based projects, there are also attempts to shift focus away from rice. **The Moringa Industry Development Initiative**, which consisted of different stakeholders in the moringa production process, strives to advocate for the medicinal value of moringa leaves and seeds. Led by the key foundation Moringaling Philippine Foundation Inc, the initiative aims to institutionalize the moringa industry and turn moringa from a backyard tree into value-added projects. Another popular approach to target child malnourishment

could be found in **the SEARCA School plus Home Gardening Project** beginning in 2016. This community-based project aims to connect school gardening to the school feeding program and facilitate home gardening in communities.

As a review of these five innovations suggests, different social groups, from the national government to research centers to private companies, employ different strategies and technologies to develop agrifood innovations for nutrition. Some target a specific type of micronutrient deficiency while others focus on increasing the overall nutritional value of the diet; some implement sophisticated technology while others utilize traditional techniques or multiple kinds of technology. These five agrifood innovation projects all carry long histories of policymaking and connect in various ways. These projects collectively provide a more comprehensive set of agrifood solutions in the Philippines to further explore the relationship between agricultural development and the issue of malnutrition and the problem-solution dynamics (see Table 1 for a detailed comparison).

Table 1: Comparison of Five Agriculture-Based Projects Targeting Malnutrition in the Philippines

	Brown Rice Campaign	School-Plus-Home Gardening	Moringa Industry Development Initiative	Iron-Premix Rice Project	Golden Rice Project
Theory of change	Consumer Education	Education, Increasing direct access	Increasing market-based access	Increasing market-based access	Production of nutritious rice
Type of intervention	Wholegrain consumption	Dietary diversification	Supplementation of whole food	Nutrient fortification	Biofortification

Type of malnutrition addressed	Overweight, micronutrient deficiency	Overweight, micronutrient deficiency	Micronutrient deficiency	Micronutrient deficiency	Micronutrient deficiency
Main promoter	Philippine Rice Research Institute	Southeast Asian Regional Center for Graduate Study and Research in Agriculture	Moringaling Philippines Foundation, Inc.	National Food and Nutrition Research Institute	International Rice Research Institute

Informed by the literatures on problematization and grounded on the puzzle about the coexistence of conflicting agrifood solutions to malnutrition, during my fieldwork, I mainly collected and analyzed data following these three guiding questions:

1) How has each of the five contemporary projects emerged as a solution to certain framings of malnutrition in the present and historically?
2) How did these five projects mobilize epistemic and material resources to develop their innovations and render their projects viable solutions to malnutrition?
3) Along the historical and contemporary formulations of problems and solutions, what *elements* have emerged and accumulated as the "soil" for further development of problems and solutions?

I conducted primary fieldwork in the Philippines from October 2017 to August 2019, including a 5-month stay and eight subsequent trips, ranging from 2-4 weeks each time. The prolonged fieldwork schedule was due to my

unexpected illness and the following medical treatments. Nonetheless, the prolonged schedule also allowed me to track the changes in these projects for a longer time and acquire a deeper understanding of them. Aside from the primary fieldwork period, I also conducted a 6-week pre-dissertation study in 2016 and maintained communication with key figures in all the projects after the primary fieldwork (See Appendix 1 for the details of my fieldwork).

During my stay in the Philippines, I held a position as a visiting research fellow (Sept. 15, 2017 – Aug. 31, 2019) at the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) and as a visiting student at the Agricultural Systems Cluster, College of Agriculture and Food Science, University of Philippines Los Baños (Oct. 15, 2017 – Mar. 31, 2018). These institutional arrangements helped me connect to key stakeholders working on projects in my dissertation research and exposed me to the entire agricultural policymaking arena in the Philippines.

University of Philippines Los Baños (UPLB), the first campus of the UP system, was established in 1909 and specialized in agricultural research. When I did my fieldwork, I was based in Los Baños, a university town in the province of Laguna and a 2-hours drive from Metro Manila. Los Baños is the center of agricultural development in the Philippines. That is why several international and regional agriculture-related agencies are located in Los Baños, including IRRI and

SEARCA. Thus, being based in Los Baños facilitated my connection with different agencies and scholars around the area.

The opportunity to serve as the SEARCA visiting research fellow was another practical reason to be based in Los Baños. I did not have any obligations in SEARCA but was supported by the center with my office and other administrative assistance. Interactions with other SEARCA colleagues, many of whom had agriculture-related degrees, were a great help for me in getting familiar with Philippine life and background knowledge about agriculture and the Philippines. Being affiliated with SEARCA, an intra-governmental agency, making it easier for me to contact different agrifood innovation projects in my research.

My dissertation research process was not linear and straightforward, especially because I studied five projects in one research. I followed or developed several strategies and principles during my fieldwork. I clearly distinguished between my research and other research focusing only on one specific case. I acknowledged that the advantage of my comparative methodology was not in-depth and well-immersed data collection from one particular case but the connections and comparisons across different cases. I followed my research questions and agenda closely to choose and evaluate my collected data. Meanwhile, I also acknowledged that I could not follow the same process to collect the same data for each of the five cases in my research. I learned to gain access in different ways for each project.

I began with projects that seemed to be more accessible and moved to another project once I established connections with the previous project and developed clearer plans for data collection. I usually focused on two to three projects at the same time. Sometimes it was challenging to schedule different events and interviews to line up in my calendar without time conflicts, especially when I traveled back and forth between the Philippines and Taiwan. I did my best to discern and choose the most important events or expert interviews. For the rest of the time – when I was free from events, visits, interviews, or other obligations – I went to different libraries to collect secondary data. Figure 3 shows all the locations I visited to collect data in the Philippines between October 2017 and August 2019.

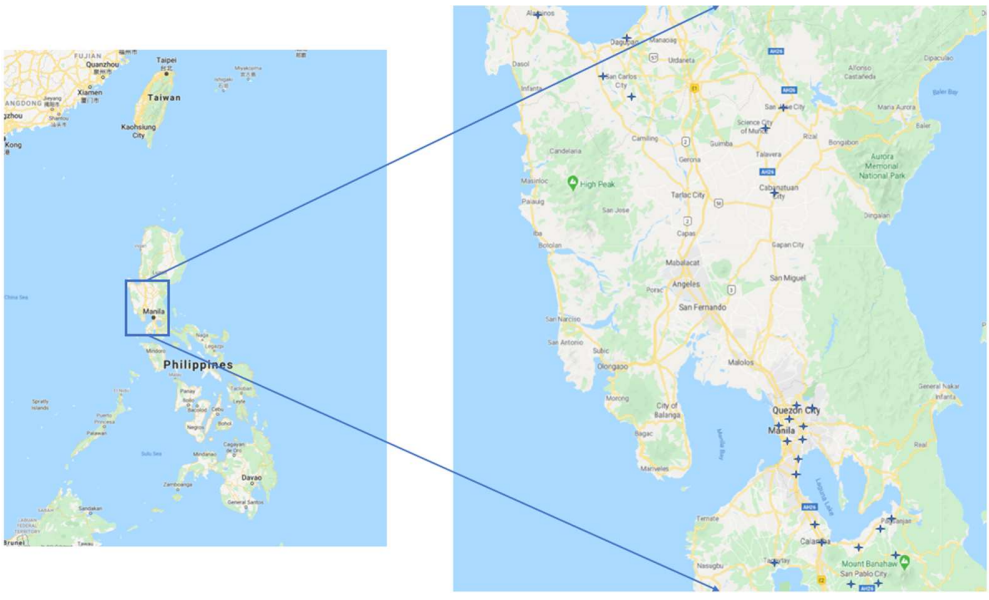

Figure 3: Locations of My Fieldwork in the Philippines (blue stars)

1-4 Chapter Overview

Based on the research agenda, my dissertation has three substantive chapters representing three aspects of analysis in the problem-solution analytical framework. In **Chapter Two**, I point out that the coexistence of multiple agrifood innovations as solutions to malnutrition is not merely a contemporary phenomenon but has existed throughout history. I developed the concept of problem-solution constellation to demonstrate how different agricultural approaches associated with the five projects in my research have reappeared in history multiple times as solutions to malnutrition. My discussion begins with the eruption of beriberi, a disease resulting from Vitamin B1 deficiency in the 1880s. The increase in the intra-Asia rice trade and the importation of white rice precipitated the beriberi eruption in the Asia-Pacific Region. Subsequently, this led to the discovery of Vitamin B1, which helped characterize the new era of modern nutrition science. Various types of agrifood solutions to beriberi also emerged during this period, many of which presented themselves as the prototypes for most agrifood innovations of the contemporary era (Section 1). After World War II and until the end of the 1970s, I argue that a rift existed between the agricultural sector focused on hunger and food production and the nutritional community concentrating on protein deficiency. This dual agenda in the international development field constituted the foundation for various solutions emerging in this period, including crop improvement, brown rice production, school gardening, and planting moringa trees (Section 2). From the

late 1980s until the early 2000s, Micronutrient deficiency re-emerged as the main and overarching focus in the international nutrition community and prompted various innovations to tackle this seemingly new challenge. Nonetheless, many of them were based on similar ideas in previous projects. These innovations included iron-fortified rice, moringa supplementation, brown rice consumption, and breeding for nutrition. What was different at this time was how these agrifood innovations also contributed to various pathways of agricultural development in the Philippines, including agri-biotechnology, organic agriculture, and the expansion of the food industry (Section 3). Beginning in the early 2000s, with the increased attention on obesity and non-communicative diseases in the global south, the challenge for nutritional governance became the question of managing multiple burdens of nutritional deficiency. Meanwhile, agri-biotechnology and organic agriculture gradually emerged in two distinct and opposite directions of agricultural development in the Philippines. These structural conditions in the nutritional and agricultural sectors led to different agrifood innovations, which became the five projects I closely analyze in the next chapter (Section 4).

While these agrifood innovations have been coexisting – some may be more than a century, how do they differ as a solution? In **Chapter Three**, I switch from a longitudinal to a horizontal view and center on the contemporary status of these five projects. I analyze how each agrifood project configured an assemblage that rendered technoscience situated. For the Iron-Premix Rice Project, I argue that the kernel-shaped iron-premix is the key element that brings together the assemblage.

And the key mechanism is to create the *pathway* from the production of iron-premix to the digestion of human bodies (Section 1). For the SEARCA School-plus-Home Gardening Project, the goal is to "ground" the garden in the community. The grounding of the garden was achieved with constant and various *coordination* among different entities, including the SEARCA-UPLB team, the garden, teachers, administrators, parents in the school, village officers, and other community members (Section 2). For the Golden Rice Project, I argue that the key mechanism is the continuous *synchronization* between gene expression and human expectation along the breeding process and over time. I also use this analytical framework to re-interpret the controversies surrounding the Golden Rice Project and why it could not achieve its success earlier (Section 3). The government-backed BeRICEponsible Campaign operates on a rather different scale; all the efforts are centered on consumers and the public. I argue that the key to the campaign is to transform the public's perception and acceptance of brown rice, and all the efforts and resources are mobilized and arranged accordingly (Section 4). Finally, For the Moringa Industry Development Initiative, the key mechanism that brought together the assemblage is creating and maintaining an idea of a win-win scenario. This meant all the stakeholders involved in developing and promoting this solution should be able to receive profit or benefit, which becomes the basic rule that guides the direction for the development of the Initiative (Section 5).

In **Chapter Four**, I move the focus from the assemblages of each agrifood project to the infrastructural conditions that allow different assemblages to emerge. I highlight three infrastructures embedded in the configuration of all the assemblages. The first is epistemic infrastructure, which concerns how malnutrition is perceived and understood. I pay specific attention to the role of the National Nutrition Survey for all the projects when they defined the problem of malnutrition they intended to counter. (Section 1). Then, I analyze how each project relied on the research infrastructure to generate knowledge or develop technologies required to build their solution. The research infrastructure included public research centers, universities, and international development agencies or research institutes. They were primarily responsible for developing new science and innovative tools to support policy agendas and solve social problems (Section 2). Finally, I consider the meetings of development actors as the mobilization infrastructure for the development of coexisting agrifood solutions. I distinguish development actors from elites and trusteeship by tracing the historical emergence of different social groups as development actors in the Philippines. I also theorize the importance of meetings of development actors in the development field and point out how problematization, affective facts, and the focus on solutions and actions were key components of the mobilization infrastructure (Section 3).

In my **Concluding Chapter**, I highlight four theoretical and policy contributions. First, I recap the proposed problem-solution analytical framework with my empirical analysis. I assess how this framework may advance STS

scholars' theorization of the dynamics between problems and solutions. Second, I discuss how the problem-solution analytical framework may engage with the debate on "technological fix" and "solutionism" and help reconsider the role of technoscience in the development context. Third, I draw on the empirical discoveries in this dissertation to illuminate the scholarly understanding of the relationship between agricultural development and public health. Finally, I revisit the contemporary policy trend of nutrition-sensitive agriculture in the international development field and contemplate what solutions do not exist within this problem-solution constellation of agriculture-nutrition linkage.

Chapter Two
Historicizing Agrifood Solutions to Malnutrition

Introduction

When I arrived at the University of Philippines Los Baños (UPLB), the first place I wanted to visit was their main library. Illuminatingly, the UBLB library materializes how the UPLB has occupied a central space in the development field for agricultural development. The building of the main library is the former headquarter of SEARCA, a regional development agency focused on agricultural education and policy[17]. SEARCA built a new building not far away from the old one – demonstrating an example of how actors in this development field intermingle with each other. When I finally obtained permission to use the library, my first impression walking down the aisles of bookshelves was that the library had many old texts, including some old conference proceedings and meeting reports. Such reports again demonstrate the trajectory of UPLB's involvement in development practices, especially regarding agricultural development in the Philippines and beyond.

I discovered a book called *Interfaces Between Agriculture, Nutrition, and Food Science*. It is a proceeding of a 1977 workshop held in UPLB. I still remember being surprised when I came across it in the winter of 2017. At that

[17] I was a visiting research fellow in SEARCA during most of my fieldwork period. See Ch1.4 for introduction of SEARCA.

time, I was still pondering the novelty of nutrition-sensitive agriculture in the international development field. The proceeding struck me because the 1977 workshop not only foregrounded agriculture as the solution to malnutrition but also extended attention to agrifood solutions in the postharvest period — that is why "food science" is one of the keywords in the title. The title of the workshop indicated that, forty years ago, this workshop was already focusing on bringing "food science" into the existing landscape of agrifood solutions to malnutrition. Compared to the policy agenda of this 1977 workshop, the current policy trend toward nutrition-sensitive agriculture may seem "backward." Then, I was even more surprised to discover that the workshop was only one in a series of workshops held across the globe in that period from the 1970s to the 1980s. According to the *Series Preface* in the proceeding[18], the United Nations University held a series of workshops based on the recommendations of the Advisory Committee to the World Hunger Programme in 1975. These workshops emphasized the role of agriculture and food science in tackling malnutrition and were held at international agricultural centers across the globe. [19] The

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[18] The old United Nations University website still stores the full text of some proceedings. To access the "Series Preface" that introduces the background of this series of workshops, see https://archive.unu.edu/unupress/unupbooks/80478e/80478E01.htm#Preface

[19] The creation of this series of workshops in the 1970s suggests that it was a wider-spread effort to explore the connections between agriculture, nutrition, and food science in the entire international development field at the time. From a broader perspective, the focus on food science reflected the shifting focus of food security in the 1970s. The World Food Conference of 1974 officially conceptualized "food security" as the main framework to evaluate global hunger. In its early years, the definition of food security expanded to form their focus on food supply and national food balance sheets to the issue of food access (Sen 1981, Reutlinger and van Holst Pellekaan, 1986). The focus on food access brought up the attention on the post-harvesting process of food production. As J.S. Kanwar's Forward in one of the proceedings points out, "all the efforts should be directed to one goal - to make available within easy

juxtaposition of this series of workshops in the 1970s and the trend of nutrition-sensitive agriculture in the 2010s suggests the importance of unveiling the historical trajectories of how agricultural development has been positioned as solutions to malnutrition in multiple historical contexts.

Analyzing the history of agrifood solutions to malnutrition constitutes the first aspect of the problem-solution analytical framework that I develop for this dissertation. This aspect of the analysis centers on tracing the history of coexisting solutions and examining how these coexisting solutions may interact with each other while responding to certain problems. I propose a concept called "problem-solution constellation" to refer to how a set of solutions and corresponding problems connect at a particular time. This concept also speaks to the existing concept of problem-solution coupling in the STS field. Building on Callon's problematization framework, "problem-solution coupling" suggests a direct binding between a formulated problem and its corresponding solution. When scholars employ the concept of problem-solution coupling in their analysis, they usually assume the coupling of a singular solution and a singular problem. By contrast, "problem-solution constellation" foregrounds the coexistence of multiple solutions and does not assume a direct binding between problems and solutions. Instead, with the historical analysis of problem-solution constellation, this chapter aims to show that problems and solutions have histories that need to be

access low-cost nutritious food to the population." For the full text of the Forward, see https://archive.unu.edu/unupress/unupbooks/80478e/80478E01.htm#Foreword

considered to understand how particular solutions and problems connect in a specific historical context.

Based on the five contemporary agrifood projects at the heart of this study, this chapter employs "problem-solution constellation" to retrace the history of agrifood approaches that underpin these five projects. These five approaches include:

- Biofortification — crop breeding to increase nutritional values in crops.
- Fortification — adding particular nutrients to the food during the post-harvesting process.
- Diet diversification with school gardening — increasing physical access to vegetables in schools to increase the consumption of nutrients.
- Wholegrain consumption — consume every part of the staple to increase nutrient consumption.
- Supplementation of nutrients via entire food — use particular nutritious foods to supplement daily nutrition consumption.

Methodologically, I trace these five agrifood approaches over time, examine the problems they were proposed to deal with, and analyze their relationships to other coexisting agrifood solutions. Furthermore, by reviewing the long-term history of the same set of five agrifood approaches, I identify agrifood approaches that do not exist as solutions to malnutrition in a particular historic period and consider the implications. Through this process, I identify four historical periods

when problems of malnutrition and agrifood solutions form particular constellations. Table 2 summarizes the analysis of the entire chapter. I highlight particular problems in these four periods on the table's top rows. Then the following five rows present five agrifood approaches to tackling malnutrition and respective agrifood projects in each historical period. In the final row of the table, I summarize the pattern of the problem-solution constellation in each period.

Table 2: Problem-Solution Constellation in each period

	1880s ~ 1950s	1960s ~ 1980s	1980s ~ 2000s	2000s ~ 2010s
	Beriberi (Vitamin B1 deficiency)	Food self-sufficiency & Protein deficiency	Micronutrient deficiency	Persistence of multiple forms of malnutrition & agricultural development agendas
Biofortification	N/A	- Rice breeding for high protein content	- Golden Rice Project - Rice breeding for high iron content	- Golden Rice Project - Healthy Rice Project
Fortification	- Rice Enrichment Project	N/A	- Fortified Vitamin (FV) Rice Project	- Iron-Premix Rice Project
Diet diversification with school gardening	N/A	- the Green Revolution Campaign (Household and School Gardening)	N/A	- School Gardening program

Wholegrain consumption	- Mandate to return to consuming brown rice	- Mandate to milling 10% of brown rice in each mill	- Asia Rice Foundation's brown rice campaign	- FNRI's brown rice campaign - OXFAM's brown rice campaign - PhilRice's BeRICEponsible Campaign
Supplementation of nutrients via entire food	- Rice bran supplementation - Milk supplementation	- Backyard Moringa production and consumption - Nutribun	- Moringa supplementation in various food - Moringa consumption	- Moringa Industry Development Initiative
Problem-solution constellation	Knowing the Problem through Exploring its Solutions	(De-)Politicized Problems and Solutions	The Singular Problem with Coordinated Solutions	The Persistence of Problems and Solutions

2-1 Knowing the Problem through Exploring its Solutions (the 1880s – 1950s)

When I trace the history of the five agrifood approaches in my research, the origin of two agrifood approaches – brown rice consumption and food fortification – was directly connected with the disease of beriberi in the Philippines. From the perspective of modern nutrition science, beriberi results from vitamin B1 deficiency.[20] From the 1880s to the 1960s, beriberi was consistently ranked among the top five death causes in the Philippines – usually

[20] See Smith (2017) for the interpretation of beriberi from the perspective of other medical systems.

known as the "beriberi epidemic" in the Philippine society – and attracted the governing regimes' attention[21]. The seriousness of the disease was partly due to the unknown cause of beriberi. The group of substances later named "vitamins" remained undiscovered by scientists and nutritionists at the time.

The background of beriberi was why I considered the disease of beriberi a departure from my analysis. The beriberi problem embodied a modern encounter between several issues, including population health, the transformation of the global food system, the breakthrough of modern nutrition science, and the emergence of the prototype of several agrifood solutions to malnutrition. The encounter demonstrated a unique moment when the problem of a particular type of malnutrition – vitamin B deficiency – and multiple agrifood solutions co-emerged. This section traces how understanding vitamin B1 deficiency and exploring agrifood solutions to beriberi went hand in hand and supported each other's development. Among all the factors that gave rise to the beriberi epidemic, "white rice" played a key role in this early problem-solution constellation and shed light on the connections between agricultural development and population health.

[21] From the 1880s to the 1950s, the Philippines were under constant political turmoil and underwent several political regime changes. The Philippine independence movement began its clash with the Spanish colonial government and the Independence war in 1897. With the help of U.S. troops, the Philippines claimed its independence from the Spanish empire in 1898. Soon after, it realized that it had been effectively "sold" to the U.S.; thus, dawning the Philippine-US War. A U.S. colonial government assumed full control of the Philippines around 1901 until its retreat in 1934. Japanese troops then occupied the Philippines for three years, but left brutal remarks. The U.S. took over the Philippines again after WWII and placed the Philippines in a commonwealth status before Philippine independence was gained in 1947.

The beriberi epidemic was closely connected to the increasing popularity of white rice consumption in the Philippines after the 1870s. The transition from brown rice to white rice in the Philippines began during the shift from mercantilism to a free-trade ideology in the 1850s, characterizing the beginning of the first food regime (Friedmann and McMichael 1989). The liberalization of the global food market during the 1850s led to the expansion of the intra-Asia rice trade network. The Spanish colonial government in the Philippines transformed more rice-growing farms into cash crop farms. It then imported rice from other Asian countries to compensate for the loss of local supply and meet the increasing demand owing to population growth (Doeppers 2016). Rice had formerly been exported unpolished. However, in Bangkok, companies began to adopt mechanical milling, thus, establishing the "white rice industry" (Miyata 2006). As a result, more rice was exported as white rice after the 1870s. At the time, the Spanish colonial government in the Philippines also imported white rice instead of brown rice. Aside from the newly industrialized milling machines – which allowed the labor-intensive and costly production of white rice to transform into large-scale production – there were other agronomic advantages of white rice exportation during that period (Smith 2017). For example, white rice had a longer shelf life than brown rice, was lighter-weight, and required less space; thus, white rice was considered more suitable for long-distance shipping. At the same time, the domestic supply of white rice also increased due to the import of steam-powered milling machines. As early as 1871, one-third of the local supply to

Manila was already in the form of white rice (Doeppers 2017, 38). At the end of the nineteenth century, several big steam-powered mills for white rice were set up in the Philippines (Doeppers 2017, 53-57). Ultimately, the rise of rice importation and the adoption of steam-powered milling transformed white rice from an expensive product into a cheap and accessible staple. This marked the beginning of the consumption of white rice in the Philippines, especially among social groups such as wealthy individuals, urban residents, and soldiers (Doeppers 2017, 89-90; Smith 2017, 121).

The increasing popularity of white rice then became the precursor to a beriberi (vitamin B1 deficiency) epidemic. Typically, people began to show symptoms of beriberi after not much more than a month of consuming white rice *only*. Thus, the highest rates of incidence of beriberi were found among particular social groups, including poor urban households without access to food other than cheap white rice, prisoners who could not make their own decisions as to what food to consume, people restricting their diet to only white rice during the cholera epidemic period, infants, and patients recovering from cholera. Arguably, the cholera epidemic of 1882 created the perfect condition for the first eruption of beriberi. As historian Ken De Bevoise points out, "the experience of 1882 illustrates a new conjunction of factors in Philippine life that could for the first time alter diets drastically enough to produce beriberi in its full-blown and fatal forms: urbanization, increasing poverty, cholera, and highly milled rice" (Bevoise 1995, 134). However, even after the cholera epidemic of 1882 and until the

1950s, recurring natural disasters and frequent warfare regarding regime changes unavoidably increased white rice importation and inadvertently exacerbated incidences of beriberi.

Although I describe the history above linearly, what caused beriberi remained a puzzle for medical professionals and the governing regime of the Philippines until the early 1900s. The alleged breakthrough came when a Dutch physician discovered that white rice-fed chicken could be sick compared to brown rice-fed ones (Carpenter 2003). The pursuit of the cause of beriberi had two important impacts on modern nutrition science. Organizationally, the disease contributed to the formation of the nutrition community in the Asia-Pacific region. As history shows, military powers were dominant in this period. U.S. Army troops took the lead in investigating the cause of beriberi. It held conferences on beriberi and invited other colonial powers in the Asia-Pacific region to join the discussion (Carpenter 2000). These conferences contributed to the early organizing of the international nutrition community. Epistemically, the disease led to the discovery of a chemical compound in the human body called vitamin B1. The discovery inspired studies and discoveries of "vitamins" as a new group of substances in food and characterized the beginning of the "vitamin era" of modern nutrition science around the 1930s. (Carpenter 2003).

During the period when nutritional disciplines came to understand the disease through white rice, white rice also served as the problem that led to related

solutions when scientists, governments, and local communities began exploring and developing “cures” that target distinct social groups (Smith 2017).

The seemingly most straightforward method would be to resume brown rice consumption. This was the measure taken by various institutions when beriberi broke out. The U.S. Army tried to ban white rice for Filipino troops but encountered huge resistance from soldiers. After Philippine independence from the U.S. in 1947, the Philippine Army made another attempt to mandate that soldiers consume brown rice but gave up after encountering a strong backlash. One particular reason for the failure in both attempts was the bad quality of brown rice produced from the manual-milling process. Based on the same rationale, the U.S. colonial government in the Philippines also attempted to reduce the import of white rice. Eventually, it gave up because, at the time, the milling machines for white rice were already introduced to the Philippines.

Increasing brown rice consumption was not the only solution. Another notable agrifood solution to fix the problem resulting from white rice consumption was a new technology that could coat synthetic Thiamine (vitamin B1) onto polished rice after the milling process. The U.S. chemist Robert Williams developed the technology. He also facilitated the pilot study of thiamine-fortified rice consumption in the Bataan region of the Philippines – famously known as the Bataan Experiment (Aalsmeer et al. 1954; Hardy 1995). In 1952, the Philippine

government passed the “Rice Enrichment Act” (Republic Act No. 832), which mandated that all mills produce thiamine-fortified white rice.

Besides resuming brown rice consumption or the new technology that coats rice with Thiamine, supplementing white rice with certain nutritious foods in the diet was also an implemented approach. One important example came from a Catholic group called the Gota de Leche, organized by women’s clubs, scientists, and governmental officials. Gota de Leche’s main target was infant beriberi, locally known as “taon.” This group of social elites organized a community network to deliver cow’s milk to households with infants. Then, they also promoted dietary supplementation with rice bran, the byproduct of white rice milling[22] (Ventura 2019, Neelakantan 2021). Intriguingly, rice bran not only served as a source of food supplementation to deal with beriberi, but its extract also became the basis of Tiki-tiki, a kind of pharmaceutical for beriberi developed by the Filipino pharmacist Manuel A. Zamora. Tiki-tiki was acclaimed as a national medicine and was eventually produced by the Philippine government and distributed to affected households by the Gota de Leche and other organizations (Ventura 2019; Scheffler 2019). This early example demonstrated the blurred boundary between supplementation with nutritious food and using particular food as a medicine-like substance. This tendency resonated with the discussion of

[22] http://gotadeleche.ph/timeline/. Access date: 06/07/2021

"superfood" and foresaw the trajectory of moringa development almost a century later.

Although the government or related social groups developed these solutions, there existed clear tension between these solutions. One particularly illuminating contention was between promoting brown rice consumption and the Rice Enrichment Project. The tension mainly existed between the Philippine nutritional community and military leaders, as documented in a commentary published in the *Nutrition News* in 1957. The commentary shows the full support of the Philippine nutrition community for enriched rice as the leading solution to the beriberi epidemic. Meanwhile, it also mentions a military official's failed attempt to mandate all the troops to consume pinawa (brown rice) instead. The commentary reiterates that brown rice could not be a solution due to cultural and technical issues involved and suggests that this military official's experiment "should end once and for all with the definitive impact the issue between pinawa and enriched rice for our people's nutritionally better staple cereal" (Nutrition News 1957:6). This commentary asserts the impossibility of promoting brown rice consumption as the means to solving the disease of beriberi and, arguably, marks the end of commercialized brown rice production and consumption in the Philippines.

Another more profound tension was between the Rice Enrichment Project and structural and education-based approaches. After Williams finished the pilot study of the Rice Enrichment Project, the Philippine government invited two advisors

from FAO and WHO, respectively, to evaluate the results and provide policy recommendations. Although affirming the Rice Enrichment Project's success in their report, these advisors expressed their concerns over large-scale adoptions of the technology in other beriberi-impacted countries (Aalsmeer et al. 1954). Their assessment was countered by the then-health secretary of the Philippines, who pointed out that the educational campaign that existed long before the Rice Enrichment Project did not effectively lower the rate of beriberi and, thus, supported the national implementation of the rice coating technology. Historian Anne Hardy (1995) argues that the tension surrounding the rice-coating technology was a part of the contention between the structural approach and the tendency to rely on technical solutions during the post-WWII international development field. To some extent, this tension remains relevant today when scholars or activists frequently uphold nutrition education aiming for behavioral change to counter technology-centered solutions. I will provide a full-length analysis of this issue in the next chapter.

Among the five approaches I center on, rice breeding (biofortification) and school gardening did not emerge as potential solutions to beriberi in this period. However, it does not mean that these approaches did not exist at the time. On the contrary, rice breeding and school gardening were active policy programs during the beriberi-epidemic period. After the U.S. took over the Philippines from Spain, they began to set up agricultural experimentation stations across the Philippines. Some of them were tasked to concentrate on rice research, including analyzing

rice varieties and developing new ones. Nonetheless, rice breeding for nutrition in general, or Vitamin B1 specifically, was not their research focus.[23] Similarly, as early as 1907, the U.S. colonial government explored the idea of creating gardens in public schools. In 1913, the Bureau of Education published *School and Home Gardening for Use in Primary Grades* to provide thorough instruction on constructing and maintaining school gardens. However, the focus was not on providing nutritious food to supplement students' dietary consumption but on providing agricultural training because "children must be led to recognize the dignity of manual labor" (the Bureau of Education 1913:7). The example of these two agrifood non-solutions demonstrate that the framing of problems did not assume specific corresponding solutions. The point becomes even clearer in my analysis of the problem-solution constellations in the following periods when rice breeding and school gardening emerged as potential solutions for similar problems of malnutrition.

The analysis in this section highlights several key points I will continue exploring in the following sections. First, the analysis exemplifies a particular pattern of the problem-solution constellation when the search for the nature of the problem is entangled with the exploration of solutions. The formation of this problem-solution constellation involved the disappearance of brown rice as the main food staple, the subsequent eruption of beriberi in the Philippines, and

[23] The conclusion is based on my review of the Philippine Bureau of Agriculture's official publications, including *the Annual Report of the Philippine Commission*, *the Philippines Agricultural Review*, and the *Press Bulletin*.

various solutions developed to address the beriberi epidemic. Second, the analysis highlights that these agrifood solutions coexisted and interacted with each other. The best example from this section's analysis would be the competition between the promotion of brown rice consumption and the Rice Enrichment Project. Third, the analysis unveils non-solutions, which refer to agrifood projects that existed, such as rice breeding or school gardening, but was not considered solutions to the problem of vitamin B1 deficiency by the governing regime at the time. Finally, all the agrifood solutions to malnutrition were embedded in and conditioned by the status of agricultural development. For example, the Rice Enrichment Act was not fully implemented in the Philippines because of the backlash from the rice milling industry, which the national government did not fully control. The entanglement between the problem of malnutrition and agricultural development becomes even more salient in the following historical periods.

2-2 (De-)Politicized Problems and Solutions (the 1960s – 1980s)

After the beriberi epidemic, four of five agrifood approaches that I traced throughout history (re-)emerged from the late 1960s to the late 1970s, constituting the second historic period of the problem-solution constellation. Agrifood solutions that emerged based on these four approaches responded to two distinct yet related problems. One was how to achieve national food self-sufficiency; the other was how to strengthen nutrition governance to address protein and energy

deficiency. Fundamentally, the pattern of the problem-solution constellation in this period was strongly shaped by global and local political conditions.

On the global level, the agricultural sector and the nutrition community were focused on two different issues. For the agricultural sector, the key issue was food supply shortage and its consequence of hunger and famine. In Asia, the concern over hunger was closely intertwined with the Cold War, especially the status of the entire Asia-Pacific region as the frontier against communist invasions. The U.S. and the development agencies believed that hungry people were easily attracted to join the communist revolution (Nally and Taylor 2015). Based on this assumption, the focus of the Asian agricultural development during the 1960s and 1970s was predominately overshadowed by promoting high-yielding rice varieties to rapidly increase rice production – the so-called "Asia Green Revolution" (Perkins 1997).

In contrast, the international nutrition community mainly centered on protein deficiency from the 1950s until the mid-1970s (Carpenter 1994). The UN established the Protein Advisory Group in 1955 to advise UN-related organizations on developing "protein-rich food programs" (Semba 2016). In the late 1960s, the "protein gap" framing became predominant across the international nutrition community. In response, the UN issued a policy termed "International Action to Avert the Impending Protein Crisis" to respond to the "protein gap," followed by other international agencies' separate actions.

Although scholars began to challenge the seriousness of protein deficiency as a global problem in the 1970s[24], "protein and energy deficiency" remained an important type of malnutrition until today.

Judging from the different focuses of the global agricultural sector and nutrition communities, it was clear that promoting high-yielding variety (HYV) seeds in the agricultural sector was not a useful solution to the nutrition community's concern over protein deficiency. They were two separate problems that coexisted in the international development field. Nonetheless, the Philippine government transformed these two separate problems into two inter-related agendas on the domestic level.

The most critical political context in the Philippines at the time was the rise of the Marcos regime and its authoritarian governance. Ferdinand Marcos became the Philippines president in 1965 and brought the Philippines under martial law in 1972 – what he termed the "New Society." The Marcos regime ended in 1986 when the U.S. government stopped its support of Marcos, and he was forced out of the Philippines after the People Power Revolution. Briefly speaking, the operation of the Marcos regime was intertwined with the Philippines' status as the frontline against Communist China, which partly guaranteed the significant presence of the USAID in the Philippines. This political context also constituted a

[24] Indeed, all these international actions regarding protein deficiency were so dominant that, when the singular and narrow focus of protein deficiency received backlash later, some nutritionists started referring to it as "the great protein fiasco" (Mclaren 1974).

unique problem-solution constellation with two inter-related problems and corresponding agrifood solutions.

The first problem was how to achieve food self-sufficiency, and it was under this context the promotion of the HYV seeds became one important tool. Yet, the so-called Green Revolution was not a self-evidenced result of its invention. Although then-president Ferdinand Marcos had announced the beginning of the "Rice Revolution" in 1966 when the development of the HYV seeds was completed, what facilitated the progress of the so-called "Green Revolution" was a series of incidents in the Philippines during the early 1970s, including the food shortage crisis of 1971-1972 and the transition into an authoritarian regime led by Marcos in 1972. Soon after, in 1973, Marcos launched the Masagana 99 program, which aimed to achieve rice self-sufficiency with the support of HYV seeds and other corresponding policies and infrastructure-building[25]. To be clear, what was known as the "Green Revolution" internationally mainly corresponded to the Masagana 99 program in the Philippines. The term "Green Revolution" had another meaning during the same period that I will bring up shortly.

The second problem was how to strengthen nutrition governance to address malnutrition in general and protein-energy deficiency in particular. The international nutrition academia recognized the Philippines as one of the most committed countries to adopting the multisectoral nutrition planning (MNP)

[25] See the *Philippine Farmers' Journal*, Volume XV, No. 1, 1973, P.27.

model[26] (Field 1987; Engel and Arnold 1979). The Marcos government made several policy changes during the 1970s to implement the MNP model. In 1971, Marcos authorized "the National Food and Agriculture Council to include nutrition coordination in its food production program." In 1974, he announced the Nutrition Act of the Philippines to acknowledge that "the nutrition program, being concerned with human resource development, is a vital and integral part of social reform and economic development.[27]"

The Marcos government's implementation of the MNP revealed its tendency to depoliticize social reforms. As nutritionist John Osgood Field (1987) argued in his review and evaluation of MNP, most countries adopting MNP at that period were conservative or authoritarian countries. He suggested that Marcos adopted MNP to use it "as a low-cost, symbolically pleasing alternative to a failed land reform (p.23)." Several nutritionists criticized MNP as depoliticizing the causes of malnutrition and having a "conservative bias" (Hakim and Solimano 1976:253). As Peter Hakim and Giorgio Solimano elaborate, "the causes of malnutrition are found primarily among the malnourished, and not in the social order in which

[26] Since the end of the 1960s, leading by UNICEF and other agencies, nutritionists began to argue for the connection between the issue of malnutrition and economic development (Berg 1973; Scrimshaw and Wallerstein 1982). This new perspective of nutrition planning indicates that addressing the issue of nutrition could contribute to national development in general. It is also advocacy to prioritize nutrition as the center in every sector in the government. Finally, it also underscores that the issue of malnutrition could only be solved with efforts from all sectors of the government.

[27] Based on this rationale, the Act has three main components: 1) declaring "that nutrition is now a priority of the government to be implemented by all branches of the government in an integrated fashion;" 2) creating a new agency called the National Nutrition Council to coordinate all the nutrition-related policies; 3) beginning to make multiple-year and integrative "Philippines Nutrition and Food Program."

they live." Field further underscores that "nutrition planning became attractive to conservative governments anxious to accommodate international benefactors without having to accept more fundamental reforms (Field 1987:24)."

The global and domestic political context underpinned the dual agendas of achieving food self-sufficiency and forging nutrition governance. It also facilitated the formulation of various agrifood solutions in the Philippines, all of which had clear political implications and considerations.

The first agrifood solution was an initiative called "the Green Revolution Program[28]," aiming to increase vegetable production in backyards and schools. The then-First Lady Imelda Marcos spearheaded the Green Revolution Program in 1971 as the parallel program to the rice production initiative Masagana 99 program.[29] Figure 4 is an iconic advertisement about the Green Revolution Program at the time. While the company Planters Product was promoting its toolkits for vegetable gardening, its main appeal was to "get involved in the Green Revolution Project of the First Lady, Mrs. Imelda Romualdez Marcos." According to the government document, up to the end of 1978, the program facilitated school food gardens in around 22,000 elementary and agricultural

[28] This terminology requires some clarification. While the international development field usually uses "Green Revolution" to refer to the effort to increase rice production with HYV seeds, the typical name for the promotion of HYV rice in the Philippines was "Rice Revolution" of 1966 and the Masagana 99 program. By contrast, in the Philippines, the "Green Revolution Program" usually refers to the initiative promoting vegetable production.

[29] The Green Revolution Program was expanded from the Home Garden Movement of 1967 and updated to focus on public and private schools.

schools[30]. Figure 5 and Figure 6 are two magazine articles published at the time. These two articles report on the Green Revolution Program in two schools in different provinces and demonstrate how the program upheld teachers and students as the pioneers of this nationwide gardening movement.

Like the Masagana 99 program, its primary goal was to increase food production to achieve food self-sufficiency,[31] but it gradually expanded its foci. After the Philippines lost its Taiwanese provider of vegetable seeds due to geopolitical changes, the Philippine government even expected public schools to step up and become seedling growers in each community (Quiban and Chrisanto 1974). Then, as a paper published in 1974 details, the Green Revolution Program was not only incorporated into the everyday activities of public schools, but it also became "a part of the total educational process" (Quiban and Chrisanto 1974: 34). More importantly, as the Marcos government began to establish the multisectoral approach to nutrition governance, the goal to address the issue of malnutrition had become more noticeable for the Green Revolution Program. For example, Figure 7 belongs to a special issue promoting the Green Revolution Program published in the *Philippines Farmers' Journal*, the official publication of the Chamber of Agriculture and Natural Resources. It lists all kinds of nutrients vegetables could

30 *Philippine Development Report* 1978, P.123.
31 See *Philippine Farmers' Journal*, Volume XV, No.8, 1973, P. 7.

provide to the body, indicating the importance of producing and consuming vegetables.

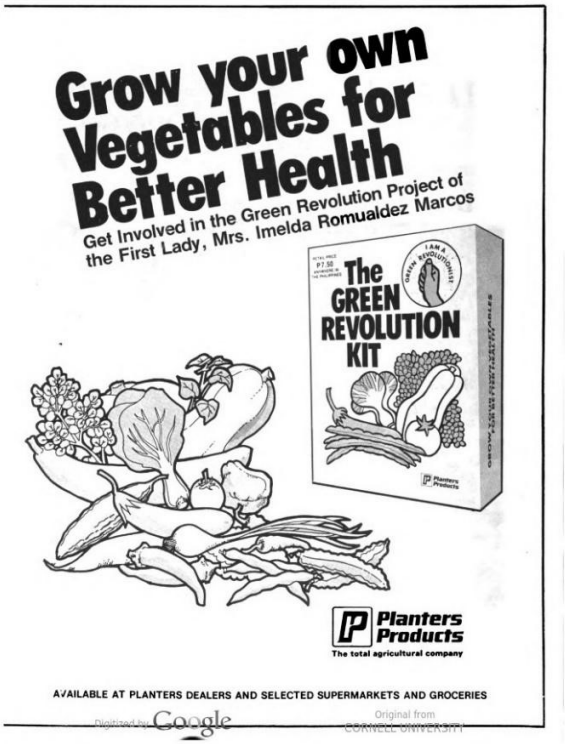

Figure 4: The advertisement in a magazine promoting toolkits for vegetable gardening[32]

[32] The packaging of the toolkit prints "The Green Revolution Kit." See *Philippine Farmers' Journal*, Volume XVI, No. 11, 1974

GREEN REVOLUTION IN NEGROS

Students Show The Way

The province-wide vegetable and root crop production program in Negros Occidental has been going on since the launching of the First Lady's "Green Revolution" project last year.

Several communities, schools, city and municipal governments throughout the province conducted their own contests to further boost the interest of Negrenses in food production.

The provincial government conducted a massive root crops campaign among rural and urban folks encouraging them to utilize every portion of idle areas in their backyards or adjoining lots designed to augment the food requirements of Negrenses.

A two-hectare lot was set aside in front of the Bureau of Agricultural Extension Building for the sweet potato pilot area where nearby communities could obtain cuttings for their own backyard planting.

Student volunteers from the Negros Occidental Provincial Community College, Negros Institute of Technology, La Consolacion College, and University of Negros Occidental Recoleto took turns cultivating and planting sweet potatoes on the provincial nursery and the pilot food garden. ROTC cadets from the above schools also spent their training periods clearing the area and digging canals for the project.

The Division Superintendent of Schools has directed all district supervisors, school principals and teachers to repossess leased portions of their school sites for planting to root crops like sweet potato, cassava, ubi, gabi, and such crops like corn, banana, papaya and others.

Public and private schools also require students to bring along sweet potato cuttings for distribution to communities and areas where these are most needed.

Several barrios and sitios have adopted an extensive root crops program. Among such places are Barrio Villamonte in Bacolod City where almost all vacant lots have been converted into lush vegetable gardens with flowering corn plantations, sweet potatoes and other crops. Other areas like Silay City, E. B. Magalona, and Bago City have utilized the vacant spaces along the highways for root crops. These projects have given the residents along these areas added income and more nutritious food for their dining tables. ■

Negros Occidental student volunteers cultivate garden for cassava, gabi, and other crops like banana.

College students don't seem to mind the heat when they are planting sweet potatoes in their garden.

Figure 5: A magazine article on the Green Revolution Campaign in the Negros island's schools[33]

HAPPY FACES in front of Sto. Niño Elementary School at Marikina, Rizal, belong to members of the GR '72 Evaluation Committee, shown above with Ramon G. Asuncion, Jr., Practical Art Supervisor of the Rizal Division Public Schools.

Rizal Teachers Show The Way

Furthermore, the Division's 5-Year Program (1970-75) was planned with the involvement of parents and community leaders. The yearly schedule aimed at practical goals:

1970-71 — Orient, train Agricultural arts teachers and school personnel on Green Revolution objectives and methods. Established seed banks (Phase I).

1971-72 — Gear the schools to act as centers of the campaign in the community (Phase II).

1972-73 — Involve all sectors of the community in all out production of vegetables, poultry and livestock, even fish (Phase III).

1973-74 — Introduce concepts of income and savings. Translate the meaning of increased production and abundant life to schools, home and community (Phase IV).

1974-75 — Follow up with food processing and marketing processes. Introduce the concept of cooperatives in schools, home and community (Phase V).

Practical-minded Rizaleños organized "RISETA", (Rizal Secondary and Elementary Teachers of Agriculture) to serve as machinery to oversee the program. Retired Eulogio Rodriguez Elementary School agricultural arts teacher, Mr. Gavino Trono was persuaded to become first president. ■

Vegetables and animals projects go together. Santiago Syjuco Elementary School, Malabon proves it with this poultry project.

Figure 6: A magazine article reporting the Green Revolution Program in a school[34]

33 *Philippine Farmers' Journal*, Volume XV, No. 9, 1973, P.17.
34 *Philippine Farmers' Journal*, Volume XV, No. 8, 1973, P.26.

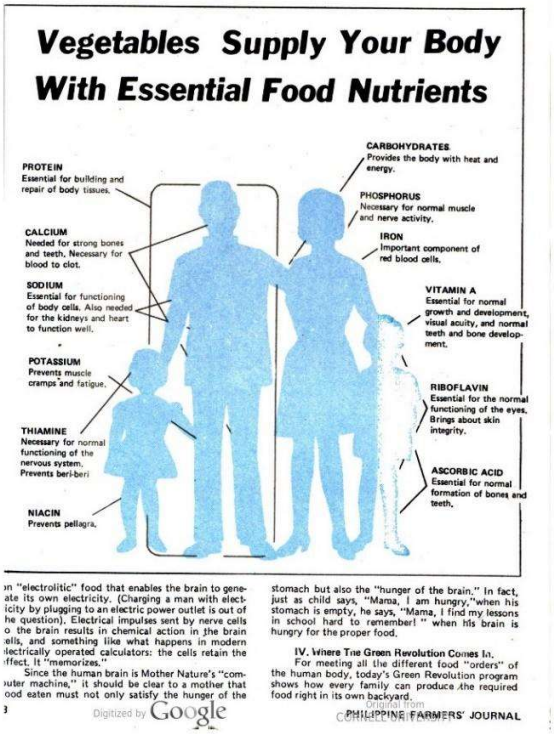

Figure 7: A magazine article listing the nutritional benefits of vegetables[35]

Supplementing food to one's diet was another popular and depoliticized approach to address malnutrition in the 1970s. Arguably, the most famous project was "nutribun," a kind of bread that contains key ingredients to make it more nutritious and was distributed to schools to supplement school children's diet. The bread was originally made with wheat donated by the U.S. and developed with the technical support of USAID (Engel and Arnold 1979). Later, intending to source raw materials locally and address protein deficiency, the Philippine government

[35] *Philippine Farmers' Journal*, Volume XVI, No. 11, 1974, P.26.

adjusted the ingredients, such as using bananas to increase protein consumption. Several governmental projects also promoted planting vegetables in the backyard and supplementing them in diets. For example, during an interview with the *Philippine Farmers' Journal*, the chairman of the executive committee of the Green Revolution Program, R. Binimira, mentioned, "I'd like our people to plan nutritious plants like malunggay [moringa], papaya, and bananas.[36]" Similarly, another project called KMPS (Kadyos-Papaya-Malunggay-Siguidillas) also targeted four nutritious vegetables for household food production.[37] Facilitated by these projects, "[e]at more malunggay (moringa)[38]" seemed to be one of the government's suggested solutions to malnutrition.

The third and unexpected solution implemented by the government was brown rice production. In 1975, the Philippine government announced the National Grains Authority Act, which mandates all rice millers to produce only second-class rice (under-milled rice) — the quality between brown rice and white rice — instead of white rice (over-milled rice). The rationale was to maintain the rice supply because under-milled rice has a 69 percent recovery rate than white rice's 61 percent recovery rate (Roxas, Loyola, and Reyes 1978). In 1977, President Ferdinand Marcos further announced the Presidential Decree (P.D.) No.1211,

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36 *Philippine Farmers' Journal*, Volume XVII, No. 7, 1975, P.8.

37 See *the 1978 Philippine Development Report*, P.123.

38 This is the title of an ariticle promoting moringa consumption published in *the Philippine Farmers' Journal*. As the article says, the FNRI "recommends fresh, dark green leaves and young, tender pods when cooking malunggay. They taste better and are more nutritious." The article also provides moringa cooking recipes. See *the Philippine Farmers' Journal*, Volume XIX, No. 12, 1977, P.36.

mandating all mills to produce at least 10 percent brown rice (Official Gazette 1977). The rationale behind this policy was documented in the USAID report (Engel and Arnold 1979):

> In the fall of 1977, when the NNC had called upon FAO for technical advisory services in the food and agriculture area, initial plans were developed for a more specific focus on the food program. Working groups were appointed to begin to examine the nutritional implications of food policies, including policy directives relating to production, processing, marketing, as well as import-export policies relating to food commodities. One national policy decision had been advanced with nutritional implications, namely, the milling of brown rice (minimum milling) instead of white rice so as to conserve quantity, as well to improve the protein level. (62)

As the USAID report explains, the policy of mandatory milling of brown rice spoke to the dual agenda. "Conserving quantity" could contribute to food self-sufficiency, while "improving the protein level" could address protein deficiency.

Finally, following the presumed success of the HYV seeds that dramatically increased rice production (under certain conditions), one rational extension would be to replicate and advance this success by developing high-protein rice varieties. In 1971, an influential nutritionist, Charles Glen King, wrote a commentary titled

"Protein foods: second stage in the green revolution" in *Nutrition Review*, an academic journal serving as the communication channel for nutritionists globally (King 1971). As King says, "there was unanimous agreement that the kind of intensive agricultural research that proved so successful in accomplishing the 'green revolution' in cereal production must be developed with great urgency through the next 5 to 10 years for increased quantities and quality of protein foods" (King 1971:1301). And this was what the International Rice Research Institute pursued after successfully developing HYV seeds. Around 1966, IRRI began a project focused on breeding for increased protein content (Beachell et al. 1972). Initially, IRRI tried to crossbreed HYV-IR8 with eight other high-protein rice varieties. But eventually, IRRI encountered various challenges, and the project failed to go through. According to their reflection, one challenge was the environmental variability, which indicates that the experimental rice was sensitive to diverse growing environments and difficult for breeders to ensure that rice could have enough protein and yield in all environments. The other challenge was an inevitable trade-off between protein content and yield performance (Juliano 1983).

For all the five agrifood approaches I trace in this chapter, the only agrifood approach that did not emerge as a potential solution was food fortification of micronutrients, although the government supported the Rice Enrichment Project (rice fortification of vitamin B1) just a decade ago. To some extent, the nonexistence of food fortification may further interrogate the "problem" that the

Philippine government deemed important at the time. Although the government and the Philippine nutrition community were aware of deficiencies in certain micronutrients such as vitamin A or iron and mentioned these problems in their Green Revolution Program, the Marcos regime may not consider these deficiencies the central *problem* to address politically. Thus, food fortification of certain micronutrients did not emerge as a viable solution[39]. Yet, it is worth noting that, since the late 1970s, the Philippine government and scholars have started working on food fortification projects. One early project was based on the collaboration between the then-director of the National Nutrition Council and U.S. scholars from Cornell University's international nutrition program. They carried out a project in the south of the Philippines that began to rekindle the interest in food fortification as a solution to vitamin A deficiency (Solon et al. 1979). I see the project as the transitional moment from this historic period focused on the dual issue of food self-sufficiency and nutrition governance to the next historic period when micronutrient deficiency rose to become the predominant focus.

This section demonstrates that global and domestic political influences shaped the problem-solution constellation in this period. The political rationale brought various agrifood solutions such as school gardening, brown rice production, food

[39] From a broader perspective, the nonexistence of food fortification may also be influenced by the global trend at the time. The series of workshops regarding interfaces between agriculture, nutrition, and food science that I mentioned at the beginning of this chapter did not include food fortification as a topic in their workshops either.

supplementation, and rice breeding into the policy agenda. Meanwhile, the list of potential agrifood solutions expanded to include school gardening and crop breeding, while the agrifood approach of food fortification became a non-solution in this period. Alongside the expansion of agrifood solutions was the increasing involvement of international development agencies and research centers that contributed to developing certain agrifood solutions — what I term the "research infrastructure" underlying the problem-solution constellation. Chapter Four provides a detailed analysis of the research infrastructure and other infrastructures supporting the coexistence of conflicting agrifood solutions.

2-3 The Singular Problem with Coordinated Solutions (the 1990s – 2000s)

Four of the five agrifood approaches I followed re-appeared from the early 1990s to the early 2000s to address micronutrient deficiency. Influenced by the "micronutrient turn" and the popular discourse on hidden hunger across the globe (Allen 2000), "micronutrient deficiency" dominated the policy direction for developing interventions during this period (National Nutrition Council 1992). As a result, various agrifood innovation projects emerged, primarily focused on increasing micronutrient access for certain social groups. The problem-solution constellation demonstrated coordinated efforts that brought certain agrifood solutions together while other agrifood solutions did not exist or sat at the margin.

Another important aspect is that agrifood solutions coexisting in this period demonstrated clear connections to diverse pathways of agricultural development in the Philippines.

As I mentioned at the end of the last section, long before the micronutrient turn was in full bloom in the 1990s, the Philippine government and the nutrition community noticed micronutrient deficiency issues and worked on them. For the Philippine nutrition community, the beriberi epidemic was not yet a forgotten memory, and they also paid attention to other micronutrient deficiencies, especially iron and Vitamin A. From 1980 to 1982, Filipino nutritionists launched a "Coordinated Research Program for the Control of Nutritional Anemia in the Philippines" organized through an inter-agency task force. They primarily studied two specific approaches to tackling iron deficiency – fortification and supplementation. The research developed the technical process of fortifying rice with iron and evaluating the efficacy and bioavailability of iron-fortified rice.[40] Meanwhile, following the emerging global awareness of vitamin A deficiency in the 1970s (Sommers 2008), Filipino scholars also began to study the prevalence of vitamin A deficiency in the late 1970s (Solon et al. 1979).

However, not until the 1990s, with international influence, did the issue of micronutrient deficiency become the central issue for the Philippine government,

[40] See the official report of the program, *The Coordinated Research Program for the Control of Nutritional Anemia in the Philippines*, published by the National Nutrition Center.

the nutrition community, and the public. As *the 1993-1998 Philippine Plan of Action for Nutrition* (PPAN) indicates, the governmental nutrition policymaking in the late 1980s concentrated on increasing food and water access and health-related interventions. The most comprehensive policy change happened following a series of international meetings during the early 1990s.[41] The World Children Summit of 1990 mainstreamed the issue of micronutrient malnutrition and motivated national governments to foreground the issue. After the Summit, the Philippine government developed *the Philippines Plan of Action for Children* (PPAC) and set eradicating micronutrient deficiency – especially vitamin A, iron, and iodine – as the primary middle-term goal (National Nutrition Council 1992). Supported by the then-President, Fidel V. Ramos, the Philippine government established the National Micronutrient Action Team (NMAT) to coordinate all the interventions. Around this period, the term "hidden hunger" began to appear in the news media to appeal to public attention.[42]

NMAT spearheaded the effort to promote two distinct types of agrifood interventions[43]. The first one was to consume particular vegetables to supplement daily dietary consumption. The team chose three vegetables and incorporated the

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41 These meetings include the World Children Summit of 1990, the Montreal Conference on Ending Hidden Hunger in 1991, and the International Conference on Nutrition of 1992.

42 For example, *the Philippine Daily Inquirer*, one of the main news outlets in the Philippines, published a special report in 1995, titled "Hidden hunger' ravaging children." (PDI 12/26/1995 & PDI 12/27/1995)

43 The NMAT also developed a medical-approach intervention to promote vitamin supplements. The team launched a campaign called Araw ng Sangkap Pinoy (ASAP), meaning to take the nutritional supplement every day.

nutrition education of consuming these vegetables into an initiative to distribute nutritional supplements. The primary vegetable they promoted was moringa because it was familiar to Filipino households, and households usually had easy access to moringa trees in their backyards or neighborhood. Furthermore, NAMT also selected Cagayan de Oro City, located in the northern Mindanao of the Philippines, to implement a social marketing study. In this social marketing study, scholars implemented two types of strategies – media and interpersonal promotion – to promote the consumption and household production of moringa and two other vegetables.[44]

Meanwhile, NAMT also foregrounded food fortification as a key strategy to improve micronutrient deficiency. NMAT picked up the research results in the 1980s and commercialized iron-fortified rice. They called it "FV-Rice," which means Fortified-Vitamin Rice, but also carried an implicit reference to the then-President Fidel V. Ramos to acknowledge his support of NMAT. NMAT conducted a wide range of studies to substantiate the efficacy and acceptance of iron-fortified rice, including a clinical trial of this newly developed FV-Rice and a market evaluation study to evaluate the public's acceptance levels. Beyond rice fortification, the team also began to appeal to food manufacturers to expand the capacity and coverage of food fortification. One famous example was the vitamin A-fortified margarine. The product came from a collaboration between Philippine

[44] See *A Report on the Project – Social Marketing of Malunggay Atbp.*, authored by Florentino S. Solon and Henry R. Briones and published by the National Nutrition Center, 1995.

and U.S. scholars with the manufacturer's support, a U.S.-owned Filipino company[45] (Solon 1998). This example exemplified the importance of the food industry's involvement in the success of food fortification. In addition to traditional fortification, NMAT also explored the possibility of utilizing real food – instead of chemical compounds – as fortificants. For example, a scholar researched how to develop moringa-supplemented dry noodles to improve the nutritional content of the staple food (Abilgos 1996). This example, again, showed how seemingly distinct approaches to malnutrition might converge under a certain rationale of policy direction.

As I mentioned, to further promote food fortification, it would be important to secure the support of the food industry. The government gathered food companies for consultative meetings to convince them to support the idea of fortification. These consultative meetings would elaborate on hidden hunger, showcase new techniques for fortifying food products, and invoke food companies' morality to contribute. In 1995, the Philippine Government also launched the "Sangkap Pinoy Seal" program to facilitate the voluntary labeling of fortified foods. "Sangkap Pinoy Seal" is a label the company could apply for and include in their packaging. Meanwhile, the government also rolled out campaigns encouraging the public to look for these labels when purchasing food. Eventually, the Philippine

[45] The company was called Philippine Manufacturing Company (PMC). PMC was established in 1908 and was acquired by Procter & Gamble (P&G) in 1935. It was because of PMC's tie to P&G that initiated the collaboration to develop vitamin A fortified margarine. At the time, P&G was collaborating with U.S. scholars to promote their fortified products in the U.S. (Solon 1998).

government passed the Food Fortification Act in 2000. The Act requires mandatory fortification of certain foods and encourages voluntary fortification of all food products. Nonetheless, the Act has little impact without the government's strong enforcement. For example, although iron-fortified rice is supposed to be mandatory, it is still rare to find iron-fortified rice on the market.

Outside NMAT's efforts, two groups of development actors in the Philippine development field were tasked to tackle micronutrient deficiency with opposite projects. One was the Asia Rice Foundation's (ARF) promotion of brown rice consumption from 2000 to 2005. Later, this campaign came to be seen as the "modern brown rice revival.[46]" The ARF brown rice campaign was led by the agronomist Dr. Emil Javier, who had retired as the chancellor of the University of the Philippines, and other agricultural and nutritional scholars in the Philippines. These scholars created the brown rice campaign aiming to "reviv[e] a lost health food" (Asia Rice Foundation 2000). In an article titled "Let's Promote Brown Rice to Combat Hidden Hunger" (Javier 2004) and published in IRRI's *Rice Today* magazine, Javier elaborated on why they targeted micronutrient deficiency as the campaign focus:

> Now we must overcome the 'hidden hunger' of the poor for essential vitamins and minerals. As cereals constitute the bulk of the diet of those

[46] Such as a 2014 news article titled "Redeeming the lost glory of brown rice" (*The Philippine Daily Inquirer*, Dec.4, 2014). https://newsinfo.inquirer.net/654234/redeeming-the-lost-glory-of-brown-rice. Access date: 06/07/2021

> who cannot afford micronutrient-rich foods such as meat, milk, fruits, and vegetables, any increase in the vitamin and mineral content of staple grains helps combat this insidious form of malnutrition. (38)

The explanation underlines the campaign's rationale. The campaign recognized the main targeted population as lower-income households whose diets consist primarily of rice. Hence, from its beginning, the campaign focused on changing the cultural image of brown rice[47]. Viewing this "dirty look" as the main challenge for consumers' acceptance of brown rice, the campaign consulted media specialists and devised a unique marketing strategy. During my interview with Javier, he noted how the campaign strategically tapped the emerging "natural food movement[48]." trend in the Philippines, especially in Metro Manila, and positioned brown rice as a new healthy food trend. Furthermore, this campaign anticipated the effect of "mass follows class," meaning that if the upper class embraced brown rice, the middle and lower classes would follow. In other words, the campaign intended to rely on "opinion leaders" or people in the upper class to change the cultural image of brown rice. Although the campaign wound down after approximately four years, it created lasting change. According to a master

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47 As one of the campaign's pamphlets "Brown Rice: Beyond the Color" describes, "white rice connotes a 'classy' lifestyle because of its distinct white polished grains. Brown rice, on the other hand, became associated with that harvested from a poorly managed paddy because of its 'dirty' look or off-color."

48 Although the natural food movement and the organic food movement may not share exactly the same ethos, they are combined as the "organic and natural food movement" in the Philippines and gained ground in the late 1990s (Salazar 2014; Sahakian, Leuzinger, and Saloma 2017).

thesis titled *Brown Rice – I love It: An Integrated Marketing Communications Campaign for the Healthier Rice*, the first commercial brand of brown rice appeared in the supermarket in 2003, and by 2009, there were already nine brands of brown rice in the supermarket (Suner-Narvadez 2009).

During the same period, another group of scholars in the Philippines began investigating how to use rice breeding to increase micronutrients in white rice. One important project was iron-biofortified rice, collaborated by scientists from IRRI, PhilRice, and UPLB (Brooks 2010). Their research strategy followed the same rationale underpinning the development of HYV rice seeds and rice breeding for increased protein content. When the initial result of the research did not meet the goal, some scientists, mainly based in IRRI, turned to genetic modification as a last resort to elevate the quantity of iron in rice, while others stuck to the original project. Interestingly, both groups of scholars claimed to reach success at the end of the 2010s.

As Philippine scientists began to explore the iron biofortification of rice with genetic techniques, the well-known Golden Rice Project arrived in the Philippines in 2000. Beginning in the 1990s, two European scientists began to explore how to use genetic modification techniques to develop Vitamin A-enriched rice. These scientists developed the first generation of seeds and transferred the project to IRRI. During the early 2000s, the Golden Rice Project attracted lots of attention and made the public familiar with the idea of genetic modification for

micronutrients. The project also aligned well with the development of agribiotechnology in the Philippines. The Philippine government began to develop the agribiotechnology industry in the 1990s. In 2002, the government approved the first GM corn variety for commercial planting, which set the milestone for the industry's take-off in the Philippines.

School gardening was the only agrifood approach to nutrition that did not exist in this period. Nonetheless, the policy promotion of school gardens existed, but it was not designed to target the issue of malnutrition. In 1995, The then-Department of Education, Culture and Sport (DECS) announced a national program called "School Inside a Garden," usually known as the SIGA program. The SIGA program belonged to the national "Clean and Green" campaign promoted by then-president Fidel Ramos to echo the global "Cleaning the World" movement since 1993. Consequently, different from vegetable-based school gardening programs, the SIGA program was set to plant flowers, medicinal herbs, and exotic or fruit-bearing trees; the main policy goal was to nurture students' consciousness and appreciation of the natural environment. The development of the SIGA program indicates that, even though school gardening was present as the policy solution during this period, the government and the development field did not intend to utilize this solution to tackle the issue of malnutrition.[49]

[49] Even home gardening was not the focus at this period. Instead, the focus at the time was to increase national vegetable production and develop the vegetable industry.

This section presents another type of problem-solution constellation whose main pattern is a singular problem with coordinated agrifood solutions. A conjunction of local history and global trends rendered micronutrient deficiency a central *problem* in the 1990s. In response, the government developed a coordinated initiative that brought together various agrifood solutions. Yet, among the five agrifood approaches I trace, the only *active* policy solutions were food fortification and vegetable supplementation. Projects belonging to the rest of the three agrifood approaches – the ARF brown rice campaign, the rice biofortification projects, and the SIGA program – were marginalized for different reasons related to agricultural development issues. The ARF brown rice campaign was late-emerging and only gained ground after the emergence of the natural food movement in the Philippines. The rice biofortification projects remained in the experimental stage throughout the 1990s, just like what happened to rice breeding for high protein content in the 1970s. As I point out in the next section, these rice biofortification projects marched on regardless, partly because they represented the future of agricultural biotechnology. Finally, although vegetable supplementation was a key strategy for NMAT, NMAT did not intend to rely on school gardening or home gardening approaches as the primary source of vegetables but aligned with the Department of Agriculture's agenda to promote the domestic vegetable industry.

2-4 The Persistence of Problems and Solutions (the 2000s – 2010s)

History so far has shown a complicated landscape of the problem of malnutrition. Different formulations of problems came to the fore in each historic period as the policy goal and intertwined with a set of agrifood solutions. In the 2000s, the problem of malnutrition appeared to be even more challenging for the Philippine government to navigate. As the government's predominant policy focus on micronutrient deficiency was shadowed by the rising issue of non-communicative diseases such as obesity, diabetes, and cardiovascular diseases, various issues began to compete for policy attention. It was not merely the "double burden of malnutrition," a popular concept developed by the international nutrition community to portray the dietary health condition in the global south. Several Filipino nutritionists I had conversations with liked to say that there was a triple – or even more – burden of malnutrition. In their calculation, undernutrition, such as child stunting and wasting, presented a different challenge from micronutrient deficiency. Both types of malnutrition persisted alongside the challenge posed by non-communicative diseases. The annual theme of National Nutrition Month (see Appendix II) from 1976 to 2020 exemplified this trend. These themes represent the most important nutrition message the government intends to deliver to the public each year. After the year 2000, non-communicative diseases and undernutrition took turns to be the focal theme of National Nutrition Month, which indicates how the government has been trying to develop policies to address various types of malnutrition simultaneously.

Meanwhile, most agrifood solutions that emerged in this period carried a long history that enabled them to flexibly address more than one type of malnutrition and issues concerning agricultural development. The *persistence* of various types of malnutrition and agrifood solutions characterizes the problem-solution constellation in this period.

The promotion of brown rice consumption is a clear example of the encounter between agricultural development and malnutrition and the intention to address multiple types of malnutrition. Take PhilRice's BeRICEponsible Campaign as an example[50]. PhilRice institutionalized the campaign after the 2013 National Rice Awareness Month and launched the campaign formally in 2014. The BeRICEponsible campaign claimed to focus on three benefits of eating brown rice. First, brown rice is healthier than white rice; second, compared to white rice, the milling of brown rice can save 10 percent of rice and thus increase national food self-sufficiency; third, buying brown rice helps farmers receive a higher income. These three points reveal how agricultural development and the issue of malnutrition intertwine to become the problems to be solved by the project.

First of all, the BeRICEponsible Campaign had a clear agenda for agricultural development, especially as a part of the Philippine government's response to the

[50] The PhilRice's BeRICEponsible Campaign was not the only one in this period. Around 2010, a wave of promotion of brown rice consumption began in the Philippines across public and nonprofit organizations. For example, the FNRI launched its brown rice campaign in 2009. Shortly after, the OXFAM Philippines also partnered with a local media Daliha to campaign for brown rice awareness. Among these campaigns, the BeRICEponsible Campaign was the longest-lasting and most extensive one.

2007-2008 food crisis.[51] After the crisis, the government announced the "Food Staples Sufficiency Program 2011-2016" (FSSP) as the new policy agenda to achieve rice self-sufficiency by 2012. The FSSP was an overarching program that included interventions across all aspects of the food system, from production to consumption. In the realm of consumption, brown rice was proposed as one of the three measures of food consumption. As the official policy brief of the FSSP elaborates, "Brown rice is more nutritious than white rice because it retains most of the nutrients from the rice bran that are removed by polishing. In addition, brown rice has a higher milling recovery rate of 75% compared with 65% for white rice. That is, 100 kg of palay produces 75 kg of brown rice compared with 65 kg of white rice" (Department of Agriculture 2012, 40). In other words, the government aimed to increase local rice production by producing and consuming more brown rice.

[51] The 2007-2008 Food Crisis facilitated the structural change in the global food system. Since early 2007, the price of several crops, including wheat, rice, maize, corns, and soybeans, began to increase in several countries (Saad 2013). Although the reasons for price volatility behind different crops are different, media, governments, and intra-governmental organizations framed this situation as a "global food crisis (Johnston 2010; Swan, Hadley, and Cichon 2010; Lang 2010). And it indeed created civil unrest and political chaos in more than 30 countries. The 2007-2008 food crisis leads to two opposite impacts. On the one hand, although some scholars and states contend that the speculative logic involved in the international food market was the major cause of the food crisis, the reforms proposed by the international development agencies and governments were not to minimize the function of the market system but to reinforce it with the creation of Agricultural Market Information System (AMIS). On the other hand, the 2007-2008 food crisis also led many state governments to recognize food self-sufficiency as an essential element of national security. Moreover, the emphasis on food self-sufficiency led to the re-appreciation of smallholder farming in the international development field and the large increase in funding for international agricultural research centers (Holt-Giménez 2009).

Additionally, as the campaign moved on, the BeRICEponsible Campaign changed the type of malnutrition it was focused on, from micronutrient deficiency to non-communicable diseases. As mentioned in the FSSP policy brief (Department of Agriculture 2012), hidden hunger, or micronutrient deficiency, was one of the main policy targets for promoting brown rice consumption. However, non-communicative diseases, or so-called lifestyle diseases, gradually became the main reason for eating brown rice in the campaign's promotional materials. The excerpt from a news article published on the PhilRice website on June 19, 2017, provides a vivid example:

> The [Philippines Rice] Institute, through its Be Riceponsible Campaign, has affirmed that eating too much rice has ill effects on human health. A study by the Harvard School of Public Health showed that excessive rice intake might adversely affect glucose metabolism and insulin production in the body thus may result in diabetes. …That is the main reason why we are promoting brown or unpolished rice as it has a lower glycemic index, which means that it takes longer before it is converted to blood sugar. It also has higher satiety, so you tend to eat less.[52]

As the excerpt indicates, the campaign underlined how the consumption of brown rice could address diabetes (lower glycemic index) and obesity (higher

[52] https://www.philrice.gov.ph/eat-rice-riceponsible/. Access date: 03/01/2022.

satiety). This focus created a stark contrast to the focus on micronutrient deficiency.

School gardening presents another agrifood solution that simultaneously addresses multiple malnutrition and agricultural development issues. In 2007, the Department of Education announced the "Gulayan sa Paaralan" (School Garden) program[53]. It mandated that all public schools set up gardens to support the "School Feeding Program," another national program also implemented by the Department of Education. Following this policy trend, several nonprofit organizations in the Philippines joined forces to promote school gardening, including two prominent projects. One was the "School Plus Home Gardening Project" (SHGP), led by the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). The other was the Bio-Intensive Gardening Program led by the International Institute of Rural Reconstitution (IIRR). Later, these two development agencies collaborated with the DepEd on several regional and international events, including an international conference on school gardening and online gardening courses, to advocate their vision of school gardening (Calub et al., 2019).

These school gardening projects also claimed to tackle multiple problems about malnutrition. On the basic level, because school gardens were mandated to

[53] It is worth noting that the promotion of school gardening in the Philippines is not part of the food movement in the global north. The primary rationale in the Philippines is an economic one rather than an educational one – school gardens need to produce "real" food to support the school feeding program.

support the preexisting school feeding program, the government and these development agencies suggested that school gardens could provide additional food for the feeding program and directly alleviate the wasting and stunting prevalence among students. On top of that, these projects also saw school gardening operations' focus on vegetable production as an opportunity to increase students' interest in vegetable consumption, which they considered would benefit these students' health in the longer term. Building on this agenda, the SHGP team further anticipated the school gardening program as an effective channel to disseminate nutritional knowledge to students' households.

The development of school gardening was also connected to two distinct agricultural development issues. The first one was about the development of organic agriculture[54] in the Philippines. The IIRR and the SHGP teams were promoters of organic farming and saw school gardening as a well-positioned platform to expand organic agriculture's visibility. Fundamentally, the government and these agencies envisioned school gardening as an opportunity to increase youngsters' interest in farming. In the long term, it may become the new

[54] After the emergence of the natural food movement in the early 2000s, the Philippine government finally passed the Organic Agriculture Act in 2010. The Act created the official certification regime of organic farming in the Philippines. Unlike the development of organic agriculture in the U.S. or other countries where the development of organic agriculture predominately focuses on its environmental impact, organic agriculture in the Philippines became an important strategy to farmers working toward the economic benefit and better livelihoods. This 2010 Act marked the official inauguration of the organic agriculture sector in the Philippines. Organic agriculture was thus positioned as one of the key pathways toward future agricultural development. As a result, organic agriculture grew rapidly in the Philippines. According to the latest statistics, in 2017, the Philippines ranks fifth globally in organic producers. The Philippines also has one of the largest proportions of organic farmland in Asia.

force for the future agricultural sector to replace aging farmers. In short, governments and development agencies saw school gardening as a better solution than expected because it can simultaneously address various nutritional and agricultural issues.

The development trajectory of moringa supplementation was another example that brought together multiple human health and agricultural development problems. In the early 2000s, the Biotech Program of the Department of Agriculture (DA) proposed to promote moringa production as the next generation of agri-technology in the Philippines[55]. The goal was to develop a "moringa industry," just like the development of the coconut industry in the 1960s. The DA Biotech Program envisioned moringa's medicinal and pharmaceutical potential for chronic diseases,[56] Yet, a twist happened around 2010. Following the global trend of recognizing moringa as a superfood and the enactment of the Organic Agriculture Act of 2010, some businesspeople formed the Moringaling Philippine Foundation Inc. (MPFI) to promote the production of moringa nationally. Like the DA Biotech Program, MPFI leaders foresaw moringa's potential as a high-value crop targeting human health issues, much more than just another backyard tree. But, unlike the DA Biotech Program, MPFI leaders intentionally distanced the image of moringa from "biotech" and worked to align the moringa industry

[55] "DA steps up commercial cultivation of malunggay," *The Philippine Star*, November 22, 2009.

[56] For example, see the cover story of *the Biolife Magzine*, September – October 2007 issue. The cover story is titled "Lowly Malunggay Makes a Comeback."

closely with the emerging trend of organic agriculture in the Philippines instead. I term their overall efforts "the Moringa Industry Development Initiative." which consists of multiple levels of effort. Their ultimate goal was to develop a win-win strategy: to help boost the health of Filipino citizens, especially to address child undernutrition, while simultaneously creating a moringa export industry that could benefit local businesses and farmers. In short, the development of the moringa industry demonstrates an interesting example of how agricultural development issues intertwine with human health issues to formulate a specific network of problems that "moringa supplementation" is positioned to be the solution.

While food fortification primarily focuses on micronutrient deficiency, even projects taking this approach intend to expand their focus to address multiple micronutrient deficiencies. The FNRI Iron-Premix Rice Project is a good example. The project utilized a new chemical compound as the fortificant and developed a product with a taste resembling ordinary white rice[57]. Arguably, the project became one of the most successful development projects and won several awards from the Philippine government and the nonprofit sector. While the project originally only focused on iron deficiency, it began to expand its focus to other types of micronutrient deficiencies. This became their ongoing project on "multi-nutrient extruded rice kernel (MNERK)." As Figure 8 demonstrates, the

[57] See next chapter for the detailed analysis of this project.

uniform of the FNRI team also shows the “MNERK fortified rice.” According to my interview with the project leader, the ultimate goal will be to produce fortified rice that can fortify all the essential micronutrients.

Figure 8: The backside of a uniform belonging to a team member of the FNRI Iron-Premix Rice Project

At the same time, the development of the Iron-Premix Rice Project was also connected to agricultural development issues. After the Food Fortification Act of 2000, the government encouraged food manufacturers to produce fortified products voluntarily and mandated the iron-fortification of rice. However, iron-fortified rice was hard to discover in rice stores due to the lack of enforcement. It was partly in this context that the FNRI team began to work on the Iron-Premix Rice Project. The project aimed to develop a commercialization structure to facilitate mandatory rice fortification in the Philippines. Figure 9 is one of the

Iron-Premix Rice Project's promotional materials exemplifying the FNRI team's effort. This promotional material clearly states that the FNRI team was looking for "entrepreneurs willing to adopt the technology and commercially produce" iron-fortified rice.

Figure 9: Promotional material for commercialization

Biofortification is a unique approach compared to the other approaches I analyzed above. While all the other agrifood projects emerging in this period intended to tackle multiple types of malnutrition, biofortification projects typically target only one specific micronutrient. Among various biofortification projects developed in the Philippines, mainly based on IRRI[58], the Golden Rice Project remained the most high-profile. When I carried out my major fieldwork in 2018-2019, the IRRI Healthier Rice Project was responsible for developing the Golden Rice Project and other similar projects targeting iron or folate. Additionally, the development trajectory of the Golden Rice Project also diverged from other agrifood solutions by its much longer development time. The Golden Rice Project was the only agrifood project already active in the previous historic period around the 1990s. In contrast, the Iron-Premix Rice Project in this period had no direct connection to the FV Rice Project in the 1990s; PhilRice's BeRICEponsible Campaign also had no direct connection to the ARF's brown rice campaign in the previous historic period.

The long life of the Golden Rice Project may partly be accredited to its unique status in the agricultural biotechnology industry in the Philippines. Although the agribiotechnology sector had an early start, it encountered a serious setback in the 2010s when the B.T. eggplant developed by the University of Philippines was challenged by a lawsuit and ordered to stop field testing in 2015. Eventually, the

[58] See the IRRI website for details: https://www.irri.org/our-work/impact-challenges/nutrition-food-security. Access date: 06/07/2021.

Philippine government updated its biosafety guideline and made it more stringent. [59] Under this context, the Philippine agricultural community considered the Golden Rice Project to embody a new focus on biotechnology that addresses public health issues and envisioned its success as a major milestone for a new era of the biotechnology industry in the Philippines. Golden Rice will be the first G.M. project undergoing the Philippine government's updated biosafety procedures. The governmental approval of Golden Rice may knock out new possibilities for the entire industry.

This period reveals how projects based on different agrifood approaches intend to address the various *problems* between malnutrition and agricultural development. I do not mean that agricultural development only appears to be an important factor in this period. In each historic period, agricultural development issues occupied different positioning when they interacted with the problems of malnutrition and agrifood solutions. Nonetheless, based on the data I gathered, a more identifiable connection existed in this period than in previous ones. Agrifood solutions are imperative to tackle agricultural development issues and

[59] The Philippine government developed its biosafety guidelines for the use of G.M. crops as early as 1991. The first G.M. crop approved for growth was B.T. corn in 2002. Shortly after that, herbicide-tolerant corn was approved in 2005. In 2012, the area of G.M. maize reached 750 thousand hectares. However, the B.T. eggplant developed by the University of Philippines was challenged by a lawsuit and ordered to stop field testing in 2015. This was a huge setback for the entire agribiotechnology industry. Eventually, the five departments in the Philippine Government (Science and Technology, Agriculture, Environment and Natural Resources, Health, and Interior and Local Government) collectively issued a document (titled "Joint Circular") to update the existing agribiotechnology guidelines, making the entire procedure more time-consuming and costly. The regulatory reform directly impacts the development and approval of new G.M. crops, including the Golden Rice Project.

malnutrition problems simultaneously. This point helps illuminate what the current trend of nutrition-sensitive agriculture entails – it is not only about how agricultural development should position nutrition as its central goal but also about how this new type of nutrition-sensitive agriculture may address existing agricultural development issues at the same time. I will elaborate on this point in the concluding chapter.

Conclusion

This chapter demonstrates how a set of agrifood approaches have kept re-emerging to address different formations of the problem of malnutrition in four historic periods. In each historic period, coexisting agrifood solutions and the corresponding problems form a particular pattern of the problem-solution constellation. In the first period, discovering how vitamin B1 deficiency caused beriberi went hand-in-hand with exploring solutions to deal with beriberi as a disease. In the second period, the political rationale of the authoritarian regime dominated the formulation of dual problems — how to achieve food self-insufficiency and how to utilize nutrition governance to address protein deficiency — and the development of politically-motivated solutions. In the third period, the predominant focus on micronutrient deficiency led the government to launch a coordinated initiative containing various solutions focusing on the constitution of food. In the fourth period, the multiple burdens of malnutrition and diverse

directions of agricultural development constituted the structural condition, and the five agrifood solutions were required to tackle multiple types of malnutrition and have the capacity to contribute to specific agricultural development agenda at the same time.

The historical analysis of problem-solution constellation advances STS scholars' theorization on problematization in two ways. First, it provides ample evidence that there are coexisting solutions in multiple historical periods, underscoring the importance of foregrounding the coexistence of agrifood solutions. Based on the discovery, I suggest that it would be more generative for STS scholars to replace the current framing of problem-solution coupling with problem-solution constellation so that scholars could be more attentive to coexisting solutions. The concept of problem-solution constellation also enables the analysis of identifying unique patterns of each problem-solution constellation. For example, in the second historical period, I argue that the political considerations of the Marcos regime dominated the framing of problems such as how to achieve food self-sufficiency and nutrition governance; the same political rationale also led to the emergence of solutions such as the school and backyard gardening campaign popularized by the then-First Lady Imelda Marcos and the USAID-supported nutribuns. By contrast, the singular problem of micronutrient deficiency tackled by a government-led coordinated initiative encompassing several types of agrifood solutions is the pattern of problem-solution constellation in the third period. This comparative example also points to the second

contribution of this chapter. While most of the problematization analysis in the STS field does not pay attention to the historical aspect, this chapter demonstrates how history matters to help understand and contextualize the problem-solution constellation in a particular period.

The historical analysis of problem-solution constellation further intervenes in the practical-critical divide in the scholarship of development solutions I discussed in Chapter One. On the one hand, the problem-solution constellation analysis highlights the limit of comparative analysis of solutions based on an individualist methodology. While this type of analysis usually aims to assess which solutions are more effective, it cannot identify potential relations that may allow these coexisting solutions to work together or fight against each other historically. This type of comparative analysis may also overlook factors that shape solutions. For example, this chapter's analysis indicates that agricultural development issues are critical in influencing the emergence of agrifood solutions.

On the other hand, this chapter's analysis also helps steer critical analysis away from focusing on the most contentious technology *only*. When critical scholars center on a specific solution, they sometimes miss the point that what is important is not only the "destruction" of this controversial solution but also the "destruction" of the *targeted social problem*. The perspective of problem-solution constellation helps situate the contentious solution in relation to other coexisting

solutions and the targeted problem. The contextualization of the contentious solution could also provide critical scholars another angle to examine the assumed importance and persisting existence of the contentious solution. For example, this chapter's analysis challenges the importance of biofortification compared to other coexisting solutions. I delineate a clear trajectory of the presence of biofortification as a solution to malnutrition since the Asia Green Revolution. Specific projects include high-protein rice breeding and the infamous Golden Rice Project for vitamin A deficiency. Yet, as the problem-solution constellation analysis shows, biofortification has never played an important role in each period's problem-solution constellation. Compared to other coexisting solutions, it has always been late coming, as it happened in the second, third, and contemporary periods.

Meanwhile, the problem-solution constellation analysis also reminds scholars of the danger of overly emphasizing particular solutions. The over-emphasis on a particular solution – even with a critical perspective – may lead to overlooking other less popular yet active solutions; it may even inadvertently help exaggerate the policy importance of this particular solution. A short look at the five agrifood approaches in this chapter demonstrates the case. With all five approaches, biofortification garnered much more scholarly attention than any other four approaches, while it has never been the most active or useful solution so far. Yet, without the same level of scholarly attention, the rest of the four approaches could never receive the same level of research support.

On top of the contribution to shifting scholarly focus from a singular solution to the connection between coexisting solutions and the corresponding problems, the concept of problem-solution constellation also enables scholars to sensitize to two additional issues. One is the relationship between these coexisting solutions. For example, this chapter's analysis shows that coexisting solutions may compete or be coordinated into a broader initiative. Paying attention to the relationship between coexisting solutions helps understand the pattern of the problem-solution constellation and how the problem is being addressed in this period; it also helps contextualize the development of a specific solution. The other issue is the existence of non-solutions, which refers to agrifood projects that, albeit active, were not considered a policy solution in a specific period. For example, while school gardening was positioned as an important solution to malnutrition in the 1970s and the 2010s, the Philippine government did not consider it a potential solution to malnutrition in the 1990s. To be clear, school gardening programs existed in the 1990s, but they were meant for the greening campaign to enhance students' environmental consciousness.

On a final note, the discussion on non-solutions and the problem-solution constellation analysis as a whole suggest a critical role of historical analysis. This chapter shows that all these problem-solution constellations did not form in a vacuum but may build on a long history of agrifood solutions and malnutrition. It is also through the comparison of problem-solution constellations in multiple

periods that scholars could identify and analyze non-solutions or the uniqueness of a particular agrifood approach.

Chapter Three
Assembling a Solution

Introduction

In the last chapter, I take a historical perspective to study the problem-solution constellation, or how coexisting solutions and corresponding problems connect in each historical period. While the last chapter establishes the importance of studying co-existing solutions collectively, it is important to acknowledge that these coexisting solutions are not just abstract ideas but have unique trajectories of development. Following this point, in this chapter, I switch the analytical scale from problem-solution relationship to center on how each of the five coexisting agrifood solutions to malnutrition developed and operated in the contemporary era. This chapter compares how these agrifood solutions developed from abstract approaches (i.e., fortification, biofortification, or wholegrain consumption) to become actualized projects situated in a concrete context of the Philippine society. As each agrifood solution counts on different kinds of technoscience to achieve its goal, this chapter pays much attention to the encounter between technoscience and the social context where these agrifood solutions manifest.

By paying attention to the role of technoscience in this chapter, I also speak to two seemingly opposite theses regarding how the framing of social problems plays a role in the development of technoscience-involved solutions. STS scholars, following Callon's problematization framework, focus on the co-

production of problems and solutions (Laurent 2017). They argue that the formulation of a specific problem goes hand-in-hand with the existence of a corresponding solution. In contrast, development studies scholars tend to employ the concept of solutionism to analyze how techno-fixes may re-frame development problems to justify techno-fixes as the ideal solution. At the center of the debate between these two groups of scholars is the agency of development solutions and to what extent these solutions would be shaped by development problems or could influence the framing of development problems. With the comparison of five coexisting agrifood solutions, this chapter aims to disentangle the assumed relations between problems and solutions proposed by these two groups of scholars. I analyze how these agrifood solutions materialize as operational projects and point out the diverse positioning of technoscience in relation to the problem of malnutrition in each agrifood solution's actualization. The comparative analysis enables me to further highlight the potential and constraints of these agrifood solutions' agencies.

I utilize the concepts of "situated technoscience" and "ethno-epistemic assemblage" to advance my comparative analysis of these five projects. Catharina Landström and Stewart Kemp (2020) draws from Donna Haraway's concept of "situated knowledge" to propose the concept of re-situated technoscience "to capture the changes occurring in technoscience when it becomes involved with local place-making" (p.39). Following Landström and Kemp's discussion, I

consider the process when technoscience is rendered context-specific a key aspect for agrifood solutions to manifest into an operational project.

Also focusing on the issue of public engagement of science, Alan Irwin and Mike Michael's (2003) conceptualization of ethno-epistemic assemblage helps further unpack how technoscience could be rendered situated. Irwin and Michael are concerned with the situation when the public encounters expert knowledge, especially amidst knowledge-involved controversies such as genetically modified crops (Irwin & Michael 2003:119). They develop the concept to investigate how seemingly universal and objective knowledge intertwines with specific social groups' life experiences. To fulfill this agenda, the concept of ethno-epistemic assemblage illustrates conditions when knowledge claims (epistemic aspect) are entangled with other heterogeneous components in a particular context (ethno aspect) to form a situated understanding of an issue. Correspondingly, I employ the concept to help compare how each agrifood solution manifests into an operational project when technoscience for solving malnutrition works with heterogeneous components to actualize its purpose.

The concept of ethno-epistemic assemblage is particularly suitable for comparative analysis. The concept's focus on how social groups develop their understanding of contentious issues by weaving together knowledge claims and situated factors lays the ground for comparative analysis of different ethno-epistemic assemblages representing different social groups. Meanwhile, the

thematic focus on knowledge claims and situated factors also makes it possible to compare different assemblages based on their epistemic and ethno components. Following this analytical approach, scholars have employed the concept to consider how social groups perceive the number of whales in the ocean differently or the variety of experiences of and relation to the government surveillance apparatus (Blok 2011; Lee 2015).

I employ the concepts of situated technoscience and ethno-epistemic assemblage in a slightly different way to accommodate my comparative analysis of the five agrifood solutions. I use these concepts to describe how a proposed solution manifests into a project embedded in a specific social context; meanwhile, the analysis also centers on how technoscience — a variety of knowledge, technology, and techniques — associated with this proposed solution are intertwined with situated factors to facilitate the actualization of the solution. The social context and situated factors — the ethno components of the assemblage — refer to a wide range of things associated with the substances utilized in each project, including rice, moringa, vegetables, genes, and iron. These things may include the biological or social characteristics of these substances, the tradition and culture associated with a certain food, the policies involved in mobilizing these substances, and the social interactions surrounding these substances.

Methodologically, the comparative analysis of these five agrifood solutions is based on these five projects' perspectives. I take on Actor Network Theory's methodology of "following scientists around" (Latour 1987) and follow the team of each agrifood project around to see how they encountered and interacted with different actors and actants to construct a stabilized assemblage. I grapple with the project development from these teams' perspectives and take in their rationale to understand how they mobilized various resources to make these projects operational. However, I do not intend to develop typologies based on these five projects. Although I selected these projects for this research because they represented common agrifood approaches to malnutrition, I did not predict what configurations of the assemblage these projects would develop, nor did I intend to utilize them to develop ideal types representing how technoscience is rendered situated.[60] Instead of developing typologies, this chapter aims to expand scholarly understanding of the wide range of possibilities about the role and positioning of technoscience in the process of solution actualization.

[60] I assume I may discover different types of assemblage configurations if I select other projects to study. For example, another popular school gardening project I encountered during my fieldwork embraced a rather different strategy to prioritize self-sufficiency within the garden, resulting in less engagement with the community. Even without further examination, one could imagine that this school gardening project's assemblage would have a different configuration from SHGP's assemblage, which relies heavily on community involvement.

3-1 The Iron-Premix Rice Project: stabilizing the pathway of delivering iron from rice to human bodies

As I mentioned in Chapter 2, fortifying rice with certain nutrients is not a new approach in the Philippines. In the early 1950s, the Philippines was the first country to adopt the then newly-developed technology to coat thiamine on the surface of white rice as the primary solution to Beriberi. Since then, several projects utilizing the fortification technology have been developed by different research centers, including two iron-fortified rice projects in the early 1980s and 1990s, respectively.

The Iron-Premix Rice Project I focus on in this section is the latest attempt. In the early 2000s, the Philippine Food and Nutrition Research Institute (FNRI) began another new project developing iron-premix rice. When I visited the Philippines for my pilot study in 2016, FNRI developed the finished product of iron-premix rice for commercial use, although the rice was not easy to spot on the market. The FNRI Iron-Premix Rice team also received several awards during that period, including a prestigious public service award delivered by the Philippine president. According to several nutritionists I interviewed, the project was recognized as successful.

While the basic idea of the iron fortification of rice seems straightforward – developing technologies to mix rice with iron during the post-harvest process, the key mechanism to "success" – to get technoscience situated – was far more complicated. The Iron-Premix Rice Project's goal was to create a *pathway* to

deliver iron into a specific part of the human body to serve its purpose. The *pathway* began with producing *the kernel-shaped iron-premix* (see Figure 10) that rendered iron an edible substance and ended with the digestion of iron-premix in human bodies that rendered iron-premix a mineral substance for bodily absorption. The primary task of the FNRI team was to assemble and stabilize this *pathway* and ensure that iron could move from the rice post-harvesting process to the digestion process within human bodies.

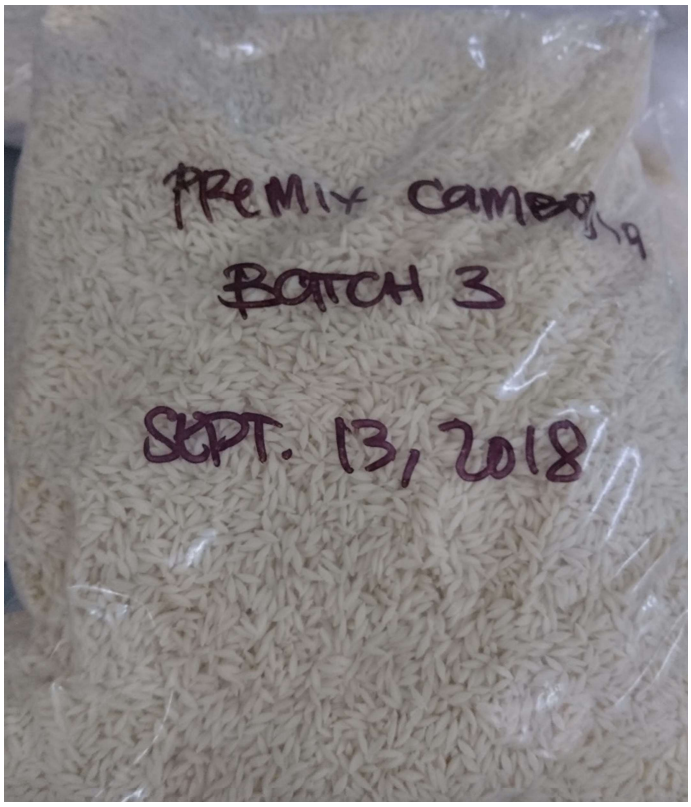

Figure 10: The kernel-type iron-premix

While the pathway began with the creation of iron-premix and ended with the absorption of iron by human bodies, in practice, it was structured as different stages of *tests* that detect iron and ensure that iron remains *in place* from the beginning to the end. The stable pathway as different stages of testing resonates with what Actor-Network Theory (ANT) scholars describe as a "trial of strength" (Callon 1986). When ANT scholars describe the process of constructing and stabling a network by enrolling different entities into the network (Latour 1987), they particularly focused on these trials of strength that made associations between two entities. In the case of the Iron-Premix Project, the trial of strength referred to all kinds of *tests* that validate the existence of iron in every stage of the process. But not only was iron under the trial of strength, but so was the FNRI team. The team also needed to solicit cooperation with other research institutions or private companies and the government's support to carry out these tests and assemble the pathway. Below I describe the entire process.

To begin with, the FNRI team needed to identify and decide the *fortificant* of the project. In the technical field of food fortification, "fortificant" refers to the substance that contains the nutrients to be fortified. According to the FNRI document[61], the fortificant is “a substance, in chemical or natural form, added to a specific food vehicle to increase its nutrient value.” In the Iron-Premix Rice

[61] The document is titled “Technology on Iron Rice Premix and Iron Fortified Rice” and could be accessed via: https://pcieerd.dost.gov.ph/images/downloads/presentation_materials/pcieerd4thanniversary/session_c/1_IFR.pdf. Access date: 06/15/2021.

Project, the targeted nutrient is iron; the substance as the fortificant is ferric pyrophosphate, a kind of inorganic compound containing iron.

It requires two stages to make a package of iron-premix rice. These two stages have different goals and utilize different machines and technical procedures. In the first stage, the FNRI team developed a procedure to create the rice-kernel-shaped fortificant. The process begins with a mixture of ferric pyrophosphate powders with rice powders in a specific ratio. Then, the FNRI team puts the mixed powders and some water into a machine. The mixed powders go through a process called “hot extrusion.” The mixed powders melt and stick together, forming a long, thin, and solid cylinder. In the next step, another machine chops this cylinder into small pieces, with each piece resembling the shape of white rice or the rice kernel. The FNRI team calls these rice-kernel-shaped pieces “iron premix.” It is a "pre-" mix because it is created before the real "fortification" stage. Finally, iron premix also needs to be steamed and dried.

The second one is the "fortification" stage. After the FNRI team creates the iron-premix, the team uses a newly designed blending machine to blend the iron-premix with ordinary white rice with a 1:200 ratio. After the blending, the iron-"fortified" rice is created and ready for packaging and commercial use. It is, thus, worth noting that the strategy of the Iron-Premix Rice Project is very different from the traditional coating technology used in the Rice Enrichment Project in the 1950s. The FNRI team does not coat nutrients on the surface of white rice. It

merely creates some rice-like substances and mixes them with ordinary white rice. Thus, when consumers eat white rice, at the same time, they also eat some iron-premix.

The iron-fortified rice production that mixes ordinary white rice with iron-premix is not the end of the story. It is only the beginning of the FNRI team's efforts to assemble a stable pathway from post-harvesting to digestion. Assuming that there is a package of iron-fortified rice in the market, the FNRI team needs to *prove* that the "iron" contained in the rice could end up being absorbed by a person whose body needs more iron to function properly. This pathway from consumption to absorption constitutes various gateways that must be verified and stabilized.

The first gateway is whether consumers would like to spend a little more money to buy iron-fortified rice. For this purpose, the FNRI team conducted two market trial tests, one on the municipality scale and the other on the province scale. They published a final report titled *Market Trial of Iron-Fortified Rice in the Philippines* to document and report their efforts and discoveries. The market trial was conducted in Bataan, the same province where the Rice Enrichment Experiment was conducted in the 1940s. The FNRI team states in their final report that “this present study aimed to provide information to policymakers and program managers the processes and barriers involved in commercializing

commercial iron-fortified rice utilizing social marketing strategies[62].” Specifically, they aimed to evaluate whether consumers would be willing to buy iron-fortified rice at 10-20% higher prices after the social marketing strategy to increase their knowledge of iron-fortified rice. Based on the result of the market trial test, the FNRI team established the potential acceptance of iron-fortified rice with "intensive continuous social marketing strategies."

After the FNRI team established that consumers are willing to purchase iron-fortified rice, the second gateway is whether the shelter life of iron-fortified rice is significantly shorter than that of ordinary white rice and whether the quality of iron remains the same after a long storage time. For this purpose, the FNRI team ran various storage tests to ensure the quality of the iron-premix could sustain for a longer time and in different storage conditions, such as in the fridge or under room temperature. They ran these storage tests in their pilot plant within the FNRI headquarter, and these tests may last for six months or longer.

The next gateway when the shelf life's satisfying length was established would be whether the iron-premix could sustain the cooking process. Thus, the FNRI team also needed to develop the experiment to evaluate the existence of iron-premix after the rice washing and steaming processes. This is a crucial gateway for the FNRI team and the new technology of “hot extrusion.” One of the

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62 *Market Trial of Iron-Fortified Rice in the Philippines*, Terminal Report, December 2009, published by the Food and Nutrition Research Institute, Department of Science and Technology.

common critiques of the traditional technology that coats iron on rice's surface is that the nutrient coated on the surface of white rice may likely be washed away. The FNRI team is obligated to ensure the hot extrusion technology would not have the same shortfall. After the experiment carried out by the FNRI scientists, the FNRI team was certain that the iron-fortified rice created by the hot-extrusion technology performs much better than the one created by the old coating technology when standing against the rice washing and cooking process.

Consumers' preference for iron-fortified rice was also a critical gateway. This may impact whether consumers would continue consuming iron-fortified rice. For this issue, the team carried out the typical sensory analysis test. The goal of the sensory analysis was not to out-compete ordinary white rice but to make sure that the texture of iron-premix and ordinary white rice is too similar for testers to tell the difference. The most crucial factor the FNRI team paid attention to was the metallic taste from the fortificant, which may ruin the entire sensory experience for consumers. According to the FNRI team leader Marcela C. Saises, compared with the old type of fortificant, ferric pyrophosphate does a much better job of reducing the metallic taste, increasing the nutritional community's confidence in the project[63].

[63] During my interview with a retired nutritionist who was involved in developing the previous type of iron-fortified rice, she also mentioned that the absence of the metallic taste gave her much higher confidence on this new type of iron-premix rice.

The final gateway was whether humans could digest and absorb the iron in the iron-premix. The nutritional community sees the bioavailability test as the ultimate gateway. All the previous efforts would seem meaningless if human bodies could not absorb the targeted nutrient effectively. Thus, the FNRI team was obligated to perform the bioavailability tests on human beings to ensure that consuming iron-fortified rice elevates the iron level in their bodies, especially those bodies (pregnant women, infants) that need iron the most. They also published the result in a peer-reviewed journal of nutrition science (San Juan et al. 2011).

It seems a long pathway that the FNRI team needed to construct to render the agrifood project a viable solution. What contributed to this pathway construction were primarily *documented test results*. Every *documented test result* proved the strength of each gateway and the stabilization of the entire pathway. More importantly, iron was under the trial of strength in this entire process, and so was the FNRI team. The team was required to reach out to and gain support from other organizations and agencies to carry out different tests. Without these agencies, the FNRI team could never assemble this stable pathway.

Right at the beginning, FNRI was not the producer of ferric pyrophosphate. The FNRI team was invited by the leading producer, the Japanese company Taiyo Kagaku Co. Ltd., to help experiment with the stability of this then newly-developed fortificant. This collaboration provided FNRI with early funding to

initiate this project and allowed the FNRI team to pursue other governmental support and expand the project. Similarly, the FNRI team only had limited capacity to carry out other tests. They worked with local universities in the province for the market trial test and a lab at the University of Philippines Manila for the bioavailability test. These institutional connections and technoscientific infrastructures outside the FNRI were essential components of this assemblage. In short, these *tests*' successful performance also indicated the FNRI team's success in bringing in other actors to help stabilize the assemblage.

Beyond the need to stand for "the trial of strength" to build and stabilize the pathway, ferric pyrophosphate's materialities also precipitated how the potential industry of iron-fortified rice may be structured in the Philippines. Because none of the Philippines' companies had the technology and capacity to produce ferric pyrophosphate, this inorganic compound could only be imported from Japan and, thus, was more expensive than other fortificants, such as ferrous sulfate. On top of this barrier, the machine for the hot extrusion process was costly. Although the FNRI team was capable of developing various types of machines, such as the blending machine I mentioned above, the team did not have the skill to create the device for hot extrusion. It could only import the machine from other countries. The situation also applies to companies that hope to enter the business. Thus, when I did my fieldwork in 2019, the FNRI team worked with some businesspeople to promote a division of labor among rice processing companies. In their vision, the Philippines only needs a few companies specializing in

producing the kernel-form premix. These companies will receive governmental support to acquire an expensive machine for hot extrusion. Other community-based and small-scale rice millers could install the blending machine developed by the FNRI team to mix the kernel-form premix with their locally-sourced white rice. In the best scenario, the division of labor will scale up the production of iron-fortified rice, lower production costs and retail prices, and make it accessible in smaller communities.

The last part of the story was about the legal environment behind the project. The Philippine Food Fortification Law of 2000 mandates the mandatory fortification of iron in any rice produced in the Philippines. Ideally, the law should motivate different kinds of innovations for food fortification. In reality, the law was never enforced. Yet, the FNRI team and other companies used the law as the justification to promote the product to different governmental agencies. When I interviewed the owner of NutriDense, one of the three iron-premix producers in the Philippines, he mentioned that 90% of the rice the company produced was bought by governmental agencies, particularly for different social welfare programs. Because the government became the primary consumer at this point, the iron-fortified rice was not fully accessible and visible in ordinary rice stores or markets.

In short, this section demonstrates how the technical procedure of fortification is situated in an assemblage that creates a pathway to deliver iron to particular

social groups' bodies. Every gateway of this long pathway is the output of situated technoscience: the market trial to assess consumers' preferences; the new fortificant to satisfy consumers' taste; the storage test and cooking experiments to consider consumers' habits of handling rice; and the newly developed blending machines to accommodate and fit it the existing rice milling industry in the Philippines. This assemblage demonstrates the Iron-Premix Rice Project team's multi-dimensional efforts to transform a seemingly common solution of rice fortification into an operational project. To be sure, the multi-dimensional efforts are typical for all the projects I analyze in this chapter. These projects are not merely one-dimensional and naively construed "fix" but involve efforts to situate different kinds of technoscience in a particular context. What differentiates these projects is their assemblage's configuration which demonstrates how technoscience and other situated components are weaved together to actualize a solution into operational projects.

3-2 The School-plus-Home Gardening Project: expanded coordination across stakeholders to ground the garden in the community and policy arena

In 2007, the Department of Education announced the Gulayan sa Paaralan (School Garden) program. It mandated that all public schools set up gardens to support their school feeding program, another national program implemented by the Department of Education. While public schools followed the order to develop

their gardens, some nonprofits reached out to schools to offer additional support. One of these initiatives was the School plus Home Gardening Project (SHGP), developed by SEARCA and UPLB. [64] The SEARCA-SHGP team worked with six public schools in the Laguna Province and helped them re-develop their school gardens.

SEARCA-SHGP and the FNRI Iron-Premix Rice Project seemed to be very different initiatives regarding their agrifood approaches. But they were also similar in terms of their rationales. While the goal of the Iron-Premix Rice Project was to create a stable pathway for iron to move from post-harvest processing to digestion, the basic goal of SHGP was to establish a gardening operation that could continuously and stably produce vegetables to support the school feeding program. Similar to the Iron-Premix Rice Project, for SHGP to be a workable solution, the primary challenge was delivering vegetables from the soil to the stomach.[65]

While the assemblage of the Iron-Premix Rice Project was a pathway with a series of gateways, the assemblage that SHGP constructed involved a series of

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[64] Another nonprofit that offered support to schools is the International Institute of Rural Reconstruction (IIRR). Established in 1960, IIRR was well-known for its promotion of bio-intensive agriculture (BIG) for household gardening. They applied the similar technique to its school gardening project and have achieved very impressive success. Eventually, SEARCA and IIRR become two main nonprofit stakeholders in the current policymaking of school gardening in the Philippines. These two organizations have crafted various collaborations but also maintained a sense of competition for their different models and focuses in school gardening.

[65] Different from the development of school gardening in the global north, the economic aspect was a key consideration in the school gardening project in countries in the global south such as the Philippines and was critical to the success and sustainability of the project.

coordinations to "root" the garden in the community. I use "coordination" to describe how SHGP rendered the seemingly ordinary practices of gardening — the fundamental technoscience of this agrifood solution — an operational project by bringing together actors with different agendas to contribute to school gardens' operations. Based on this definition, the practice of "coordination" differs from "collaboration," which assumes the same goal shared by all the actors involved. The coordination between actors happened based on "common grounds" that could be the platform that allows mobilizations, the regulatory regime that different actors are required to follow, or the imaginary that could invoke different actors' collective actions.

Juxtaposing the configuration of these two assemblages further underscores the key feature of "coordination." In the Iron-Premix Rice Project, the project's core team – the FNRI team – remained the same from the beginning to the end. Although they collaborated with different agencies and organizations, the collaborations – the trials of the strength – ended after each test was finished and the document-backed knowledge was produced. In contrast, in SEARCA-SHGP, while there was a core team at the beginning of the project, the assemblage constantly expanded to include more actors and actants through the series of *coordination*. These actors and actants stayed to become a part of the assemblage while the core team from SEARCA and UPLB was no longer in the center of the assemblage. During the entire process, the overall practice of SEARCA-SHGP

was to secure the physical presence of the garden and the gardening operation in a particular community by including community actors in the project.

The juxtaposition reveals another key difference between the Iron-Premix Rice Project and SEARCA-SHGP. While the Iron-Premix Rice Project as a solution had a very clear problem to be solved, the problem was much more fluid for SEARCA-SHGP. The fluidity of the *problems to be solved* corresponded to the practice of coordination. The SHGP team needed to modify, revise, or expand their goals and *problems to be solved* along the way to accommodate different actors' agendas and facilitate coordination between them. Below I delineate how the assemblage of SEACA-SHGP expanded with a series of coordination.

The creation of the project itself was the result of coordination that brought the government, academia, and non-governmental organizations together. SHGP was a coalition of an intra-governmental development agency (SEARCA), university researchers (UPLB), local governments, and six public schools. Initially, SEARCA was encouraged and urged by the then Secretary of the Department of Education (DepEd) to launch a school gardening project to support the DepEd's policy.[66] SEARCA approached UPLB and asked them to recommend project leaders to join the team. When Dr. Blesilda Calub was selected and agreed to join the team, she brought in the idea of organic agriculture, which was her expertise and what she focused on at the time. SEARCA and UPLB then invited

[66] The origin story of the project is introduced in the video: https://youtu.be/9934BdzCNGQ.

the Laguna Province Division of the Department of Education (DepEd-Laguna) to participate in the project. The coordination with DepEd-Laguna was crucial because DepEd-Laguna's involvement granted the project legitimacy and facilitated coordination with public schools. The SEARCA-UPLB team coordinated with DepEd-Laguna to decide which public schools they would invite to join the project. Along the way, the SEARCA-UPLB team[67] constantly discussed with different funding agencies, including the Asia Development Bank and SEARCA, to ensure they supported the project's operation.

Operating as a development project meant that the SHGP team was required to generate "evidence-based" results as proof of success. They followed the trend in the development field to develop a quasi-experimental project design that included the "experimental group" and the "control group." This means the SHGP team also selected six schools as the control group. They collected the same kind of data from the six pilot schools the SHGP team supported their gardening operation and six "control group" schools from which the SHGP team only collected data. According to my interview with members of the SHGP team, the selection process created some tension with the "control group" schools. And the DepEd-Laguna's involvement in the project helped coordinate with these "control group" schools and ensured the smooth data-gathering process.

[67] The SEARCA-UPLB team consisted of five core members with seven different positions: the project leader, a study leader of socioeconomic aspect, a study leader of nutrition aspect, a study leader of agricultural aspect, a SEARCA coordinator, a SEARCA supervisor, and a project assistant.

The next stage of coordination was to root the gardening operation within the school, which required two fronts of effort — institutionally and physically. Institutionally, the most important goal was the coordination between the school gardening operation and the school feeding program, which was mandated by the specific policy mandating the creation of a school garden. When the Department of Education launched the school gardening program *Gulayan sa Paaralan*, it also devised the policy and rules about how school gardens should contribute to the school feeding program. Thus, for the SEARCA-SHGP to be recognized successfully, the SHGP team was expected to produce a fair number of fresh vegetables supporting the school feeding program.

In practice, the coordination between growing vegetables and feeding pupils means the coordination of personnel within the school. The SHGP team held a series of workshops to facilitate the coordination. One key effort was that the team invited all the school's relevant actors to the workshop, including teachers responsible for gardening and feeding programs[68], the principal, and other administrative officers.[69] They were required to identify and analyze their school gardens and feeding programs' current status and develop strategies to address their collective issues. For example, when designing the layout of school gardens, there were no prescribed school garden plans imposed on these schools. Instead,

[68] In some schools, these two positions may be held by the same teacher, which facilitated the coordination between these two programs but also increased the workload for this teacher.

[69] During my interview with the SHGP Team, the team leader stressed the importance to get the principal involved as a way to streamline all the coordinations.

the SHGP team held a School Garden Planning Workshop where participants from each school created their school garden layout and action plan for setting up and maintaining their school gardens. These workshops substantively expanded the participants in these school gardening operations. It ensured the coordination between the school gardening and the feeding program.[70] More importantly, the involvement of the school principals in these workshops made them more committed and supportive of the school gardening operation.[71]

Alongside these workshops facilitating coordination between school personnel, the SHGP team also built a small greenhouse in these schools (see Figure 11) to help coordinate the school garden's growing calendar and the school's administrative calendar. According to the SHGP team, based on prior knowledge, an outstanding problem of the existing school gardens was that schools could not produce good quality seedlings for transplanting due to the Philippines' changing weather patterns. Thus, the first significant decision that the SHGP team made was to sponsor each school with a small greenhouse from their initial funding. The SHGP team designed the greenhouse with a rainwater collection system to adapt to the Philippines' weather conditions. This innovation

[70] One basic issue for their coordination would be what vegetables they could expect to harvest from the school garden and what else the feeding program operator should purchase from the market.

[71] Usually when I followed the SHGP Team to each school, the principal and the teacher responsible for gardening operation were both there to greet the SHGP Team.

enabled schools to produce good quality seedlings year-round and became the key to the continuous operation of the school gardens.

Figure 11: The small greenhouse at the corner of a school garden

The coordination among school personnel not only facilitated the linkage between the school garden and the feeding program but also ensured the necessary data collection for SHGP's quasi-experimental research. The gardening coordinator – the official name of the teacher responsible for the gardening operation – was required to make detailed documents of the kinds of vegetables they harvest, the quantity (weight), and where the vegetables go. As Figure 12 shows, the gardening coordinator was required to keep track of the type and amount of vegetables harvested from the school garden, especially the proportion

of the vegetables utilized by the school feeding program. The entire process of documentation may not be accomplished without the feeding program coordinator and other school officials' support. The data collected by these gardening coordinators then became the basis of the accomplishments presented in the SEARCA-SHGP publications, such as Figure 12 and the final report's excerpt below:

> For the School Year (SY) 2016-2017, a total of 1,397 kilograms (kg) of assorted vegetables were harvested in all the six pilot schools.
>
> Almost half (46%) or about 635kg of these harvests were used as ingredients in the School-Based Feeding Program. Mustard, pechay, okra, spiny amaranth, and papaya were the top most harvested vegetables and used for the SBFP.[72]

This excerpt summarizes and elaborates on the information included in Figure 13, which compares the type and amount of vegetables produced in each school. This kind of detailed data would not be possible without the coordination within the school that incorporates the school garden operation into the entire school institution.

[72] Source: the SEARCA-SHGP Final Report.

CROP HARVES-TED	DATE HARVESTED	COOKED BY CLASS		PUPILS'/ PARENTS' SHARE		CANTEEN/ FEEDING SHARE		SOLD		NON-MARKETABLE		TOTAL HARVEST	
		QTY (KG)	AMT*	QTY (KG)	AMT*	QTY (KG)	AMT*	QTY (KG)	AMT*	QTY (KG)	AMT*	QTY (KG)	AMT*

Figure 12 : The table from the SEARCA-SHGP Final Report

Annex 15B Table 20. Amount (kg) of vegetables harvested from the school garden and used for the School-based feeding program

Vegetables	CCS	SAES	CGMES	MES	LES	PGMNHS	Total
Mustard	3	**26**	13.86	4.5	9	12	68.36
Pechay	4		**26.025**	10.5	4	2	46.53
Lady finger	6	**24**	0.5	6.4	7	2	45.90
Amaranth (Kulitis)		**34**		3.75			37.75
Papaya		**19**		15	2.5		36.50
Radish				**16.8**	10.5	8	35.30
Jute (Saluyot)		**30**			3.5		33.50
Ceylon spinach (Talinum)		**28**		3	3.5		34.50
Bok Choy			**27.08**				27.08
Malabar Spinach (Alugbati)		**19**			1	5	25.00
String beans	5	**9**		2.8	4.5		21.30
Lettuce		**10**	5.88	4.5			20.38

Figure 13: The table from the SEARCA-SHGP Final Report

To make successful coordination to root the garden in the school, the SHGP team also needed to address the physical presence of the garden. It is important to acknowledge that these gardens occupy a significant proportion of land within the school and would be required to be incorporated into the school's operation. Techniques associated with organic agriculture played a key role. While it was given since the beginning that the gardening process should be pesticide- and herbicide-free since all the children will have regular contact with the garden, UPLB scholars developed systematic knowledge and techniques of organic farming that was suitable for small-scale farming in the limited space in schools. These scholars also tried incorporating farming knowledge into other school

operations and curriculums. For example, the technique of solid waste management and organic compost making helped coordinate the circulation of solid waste within the school. These scholars also developed teaching materials that could incorporate organic agriculture into the school curriculum and utilize the school garden for teaching demonstrations.

Beyond these organic farming techniques, the infrastructural arrangement of the entire garden could also help maximize productivity and accommodate each school's material condition. For example, some schools also incorporated growing economic crops like mushrooms, aquaculture, or even livestock in their school gardens. Instead of directly providing vegetables to the school feeding program, they utilized the garden to gather some economic benefit and purchase additional food for the feeding program or support other school operations.

The final stage is coordination between the school and the local community. To sustain the school gardens' operation in the long term, the SHGP team made efforts to sustain the support from community members, particularly parents and officers of local government units (LGUs). The physical presence and manifestation of the gardens bring together these different "stakeholders" – a term typically used in development projects. Specifically, the SHGP team adopted edible landscaping in the garden design that pays attention to the productivity and aesthetics of the garden. The SHGP team considers the garden's aesthetics an important contributor to community engagement. The aesthetics attracted students

and members of the community to visit school gardens. During holidays and weekends, gardens may become a mini-park for families and groups.

Among all the "stakeholders," the SHGP team recognized school pupils' parents as critical and engaged with them in various garden activities. In one of the organizing workshops titled "Developing Scaling-up Strategies for the School and Home Gardens Project," the SHGP team also invited the parent representatives of the school Parent-Teacher Associations (PTA) to participate in the meeting. Parents were also involved in various garden activities, such as cooking competitions or maintaining the school garden. Some schools also distributed or sold gardening products to parents.

The SHGP team also purposely built connections between schools and the local government units (LGUs) to solicit their support for the garden's continued maintenance. In three of the eight workshops held by SHGP, different LGUs agencies or officials were invited to attend. These agencies included Municipal Agriculture Offices, Municipal Nutrition Action Offices, Municipal Social Welfare, Development Offices, Barangay Offices, representatives from the Barangay Officials, Barangay Nutrition Scholars, and Barangay Health Workers. Additionally, the SHGP team actively conducted consultative meetings with various LGU Offices at the provincial, municipal, and barangay levels where the pilot schools were located. These consultative meetings fostered the link between schools and the LGU's existing programs. For example, schools may receive

assistance directly from the municipal government on organic agriculture inputs such as seeds or equipment and training based on the Organic Agriculture Act (RA 10068). Some municipal agriculturists also included school gardens in the allotment of garden inputs and other relevant services or training for school pupils' families.

To sum up, the series of *coordination* between different actants and actors facilitated the "rooting" of the garden in that community – in both social and physical ways. The process also expanded the assemblage to include various stakeholders who help sustain and maintain the assemblage. Indeed, while the SHGP team only included five core members at the beginning, everyone who remained involved increased significantly at the end of the project. There were more than one hundred members in a Facebook Group for all the actors involved in the project. More striking is that, eventually, the success of SHGP seems not to rely on the analysis of the data they collect[73] but on this expanding assemblage continuously scaling up.[74]

[73] Based on my review of the SEARCA-SHGP Final Report, the statistical analysis showed that there was no statistically significant difference between experimental and control group schools on various nutritional indicators. I discussed this issue with the UPLB nutritionist, who was the Study Leader of Nutrition in the Team. She acknowledged that the reason may result from the original design of the project. Regardless, these statistical data did not appear in official publications and did not generate further discussions.

[74] The concept of SEARCA-SHGP is expanding from original six schools to their nearby schools. The SHGP Team have also involved in the national policymaking of school gardening ans is tasked to develop the School Gardening online course for the Department of Education.

3-3 The Golden Rice Project: continuous synchronization between gene expressions and societal expectations

The Golden Rice Project has attracted attention since researchers in the initial project announced that they successfully increased the provitamin-A ingredient in rice. According to Ingo Potrykus, one of the key researchers in the initial project, the project team explored how to genetically modify rice to increase the provitamin-A quantity in 1991. In 1999, the project achieved a breakthrough. Subsequently, in 2000, the project was transferred to the International Rice Research Institute (IRRI) in the Philippines. After several times of restructuring, when I carried out my fieldwork in 2018-2019, the Golden Rice Project was under a team titled "Healthier Rice Project," which was in charge of several genetically modified rice for micronutrients such as Vitamin A, iron, and folate. In 2019, the Healthier Rice Project announced that Golden Rice had passed the Philippines' official biosafety protocol and was only a step away from commercial use.

Yet, the key to the Golden Rice Project's success was not merely whether Golden Rice could pass the Philippines' biosafety protocol. More fundamentally, I argue that the success depended on whether the gene expressions of the GM rice variety could *synchronize* with societal expectations during the entire trajectory of development. These societal expectations from the public and regulators formed the “goals” for the Golden Rice team to achieve and guided the team’s efforts to “improve” the rice variety. Considering the process of situating technoscience as *synchronization* also indicates that technoscience of biofortification and societal

expectations are like two parallel pathways; getting technoscience situated means maintaining the synchronization of these two pathways.

Following the discussion, I also use the metaphor of "synchronization" to highlight the entire process's temporal and fragile aspects. As I demonstrate in this section, the Golden Rice team's challenges did not always come from technological difficulties. Instead, they usually originated from the Golden Rice Project's particular assumption of society or society's expectations of GM seeds. More critically, societal expectations do not always stay the same and could change over time. The "success" – the stabilized assemblage – only represents the moment when the Golden Rice variety's gene expressions could *synchronize* with all the societal expectations. It could not guarantee the next moment of the stabilized assemblage since the Golden Rice team could not control all these societal expectations and needed to respond to them constantly.

Meanwhile, the "gene expression" I discuss in this section is more than just the exogenous genes in Golden Rice. Most of the time, the discussion on GM crops focuses on the sequence of DNA inserted with the scientific procedure and how this sequence leads to corresponding gene expressions that transit the genotype into the phenotype or the observable trait. In the case of Golden Rice, there are two new DNA sequences – one from daffodil and the other from a kind of bacteria. These two new DNA sequences need to function together so that β-carotene (a precursor to Vitamin A) can accumulate properly in the rice's

endosperm. However, while the gene expression of the two new genes must meet scientists' and society's expectations, other pre-existing genes' expressions also impact whether the Golden Rice Project could succeed. The gene expression of other pre-existing genes also needs to *synchronize* with external expectations. The analysis, thus, pays attention to not only the presumably technoscientific breakthrough of GM seeds but also the materialities of other parts of Golden Rice and the Golden Rice team's other efforts, such as understanding consumer preferences or navigating governmental regulations.

The first type of *synchronization* happened when scientists tried synchronizing GM seeds' design with consumers' dietary preferences. When scientists designed the potential pathway to increase the amount of β-carotene in rice, they decided that the nutrient should be stored within the "kernel" (i.e., white rice) rather than other outer parts such as bran. It is essential to recognize that although brown rice (i.e., white rice plus bran) is frequently used as an alternative to Golden Rice (including the website of the Golden Rice Project), consuming brown rice could not address the issue of Vitamin A deficiency. Brown rice does not contain β-carotene or Vitamin A. Nonetheless, if scientists chose to develop a type of GM rice that could store β-carotene in the bran, the goal might be easier to achieve since the bran already contains other types of nutrients and minerals. But because scientists assumed that white rice was more (or the only) acceptable kind of rice for consumers, they set their goal of genetic engineering based on that

assumption, making it more challenging to develop the GM rice variety for Vitamin A.

In addition to consumers' preferences, the Project aimed to ***synchronize*** with farmers' farming practices and preferences. Two examples are particularly illuminating. One is about yield performance. The other is about the patent of seeds.

The Golden Rice Project has several critical moments of development. One was in 2004 when the project developed the updated version of Golden Rice, commonly denoted as GR2, with a much higher amount of β-carotene. There were thirteen events of GR2, which means thirteen rice seeds with slightly different DNA sequences. From 2004 to 2013, the Project focused on one of the events, GR2-R. But as reported by Adrian Dubock of the Golden Rice Humanitarian Board in his 2014 article "The present status of Golden Rice:"

> While the target level of beta-carotene in the grain was attained, the average yield was, unfortunately, lower than that from comparable local varieties already preferred by farmers. An important goal of the trials was to test whether the new rice variety's agronomic performance would be acceptable to farmers. The initial results indicate that more research is needed, with a greater focus on increasing yield. (81)

Because of the unsatisfactory outcome of yield performance, the Golden Rice team decided to explore other GR2 events. Eventually, GR2-E achieved yield

performance in 2017 and enabled the Golden Rice Project to progress to the succeeding stages. In short, the yield performance, not the amount of β-carotene, was why the Golden Rice Project had stalled for more than ten years. In the same article, Dubock elaborates on the rationale associated with the criterion of yield performance:

> For any trait, especially a consumer trait such as nutritional enhancement, commercial growers expect excellent agronomy. … Normally commercial growers adopt new crop varieties and traits only because of increased profitability, and or ease of cultivation or processing both of which have economic benefits. (81)

As Dubock indicates, the Golden Rice team's rationale was based on a particular assumption of "commercial growers" and their practices. This rationale became the primary obstacle for the Golden Rice Project to claim success. As the Golden Rice Humanitarian Board website states, "it would be very hard to convince a farmer to adopt Golden Rice just because of improved nutritional quality unless yield and other agronomic characteristics were at least as good or better than their best varieties." The same reasoning was also crucial when the Golden Rice Team began developing its communication strategy with farmers. For the Project's Development Communication (DevCom) team, yield performance was critical when introducing Golden Rice to farming communities. With the *equivalent* yield produced by Golden Rice, the DevCom team could tell the farming communities that they would not need to change any farming

practices or production procedures, and they could still get the same quantity of rice.

A similar rationale also applied to the issue of the patent. The Golden Rice Project had a vision regarding how technology for the poor should be developed. As Potrykus states in a 2017 article,

> "The public sector – not the private one – has the responsibility to develop GMO-crop projects specifically targeted at the needs of the poor. Ideally, the outcome should enable the poor to help themselves in dignity and sustainably, and with respect for their independence" (Potrykus 2017:91).

For this reason, the Golden Rice Humanitarian Board collected most of Golden Rice's patents for humanitarian purposes, enabling resource-poor farmers to grow Golden Rice varieties freely under certain conditions. More importantly, the Golden Rice seeds' patent arrangement allows it to be introduced to different locally-preferred varieties by traditional breeding, and "its agronomy, preparation, and taste will be the same" (Dubock 2013:6). The Golden Rice Project hoped that this new variety of rice could still have the same agronomic performance as the existing rice varieties. When farmers replace the old rice variety with Golden Rice, farmers don't need to change other farming practices.[75] For this reason, the final goal, as Dubock describes, is that "farmers will subsequently, initially using

[75] There is a limit for the humanitarian use of patent. The income of the farmer could not exceed a certain amount.

seed from their national seed supply system, be free to plant, harvest, save seed, and locally sell Golden Rice as they wish" (Dubock 2013:6).

The efforts of ***synchronization*** did not stop with farmers' assumed expectations; the issue of consumers emerged again. While the Golden Rice Project aimed to perform a technological "shortcut" to make farmers switch the rice variety they grow seamlessly, they need to make other efforts to meet consumers' expectations. One effort was to use traditional breeding techniques to transfer the new traits that the "prototype" Golden Rice variety possessed to different local varieties. These local rice varieties were more acceptable among consumers in different regions. To be specific, the Golden Rice team were obligated to spend extra time and resource to breed "localized" Golden Rice varieties and, at the same time, ensure that these local rice varieties still *synchronize* with farmers' expectations – that is, the yield performance.

Similarly, the Golden Rice team must ensure the Golden Rice variety can perform equivalently in other agronomic characteristics. For example, the Golden Rice team worked with Philippine Rice Research Institute (PhilRice) to perform sensory tests to ensure that cooked Golden Rice tasted the same as ordinary white rice and could meet all the quality standards. Eventually, similar to the Iron-Premix Rice Project, the Golden Rice Team's ultimate *synchronization* would be whether the Golden Rice seeds could synchronize with human bodies. This includes the biosafety test, which ensures that the consumption of Golden Rice

causes no extra harm to consumers, and the bioavailability test, which ensures that the expected efficacy indeed exists after the digestion of Golden Rice.

Other than consumers and farmers, Golden Rice's other crucial *synchronization* was with the environment; this was the basic idea of the field trial. While most of the earlier experiments happened in laboratories or controlled environments, the Golden Rice team eventually was obliged to grow Golden Rice in a real environment where the team could not control its condition. The Golden Rice Team conducted field trials in several locales[76] where Gold Rice seeds were expected to be grown. The field trial was a research process to ensure that the gene expressions of Golden Rice could *synchronize* with the uncontrolled environment, meaning to have the same agronomic performance as other traditional varieties. This was also the primary reason why the Golden Rice Project was transferred to the IRRI in the Philippines in the first place. The initial research team of the Golden Rice Project was based in Europe, where the Golden Rice varieties were not planned to grow, and consumers were not the targeted population.

One aspect that the Golden Rice fails to *synchronize* with societal expectations is the yellow color of the appearance. The yellow color was definitely not “substantially equivalent” to the appearance of the white rice. But it

[76] According to my interview with the Golden Rice Team, there were three field trial site. The primary one was in the province of Nueva Ecija, where the PhilRice headquarter was located and also the main rice producing region in the Philippines.

turned out to be the most illuminating example to demonstrate the temporal aspect of *synchronization*. The Golden Rice team made many efforts to re-frame the rice's color – hence the term "golden" – and was prepared to mobilize different resources to transform consumers' perception of yellow-color rice. But in recent years, the rise of heirloom rice, famous for its diversity of colors and rich amount of nutrients, provided a new "external expectation" for the Golden Rice Team. According to my interview with the Development Communication Team (DevCom) in the IRRI and PhilRice, the Golden Rice Team began to see and explore the potential to *synchronize* the gene expression of yellow color with the human expectations of colorful-healthy rice varieties. In other words, the rise of heirloom rice, which carries the opposite value to GM rice, may paradoxically help Golden Rice to meet consumers' acceptance and expectations

It is illuminating to compare the temporal and fragile synchronization as the configuration of the Golden Rice assemblage with the configurations of the Iron-Premix Rice Assemblage and the SEARCA-SHGP assemblage. The Golden Rice Project shares many similar epistemic elements with the Iron-Premix Rice Project. The Golden Rice team was required to carry out all the tests that the Iron-Premix Rice Project underwent. The basic goal of the Iron-Premix Rice Project was also to create the iron-premix that was substantially equivalent[77] to ordinary

[77] Substantial equivalence is the concept employed by the FAO to evaluate the food safety issues regarding genetically modified rice. The general idea is that "if a new food or food component is found to be substantially equivalent to an existing food or food component, it can be treated in the same manner with respect to safety (i.e., the food or food component can be concluded to be as safe as the conventional food or food component)" (FAO 1996).

white rice. And both projects encompassed a clear and singular problem to be solved.

But the different materialities of iron and exogenous genes – although they were both "added" to the original rice – pose distinct challenges to these two teams. The substance of iron seemed easier to manipulate and stabilize while manipulating DNA sequences was more complex and time-consuming. Indeed, the temporality embodied in these two projects was another key difference. For the Iron-Premix Rice Project, once the ethno-epistemic assemblage of the pathway was created and the project claimed its success with various awards, the assemblage soon became a "black box" that would not be examined again. But the prolonged temporality associated with the time-consuming aspect of gene manipulation contributed to the assemblage of the Golden Rice Project as a series of fragile synchronizations. When the assemblage could not become a black box, all the previous synchronizations were subject to reexamining and repeated challenges.

The comparison between the Golden Rice Project and the SEARCA-SHGP unveiled another fragility of the Golden Rice Project assemblage. While the *synchronization* in the Golden Rice Project seemed similar to the *coordination* in the SEARCA-SHGP, there was one stark difference. Coordination is when different actors and actants in the SEARCA-SHGP may change and modify to fit each other. More importantly, all of these actors and actants were brought into the

assemblage to help "root" the garden in the community. By synchronization, I argue that the Golden rice project did not intend to include other actors and actants in the project but only strived to self-adjust and meet societal expectations. For this reason, the assemblage of the Golden Rice Project would be more fragile than the assemblage of the SEARCA-SHGP.

3-4 The BeRICEponsible Campaign: constructing an imagined collective of brown rice-eating citizens

In 2013, the Philippines government announced December as National Rice Awareness Month and launched a series of national events encouraging the public to eat brown rice instead of white rice. This was the Philippines' latest governmental campaign focusing on eating brown rice since the country began to consume white rice in the 1870s. In 2014, directed by the Department of Agriculture, PhilRice officially established a Brown Rice campaign titled "Be RICEponsible." In Filipino, the title was "RICEponsible Ako," meaning "I am responsible.” The "Be RICEponsible" campaign was active for at least seven years until the end of my fieldwork in 2019.

From the beginning, the BeRICEponsible campaign operated in a direction different than the other three projects I introduced. While the campaign's core idea was based on the nutritional value of brown rice, brown rice as the key substance was not the campaign's main focus. Unlike the Iron-Premix Rice Project, the

campaign was not interested in creating a pathway to deliver brown rice from farmers to consumers. Similarly, the campaign did not aim to breed a new variety of rice that could seamlessly substitute original rice production and consumption, as the Golden Rice Project aimed to achieve. Likewise, the campaign differed from SHGP's community-based efforts and did not intend to bring the existence of brown rice into a specific community. Rather, the campaign was predominately focused on transforming consumers' behaviors from white rice consumption to brown rice consumption.

While the BeRICEponsible campaign intended to transform consumers' dietary habits, it did not target a specific group but aimed to directly address the entire population. To achieve the goal, the campaign's main agenda was to create conditions that attracted and supported citizens to consume brown rice. In this sense, the assemblage that the campaign constructed was the enabling environment that envisioned the existence of a collective of brown rice-consuming Filipinos. Meanwhile, although the campaign's strategy did not center on brown rice, technoscience associated with brown rice remained important in contributing to the assemblage of the enabling environment.

On the surface, promoting brown rice to consumers to improve their health seemed more than ideal. Processing brown rice requires fewer, not more, procedures and should be more straightforward compared with other "new" interventions. Additionally, consuming whole grains could absorb all kinds of

nutrients without extra effort to put specific nutrients back into the white rice. Yet, as the history of brown rice promotion in the Philippines shows, changing Filipinos' dietary habits was anything but easy, involving issues far more complicated than behavior change. As a result, the BeRICEponsible campaign's comprehensive efforts of creating the enabling environment could be seen as responding to the consumers' imagined or real needs.

The most important component of the BeRICEponsible Campaign was the media promotion that aimed to create consumer awareness. The Campaign spent time and energy designing attractive logos and promotional materials, including printed pamphlets and short videos. The catchy name, BeRICEPonsible, was one clear example. The Campaign also engaged heavily with celebrities and relied on their popularity to attract the general public's attention. These messages were disseminated from all kinds of media channels. Aside from traditional platforms such as TV shows, radio programs, and printed media, the Campaign maintained an active presence on Facebook, Twitter, and Instagram. Furthermore, they launched various short-term activities on social media to interact with consumers. For example, they launched the "RICEponsible Plate Challenge" and encouraged their Facebook Page followers to upload photos of their meals with brown rice. Browsing through content under the hashtag #RICEponsiblePlateChallenge, several hundred Filipinos joined the challenge and shared their photos (though brown rice is not always included in the photo).

On top of building up the social media portfolio, the media campaign reshaped consumer awareness with two distinct strategies – evoking individual responsibility and redefining the traditional rice-consumption culture. On the individual level, as the campaign title “BeRICEPonsible” illustrates, the campaign did not merely intend to encourage consumers to eat more brown rice. It began with evoking the "morality" of consumers. The campaign asked consumers to be *responsible* for four aspects. First, they were responsible for their health, so they should eat brown rice rather than white rice. Second, they also had the responsibility to help achieve the country's rice self-sufficiency because they were also citizens. Third, consumers also had the responsibility to be grateful to farmers and took action to support farmers. Buying brown rice was good support because farmers could get higher incomes. Four, consumers also had the responsibility to take care of other Filipinos. Buying brown rice could help lower the price and make it affordable to more Filipinos.

Figure 14: The BeRICEponsible Campaign promotional material – Brown 4 Good

In addition to constructing a new moral vision associated with consumers, the campaign also attacked the taken-for-granted rice-consumption culture on the collective level. For example, in promotional material, it says,

> "We Filipinos are rice eaters. We somehow feel deprived when we do not get to eat our favorite staple. And when we do, we indulge. 'Extra rice' excuses more expense. 'No rice, no rights,' militants

would even cry. We tend to disregard the health complications careless rice-eating could inflict on our body."?[78]

This quote shows how rice and culture were entangled and how the discourse intends to change the cultural practices of consuming rice. But what was more critical was to change the cultural image of brown rice. The Campaigns made efforts to invoke traditional culture to legitimate brown rice consumption. During a TV show, the Campaign director pointed out that "whiter doesn't always mean better, brown rice is even more delectable in goto and lugaw (porridge)[79]." Here she intended to connect brown rice with traditional Filipino cuisine to legitimate the consumption of brown rice. Another strategy was to refine the rice culture directly. For example, another promotional material uses "Redeeming the lost glory of brown rice" as the title to indicate that brown rice, not white rice, should be the real center of the Philippines' rice culture. Additionally, the campaign strategically aligned brown rice with heirloom rice, such as red rice and black rice, because brown rice may also be seen as *colorful* rice[80]. Although the promotion and popularity of heirloom rice came from different rationales irrelevant to rice self-sufficiency, on some occasions, the BeRICEponsible

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78 "Editor's Note," *The PhilRice Magazine*, Vol. 29, No.3, p.1.

79 The content of the TV show could be found via: https://youtu.be/---KM5XvbGU. Accessed date: 03/04/2022.

80 For example, in a campaign exhibit at a shopping mall in Cabanatuan (Nov. 19, 2017), the campaign organizers showcased different types of heirloom rice while promoting brown rice consumption.

campaign promoted them together and demonstrated that they all have nutritional benefits.

To construct the enabling environment for brown-rice-consuming Filipinos, it was not enough to merely address the cultural image of brown rice consumption. Accessibility and affordability were also critical issues. Indeed, the brown rice price and where to buy it became two key obstacles the campaign encountered at the early stage[81]. For accessibility, the campaign mobilized different resources to increase brown rice availability in rice stores and restaurants and reduce brown rice prices. They worked directly with the Philippine government and convinced it to be the "role model" of the campaign. As a result, the government released a policy announcement that required all government facilities and public schools to provide brown rice in their canteens. Following the same rationale, the campaign also mobilized different levels of local government units to encourage restaurants to provide brown rice in their cities. For availability, the campaign collaborated with the National Food Authority (NFA), the governmental agency in charge of rice import and price before the Rice Tariffication Act of 2019, to lower the price of brown rice. With NFA's support, the campaign claimed they had significantly reduced brown rice prices to the same level as white rice prices.[82] Furthermore, the campaign also reached out to some local farmer cooperatives. It worked with them to reduce the cost of producing brown rice or connected farmers directly

[81] See ”Redeeming the lost glory of brown rice,” *The Philippine Daily Inquirer*, Dec. 07, 2014.
[82] “Brown rice made affordable.” PhilRice Website: https://www.philrice.gov.ph/brown-rice-made-affordable/. Access date: 03/03/2022.

with restaurants to lower the price.[83] To be sure, all these efforts did not happen in all the rice stores and restaurants in the Philippines but mainly centered on certain major cities. Nonetheless, the official announcements and media reports of these efforts contributed to the *prospect* that a collective of brown rice-consuming citizens could be emerging all over the Philippines because of the enabling environment created by the campaign.

Technoscience was also crucial for the campaign to construct the enabling environment for brown-rice-consuming Filipinos. To some extent, the technoscience around brown rice characterized what STS scholar David Hess termed "undone science" (2016). From the aspect of brown rice production to the aspect of consumption, very few technologies, knowledge, and techniques existed before the campaign. The BeRICEponsible campaign engaged with various research centers to develop different knowledge, technology, and techniques; these technologies and knowledge centered on lowering the barrier and increasing consumers' willingness to consume brown rice. To begin with, the campaign facilitated research on traditional rice breeding. The aim was to select rice varieties that could provide better taste and texture when consumed as brown rice.[84] To improve the taste of brown rice, the campaign also worked with nutritionists within PhilRice to develop cooking tips and new recipes.[85] Cooking

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83 See *the PhilRice 2014 R&D Highlights*.
84 "PhilRice pushes for brown rice," The PhilRice Magazine, Vol. 29, No.3, p.11.
85 "Brown rice recipe book launched." PhilRice Website: https://www.philrice.gov.ph/brown-rice-recipe-book-launched/. Access date: 03/03/2022.

tips were especially crucial because the cooking of brown rice requires more water and a longer time, which means consumers need to modify their cooking habits. Even more fascinating was the campaign's promotion of the study on germination and how it may simplify the cooking process, increase nutritional benefits, and improve the bioavailability rate. This type of germination research was not well-developed before the campaign initiated the research because only brown rice has bran and germ and has the potential to germinate.

The “undone science” situation also appeared in another key issue – how to ensure the food safety of brown rice consumption. Among all the disadvantages of brown rice, food safety was crucial. Brown rice was known for its shorter shelf life. Under the Philippines' humid weather conditions, it was especially prone to grow aflatoxin, which could cause cancer and other diseases. This issue also increased the cost of brown rice consumption because consumers were required to either have better equipment to store brown rice or buy a small quantity of brown rice at once, which was usually more expensive. The campaign, thus, looked into different ways to deal with the issue. One approach was to develop a new post-harvest and packaging process that allows brown rice to have a longer shelf life. Another approach was to reduce the cost of the smaller packaging of rice. To achieve this goal, the campaign went upstream and reconsidered the milling process. The campaign began to work with the Philippine Center for Postharvest Development and Mechanization (PhilMec) to develop a new milling machine. At the same time, another team in the PhilRice also developed their milling machine.

Before the end of 2019, the prototype of two types of milling machines had been developed. Philrice developed a village-scale milling machine, much smaller than the current milling machines for white rice and suitable for localized production and retailing of brown rice. The collaboration of the BeRICEponsible campaign and PhilMec also developed a pedal-style milling machine to target households. The ideal scenario for this type of milling machine would be that households mill their brown rice whenever they plan to cook it. Most of the "undone technoscience" – either for brown rice's taste or post-harvest processing – took a long time to actualize. Similar to the campaign's efforts on brown rice affordability and accessibility, what was important was how these efforts on "undone technoscience" all gestured toward a prospect that brown rice consumption could be common and ordinary for brown-rice-consuming Filipinos.

Figure 15: The prototype of the village-scale milling machine developed by PhilRice

Figure 16: The Pedal-Type Milling Machine

Although encountering the challenge of validating the success[86], the campaign was a very long-living social campaign compared with similar campaigns launched by PhiliRice or other organizations. One unforeseen evolvement was that the BeRICEPonsible campaign gradually became a *platform* with flexible agendas. Whenever the government plans to deliver other health-related messages regarding rice consumption, they would deliver it through the pre-existing platform of the BeRICEponsible campaign, though usually without those comprehensive efforts I went through in this section. This transformation from a brown rice campaign to a platform for other rice-related campaigns demonstrated how the campaign successfully created the assemblage of the enabling environment that seemed to be able to reach out and mobilize the Filipino public.

A further comparison with the three agrifood projects I analyzed so far in this chapter would clarify the nature of the BeRICEponsible campaign, especially regarding the role of technoscience in the campaign. By juxtaposing the campaign with the other two rice-based projects, we could hypothetically image brown rice projects that mirror the configuration of the Iron-Premix Rice Project or the Golden Rice Project. We may consider a brown rice project that primarily focuses

[86] When I discussed with then-campaign director about the campaign's various efforts to promote brown rice in 2017, she also acknowledged that, as a national campaign, it was challenging for them to evaluate their success. They also did not have data regarding how much more brown rice was consumed because of the Campaign. Thus, in opposite to other projects, the campaign moved to "scale down" and began a project in a particular municipality as a way to evaluate the effectiveness of their campaign. Nonetheless, judging from all the initiatives I mentioned in this section, even the locale-specific experiment could not properly evaluate the Campaign's impact.

on developing and promoting a new rice variety that tastes better as the brown rice format – then the assemblage may resemble the Golden Rice Project. Or we could consider another brown rice project that creates a different type of rice supply chain based on a newly-developed small-scale milling machine – this would operate similarly to what the Iron-Premix Rice Project did when it engaged with private businesses and community rice millers. By contrast, the singular focus on the public led the campaign to formulate a rather different configuration of the assemblage. Interestingly, when comparing the BeRICEponsible Campaign with the School-plus-Home Gardening Project, we see that, although they operated on a different scale – one in a national policy arena and the other in a specific community, they shared a similar rationale. While the School-plus-Home Gardening Project team coordinated with different actors to root the school garden in the community, the BeRICEponsible Campaign worked with various government units, public research centers, and private businesses to *materialize* the prospect of a brown rice-consuming public in the policy arena. The most significant difference between the BeRICEponsible Campaign and the previous three projects was the condition and positioning of technoscience. For the BeRICEponsible Campaign, getting technoscience situated often means generating context-specific technoscience that has not yet existed. The "undone science" situation is even more noticeable in the next project I will discuss.

3-5 The Moringa Industry Development Initiative: exerting creating win-win scenarios to broaden the support

Moringa has been a traditional plant in the Philippines for centuries, but not until around 2010 did the large-scale production of moringa take off in the Philippines. This was mainly facilitated by a foundation called the Moringaling Foundation Philippines Inc. (MFPI). As the MFPI website states, the foundation's official purpose was "to promote moringa's health and economic benefits, thereby providing a platform for the people's fight against malnutrition and poverty, especially in agricultural areas.[87]" While MFPI aimed to promote moringa as the solution to malnutrition and other social issues in the Philippines, the foundation envisioned that creating a moringa industry that could support large-scale production of moringa was key to achieving the goal. Based on this purpose, MPFI's mission was to "be the moringa umbrella organization in the Philippines connecting all stakeholders and working together for a sustainable and globally competitive industry.[88]"

In this section, I center on MPFI's moringa industry development initiative[89] as a unique solution to malnutrition. When the MPFI members considered the moringa industry – not merely the moringa tree – as the solution to malnutrition, they assumed that scaling up production and consumption was key to tackling

[87] See the MPFI website: http://moringaling.global/. Access date: 03/03/2022.
[88] See the MPFI website: http://moringaling.global/. Access date: 03/03/2022.
[89] The MPFI does not officially use "moringa industry development initiative" as the project it worked. This term is my conceptualization of their actions.

malnutrition. With this shift of focus from moringa trees to the moringa industry, MPFI employed multi-dimensional efforts to construct an assemblage of the *industry* and engaged with policymaking, traditional culture, farmers, consumers, the global superfood boom, and technical procedures. This section points out that all MPFI's efforts followed the rationale of envisioning multiple win-win scenarios that could broaden stakeholders to construct the industry assemblage.

The operational logic of the win-win scenario is profit-driving and business thinking. Based on the basic economic principle, any economic exchange happens only when two parties perceive they could benefit from the exchange – they both think they are better off than their situation before the exchange. Following this logic, when MPFI strived to create win-win scenarios as a strategy to develop the moringa industry, the basic assumption was that, while the project aimed to solve the issue of malnutrition, all the stakeholders contributing to the project should also benefit from promoting moringa, including the MPFI members' business.

The pursuit of the win-win scenario became one major difference between the MPFI's moringa industry development initiative from other agrifood solutions I discussed in this chapter. While the MPFI members positioned moringa promotion as the best solution to malnutrition as a social problem, they considered it equally important that all the social groups involved could benefit from their contributions to solving this social problem. In contrast, profit-making

or economic benefit was not the core issue for the other projects I analyzed in this chapter.

Yet, it is important *not* to reduce the rationale behind win-win scenarios to economic interest and simplify their practices as merely pursuing their self-interests. I considered that many of the MPFI members I encountered genuine about contributing to the cause of utilizing moringa as a solution to malnutrition. For example, during our interview, one of the primary business owners in the moringa processing industry mentioned that she has been sharing how to build a processing plant with other interested people. Based on my understanding, her rationale was grounded in the understanding that the Philippines needed to cultivate a collective power of business to expand the capacity of moringa production in the Philippines and compete with moringa producers in other countries. In short, rather than centering on individual practices, I am more interested in how the "win-win scenario" as a collective mindset and logic guided MPFI to roll out its actions, including its ongoing efforts and projected best scenarios.

MPFI was a loosely connected organization created by several retirees. Although established only in 2009, MPFI has undergone various changes in the past decade. The most important figure was Bernadette Estrella Arellano, recognized by other promoters as "the queen of moringa" in the Philippines. Arellano belongs to a local political family and has also been the mayor of a small

town in central Luzon. With Arellano's charismatic persona and her connections to different agencies, she mobilized different resources to promote the development of the moringa industry. In 2013, MPFI co-held the 1st *International Moringa Symposium* with the International Society for Horticultural Science. The event was supposed to be the milestone of MPFI's development in the Philippines. However, the event led to the organization's restructuring and a few years of inactivity because of unforeseen factors[90]. MPFI gradually resumed its activity in 2017, especially in policy advocacy. In recent years, MPFI also facilitated the organizing of the *National Moringa Congress*, which serves as a get-together and educational event for all the stakeholders interested in moringa. During my fieldwork, some of MPFI's active members were companies that produce moringa products. Other members include farmers, potential farmers, processing companies, scholars who research moringa, and friends of some active members.

The 6th *National Moringa Congress* in April 2019 was held in the middle of MPFI's efforts to develop the moringa industry, exemplifying its rationale and strategy. The theme of the event, "Produce, Promote, Process Malunggay: A Solution to Malnutrition," illustrated how MPFI upheld the creation of the moringa industry as the solution to malnutrition. As Figure 17 demonstrates, during the summary section of the event, the presenter also reiterated the key

[90] A typhoon hit the Philippines right before the event began, which prevented many international participants from arriving in the Philippines, and, subsequently, incurred a huge deficit for the organization's budget. The incident also created a significant setback to the development of the organization.

points of MPFI's efforts. While the presenter highlighted the high child stunting rate, he associated the issue with national economic loss. To solve the problem, the presenter stressed the uniqueness of moringa as a superfood and concluded the event by calling for all the event participants to "let us build the moringa industry together."

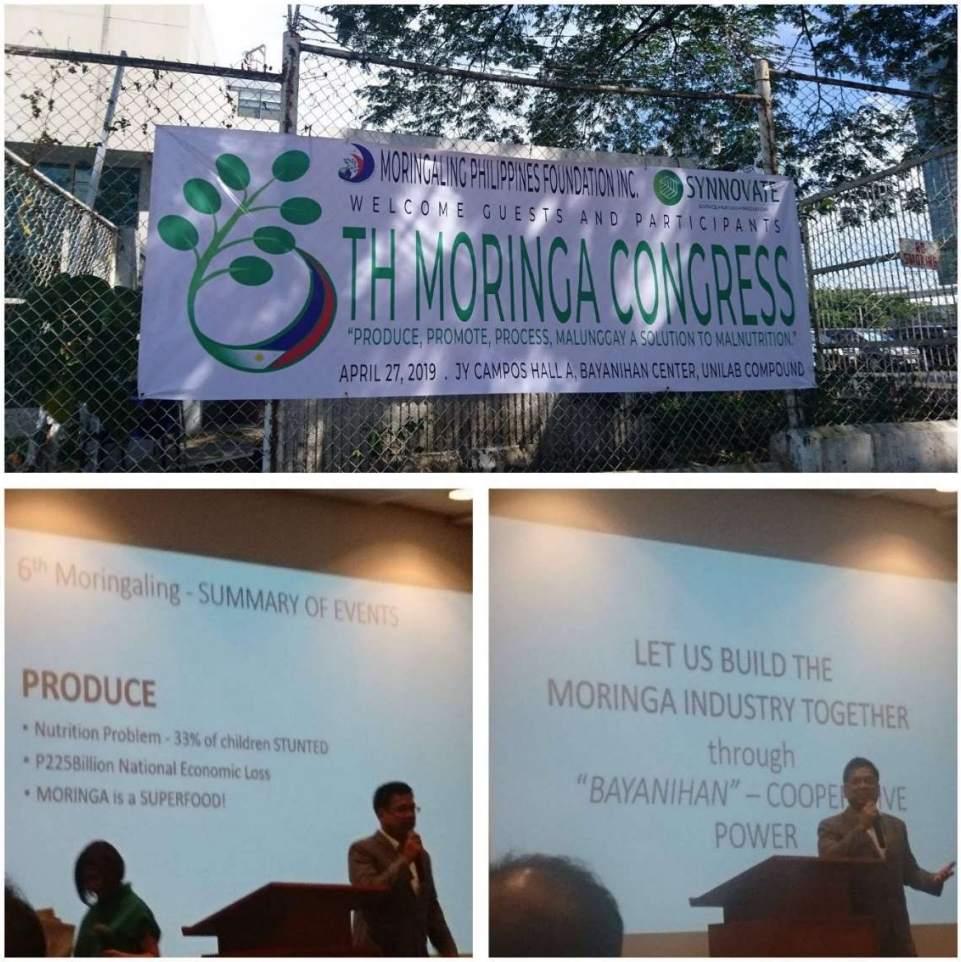

Figure 17: A collection of photos from the 6th Moringa Congress

The unique positioning of moringa in the traditional Philippine culture constituted the primary challenge and opportunity to create a moringa industry. Moringa has been used in local communities all over the Philippines for centuries. Until today, moringa is still the most commonly used medicinal plant in the Philippines. According to *The Philippine Traditional Knowledge Digital Library on Health*[91], these communities utilize all the parts of the moringa tree, including bark, roots, leaves, and dry seeds; they also use moringa for a wide range of purposes, from snakebite to high blood pressure to antifertility. Indeed, the Philippine nutrition community has long been aware of moringa's medicinal value and has developed nutritional interventions utilizing moringa trees since the early twentieth century. At the same time, the Philippine government has also included moringa in their policymaking several times. As I mentioned in Chapter Two, in 1930, the government encouraged households to grow moringa trees in their backyards as a source of vegetables. In the 1970s, after the global energy crisis, the government promoted growing moringa trees in schools to supplement the feeding programs. In the 1990s, to tackle micronutrient deficiency, the Philippine nutrition community selected moringa as one of the three strategic vegetables that could increase the consumption of micronutrients. The government further tasked the Philippine Nutrition Foundation to study effective social marketing and campaign for moringa consumption. Indeed, even FNRI – the most important

[91] The background information and the online database of the *Philippine Traditional Knowledge Digital Library on Health* could be accessed via https://www.tkdlph.com/

public research center on nutrition interventions – uses moringa as its logo to represent its work, as shown in Figure 18.

Figure 18: The Logo of the Food and Nutrition Research Institute.[92]

Yet, none of the efforts was to create an industry. To navigate the traditional culture and all the previous policy legacies embedded in moringa, the MPFI members employed three inter-related efforts to build up an assemblage of the moringa industry, which corresponded to three challenges. The first was consumers who did not think of moringa as products worthy of buying; the second was farmers and producers who did not think it was profitable to grow moringa trees; the third was governmental agencies that did not support the institutional building of the moringa industry. When MPFI strived to develop win-win scenarios between their interests and potential consumers, prospective

[92] All the research institutes under the Department of Science and Technology (DOST) have the same outer part of the logo – the four half-blue and half-black circles. The only difference between these research institutes' logos is the figure they use at the center of the logo. In other words, moringa is symbol that the FNRI chooses to distinguish itself with other DOST research institutes.

farmers and producers, and government policymakers, “malnutrition” became one connecting point among these different social groups and one potential source of “benefits.”

Consider consumers. While Filipinos were familiar with moringa's medicinal effect, they normally regarded moringa as the "backyard tree" that should be easily accessible without monetary expenses. Households normally utilize moringa leaves as vegetables and cook moringa leaves with other food materials[93]. Based on this practice, households tend to source moringa leaves freely, either from their backyards or nearby. To counter this traditional practice, the MPFI focused on the materialities of moringa and the format of moringa-based products to reshape how Filipinos utilize moringa. To begin with, MPFI tapped into the popularity of moringa as a superfood in the global market to rebrand the cultural image of moringa (See Figure 19 for an example). It advocated that malnourished people, especially children, should consume a more extensive amount of moringa to enjoy its medicinal benefit. Following this argument, ten small leaves in a dish were far from enough for moringa to be effective. In contrast, the MFPI advocated that moringa leaves must undergo a post-harvesting process to become a product with more nutritional values – a twist to the common meaning of “value-added” in business terms. The MPFI members utilized various approaches to achieve the goal. The most common one was the

[93] One common dish that includes moringa is the chicken soup.

supplementation of moringa powders in different food products, including dry noodles, instant noodles, bread, or instant drinks. Another type of products that may have better health benefits would be moringa tea, which was also based on the powder form of moringa leaves but resembled other herb tea. An even more "sophisticated" type of product was capsules containing pure and organic moringa leaf powders or the oil extracted from moringa seeds. This type of products resembled vitamin supplements; with the much higher quantity of moringa, consumers can supposedly enjoy the medicinal impact of moringa more effectively.

Figure 19: A collection of moringa-based products manufactured by Filipino companies

One particular proposal floating among the MPFI members was about malnutrition among Filipino school children. During several internal meetings and public events, some members discussed whether it was possible to persuade the Department of Education to include “moringa capsules” as an essential component of their school feeding programs. I still recall a sense of excitement circulating in the meeting room when the question was raised because, if this policy could be pushed through, it would be a magnificent boost to the Philippine moringa industry!

This policy proposal had several benefits for the MPFI members. First, it transformed the government from a passive supporter into an active consumer. Second, it presented one concrete example of a win-win scenario. By providing moringa capsules to malnourished children via the educational channel, the MPFI members could get hold of a stable domestic market. Meanwhile, they believed those moringa capsules would also be the best solution to malnutrition among school children due to the rich nutrients in moringa capsules. Finally, the policy proposal would also popularize the "capsule” format of moringa and reshape the cultural image of moringa in the Philippines.

Consider farmers. The traditional culture also affected how farmers may see moringa as high-value crops and be willing to turn their lands into moringa farms on a larger scale. The MPFI members envisioned another win-win scenario to

address the supply-side issue. They advocated that the goal of achieving farming households' prosperity and maintaining a stable supply of raw moringa leaves and seeds for moringa processing companies was the perfect solution to each other. Under this scenario, farmers would have a stable income by growing moringa trees while moringa-based food manufacturers could have enough raw materials.

One key element that made this scenario work was the adoption of organic farming. The development of organic agriculture in the Philippines was closely connected with the natural food movement in the early 2000s. Organic products have been portrayed as healthier than conventional food (Montefrio 2020; Montefrio et al. 2020). From this perspective, the organic farming label resonates well with moringa's superfood status and provides additional advantages for moringa export. Furthermore, the MPFI also worked closely with the transnational organic certification regime [94] to make it even easier for cross-border organic certification. The premium generated by organic moringa export and the emerging domestic organic agriculture market become the basis of the win-win scenario between moringa businesses and farmers.

[94] The MPFI has a close relation with a transnational certification company called the Control Union.

Figure 20: The entrance of JPM Eco-Farm, which highlights various organic certifications across the globe

The MPFI members developed different types of capacity-building opportunities for farmers. One example was the training program developed by the MPFI founder Bernadette Arellano. She utilized her moringa farm to establish "the Accredited Training Program for Organic Moringa Production" under the Agricultural Training Institute (ATI), Department of Agriculture. ATI was the main extension arm of the DA, and Arellano's training site was the only one for moringa production in the Philippines. This accredited training site for the organic production of moringa provided a free 3-day training program sponsored by the ATI and operated by Arellano's farm staff and other MPFI members. I attended the training program at the end of 2019, and the participants came from both local areas and other regions of the Philippines. Many of them were planning to start

their moringa farm. They may have their land or come from other industries but dream of making a living with organic moringa production. After the training program, MPFI invited these potential farmers to join the MPFI. In other words, the training program also served as a channel for MPFI to expand its organization and the industry assemblage.

Consider the policy arena, which represented MPFI's predominant efforts and intersected with their focus on consumers and producers. The MPFI members had contacted the Philippine Congress members to promote bills that could increase the popularity of moringa consumption and support moringa production. The first attempt was promoting a bill that proclaims moringa as "the national vegetable," which may increase the visibility of moringa and elevate its status as a mundane vegetable. The rationale behind this bill was exactly based on the Philippine society's familiarity with moringa. Nonetheless, the bill failed because of opposition from other agricultural sectors.

In 2018, the MPFI began to mobilize another bill that recognizes moringa as a high-value crop, joining other well-known crops such as coconut and sugarcane in the Philippines. From the policy perspective, designating moringa as a high-value crop will guarantee much more funding for research and development, solicit collaboration with other government agencies, and facilitate the institutionalization and regulation of the moringa industry. Similarly, the rationale

that moringa may become an economic crop similar to coconut was based on the already prevalent existence of moringa trees in the Philippines.

The MPFI's mobilization for the moringa industry made some substantial progress. The mobilization prompted Congress to request an assessment of the economic potential of the moringa industry from the Department of Agriculture (DA). The DA then assembled a "technical workgroup" and invited different stakeholders to craft a "Moringa Industry Development Roadmap.[95]" The MPFI and its members comprised a significant portion of the technical group. The process of creating the document titled *the Malunggay Industry Roadmap (2019-2024)* also helped the MPFI connect to all the stakeholders and resources about moringa in the Philippines. In this document, the technical workgroup argued that public investment in the moringa industry could lead to better agricultural development and healthier citizens. Especially, moringa consumption was easy and cheap enough to solve various types of non-communicative diseases and the issue of micronutrient deficiency. In short, the document envisioned a win-win scenario between society's benefit and MPFI's interest.

Another aspect of policy mobilization was the lack of a regulatory regime. When I did my fieldwork, only a few official regulations companies could rely on to develop and validate their products. This included "the Philippine National

[95] The document of the Roadmap could be accessed via: https://docs.google.com/document/d/1p7_EpUp9Mn7Qjc3_z43JMd9LgH62RPXYKIg_Knia_y4/edit

Standard (PNS) for Malunggay Powder" and "the Protocol for Post-Harvest Processing." In comparison, this created a stark difference from the regulatory regime that the Golden Rice Project encountered. And according to my discussion with the MPFI members, the lack of regulations and standards did not mean that they could act freely as they liked but would only undermine the credibility of their products and the public's confidence in the medicinal effects of moringa.

Nonetheless, before the government could establish standards and regulations, there needed to be enough research on related issues, and this was also what the MPFI found lacking. The MPFI intended to look for collaborations with research centers and universities on basic research on moringa, including its medicinal effects and production techniques. In 2020, the MPFI finally signed the memorandum to collaborate with the Central Luzon State University for the agronomic research of moringa, which characterized a significant step forward but also indicated how difficult it was for them to mobilize research support compared to their policy advocacy or other innovation projects' research partnership.

Similar to the BeRICEponsible campaign, for MPFI to get technoscience situated means the efforts to generate context-specific technoscience. The context-specific technoscience intertwined with the three win-win scenarios MPFI intended to develop. For consumers, several issues remain unstudied. For example, there is no data regarding the bioavailability rate of moringa-

supplemented products. More critically, while some people raised concerns that moringa leaves may be prone to have high concentrations of heavy metals if growing in a polluted location such as along a major road, there has never been comprehensive studies about this issue. For farmers, there is also no established protocol or procedures that could increase the yield of moringa leaves or be resource-efficient. The difference between the BeRICEponsible campaign and MPFI was that, because of its positioning as an organization outside the public sector, it was difficult for the MPFI members to secure research support from public research centers in the Philippines. I pick up this issue again in the next chapter.

While it may be unusual to see MPFI's moringa industry development initiative as a development project, MPFI's effort to build up an industry assemblage speaks to other projects' assemblages in various ways. The idea of a win-win scenario is similar to SHGP's assemblage based on a series of coordination. Although these two projects worked on starkly different scales, they shared a similar goal to build up the assemblage by expanding the involvement of actors. From this perspective, the idea of win-win scenarios may be a specific way to facilitate coordination. By contrast, for SHGP, without the driving force of the market logic, the series of coordination was mainly based on other kinds of institutional forces, such as the organizational format of the development project, the policy mandate to connect the school gardening operation to the feeding program, or the policy to promote organic agriculture in the community level.

Additionally, MPFI was not the only project concerning the agrifood industry. Both the Iron-Premix Rice Project and BeRICEponsible campaign involved particular agrifood industries. Yet, these two projects' assemblages mainly worked on fitting in or bringing in support of the existing industries rather than transforming or creating a new agrifood industry. It would be illuminating to imagine what may be done if the effort was to target the industry directly.

Conclusion

This chapter analyzes how agrifood solutions materialized from abstract ideas to operational projects and the positioning of technoscience in the process. I argue that each agrifood solution has a unique configuration of ethno-epistemic assemblage. Table 3.1 summarizes the takeaways of this chapter.

Table 3: Epistemic and ethno components and the configuration of each project

Agrifood project	Epistemic	Ethno	Configuration of assemblage
The Iron-Premix Rice Project	- technology, technical procedure, and equipment to produce iron-premix and iron-fortified rice - market trial - storage test - cooking test - sensory analysis test - bioavailability test	- a metallic taste of iron-premix - consumers' preference for purchasing iron-fortified rice - Filipinos' way of storing and preparing rice - food safety concerns - the current structure of the rice-milling industry and the capacity of the mechanical and chemical industry	Pathway with multiple gateways
The School-plus-Home Gardening Project	- quasi-experimental design of the project - knowledge regarding organic agriculture - equipment and techniques for gardening	- the organizational structure of a development project - institutional and physical aspects of the school - the community where the school was located - community members	A series of coordination to root the garden in the school and community

The Golden Rice Project	- a series of crop breeding, including genetic modification and traditional breeding - sensory analysis test - bioavailability test	- consumers' dietary preferences - existing farming practices - consumers' impressions associated with the color of rice - locales that grow rice	Fragile synchronization between gene expressions and societal expectations
The BeRICEponsible Campaign	- historical knowledge about brown rice - new types of milling machine - cooking tips and recipes for brown rice - germination-related science	- the taste of brown rice compared to white rice - cultural perception of brown rice - Filipinos' cooking practices associated with white rice - Filipinos' common habits of storing rice	Constructing an enabling environment for the possible existence of brown-rice consumers Filipinos
The Moringa Industry Development Initiative	- scientific research on moringa regarding its nutritional values and food safety concerns - technical procedures and growing techniques for moringa production - regulatory guidelines for moringa-related products	- cultural image and traditional food practices of moringa - consumers not interested in buying moringa-supplemented products - farmers not interested in growing moringa - the government not believing in moringa as a high-value economic crop.	Crafting win-win scenarios between the business and farmers, consumers, and the policy arena to construct a moringa industry

The table shows that the assemblage of each agrifood solution has a unique configuration involved in various types of epistemic and ethno components. For the Iron-Premix Rice Project, the assemblage was a pathway from the production of iron-premix to the digestion of iron in human bodies. Multiple gateways existed in this gateway, each representing a specific condition that called for a particular kind of technoscience. For example, Filipino people's ways of preparing rice required a cooking test to evaluate whether iron-premix could sustain the process. For SEARCA-SHGP, the assemblage that "rooted" the garden in the school and community was constructed through a series of coordination that brought in various actors, including development agencies, academia, governmental agencies, school officials, teachers, parents, and community members. Two distinct types of technoscience were intertwined in these

coordinations. The first one was gardening-related techniques, knowledge, and equipment. The second one was the data collection about gardening products and students' nutritional status for the quasi-experimental design of the project. For the Golden Rice Project, the assemblages involved continuous synchronization between gene expressions and societal expectations along the rice breeding process and over time. While crop breeding, including traditional methods and genetic modification techniques, was the main technoscience embedded in the assemblage, the goal of these breeding experiments was to enable golden rice to fit into a specific social context of rice production and consumption to replace the original rice variety seamlessly. For the BeRICEponsible campaign, which centered its efforts more on consumers than brown rice, the assemblage was the enabling environment that could give rise to the possible existence of brown rice-consuming citizens. All the technoscience involved in the assemblage was oriented toward creating this enabling environment, such as the pedal-style milling machine or the new cooking procedure. Finally, for MPFI's Moringa Industry Development Initiative, the assemblage was a structure of the moringa industry that brought together private businesses, farmers, consumers, and the government with the proposal of various win-win scenarios, which indicates that all the stakeholders involved in developing industry should be able to receive profit or benefit. Technoscience was supposed to be a key component in each win-win scenario, including technical procedures of organic moringa farming, the

evidence of nutritional benefit and food safety concerns for consumers, and the regulatory standards for moringa products.

This chapter constitutes the second component of the problem-solution analytical framework. Building on the last chapter's historical analysis of problem-solution constellation, this chapter creates another dimension of analysis by examining the development trajectories of these coexisting solutions. This dimension of the analysis speaks to two opposite scholarly theses regarding how solutions connect to a specific social problem and contributes to framing the STS problematization framework. On the one hand, STS scholars working on the problematization framework suggest the co-production of formulated problems and a corresponding solution (Laurent 2017; Callon 2003). On the other hand, scholars employing the concept of techno-fix or solutionism stress how techno-solution promoters often tailor problems to fit their preexisting solutions (Morozov 2013). In response to these two theses, this chapter draws on the concept of situated technoscience and ethno-epistemic assemblage to show how each agrifood solution was actualized as an operational project following a unique development trajectory to form a particular configuration of assemblage. This chapter suggests that, while these agrifood solutions possessed their agency of development regarding the problem they responded to, they were also constrained by structural and material conditions and were not freely choosing the problems they intended to target.

This chapter's assemblage analysis also sheds light on the practical-critical divide in the scholarship of development solutions I discussed in Chapter One. For critical development scholars, this chapter complicates the scholarly understanding of technology by theorizing two opposite types of situated technoscience. I term the first type of technoscience "context-expanding." This type of technoscience usually serves as the core of agrifood solutions, such as genetic modification techniques in the Golden Rice Project, the technical procedure of fortification in the Iron-Premix Rice Project, or organic gardening practices in SHGP. During the process, when solutions were actualized as operational projects, project teams needed to expand the scope of the core technoscience so that the core technoscience could work in a specific context. In the case of the Golden Rice Project, the expansion of the scope referred to conducting biosafety and sensory tests and creating local varieties of golden rice. These context-expanding techno-practices not only proved golden rice's efficacy but also ensured that farming practices and environments could maintain "substantial equivalence" with the condition before the adoption of growing golden rice. In the case of SHGP, the context-expanding techno-practices associated with organic gardening techniques included building the small-scale greenhouse, developing the localized growing calendar, designing the school-based procedure of solid waste management, and teaching materials of organic agriculture. These context-expanding techno-practices helped connect the gardening operation and the school operation and contributed to the school

garden's long-term sustainability. The idea of "context-expanding" technoscience helps underscore the fact that, when technoscience is adopted as a solution, it usually becomes more complicated and extensive than its original form.

By contrast, I term the second type of technoscience "context-generating." This type of technoscience may not be deemed important or even exist before the agrifood solution's materialization. Examples include the Iron-Premix Rice Project's rice blending machine, the BeRICEponsible Campaign's pedal-type milling machine, and the large-scale growing techniques of moringa trees. This type of technoscience became meaningful to be developed only through the configuration of a particular assemblage. In the case of the Iron-Premix Rice Project, the project team developed the rice blending machine to fulfill its vision of how iron-fortified rice could be produced, commercialized, and delivered to consumers on a larger scale. In the case of the BeRICEponsible Campaign, the project team considered the pedal-type milling machine a perfect tool to address consumers' concerns on food safety issues, particularly regarding aflatoxin, and to align with the campaign's target of obesity and non-communicative diseases. The idea of "context-generating" technoscience helps direct critical development scholars' attention to the less noticeable type of technoscience developed during the actualization of agrifood solutions. It may further push scholars to re-theorize their critiques on techno-based solutions.

For practical scholars, the analysis in this chapter also provides a new understanding of "the catalog of solutions" that I brought up in Chapter One. Practical scholars usually consider the catalog of solutions as just a list of static projects that could be mobilized anytime when being selected by policymakers. From the assemblage perspective, policymaking is only one aspect of the assemblage. Policymakers did not "select" projects from their catalogs; each project brought policymakers into their assemblages in specific ways. The most straightforward example came from the Golden Rice Project. The entire process of getting the governmental approval encapsulated its effort to enroll policymaking into the assemblage. Similarly, SHGP collaborated with governmental agencies and tapped along a particular policy to carry out its school gardening project. This connection with the policy and governmental agencies also became the basis when SEARCA intended to intervene in expanding the original policy. In contrast, MPFI chose to engage with Congress to craft policies that could facilitate the development of the moringa industry as a solution. Following the same logic, projects that were not included in the policy solution may not be because they were not viable options but may only indicate that they did not bring policy components into their assemblages and, thus, were not visible from the policymaking perspective.

This new understanding of the catalog of solutions as polyphonic assemblages helps reconsider how the project may scale up in a different context. For practical scholars, project scaling-up usually means that policymakers or development

practitioners “select” a solution to implement in other contexts or expand the project's scope. Yet, from the perspective of assemblage analysis, the key to “policy implementation” may be the strength of the project assemblage, especially whether the project team could mobilize and re-configure the assemblage and bring in policymakers in another context to the assemblage. In the concluding chapter, I will continue this aspect of discussion when I introduce these agrifood projects’ potential scaling-up plans.

Chapter Four
Infrastructuring Problematization

Introduction

Figure 21: Seminar-Workshop on Understanding Food Fortification

In late June of 2019, I traveled more than 10 hours from my residing city at the time, Los Baños of the Laguna Province, to attend a regional seminar titled "Seminar-Workshop on Understanding Food Fortification" in Lingayen city of Pangasinan, a province in Central Luzon and six hours of bus away from the north of Metro Manila. This seminar was about food fortification and was held by the regional office of the Department of Science and Technology (DOST) as a part of their service to people in this region. Evidently, most of the participants in this

seminar were from Pangasinan or nearby provinces. While their backgrounds varied, many represented local businesses or came from different corners of the public sector, including schools and local government units (LGUs). The primary speaker of this particular seminar was Marcela C. Saises, the supervising senior research scientist at the Food and Nutrition Research Institute (FNRI). FNRI has been the primary research center for developing fortification technology in the Philippines since the institute's establishment in 1947. "Iron-Premix Rice" was their flagship project and the predominant focus of this seminar talk. While this seminal talk in Pangasinan was about the Iron-Premix Rice Project, one of the five agrifood projects I analyzed in Chapter Three, I was intrigued to discover that other agrifood projects in my study also appeared in the seminar on various occasions.

Ms. Saises began the presentation with a broader context of malnutrition before concentrating on food fortification. She mentioned several methods for tackling malnutrition. Among these methods were nutritional supplements and dietary diversification. She further mentioned **home gardening and school gardening** as the main tools to improve dietary diversity, which carried the implicit reference to the well-known Gulayan sa Paaarlan (school gardening) program mandated by the Department of Education in 2007. But then, Ms. Saises quickly shifted her focus to fortification as another important solution to malnutrition and delved into the technical details of food fortification. She used the **Iron-Premix Rice Project** as the primary example to demonstrate the entire

fortification process and what the finished product looked like and ended the presentation by encouraging the audience to join the business of producing iron-premix rice.

After her presentation, several participants immediately expressed their interest by raising questions and engaging in small-group discussions, and during this lively discussion, other alternative solutions to malnutrition were mentioned. A participant, who owned a small agricultural business, asked, instead of making all these efforts to mill the rice and fortify it with nutrients, why Filipino couldn't just return to **consuming brown rice**. The business owner's advocacy for brown rice was immediately seconded by several participants, which was slightly surprising for me, given the unpopularity of brown rice in the Philippines. However, at the same time, I also noticed that the participant's argument for brown rice consumption resonated much with the key rationales promoted by the BeRICEponsible Campaign. which had been ongoing in the Philippines since 2013. Ms. Saises then responded to the question by comparing the differences between iron-fortified rice and brown rice. She also underscored the advantage of iron-premix rice and the goal that could only be achieved by iron-premix rice.

Then another participant initiated another line of discussion. She asked, could the iron-premix rice be certified as organic? The answer from Ms. Saises was negative – because the iron fortificant comes from a synthetic process, the finished product could not meet the organic agriculture standard in the

Philippines. Many participants looked disappointed and discouraged by Saises's answer. This conversation reflected the trend of agricultural development in the Philippines at the moment. Since the enactment of the Organic Agriculture Act in 2010, organic agriculture has been positioned by the government and predicted by various farmers' groups as one of the most lucrative agribusinesses in the Philippines. A few questions and comments later, another participant returned to the topic of the source of fortificant and explored the possibility of **using the leaves of organic moringa** as the fortificant since they also contain high amounts of nutrients.

The question about utilizing moringa leaves was significant because it indicated that participants in the seminar were also familiar with moringa supplementation, a coexisting agrifood approach I analyze in this research. The question may reflect the fact that the only government-accredited training institute for organic moringa production was located in the Pangasinan province. Some participants in the seminar were even acquaintances with the MPFI's founder, whom I introduced in Chapter Three. Furthermore, the question showed how these participants were interested in developing iron-fortified products but also intended to balance their other agenda of engaging in organic agriculture. These participants' considerations indicated they were not concerned with potential conflicts between these approaches. They only wanted to explore possible combinations and adaptions of agrifood approaches to achieve their goals.

Encountering the question about replacing synthetic iron with organic moringa, Ms. Saises tried to make clear distinctions between these two types of products and, once again, highlighted the advantage of iron-premix technology. A seminar participant also chipped in with his experience partnering with the project to produce iron-premix rice. He was the owner of a small food manufacturer called NutriDense. As a local businessman and a familiar face to many participants, he echoed Ms. Saises's call for investment in producing iron-premix rice, aiming to boost the confidence of other participants with his own experience. This businessman's experience-sharing also marked the seminar's ending, followed by a free lunch expectedly featuring iron-premix rice![96]

This seminar presentation and the following Q&A session provided multiple examples of how these agrifood solutions coexisted in the development field of the Philippines. Both the speaker, Ms. Saises, and seminar participants were aware of agrifood approaches to addressing malnutrition other than food fortification. While Ms. Saises contextualized iron-fortified rice as one among a few agrifood approaches to tackling malnutrition, participants were interested in

[96] What was also intriguing to me was that neither the speaker nor the participants mentioned a seemingly popular approach to malnutrition — genetically modified (GM) rice. When the seminar happened, Golden Rice Project, which developed the first GM rice for vitamin A deficiency, had just re-emerged in the Filipino media and attracted massive attention in social media because the project finally entered into the regulatory review for commercial use. Meanwhile, GM rice for Iron-deficiency was also in line to get ready for applying for governmental approval. Nonetheless, while having mentioned various potential alternatives to iron-premix rice, both the speaker and participants never brought up the topic of GM rice in the seminar. To some extent, this situation may reflect on the unpopularity of the Golden Rice Project in the Philippines and its marginalized role as an agrifood solution to malnutrition, which is a point I mentioned in the previous two chapters and will return to it in the concluding chapter.

comparing rice fortification to other ongoing efforts based on different agrifood approaches and considering how to combine different approaches to fit into their business plan. For example, some participants proposed using moringa powders as a potential alternative to the synthetic iron compound for making iron-fortified rice, even though Ms. Saises may not agree with this idea.

Beyond the seminar speaker and participants' awareness of coexisting agrifood solutions to malnutrition, the seminar also hinted at various types of *resources* shared by all or some of these agrifood projects. To begin with, the FNRI Iron-Premix Rice Project collaborated closely with a small food company to produce iron-premix rice. During the same period, the company also worked with other agencies to produce moringa-supplemented food and brown rice-based products. Likewise, FNRI did not only support the development of iron-fortified rice but was also instrumental in generating scientific knowledge about the nutritional value of moringa trees. Last but not least, all the agrifood projects engaged with similar events as the DOST seminar that connect the agrifood project with people who may be able to support the project's development. In short, the company making products for multiple projects, the research institute producing technoscience related to multiple projects, and events facilitating the gathering of diverse social groups were just a few examples of the resources that supported the development of these coexisting projects.

This chapter concerns these resources. The *resources* supporting coexisting projects resonate with what Foucault (1984) terms the "soil" that nourishes the co-emergence of various solutions. Following Foucault's metaphor of "soil," I use *infrastructure* – what Star (1999) mentions as "the system of substrates" – to conceptualize resources shared by these coexisting projects. The concept of infrastructure adds to the metaphor of soil by highlighting the systematic nature of resources that "has reached beyond a single event or on-site practice" (Star 1999:381; also see Larkin 2013). This definition of infrastructure allows me to stress the structural configuration of resources I analyze in this chapter.

I further draw on Star's (1999) and Larson's (2013) analyses to consider how to identify these infrastructures. I concur with Star's insight that researchers could only define infrastructures through these infrastructures' *relations* to other organized practices supported by these taken-for-granted systems (Star 1999). Larkin (2013) provides an example to demonstrate this point. He mentions that while electricity could be seen as the infrastructure for industry development, electricity requires the support of its infrastructure as well. Similarly, in my research, while I aim to unveil infrastructures underlying these coexisting agrifood solutions, if analyzed through another perspective, coexisting agrifood solutions could be recognized as the infrastructure of development policymaking.

On top of the focus on relationality, I further acknowledge Larson's (2013) assertion that "the act of defining an infrastructure is a categorizing moment"

(Larson 2013:330) that requires the involvement of the "epistemological and political commitments" (Larson 2013:330). This suggests the constructive nature of infrastructures and stresses the importance of the researcher's analytical viewpoint. Following this point, I sift through various issues and factors to consider the essential infrastructures underlying coexisting solutions. While several structural factors may impact the development of agrifood solutions, I identify three essential resources based on the analytical focus of the problem-solution analytical framework and treat these resources as *infrastructures* because of their relations with the coexisting agrifood solutions I study.

The example of the DOST seminar on food fortification that opens this chapter exemplified these three types of infrastructures. First, the participants of the seminar – both presenters and audience – belonged to a group of people whom I refer to as "development actors" (Richey & Ponte 2014). Despite their varied backgrounds, development actors shared a similar will and capacity to improve other Filipinos' lives and had the ability to do so in their positions of administrative power. While the existence of these development actors acted as an important resource to the development of agrifood projects, what was also critical were meetings, such as this DOST seminar, that helped mobilize development actors. These meetings contributed to formulating a system of social relations that structured development actors' power relations and interactions. I consider these meetings of development actors as a whole the "mobilization infrastructure" for coexisting agrifood projects. Second, the seminar served as the channel to convey

the existence of iron deficiency to development actors with the observed capacity and willingness to act on the problem by developing solutions. I use "epistemic infrastructure" to conceptualize how the problem of malnutrition could be made known to development actors (Bueger 2015). Third, the seminar was held by the DOST regional office and presented by the FNRI researcher. Both institutes belonged to the "research infrastructure" that supports the development of various types of solutions to particular social problems.

This chapter's infrastructural analysis constitutes the third aspect of the problem-solution analytical framework and corresponds to the analysis in the previous two chapters. Chapter Three's assemblage analysis highlighted how each agrifood solution developed a particular ethno-epistemic configuration to become an operational project and render technoscience situated in a specific context. Relatedly, this chapter's analysis of resources as infrastructures points out that these coexisting solution assemblages shared a same set of infrastructures. In Chapter Two, I illustrated distinct problem-solution constellations in different historical periods. This chapter's focus on infrastructures considers underlying forces that could help formulate and sustain each problem-solution constellation. To streamline my discussion in this chapter, I begin the discussion with the epistemic and research infrastructure and leave the analysis of the mobilization infrastructure to the last section.

4-1 Epistemic Infrastructure & Problematization

The first infrastructure that supports each project's development was the epistemic infrastructure, which concerned how development actors perceived the problem of malnutrition. While the concept of the epistemic infrastructure has its root in the STS field, especially Knorr-Cetina's (1999) theorization of epistemic culture that compares how different scientific disciplines produce knowledge, some recent scholars take the concept to the international development context. Christian Bueger (2015) employs epistemic infrastructure to investigate how "international phenomena and issues are produced and enacted" and argues that the practices of epistemic infrastructures have the power to construct certain issues such as poverty, peace, or terrorism. In his empirical study, Bueger asks, "how does the United Nations Security Council (UNSC) know piracy?" (Bueger 2015: 2) and highlights three types of epistemic practices: "quantification - centers of calculating piracy," "monitoring groups - local knowledge and detective work," and "special advisors: network and diplomatic knowledge generation" (Bueger 2015). Following Bueger, Tichenor and her colleagues (2022) theorize SDG goals as epistemic infrastructure "grounded in these particular types of building blocks—data and the techniques of its collection, indicators and their categorization into different tiers, reports, scorecards, PowerPoint presentations, minutes of meetings, and all other relevant inscriptions" (p.5).

The concept of epistemic infrastructure also resonates with Collier and Cox's (2021) discussion about how private insurance data contribute to the problematization of urban resilience. Building on Callon's problematization framework, they argue that cities in the U.S. relied on private insurance companies' data and modeling techniques "to specify resilience to the risks associated with climate change as problems that government officials can address through specific planning and policy measures" (Collier & Cox 2021: 277). Their analysis indicates that, instead of replacing existing public-based solutions[97], private insurance became a part of the epistemic infrastructure for public agencies in the existing configuration of problematization.

In the case of malnutrition, although the Philippine government and the nutritional community have recognized malnutrition as a significant issue for more than a century and have focused on different types of malnutrition in different historical periods, the existence of malnutrition has never been straightforward. The government and relevant social groups relied on certain types of knowledge to accumulate their understanding of malnutrition. The most important epistemic infrastructure that enabled "malnutrition" to be detected and perceived as a social problem was built on the National Nutrition Survey and other nutrition standards developed by the Food and Nutrition Research Institute (FNRI).

[97] This has been the primary argument for scholars before Collier and Cox's research.

Surveying nutrition conditions has a long history in the Philippines. The current organizational structure of the National Nutrition Survey originated from the Bataan Experiment that I discussed in Chapter Two. As the first systematic nutrition survey in the Philippines, the Bataan Experiment facilitated the institutionalization of the nutrition community in the Philippines. The Philippine government created the Institute of Nutrition (today's Food and Nutrition Research Institute, FNRI) to help carry out the Bataan Experiment, which included the promotion of Vitamin B1-fortified rice and a nutrition survey featuring biophysical and socioeconomic data. The most important academic community studying malnutrition – the Philippine Association of Nutrition – was also established during the same period.

The Bataan Experiment paved the way for the subsequent nutrition surveys conducted by FNRI. After the Bataan Experiment, the institute continued carrying out other nutrition surveys. It conducted a nutrition survey of the Armed Forces of the Philippines and published the result in 1957 (Darby et al. 1959). Based on this experience, the institute began surveying the general population in 1957. It conducted nutrition surveys in 8 out of 10 regions in the Philippines. As the summary report of this research states, the objective of the survey was "to establish a nutritional status baseline of the population in the different regions of the country. This baseline will serve as the basis for determining the nutritional needs of the population and for evaluating the progress of nutrition programs over the years" (FNRI 2019).

Meanwhile, the institutionalization of nutrition science also facilitated the development of other nutrition standards. In 1951, the Institute of Nutrition published the first version of the *Handbook on Food Composition Tables*, which documents the nutritional value of common Filipino foods, including minerals, vitamins, protein, fat, and carbohydrate. Then, in 1960, the Institute of Nutrition published the first edition of *Philippine Recommended Dietary Allowances*, which quantified how much food a Filipino should consume daily. Together these two publications provided a concrete standard for the Philippine government to evaluate any type of nutrition "deficiency."

In 1978, FNRI launched the first National Nutrition Survey (NNS). Since then, FNRI has continued conducting the National Nutrition Survey every five years without political or social interruptions. The survey's sample size also grew over time. There were around 2800 households surveyed in the 1st NNS of 1978. In comparison, the latest survey in 2018 included data from around 52000 households. The core dataset included three components: the biophysical survey that measured body conditions and collected blood samples; the dietary survey that documented different kinds of food households consume; and the socioeconomic survey that collected background information about households. Judging from the content of the three data types, it was clear that FNRI must have invested vast amounts of personnel and resources in completing each survey. It

was particularly challenging for survey conductors to collect data in remote rural areas[98].

FNRI's budget distribution further demonstrated how resource-consuming the NNS had been. For example, according to the official FNRI document, the budget for conducting the 8th NNS (102 million Philippine pesos) in 2014 occupied more than one-third of the entire FNRI budget (273 million Philippine pesos) [99] while more than half of the FNRI budget in that year was dedicated to all the nutrition monitoring and assessment activities. In contrast, although the FNRI was also responsible for developing agrifood *solutions* to malnutrition, less than one-third of the budget was distributed to these research activities. This example of the budget distribution indicated that most of FNRI's budget was dedicated to making the *problem* known rather than solving the *problem*.

It may be more striking to compare the development of national nutrition surveys in the Philippines and other countries in the global south. Most countries relied on the USAID-supported Demographic and Health Survey (DHS) program to monitor their population's nutrition status (Boerma and Sommerfeltb 1993; Corsi et al. 2012). The DHS Program began only in 1984, whereas the Philippine government began to monitor their citizens' nutrition status two decades earlier. Due to the varied focuses of the DHS and the NNS, the nutrition-related data

[98] Based on personal conversations with a previous survey conductor in the FNRI, 07/05/2019.
[99] See https://www.fnri.dost.gov.ph/index.php/72-transparency-seal/approved-budget-and-corresponding-targets/119-approved-budget-and-corresponding-targets. Access date: 04/22/2022.

collected by the NNS was also much more detailed, especially for the biophysical aspect, which was critical for detecting micronutrient deficiencies.

The NNS's continuous documentation and monitoring of the Philippines' nutritional condition[100] alone were insufficient to act as the predominant epistemic infrastructure for malnutrition. What was also critical was how FNRI disseminated the survey result to relevant development actors. Since 1975, FNRI has carried out the "FNRI Seminar Series" annually, which serves as a key educational event and gathering for nutritional workers and other associated social groups all over the country. During the event, The NNS had always been the highlight. For example, in the 46th FNRI Seminar Series in 2020, the two-day virtual event opened with a lecture titled "Trends and Current Nutritional Status of Filipino Children," which mainly focused on the result of the latest NNS. In 2016 and 2019, when the most updated NNS results were published, the entire two-day events were dedicated to showcasing different parts of the NNS, including the methodology, different components of the survey result, and policy implications.[101] In addition to the FNRI Seminar Series, the FNRI staff members were invited to various events to present data they collected and shed light on

[100] In addition to the NNS, the Philippine government also began an initiative called Operation Timbang (weight) in 1968. The initiative was further institutionalized and expanded in 1974 and is still operating now (Solon 2006). The basic goal of Operation Timbang is to measure the weight and height of schoolchildren annually. The result becomes the primary evidence to decide the rate of child stunting and wasting and helps determine the distribution of certain social welfare benefits. Together, these survey results made the government aware of the prevalence of malnutrition since the 1960s.

[101] For the detailed schedule of the FNRI Seminar Series in the past 20 years, see https://fnri.dost.gov.ph/index.php/67-publications/seminar-series/83-seminar-series. Access date: 09/06/2021.

Filipino people's nutritional status in the Philippines. I also encountered their presentations at almost all the malnutrition-relevant events I attended[102].

Figure 22: The conference room of the 42nd FNRI Seminar Series

On top of the FNRI Seminar Series as the means to distribute the *problem*, the media has also recurringly reported malnutrition as a national issue. Most of the time, the NNS was cited as evidence of the issue. As early as 1988, a year after the collapse of the Marcos regime and the re-flourishing of journalism, the *Manila Chronicle* reports that "2.2m schoolchildren are underweight" based on the data provided by the nutrition agencies. [103] Similarly, in 1995, the *Philippine Daily Inquirer* published a special report titled" 'Hidden hunger' ravaging children" and extensively drew data from the NNS.[104] As recently as August 14, 2021, the *Manila Bulletin* published a news article titled "DOST study: Adolescents in

[102] Just to name a few, these events include the 2018 International Conference on Nutrition-Sensitive Agriculture, the Asia Development Bank's Food Security Forum, and the 6th National Moringa Congress.
[103] *Manila Chronicle*, July 18, 1988, page 9.
[104] *The Philippine Daily Inquirer*, December 26, 1995, page 10.

urban areas more likely to be obese, overweight than rural counterparts.[105]" Here, the DOST study referred to the latest NNS conducted in 2018. In all these news reports, the NNS survey provided quantified numbers that contextualized individual accounts, objectified the issue, and portrayed a comprehensive, nationwide picture demanding policy interventions.[106]

In hindsight, the epistemic infrastructure of malnutrition in the Philippines also significantly shaped how I formulated my research and my research process. I began the research against the backdrop of the persistence of malnutrition in the Philippines, which, unsurprisingly, was illuminated by the NNS. During my preliminary fieldwork, I attended the National Nutrition Seminar and was exposed to potential solutions showcased at the event, such as iron-premix rice or moringa-supplemented products. The experience also contributed to my formulating this research to compare diverse types of solutions.

My research experience indicated the pervasive influence developed by the epistemic infrastructure of malnutrition in the Philippines, with no exceptions for all five agrifood projects I study in this research. They must encounter and

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[105] See https://mb.com.ph/2021/08/14/dost-study-urban-adolescents-more-likely-to-be-obese-overweight-than-rural-counterparts/. Access date: 09/06/2021.

[106] The historical development of the epistemic infrastructure for malnutrition helps shape development actors' awareness of various forms of malnutrition. To be precise, neither did the development actors' concern over and actions on malnutrition come directly from their experience, nor were their concerns and actions a given result of malnutrition's prevalence in the Philippines. Rather, the epistemic infrastructure that makes malnutrition visible through numbers is critical in shaping these development actors' awareness of malnutrition and contributing to shaping the direction for developing solutions. In Section Three I continue the discussion on this point.

interact with the epistemic infrastructure of malnutrition – especially the influence of the NNS – when these projects problematized the issue they aimed to tackle. Yet, not all the projects emerged directly due to their encounters with the epistemic infrastructure. Rather, each project engaged with the epistemic infrastructure in a particular way. Analyzing these various types of engagement with the epistemic infrastructure could broaden the scholarly understanding of the functioning and importance of the epistemic infrastructure.

The Iron-Premix Rice Project was a typical example of a project directly motivated by the epistemic infrastructure. Since the first NNS, nutritionists in the Philippines have long been aware of iron deficiency and anemia. The Iron-Premix Rice Project, thus, had a clear problem when it was launched. The project also often drew data from the NNS to elaborate on the problem it intended to address. For example, a news release by the DOST introduces Iron-Premix Rice by citing the NNS:

> FNRI developed this iron-fortified rice technology to help address **iron deficiency anemia** (IDA) which is still prevalent among four out of 10 and three out of 10 **pregnant and lactating women**, respectively, according to DOST-FNRI's Seventh National Nutrition Survey (7th NNS) in 2008. IDA also affects two out of 10 **children** six months to five years old, as well as the six- to 12-year old. One out of ten 13- to 19-year-old teens are likewise

affected by IDA, the survey results further revealed.[107] (Emphasis added by the author.)

The excerpt demonstrates the Iron-Premix Rice Project's familiarity with iron deficiency. It provided a comprehensive picture of the problem in the Philippine population by detailing the prevalence of iron deficiency anemia in different social groups.

Similar to the Iron-Premix Rice Project, the problem that the SEARCA-UPLB SHGP intended to address also facilitated the project's emergence. According to the public account[108] and my interview with the SHGP team, then-DepEd secretary Armin Luistro encouraged the SEARCA to develop a school gardening project to strengthen and supplement the school feeding program. The secretary "discuss[ed] his plans and ask for support from SEARCA in strengthening effort to address malnutrition concerns among students.[109]" Although SEARCA's primary mandate was not basic education but graduate education, and it had no prior experience in school gardening, it began to invest in developing the project, including forming the collaboration with the UPLB and securing initial funding

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[107] "DOST-FNRI's iron-fortified rice technology churns out instant meals for people on the go." See https://www.dost.gov.ph/knowledge-resources/news/36-2011-news/252-dost-fnri-s-iron-fortified-rice-technology-churns-out-instant-meals-for-people-on-the-go.html. Access date: 09/11/2021.

[108] See, for example, the official project video: https://youtu.be/9934BdzCNGQ. Access date: 09/11/2021.

[109] See the press release by the DepEd, titled "DepEd, SEARCA, UPLB to promote school-based vegetable gardens." November 22, 2020.

from the Asian Development Bank. In an early proposal of the SEARCA-UPLB SHGP, it began with the synthesis of malnutrition among school children:

> Malnutrition and undernutrition are common among the majority of school-aged children in the Philippines. Findings of **the 2008 National Nutrition Survey** of the Food and Nutrition Research Institute of the Department of Science and Technology showed that in every 100 **school children** aged 6-10 years, 26 were **underweight**, 33 were **underheight**, and 2 were **overweight**. From 2005 to 2008, a noted increase in the proportion of **underweight** (22.8% to 25.6%) and **underheight** (32.2% to 33.1%) among school children was also observed. Such conditions inhibit cognitive development of children and consequently lead to **poor health and poor performance in school**. (Emphasis added by the author)

This problem statement cites the 2008 NNS and reviews the survey result extensively to establish the existence of multiple forms of malnutrition for school children. Based on this problematization, the proposal argues that a vegetable garden could be a useful tool to address the problem.

In contrast, MPFI's moringa industry development initiative demonstrated how the epistemic infrastructure could reshape the problem-setting of the project. Being positioned as a superfood, moringa was supposed to be useful for a wide

range of health issues – even the traditional use of moringa in the Philippines suggests a dozen ways of utilization for health purposes. Among all the potential benefits of moringa, malnutrition would not be the primary reason the MPFI members developed their interest in moringa due to their socioeconomic status. In contrast, some gained personal interest in moringa for its medicinal value in chronic diseases or cancer. However, the NNS and knowledge regarding how moringa leaves could address malnutrition played a role in re-orienting malnutrition as the organization's target for its long-term development. Based on this target, MPFI set malnutrition as the theme for the 6th National Congress in 2019. The policy document for the moringa industry development, *Roadmap toward Moringa Industry*, also positions malnutrition as the key issue that moringa could solve. The document begins with a comprehensive synthesis of statistical data from the 2015 National Nutrition Survey. It particularly focuses on Filipino children's nutritional status.

> In the 2015 Updating of the Nutritional Status of Filipinos by the Food and Nutrition Research Institute (FNRI) of the Department of Science and Technology, one in every three **Filipino children** below 5 years old is affected by **stunted growth** or a **lack of height for their age**. The study also showed that one in three children was underweight for his or her age. During the period covered, the prevalence of **underweight** children in this age group increased from 29.1 to 31.2 percent or one of three children. The

> **stunting** prevalence increased from 29.9 percent to 31.1 percent or one of three children.

As the excerpt indicates, Filipino children's malnutrition becomes the primary focus in the background section of the document. It serves as the main drive and rationale for developing the moringa industry. This focus diverged from MPFI's early intention to tag along with the trend of moringa as a superfood globally and to increase moringa export. Resonating with this agenda, the document also quotes Senator Loren Legarda's speech in the Senate, which says, "Beyond our moral obligation and humanitarian imperatives, the high economic cost of not doing anything to lift the burdens of undernutrition in the Philippines should compel and drive urgent action." This quote shows how MPFI further formulated the problem at stake as not only a public health problem but also an economic and national development problem that requires an urgent response. I elaborate on this point in Section Three when I discuss the mobilization infrastructure.

Like MPFI's re-orientation of its problem by the epistemic infrastructure, the BeRICEponsible Campaign's engagement with the epistemic infrastructure also reshaped its focus on the problem. As the 2014 BeRICEponsible Campaign Report points out, rice self-efficiency was the campaign's initial focus. Accordingly, rice wastage was the main issue that attracted the campaign's attention. As the report says,

> Rice wastage is a serious and alarming concern that needs to be addressed. A study conducted by the Food and Nutrition Research Institute (FNRI) in 2008 shows that "every Filipino wastes an average of 2 tablespoons (9 grams) of unmilled rice daily."

This excerpt from the campaign's first-year summary report does not draw on the NNS's data about malnutrition but on rice wastage, which directly connects to the food self-sufficiency agenda. Nonetheless, the campaign's focus shifted along the way and leaned more toward the issue of non-communicative diseases. For example, the 2016 July-September edition of the *PhilRice Magazine* published a special issue on the BeRICEponsible Campaign and brown rice consumption titled "Healthy Living with Rice." As this title indicates, the main focus was on brown rice's health benefits rather than economic considerations. The discussion begins again with the NNS: "the 2013 National Nutrition Survey notes that three of every ten adult Filipinos are obese and overweight — mostly among ladies." Similarly, a press release published on the PhilRice website a year later also upheld the same focus:

> The [Philippine Rice Research] Institute, through its Be Riceponsible Campaign, has affirmed that eating too much rice has ill effects to [sic] human health. A study by the Harvard School of Public Health showed that excessive rice intake may adversely affect glucose metabolism and insulin production of the body [and]

> thus may result in diabetes. 'That is the main reason why we are promoting brown or unpolished rice as it has a lower glycemic index, which means that it takes longer before it is converted to blood sugar. It also has higher satiety, so you tend to eat less…' explained Be RICEsponsible campaign director Myriam Layaoen.

The campaign's shift of focus towards diabetes and other lifestyle diseases resonated with a broader trend of nutrition policymaking in the Philippines to tackle the double burden of malnutrition after the so-called nutrition transition over the past three decades (Lipoeto, Lin, and Angeles-Agdeppa 2013). It also demonstrated how the campaign shifted its framing of the problem in light of the epistemic infrastructure it encountered.

The Golden Rice Project presented another dynamic when the project needed to respond to or counter the knowledge produced by the epistemic infrastructure. The best example came from IRRI's now-archived webpage titled "Why is Golden Rice needed in the Philippines since vitamin A deficiency is already decreasing?[110]" This webpage belonged to the "Frequently asked question" section for the Golden Rice Project. Around early 2010, the most common critique of the Golden Rice Project in the Philippines was that Vitamin A

[110] The archived version of the webpage could be accessed via: https://web.archive.org/web/20140731160310/https://www.irri.org/golden-rice/faqs/why-is-golden-rice-needed-in-the-philippines-since-vitamin-a-deficiency-is-already-decreasing. Access date: 09/11/2021.

deficiency was not prominent anymore. Thus, the project was not needed, at least not in the Philippines. As the webpage lays out the critique:

> The Philippines' most recent data about vitamin A deficiency comes from the Food and Nutrition Research Institute's (FNRI) 7th **National Nutrition Survey** in 2008. Vitamin A deficiency affects 15.2% of children aged 6 months to 5 years, an improvement from the 2003 survey which found 40% of children were suffering from vitamin A deficiency. The prevalence of vitamin A deficiency among pregnant women also decreased. The exact reasons for these improvements have not been determined. They may be the results of proven approaches to prevent vitamin A deficiency, such as vitamin A supplementation, dietary diversification, food fortification, or promotion of optimal breastfeeding.

This excerpt cites the 7th NNS and points out the significantly improving pattern of Vitamin A deficiency in the Philippines. At the time, the Golden Rice Project acknowledged this improvement by the NNS result and did not respond well to the issue. The project's response on the webpage only stressed that "more than 1.7 million children under the age of five and 500,000 pregnant and nursing women" were affected by Vitamin A deficiency, meaning that 15% of children were still a huge number. Nonetheless, the response did not address the

implication of the NNS result that there may be even fewer people with Vitamin A deficiency when Golden Rice could be ready for commercial use.

Intriguingly, the same epistemic infrastructure helped justify the project's existence. As a news article titled "A fight against vitamin A deficiency" and published in December 2018 illuminates:

> The eighth National Nutrition Survey of the Food and Nutrition Research Institute to showed VAD remains a persistent public health issue in the Philippines. There was an increase of VAD incidence (among children ages six months to five years old) from 15.2 percent in 2008 to 20.4 percent in 2013.
>
> "This is equivalent to 2.1 million children who are at risk of getting sick, blind, and even dying if left untreated," Dr. Reynante L. Ordonio, a visionary young scientist working at the Philippine Rice Research Institute said[111].

As the excerpt shows, the rate of vitamin A deficiency surprisingly increased according to the data from the 8th NNS, which gave the Golden Rice Project a stronger come-back. The project utilized the data to make a case for the importance of Golden Rice as the solution to vitamin A deficiency. For example, a news release on the IRRI website on December 18, 2019, titled "The Philippines

[111] https://businessmirror.com.ph/2018/10/25/a-fight-against-vitamin-a-deficiency/

approves Golden Rice for direct use as food and feed, or for processing," re-interprets the NNS data. It points out that "[d]espite the success of public health interventions like oral supplementation, complementary feeding, and nutrition education, Vitamin A deficiency (VAD) among children aged six months to five years increased from 15.2 percent in 2008 to 20.4 percent in 2013 in the Philippines. [112]" This excerpt demonstrates how the Golden Rice Project effectively argued for the essential role of Golden Rice based on the long-term trend presented by the NNS data. Following the same rationale, even when the latest 2018 NNS result shows that the rate of vitamin A deficiency decreased to 17%, it did not guarantee that the situation won't worsen again. The twist of data also indicates that the NNS as the key epistemic infrastructure would never be a barrier but became supporting evidence for the project's usefulness.

How did the epistemic infrastructure support the coexistence of agrifood solutions? The epistemic infrastructure of malnutrition was meant to make malnutrition *known* in two senses. It justified and proved the existence of malnutrition and distributed knowledge regarding malnutrition to the development field in the Philippines and beyond. The epistemic practices of making malnutrition known also aimed to invoke actions and, during the process, facilitated the development of solutions. However, although the epistemic infrastructure of malnutrition did not necessarily support specific solutions, the

[112] https://www.irri.org/news-and-events/news/philippines-approves-golden-rice-direct-use-food-and-feed-or- processing

type of data it generated and selectively disseminated set the direction and priorities that may make some solutions to be seen as more useful and others less relevant. I take up this point further in the concluding section of this chapter.

The analysis in this section also corresponds to the assemblage analysis in Chapter Three. In Chapter Three, I explored the agency of each project and how they mobilized various resources to materialize the solution into operational projects. Building on Chapter Three's analysis, this section showed how the epistemic infrastructure interacted with each project in various ways – from being the catalyst to reshaping the project's direction and acting as the potential barrier to the project. Without the instrumental role of the epistemic infrastructure of malnutrition, some projects may not exist anymore, such as the Iron-Premix Rice Project or the Golden Rice Project. Some other agrifood projects may not set the problem of malnutrition as the goal for their projects. For example, MPFI's events and policy documents may not formulate malnutrition as the key benefit for the moringa industry's development, which may, in turn, reshape the configuration of the solution assemblage. Similarly, the BeRICEponsible Campaign may retain its focus on rice wastage without extensive knowledge of malnutrition. From this perspective, the analysis also suggests that the epistemic infrastructure was instrumental in bringing the problem and solutions together and helped formulate the pattern of problem-solution constellations.

4-2 Fragmented Triple-Helix of the Research Infrastructure

The research infrastructure was the second component that supported each project's development by providing knowledge, techniques, or technologies. Scholars have long pointed out that the development of the research infrastructure closely connects with the state's intention for national development. In the earlier 20th century, scholarly concerns over research infrastructure were usually embedded in the inquiry into the relationship between technological innovations and economic growth (Rosenberg 1982). Since the 1970s, scholars from various fields[113] began to reject the linear model of research development that assumes a direct and clear pathway from purely scientific research to applied science to applications of scientific knowledge; much attention was put on the *state* as one of the primary drivers and supporters for research development (Kline & Rosenberg 2010). After the 1980s, the private sector emerged as another key player in research development. Some scholars conceptualize the innovating process based on the linkage between the government, academia, and the industry as the triple-helix innovation model (Godin 2009; Etzkowitz & Leydesdorff 2000). While I rely on the concept "triple-helix model" to define the research infrastructure I refer to in this research, I draw on recent studies focused on innovating in the global south to modify the concept.

[113] Innovation is a topic studied by various disciplines, and these disciplines may or may not communicate with each other. Some primary disciplines include economics, knowledge management, and public policy.

Concerned that all the empirical studies about the research infrastructure are primarily based on examples in the global north (Tsvetkova et al. 2017; Amir & Nugroho 2013), scholars have begun to pay more attention to the research infrastructure in the global south and the international development context. Some scholars center on the shifting role of technoscience in the current development context. Adriana Petryna (2009) develops the concept of "experimentality" to analyze how different local medical systems in the global south are incorporated into different kinds of clinical trials and experiments for the development of new STIs (also see Al Dahdah 2019). Danish scholar Adam Moe Fejerskov (2017) provides a concise sketch of this unique positioning of STI in the current era of development cooperation. As he points out, after WWII, development agencies began to consider technology transfer from developed to developing countries as the key tool for economic development. However, the focus on technology was sidelined by other agendas in the 1980s until the "second coming of technology" emerged in later years. Fejerskov suggests that one of the characteristics of this second becoming is that "the global south is increasingly articulated and utilized as a live laboratory for technological innovation and testing by especially private foundations and philanthrocapitalists" (Fejerskov 2017:95, also see Nguyen 2009). Based on this perspective, in the current era, countries in the global south have transformed from the recipients of usually de-contextualized technology to the site for innovations to be developed and experimented with.

Resonating with the research of this trend from technology transfer to experimentality, some other scholars point out different actors that play more important roles in the global south than in the north. While *states* are still key to understanding the innovation development in the global south (Amir 2012), Williams and Woodson (2012) argue for the importance of the nonprofit sector as the driver of innovations to social problems in the global south. Williams's (2018) study in India reveals how nonprofit organizations are instrumental in developing ophthalmology-related medical innovations. Similarly, Kang (2021) uses three public research institutes in three countries to discuss their innovation processes and urge more attention to their role in innovation development.

The research infrastructure that supported the development of each agrifood project in my research also spoke to these two points. Most projects I observed in the Philippines were locally developed, some being experiment-oriented pilot projects. Meanwhile, public research centers and nonprofit organizations were critical for these agrifood projects' development. The research infrastructure in the Philippines, thus, demonstrated another type of triple-helix structure consisting of the public sector, academia, and the nonprofit sector. Figure 23 illustrates this model. As my discussion below reveals, the private sector only

occupied a marginal position in the research infrastructure.

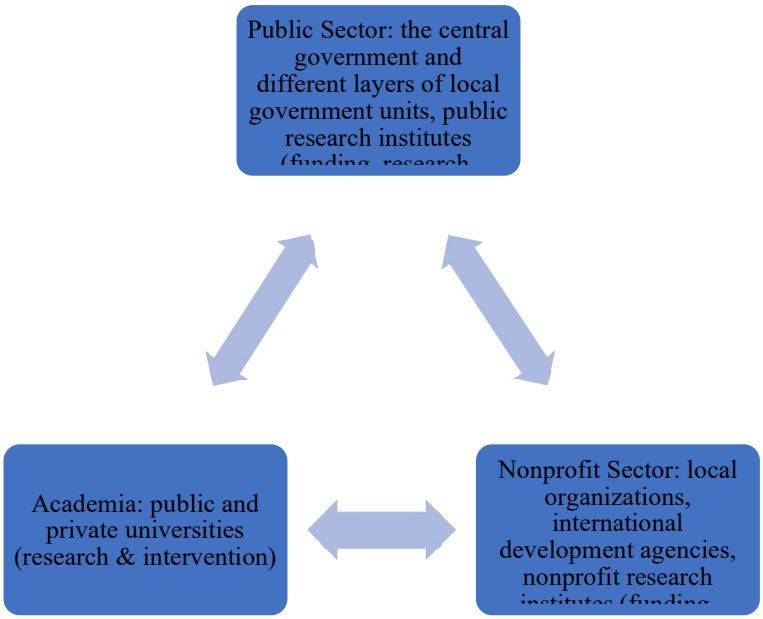

Figure 23: The triple-helix model in the Philippines

From a historical perspective, the 1960s to 1970s were critical for developing the research infrastructure regarding agricultural development in the Philippines. The emergence of the international agricultural research system — especially the gradual forming of the Consultative Group on International Agricultural Research (CGIAR) — during the same period (Gomez 1986) was instrumental in the development of the "national agricultural research system" in the Philippines. One of the CGIAR member institutions, the IRRI, was established in the Philippines in 1960, which characterizes the involvement of major international donors, including the Ford Foundation, the Rockefeller Foundation, and USAID. Besides

contributing to establishing IRRI, USAID was directly involved in the Philippine agricultural and nutritional policymaking at the time, with the Green Revolution as the most prominent output (Engel & Arnold 1979).

Following the establishment of IRRI and the promotion of the Green Revolution, the Philippine government also intended to increase its research capacity by reorganizing governmental institutions. One critical moment was the creation of The Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD) (Valmayor 1985), which scholars recognized as a watershed event in the development of the agricultural research system in the Philippines (Evenson et al. 1981; Librero et al. 1986; Vega 1990). The government created PCAARRD to address the lack of central planning and lack of coordination across regulatory institutions and research centers within the government. For this purpose, PCCARRD developed a new ranking system to decide the research priority among different crops and allocated research funding based on the ranking system (David et al. 1999).

The establishment of PCCARRD also corresponded to the creation or restructuring of individual institutions during a similar period. Take institutions that have been involved in the projects in my research as examples. After IRRI's creation in 1960, SEARCA was established in 1965 as the Southeast Asia region's graduate training and agricultural policy research center. IRRI and SEARCA were located in Los Baños, with institutional connections with the

University of the Philippines Los Baños (UPLB). Although UPLB was established in 1909, it was during the Green Revolution period that the UPLB was elevated "into an autonomous unit within the University of the Philippines' system with its chancellor," which "gave UPLB a new vibrancy, thus earning it the distinction of being the premier agricultural research and educational institution in Southeast Asia" (Vega 1990:203). Meanwhile, the Philippine government established the National Postharvest Institute for Research and Extension in 1978, later reorganized and re-named the Philippine Center for Postharvest Development and Mechanization (PhilMech). PhilMech's creation followed the rationale to move the focus of agricultural development to the post-harvesting stage after the government assumed that agricultural production had been improved thanks to the Green Revolution.

The Philippine Rice Research Institute (PhilRice) was late-emerging compared to the institutes above. Partly, it was because of the existence of IRRI in the Philippines. However, when PhilRice was established in 1985, the rationale for its creation still held a strong connection to the impact of the Green Revolution period. As Executive Order No. 1061, which mandates the creation of PhilRice, states, although "substantial progress in improving irrigated-lowland rice production through the use of high-yielding cultivars, fertilizers, pesticides, and judicious water management, has been achieved in the country," several negative consequences had emerged a decade later. While "rice productivity in certain areas … has remained low," there was also continuous emergence of

biological and socioeconomic problems, including “the rising costs of farm inputs and by the continuous reduction of per capita cultivated land.” As a result, “there [wa]s a need to unify the efforts of various agencies and institutions working on rice research and development to generate an in-depth approach to the present and future problems specific to the Philippines.” As the policy excerpt indicates, PhilRice’s creation was the governmental response to the negative consequences of the Green Revolution.

The current structure of agricultural research infrastructure that the five agrifood projects in my research encountered during their development still operates on the same structure developed during the Green Revolution period. While all five projects’ research and development processes were embedded in this triple-helix structure, the research support they received varied depending on their distinct positionings. The varied positioning of these projects provided an opportunity to further understand this research infrastructure’s characteristics and operation.

SEARCA-SHGP was a model project of this triple-helix structure. The project itself was a coalition of the government (Department of Education), the academia (UPLB), and the development agency (SEARCA). All the funding came from development agencies and the government. Funding agencies included the Asian Development Bank, the Japan International Cooperation Agency, and SEARCA’s internal funding. Meanwhile, agricultural scholars and nutritionists from the

UPLB were the main sources of technoscience. Not only did they bring into the project their pre-existing research output, including edible landscaping, organic farming, and community nutrition promotion. They were also responsible for monitoring and evaluation studies alongside promoting school gardening. After the project was deemed successful, SEARCA also collaborated with different levels of government to promote and scale up the project.

The Golden Rice Project demonstrated another dynamic among these three types of actors. IRRI was responsible for developing the project with funding from international development agencies and the Philippine government's in-kind support[114]. Once the GM variety was deemed successful, IRRI worked closely with PhilRice (public sector) for all tests mentioned in Chapter Three. Furthermore, the IRRI team also worked closely with the PhilRice team to apply for biosafety approval from the Philippine government while PhilRice, specifically its development communication unit, was responsible for promoting the Golden Rice variety to farmers in the Philippines. During the process, academia and the government played a supportive but necessary role. The UPLB scholars had long-term collaborations with IRRI on rice biotechnology research; the government also demonstrated its support for biotechnology development in the Philippines – that was why PhilRice carried out biosafety applications and promoted the Golden Rice variety.

[114] Including the cheap rent for the land and other utility expenses.

By contrast, the BeRICEponsible campaign was mainly based on the public sector's effort. The campaign was initiated by the Department of Agriculture and executed by PhilRice's development communication unit, a public research center under the Department of Agriculture. Furthermore, the campaign easily gained support from other governmental agencies, including the National Rice Authority, which had strong control over the rice supply and prices in the Philippines. Similarly, the campaign could easily access other public research institutes for their services or solicit collaborations, such as the milling machine developed with PhilMech or the market trial with regional universities.

FNRI's Iron-Premix Rice Project presented a slightly different dynamic than the three projects above. Being one of the research centers under the Department of Science and Technology, FNRI received funding from the government to develop various types of projects. Iron-Premix Rice Project was one of the flagship projects in recent years. Similar to the BeRICEponsible Campaign, the project also had better access to other public research agencies. Meanwhile, FNRI had been actively transferring its research output to private companies; the Iron-Premix Rice Project followed the same policy. While it relied on the National Nutrition Council to designate iron-premix rice as one of the policy solutions, the Iron-Premix Rice Project team also transferred the know-how of producing iron-fortified rice to private companies and helped some companies to get a governmental subsidy to purchase necessary machines. To some extent, the

research and development model of the Iron-Premix Rice Project was closer to the original triple-helix model conceptualized based on the situation in the U.S.

MPFI's Moringa Industry Development Initiative provided a rather stark contrast with the projects above. It occupied a marginal position in this triple-helix research infrastructure as a nonprofit organization mainly comprising small business owners, farmers, and others. MPFI constantly encountered difficulties acquiring the knowledge it hoped to have, such as maximizing moringa production or ensuring food safety during the processing period. It was also more challenging for MPFI to secure collaborations with academia or public research centers. MPFI did not have access to pre-existing research results, nor did it have the capacity to initiate new research for its project. One key goal for MPFI's Moringa Industry Development Initiative was to alleviate the status of moringa so that more public research funding would tilt toward moringa production-related research or studies exploring the medicinal and nutritional value of moringa.

The analysis in this section reveals three characteristics of the research infrastructure and how the research infrastructure supports the coexistence of these diverse projects. To begin with, public and nonprofit research centers and universities were involved in multiple projects simultaneously. Some of these projects may hold different ideologies or even oppose each other directly. For example, the development communication unit in PhilRice was responsible for carrying out the BeRICEponsible Campaign. At the same time, when IRRI

collaborated with PhilRice to carry out breeding experiments and field trials for the Golden Rice Project, the same development communication unit also shouldered the responsibility for boosting the popularity and acceptance of Golden Rice in the Philippines and communicating with local communities where the field trials carried out. Similarly, while SEARCA has promoted school gardening with a strong focus on organic agriculture for the past decade, it also housed the regional biotechnology center responsible for promoting agricultural biotechnology, mainly genetic modification, in Southeast Asia. These examples indicated that the research infrastructure as a whole enabled and supported contrasting projects to grow together.

Meanwhile, the research infrastructure also posted constraints on what types of projects it could support. As these five projects' positioning and knowledge production demonstrate, some kinds of technoscience have hardly or never been produced – a situation STS scholars term "undone science" (Hess 2006). For example, the milling machine suitable for brown rice production was never invented in the past century, although it was an essential and common technology for rice production. The systematic knowledge of moringa production had also never been developed by the research infrastructure, albeit its existence as the solution to malnutrition for several decades. Furthermore, the research infrastructure's organizational structure also precluded knowledge access for certain backgrounds of development actors, such as people from the private sector. That was why the MPFI members had difficulty getting hold of the food

safety or health-related data produced by certain research agencies in the research infrastructure. All these examples revealed the epistemic and organizational stratification and hierarchy of the current structure of the research infrastructure that determined what technoscience to be produced or accessed and what was left ignored.

Finally, the disciplinary boundaries also impacted the structure of the research infrastructure and further influenced the interactions and collaborations across these coexisting solutions. As the analysis in this section implies, there existed a clear demarcation of research centers between the agricultural and nutritional sectors in the Philippines. While IRRI, PhilRice, PhilMech, and SEARCA were agricultural research agencies involved in different agrifood projects, FNRI was the primary research center within the nutrition sector. Although all these institutes were involved in developing agrifood solutions to malnutrition, collaborations across the discipline were not very common based on my research analysis. For example, when PhilRice launched the BeRICEponsible Campaign to promote brown rice, it did not form a partnership with FNRI, which also developed its brown rice-related innovations and launched its brown rice campaign around a similar period. The lack of coordination within the research infrastructure also explained the coexistence of similar agrifood innovations and contributed to the proliferation of agrifood projects.

4-3 Meetings of Development Actors as the Mobilization Infrastructure

The last type of infrastructure was the mobilization infrastructure, which mainly referred to how meetings of development actors helped these agrifood projects create partnerships and mobilize development actors to join the force. Both "development actors" and "meetings" require further elaboration and contextualization.

I use development actors to refer to people involved in the development field, including people connecting to these five agrifood projects. These development actors were similar to what Rottenburg terms *elites* in his conceptualization of the field of development cooperation. He points out that the field involves "a class of elites who believe they have been called upon to modernize their own society" (Rottenburg 2009:xii). Rottenburg highlights the difference between *trusteeship* and *elites*. He mentions that, in the early years, there were strong and sometimes forceful international interventions in local policymaking coupled with "foreign aid" – the typical model of *trusteeship* (Cowen & Shenton 1996; Li 2007). The pattern of foreign intervention gradually shifted to "fields of development cooperation" that promote local leadership and prioritize agendas identified by local actors – often local elites. Rottenburg's description resonates with what I observed in the Philippines. Most of the development initiatives I observed were carried out by public, nonprofit, or private local agencies based in the Philippines. While there was still a clear presence of international agencies, they usually

stayed in the background. Building on Rottenburg's definition, I consider *development actors* with the will and capacity to improve *other* Filipinos' lives.

Yet, the scope of development actors I refer to in this research was much broader than the political elites in Rottenburg's discussion. While the political elites' domination over the Philippines' political arena is well-documented (Go 2008; McCoy 2009; Clarke & Sison 2003; Roces 2000), they are not the only social group active in the development field. As recent scholars began to pay attention to "new actors and alliances in development" (Richey & Ponte 2014), such as private businesses, consumers, celebrities, and diaspora groups, my research in the Philippines also saw diverse types of development actors active and present in all kinds of development meetings and projects. What they all shared may be their intention and moral responsibility to solve malnutrition and help other Filipinos with agrifood innovations.

The historical emergence of two social groups contributed to the expansion of the breadth of development actors in the Philippine development field – one was the rise of technocrats in the Marcos regime; the other was the rapid expansion of NGOs after the collapse of the Marcos regime. According to political scientist Teresa S. Encarnacion Tadem (2019), the Marcos regime was entangled with his heavy reliance on specialists as governmental officials. Coupled with the expansion of public research centers during the same period, a group of experts emerged and sat across the policy and academic arena. In contrast, after the

authoritarian regime ended in 1986, the government revised policies to allow NGOs to work directly with international aid agencies. The proliferation of NGOs in the 1990s was even more rapid than the increase of private companies (Clarke 1998; Lopa 2003; Reid 2008). It is worth noting that these two groups of people may overlap. For example, I mentioned the Asia Rice Foundation's brown rice campaign in Chapter Two. Several campaign organizers were influential governmental officials or academics before they retired and became active in the nonprofit sector. This example also indicates the close relationship between the public sector and the nonprofit sector in the Philippines.

While development actors were important resources in the development field, it was through the *meetings* that development actors were structured and mobilized. Meetings rendered people from different backgrounds active development actors. The recent surging focus on theorizing meetings helps me consider the importance of these meetings in the development field (Allen, Lehmann-Willenbrock, and Rogelberg 2015; Brown, Reed, and Yarrow 2017; Sandler and Thedvall 2017a). While scholars define meetings diversely, they all point out how meetings are taken for granted for their importance in modern lives and share a basic definition of meetings as the gathering of multiple participants with a focused agenda. Based on this basic definition, scholars work on analyzing and theorizing the importance of meetings in various social arenas, including formal organizations (Allen, Lehmann-Willenbrock, and Rogelberg 2015), social movements (Haug 2013; Sandler 2022), educational settings (Midha 2022), and

the international development field (Brown and Green 2017; Kendall and Silver 2007).

This body of scholarship helps me theorize meetings of development actors as critical infrastructure in the international development field. I draw on Brown and Green's assertation that "international development is a system of meetings" (Brown and Green 2017:46) to consider the nature of *the meetings of development actors*. Brown and Green (2017) use the Kenya health sector as a case to illustrate how meetings "situate development actors within a network of relations" (58) that "enable development projects to be instantiated within existing organizational structures" (59). Based on their empirical analysis, Brown and Green foreground the meeting's role in creating partnerships and structuring social relations across the development field.

While I take Brown and Green's insight in theorizing meetings of development actors as an infrastructure to create and maintain social relations within the development field, from the perspective of the problem-solution analytical framework, I am also concerned about how meetings were important for fostering coexisting solutions. Below I use the 2018 International Conference on Nutrition-Sensitive Agriculture (UPLB-NSA Conference) to exemplify how meetings may serve as a space for identifying problems, crafting solutions directions, and mobilizing more development actors.

The four-day UPLB-NSA Conference was held November 7-10, 2018. The venue was the Development Academy of the Philippines (DAP)[115] in the Tagaytay City of Cavite province. I consider the significance of the conference in two opposing dimensions. On the one hand, the conference was ordinary in the Philippine development field. Different agencies in the Philippines may hold similar kinds of issue-based conferences throughout the year. This 2018 UPLB-NSA conference represented a typical meeting where development actors gathered to discuss particular social issues. On the other hand, the conference was a distinct one for the issue of nutrition-sensitive agriculture in the Philippines. It was not only the first conference that focused on this issue but also co-held by all the most prominent agricultural research organizations in the Philippines. It characterized the mainstreaming of the issue in the Philippines and could hold weight for influencing future research and policy directions across the Philippines.

While the conference was a manifestation of the development field, the participant listed in the conference also revealed who the primary development actors were in this field. Appendix 3 provides a comprehensive list of presenters and moderators in this conference, which shows diverse social groups involved in

[115] During the early months of the martial law period, the Development Academy of the Philippines (DAP) was built to serve as the "development-oriented academy for the civilian bureaucracy" and represented a new type of development thinking in the "New Society." Nowadays, it still operates the Public Management Development Program (PMDP) and serves as a public conference center for various similar conferences. In other words, the DAP exemplifies a space where the development field materializes and different development actors gather.

the development field, including scientists from universities, governmental officials at local, national, and international levels, scientists from international and local research centers, officials from international and domestic development agencies and NGOs, and local businesspeople. Among them, the UPLB was the primary academic institution involved in the conference, while several agencies under the Department of Agriculture were also present. The two primary local research centers active in the conference were PhilRice and FNRI. As I demonstrated in previous chapters, all these organizations were connected with the five agrifood projects I analyze in this dissertation. Although in different contexts and with various degrees of visibility, all five agrifood projects were presented at this conference.

The operation of the conference echoed Haug's (2013) theorization of the meeting's duality of structure, which considers meetings as "the result of the participants' interactions while it simultaneously structures these interactions" (p.710). On the one hand, the conference reproduced and represented the power relations in the existing development field. The conference functioned as a "moderated workshop" where conference organizers invited most presenters. Most of the presenters were influential scholars or occupied an institutional position in the government or international agencies. In contrast, the conference attendees were there to learn and update their knowledge about various malnutrition and agricultural development issues crammed into a short period and packed schedule. On the other hand, the conference facilitated development

actors' interactions across the existing power hierarchy. The conference provided a space where people could approach other people directly and without bureaucratic procedures,[116] including an opportunity for policy exchanges with governmental officials at the conference or for exploring partnerships across institutions.

In addition to structuring and facilitating social relations, the conference also materialized the central role of problems and solutions regarding nutrition-sensitive agriculture in the development field. As the official program states, "this conference will enable the country to benefit from the knowledge already generated on the subject and a range of technologies available from the Southeast Asian region and local agencies. This will enable us to raise the understanding of agriculture's role in meeting the population's nutritional needs." Thus, one primary focus of the conference was to specify key *problems* at stake. At this conference, three different sets of problems were upheld by keynote speakers. The first one was the problem with the current food production system. The second one was the lack of governmental support for farmers. The third one was to diversify and specify various malnutrition and their connections to agricultural production.

[116] For example, during the conference, I scheduled an interview with a nutritionist who works in a governmental agency. If I had not directly met this government-employed nutritionist at the conference, the proper channel for making contact would have involved sending a request via SEARCA to the governmental agency. Then, the government agency would have to arrange the interview for me.

Framing problems at stake during the conference usually came hand-in-hand with what Carly Nichols (2019) analyzes as "the affective quantitative practices of global nutrition." Nichols's concern was how the current policy discourse regarding global nutrition renders the uncertain future threat into a "felt reality" (Nichols 2019:181). She draws from Brian Massumi (2015) and Michelle Murphy (2007) to point out that the quantitative data for malnutrition is far from objective but exerts an affective effect through "calculations, modeling, and words that appeal to different affective registers" (Nichols 2019:181). These affective quantitative practices then call for nutrition governance and invoke urgent responses based on quick fixes. I also observed how similar kinds of affective quantitative practices about malnutrition mobilized development actors during meetings. Figure 24 shows a typical example presented in multiple meetings I attended, including the 2018 UPLB-NSA Conference.

Briefly speaking, Figure 24 demonstrates the trends in stunting and wasting among children less than five years old from 1989 to 2015. On top of indicating the current status of malnutrition in the Philippines, the chart is also seen as concrete evidence that the problem of child wasting and stunting has not been "improved" or only improved slightly in the past thirty years and is beginning to worsen again. The interpretation of the chart further implicates the continued failure of all kinds of efforts and projects over time. Based on the development

actors' political stance, they may invoke the memory of the Marcos regime in a nostalgic sense or as the root of all these failures[117].

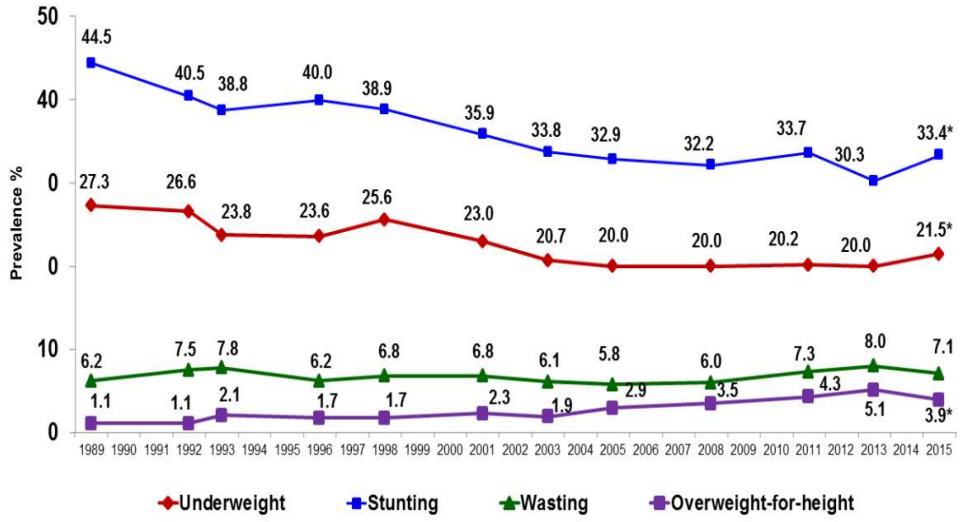

Figure 24: Trends in the prevalence of malnutrition among children less than 5.0 years old, 1989-2015

While Nichols's research focuses mainly on how the logic of affective fact is embedded in the development of global nutrition policymaking, Massumi's original conceptualization of "affective fact" provides clues on how these affective facts could mobilize actions. He points out that affective facts are built

[117] Following the rich scholarship that investigates how "the structuring of a collective national sentiment" serves as "a technology of state power" (Choi 2021:87), Vivian Choi (2021) points out that infrastructures could also be "the establishment of stable social relations" (p.87). She further defines infrastructures of feeling as "constituted by the ways our social emotions are developed, felt, and communicated in particular tangible, materials conditions" (p.87). Particularly, Choi highlights "the longue duree in response to decades of social and political instability and duress" (p.87) as the infrastructure that could invoke collective feelings. She uses the traumatic experience of natural disasters and war violence in Sri Lanka to illustrate how these past experiences manifest in the environment that generates peoples' feeling of "always alert" (Choi 2021: 97). In short, the occasion of affective encounters and the historical manifestations in the present are two key components.

on a "double conditional" feature structured in a "would be/could be" argument. Massumi's example is about the U.S. national security regime's assertion that the terrorists *would* attack the U.S. if they *could* have the capacity. This double conditional structure of argument renders affective facts "the felt reality of threat legitimat[ing] preemptive action" (Massumi, 2015:191). From this perspective, preemptive actions for national security do not hinge on whether terrorists have the capacity or not anymore but become self-justified and invoked. As Massumi argues, "the affect-driven logic of the would-have/could-have is what discursively ensures that the actual facts will always remain an open case, for all preemptive intents and purposes" (Massumi, 2015:192).

Similarly, the same "double conditional" logic also appears in the case of malnutrition. The most typical discourse goes like this: what would the Philippine *economy* become if *malnutrition* could continue to erode the capacity of the next generation of Filipinos? The "double conditional" structure strengthens this discourse's linkage between public health and the national economy. For example, international agencies released reports in 2016 and 2019, respectively, and both caused media attention. As one news article's title states: "a growing problem, child malnutrition costs the Philippines $ 7 billion in a year.[118]" The other simply put: "Malnutrition's impact: $4.5 billion a year[119]." Underlying the

[118] See https://www.reuters.com/article/us-philippines-economy-malnutrition/a-growing-problem-child-malnutrition-costs-philippines-7billion-in-a-year-idUSKCN1151FE

[119] See https://businessmirror.com.ph/2019/10/17/malnutritions-impact-4-5-billion-a-year/

quantification and economization of malnutrition is the double-conditional structure of affective facts that call for preemptive and urgent actions.

Demonstrating solutions and drawing on such affective resources to call for action was another important component of the 2018 UPLB-NAS Conference. Conference presenters showcased diverse solutions based on competing approaches to agricultural production, while the poster session was also crowded with potential solutions to certain types of malnutrition. More importantly, the conference's final session was a workshop designed for group discussions. The workshop's theme was "Identifying Strategies in Integrating Nutrition in Agriculture Programs." Participants were invited to participate and contribute to the discussion. They were divided into three groups, each with different aspects of the theme to discuss[120]. Every group had a chair facilitating the discussion and a rapporteur responsible for reporting to the larger group (Figure 25). To some extent, the workshop discussion sought to do more than collect contributions and feedback from conference participants. It created a sense of urgency for immediate action that should be carried out after participants returned to their positions in different parts of the country. It may also aim to consolidate a collective consciousness among participants as *development actors* responsible for tackling malnutrition in the Philippines.

[120] These three themes included: "Food Production, Food Handling, Storage and Processing," "Food Trade, Marketing, Consumer Demand, Food Preparation and Preferences," and "Cross-Cutting Issues (Gender and Empowerment, Crop Insurance, Food Quality, Safety and Hygiene, Food Loss, Nutrition-Sensitive Value Chain)."

Figure 25: A workshop group gathered in the middle of a room

All these components, including problem-identifying, affective fact, solution-proposing, and workshopping actions, were not exclusive features in this conference but typical elements in other meetings of development actors. These various types of meetings of development actors constituted a significant part of my fieldwork. All the projects were built on and exemplified a wide range of meetings. Although I do not intend to exhaust all the meetings in these projects, a brief highlight of how the five projects utilized meetings to mobilize their projects could shed additional light on what it means to treat meetings of development actors as an infrastructure for social relations in the development field.

For the Iron-Premix Rice Project, the DOST seminar I introduced at the beginning of this chapter provides a good example. While the seminar belonged to a series of seminars held by the DOST to bridge local development actors with the development projects developed by public research centers under the DOST, the Iron-Premix Rice Project team utilized the opportunity to meet with businesspeople, community leaders, and local public sector officials. The team's main purpose was to broaden the partnership and expand the production capacity of iron-premix rice. Another example would be the National Nutrition Seminar. The Iron-Premix Rice Project has been active in the National Nutrition Seminar in recent years. They had a booth that introduced their projects as solutions to iron deficiency to community nutrition workers, local NGOs, and other social groups attending the event. They also had a chance to present the project to these development actors on one of the panels. All of these efforts helped the project increase its popularity and acceptance.

For SHGP, the project was partly built on various levels of meetings and partnerships. On the basic level, there were coalition meetings between UPLB scholars, SEARCA, the DepEd representatives, and their funders. On top of it, the SHGP team held various workshops with school and community members. Because of the strategic positioning of SEARCA in the development field, SHGP was also involved in organizing various meetings, including the international conference on school gardening and a training workshop. These meetings helped promote the idea of school gardening and solidify the project's success.

Like SHGP, the BeRICEponsible campaign relied on partnerships with other governmental agencies and private companies to mobilize its agenda. Meetings would be involved in the process of building these partnerships. Furthermore, similar to the Iron-Premix Rice Project, the Campaign utilized various meetings and events to promote its project and explore further partnerships. For example, the 2015 Annual report mentions that the campaign was "promoted through presentations in about 20 different meetings, conferences, and events both by DA, other government agencies, NGOs and private agencies." The data demonstrated that, in addition to directly engaging with the general public, the campaign also made significant efforts to reach out to other development actors through various types of meetings and gatherings.

MPFI also utilized all kinds of meetings to broaden its member base and build partnerships. While MPFI held regular internal meetings, the organization was also responsible for holding the annual National Moringa Congress, gathering development actors from different sectors. Meanwhile, the MPFI members also collaborated with the Department of Agriculture to hold Organic Moringa Production Workshops, which aimed to broaden its member base among farmers and producers. Another critical meeting that facilitated MPFI's agenda was their meeting with the undersecretary of the Department of Agriculture about drafting the Moringa Industry Development Roadmap. Because the meeting was a gathering of governmental officials, moringa-related academics, and the business

sector, it allowed MPFI to explore partnerships with agencies in the research infrastructure to generate moringa-related knowledge.

As an internationally funded project, the progress of the Golden Rice Project was sure to be supported by all kinds of meetings across development agencies. Besides these inter-agency meetings, another crucial type of meeting was community consultation meetings required by the Philippine biosafety regulations before they could carry out their field trials in specific rice-growing communities in the Philippines. The project was required to connect with the local community to receive their support for these field trials. Meanwhile, the Golden Rice Project members also frequently presented at conferences to introduce and defend the project and seek support within the development field of the Philippines and beyond. For example, the main scientist of the Golden Rice Project presented at the 2018 UPLB-NSA Conference, and the presentation garnered many discussions, which sustained the visibility of the project.

Although I could not trace and document all the meetings of development actors involved in each project, I showed how pervasive and diverse these meetings were by taking together how they utilized various types of meetings to develop their projects. It also indicated how each project relied on certain types of social relations to thrive depending on these projects' configurations of the assemblage.

But more critically, how could the meetings of development actors support the coexistence of these solutions? On the basic level, these projects coexisted in certain types of meetings, such as the 2018 UPLB-NSA Conference. Since these meetings materialized the operation of the development field, the fact that diverse projects could be present in the same meeting indicated the support from development actors in general. Fundamentally, coexisting solutions meant coexisting development actors who embraced different ideologies and supported different directions of solutions. From this perspective, meetings were not only where projects crafted necessary partnerships or development actors sharing similar ideologies consolidated their strength. Meetings were also spaces to examine whether development actors with diverse ideologies could coexist and how diverse those coexisting ideologies could span. Pushing this point further, it also meant the diversity of meeting format may influence what types of projects can emerge and coexist. I take up this point further in the concluding section below.

Conclusion

The chapter begins with Foucault's assertion that it is important to pay attention to the *soil* that enables multiple responses to coexist with the same problem. I draw from scholarly theorization of infrastructure to identify and analyze three key infrastructures that support the existence of the problem-

solution constellation and the coexistence of various solutions. I discussed their expansion and how they interacted with individual projects.

The epistemic infrastructure was about how malnutrition could be known widely in the development field. I point out that the epistemic infrastructure of malnutrition in the Philippines consisted of the National Nutrition Survey (NNS), other nutritional standards developed by the Philippine nutrition community, and all the channels that helped distribute the NNS result to development actors. The research infrastructure referred to institutions that helped generate technoscience for agrifood solutions. I suggest that the research infrastructure have a triple-helix structure consisting of the public sector, the academia, and the non-profit sector. The mobilization infrastructure referred to how these agrifood projects could enroll more development actors to support the development and expansion of their projects. I highlight the importance of meetings of development actors as the basis of the mobilization infrastructure.

Then, how does this chapter contribute to the formation of the problem-solution analytical framework and speak to STS scholars' theorization of problematization? This chapter's discussion interconnects with the previous two chapters; together, these three chapters constitute a comprehensive perspective of the problem-solution analytical framework. In each section of this chapter, I demonstrate how each of the five agrifood solutions interacted with each of the three infrastructures; here, I elaborate on how the infrastructural analysis sheds

light on the analysis of the problem-solution constellation. This chapter concentrates on infrastructures that impact contemporary agrifood projects and provides a brief historical sketch of each infrastructure. It is clear that in each historical period I analyze in Chapter Two, infrastructures would appear in different shapes and interact with agrifood solutions active in that period differently. Interactions between infrastructures and agrifood solutions would impact not only the configuration of each solution assemblage and the pattern of the overall problem-solution constellation in that particular period. Their interactions may also contribute to the sustainability and expansion of these infrastructures in the long term. While this type of historical analysis is beyond the scope of this chapter's discussion, this chapter provides a lens to suggest how infrastructures and agrifood solutions may have intertwined throughout history and opens up future research directions.

This chapter's infrastructural analysis also sheds light on the practical-critical divide in the scholarship of development solutions I discussed in Chapter One. For practical scholars conducting comparative analyses of coexisting solutions, the existence of shared infrastructures may push them to confront the question of whether it is meaningful to *just* compare these solutions without considering why coexist *these* solutions. For critical development scholars, the existence of shared infrastructures adds to the complexity of analyzing the controversy surrounding the contentious solution's emergence and persistence. Since the contentious solution shares the same set of infrastructures with other coexisting – and even

conflicting – solutions, critical scholars will need to consider whether the controversial aspects of the contentious solution may attribute to the shared infrastructure and also appear in other coexisting solutions.

Another key implication for analyzing these infrastructures is to consider how it is possible to change the existing problem-solution constellation. Several discussions in this chapter imply this point. I mentioned how some technoscience had never been developed before the development of these projects. Then, what may change if the structure of the current research infrastructure is different? For the epistemic infrastructure, I mentioned how the knowledge developed by the epistemic infrastructure enables different projects to position the problem as their target. If the problem could be *known* differently, other projects may be attracted to work on the problem. For instance, following SDG #2's focus on eradicating malnutrition and promoting sustainable agriculture, I wonder if the National Nutrition Survey includes "land relations" as a question in their survey and features the corresponding statistical result in their official report and presentations in the annual nutrition seminar series, would that generalize another problematization and lead to another problem-solution constellation centered on land reforms? For the research infrastructure, in the Philippines, there exists another research institute called the Philippine Institute of Traditional and Alternative Health Care (PITAHC), which is under the Department of Health and has very little interaction with the research infrastructure I introduced in this chapter. If the PITAHC could become a part of the research infrastructure, will

other types of solutions emerge? For the mobilization infrastructure, following scholars who have pointed out how meetings are products of western modernity (van Vree 1999), I wonder how different formats of meetings may attract diverse groups of people to become development actors. I continue my examination of all these implications in the concluding chapter.

Chapter Five
Conclusion

Malnutrition has been recognized as a persisting social problem since the emergence of modern nutrition science. In recent years, the international agricultural development field has made efforts to tackle malnutrition through agrifood innovations, commonly known as nutrition-sensitive agriculture. However, these efforts have been caught up by contentious competitions between two visions of agricultural development: precision agriculture and agroecology, both claiming to be the most suitable agrifood solutions to malnutrition. Despite these contentions, development agencies such as FAO favor bringing together potentially conflicting agrifood innovations into one "catalog of solutions" to address the ever-worsening problem of malnutrition. Yet, development agencies' practice of cataloging solutions has not resolved the internal contentions within agricultural development, nor has it acted as an effective way of tackling malnutrition.

This research argues that the current failure of nutrition-sensitive agriculture is not solely due to development agencies' inability to choose the *best* agrifood solution to address malnutrition. Rather, the essence of the issue lies in the challenge of grappling with the complexity beneath the coexistence of agrifood solutions. How and why do particular agrifood solutions coexist? And how do these coexisting solutions attempt to address malnutrition collectively?

The current literature in social sciences reiterates the dilemma between two conflicting visions of agricultural development, paying little attention to how to evaluate the possibility of multiple solutions. I have identified two common approaches: the practical approach and the critical approach. The practical approach uses cost-benefit analysis to compare coexisting solutions. However, it often employs an individualist methodology and overlooks the historical, materialized, and infrastructural connections and differences among these solutions. In contrast, the critical approach aims to unveil unintended consequences or hidden agendas of a seemingly problematic solution. This approach either assumes that a better solution would emerge automatically by criticizing the problematic solution. Or, it may overlook other coexisting solutions that may be less noticeable but more commonly adopted.

Against the backdrop of a lack of policy and theoretical frameworks, this research develops a novel analytical approach to studying coexisting solutions. Inspired by Foucault's discussion on problematization, this approach recognizes that for every problem, there exist multiple responses, and researchers need to explore the "soil" that nurtures these coexisting solutions. Furthermore, this new approach builds on STS scholars' theories about the relationship between framing a social problem and its corresponding solution — or the process of problem-solution coupling.

I looked to the Philippines to illuminate our understanding of the relationship between social problems and proposed solutions. While observing the familiar pattern of agricultural development and the emerging trend of nutrition-sensitive agriculture in the country, I considered that the Philippines' long history of agricultural development and nutrition interventions provided rich materials to explore further implications. Malnutrition has been a persistent problem in the Philippines, and the involvement of international and local development agencies over the years has resulted in or facilitated numerous solutions. This historical background enabled me to identify and analyze coexisting solutions present during the same period. Specifically, I centered on five agrifood solutions to malnutrition and documented their development from solution proposals to operational projects. I further traced the appearance of these coexisting agrifood approaches in the Philippine historical context, the social problems they addressed, and the circumstances in which they emerged and coexisted.

Two main considerations shaped how and why I chose the five projects in my research. First, while these five agrifood projects may claim to address multiple aspects of the cause of malnutrition, they all identify the immediate cause of inadequate nutrient intake as the main problem to tackle. Nevertheless, these five projects represent distinct ways to utilize agrifood practices or products to address the problem. Second, I selected these five specific projects partly because they were the most visible projects I encountered during my fieldwork. The visibility

meant that these projects were comparatively “successful” or well-known compared to similar projects in the Philippines.

Each of these projects provides insight into whether agriculture could serve as the solution to malnutrition.

Food fortification, which is often proposed as a solution to address micronutrient deficiency, has become a traditional and less exciting technique. The Philippines government has struggled to align the approach with the interests of the food industry, making it challenging to secure their full support. Despite these challenges, the FNRI Iron-Premix Rice project was still attempting to work with the rice milling industry to produce iron-fortified rice in various locations.

School gardening has been used as a policy solution for a range of issues, including cultivating future farmers, addressing food crises, tackling malnutrition, and promoting environmental consciousness among students. The SEARCA School-plus-Home Gardening Project was designed to address malnutrition, but it was initially unclear what types of malnutrition it would target. Ultimately, the project was operationalized based on its multi-functionality, which at least included supplementing vegetables to the school feeding program, providing nutrition education, and promoting organic agriculture.

Biofortification, which followed the Asia Green Revolution in the 1960s, has not kept up with the paradigm shift in addressing malnutrition and has not been a

viable solution for addressing protein or micronutrient deficiency until recently. Facing a similar situation, the Golden Rice Project has been proposed as a solution not only for solving malnutrition but also for developing the Agri-biotechnology industry in the Philippines. The project's approval would be significant as it would mark the first genetically modified (GM) crop to pass the more stringent food safety protocol and serve as a model for future GM crop projects.

Brown rice consumption has been proposed as a policy solution to malnutrition during times of food crisis in history. Similarly, the BeRICEponsible Campaign was initiated as a policy solution to achieve rice self-sufficiency. Later, the campaign incorporated malnutrition as its targeted problem. However, the focus of the campaign shifted from addressing micronutrient deficiency to non-communicable diseases over time.

The popularity of moringa as a solution to malnutrition has persisted over time, but the government's approach to promoting it has evolved. While initially promoting growing moringa trees and incorporating moringa leaves into daily dishes, the government has shifted towards developing moringa-supplemented food projects and exploring the pharmaceutical potential of moringa extract. Following a similar rationale, the contemporary promotion of the moringa industry development initiative also emphasizes the importance of creating an industry to produce a large quantity of moringa to address malnutrition.

Although all these agrifood projects demonstrate valuable insights and are worthy of their standalone studies, when analyzed collectively, these coexisting agrifood solutions help understand the dynamics between problems and solutions in the international development field. This research argues researchers should not prioritize research focus based on presumptions of the importance of a particular solution but rather situate any specific solution within the context of coexisting solutions. To illustrate this point, this research conducts a comprehensive analysis of the five agrifood solutions to malnutrition to introduce a problem-solution analytical framework consisting of three aspects.

In chapter two, I point out that the coexistence of multiple agrifood innovations as solutions to malnutrition is not merely a contemporary phenomenon but has reappeared in history multiple times. I developed the concept of problem-solution constellation to demonstrate how the problem of malnutrition and agrifood solutions connect in each period. The historical analysis of problem-solution constellation advances STS scholars' theorization on problematization in two ways. It shows that there are coexisting solutions in multiple historical periods, underscoring the importance of foregrounding the coexistence of agrifood solutions. Based on the discovery, I suggest that it would be more generative for STS scholars to replace the current framing of problem-solution coupling with problem-solution constellation so that scholars could be more attentive to coexisting solutions. Furthermore, while most of the problematization analysis in the STS field does not focus on the historical aspect, this research

shows that the historical analysis could reveal non-solutions that did not appear to be a policy solution in a specific period and shed light on the potential of transforming the contemporary problem-solution constellation.

In chapter three, I shift the focus from the static view of problem-solution constellation to center on the agency of these five contemporary projects. Drawing on the concept of situated technoscience, I point out that the process of turning a solution proposal into an operational project requires efforts to intertwine technoscience with context-specific factors. Each agrifood solution, then, demonstrates a unique configuration between technoscience and context-specific factors, and the specific configuration would impact each agrifood solution's ability to respond to the problem of malnutrition. My analysis suggests that while some agrifood solutions were relatively flexible in targeting the social problem they intended to respond to, all the projects were constrained by structural and material conditions and did not have the freedom to choose the social problems to target. This aspect of analysis contributes to the problematization framework by foregrounding situated technoscience as a factor in analyzing each solution's agency and potential within the problem-solution constellation.

In Chapter Four, I move the focus from each agrifood solution's agency to the infrastructural environment that facilitates the emergence of coexisting solutions to malnutrition. Three infrastructures are discussed. The first is epistemic

infrastructure, which concerns how malnutrition is perceived and understood. The most important element of the infrastructure is the National Nutrition Survey and its apparatus that makes malnutrition known to development actors. The second infrastructure is the triple-helix research infrastructure, which includes public research centers, academia, and international development agencies or research institutes. I also point out that each project in my research has different positionings in relation to this research infrastructure, which influences the project's capacity to generate the technoscience required to develop the project. The third is the mobilization infrastructure, which refers to social relations in the development field. And I consider the meetings of development actors as the key format of the mobilization infrastructure. I also point out that these meetings could transform the framing of problems into affective facts that demand actions and enact solutions.

Mapping out these shared infrastructures strengthens and intersects with the previous two aspects of analysis. While the infrastructural analysis concentrates on the contemporary period, it sheds light on the formation of other problem-solution constellations in particular historical periods. Meanwhile, the infrastructural analysis helps contextualize factors that contribute to the configuration of each agrifood solution. The analysis also suggests that the interactions between infrastructures and individual projects support the expansion of these infrastructures in the long term. Together, this problem-solution analytical framework unveils particular types of power relations in the

development field, including the neglect of certain types of causes, the marginalization of certain solutions, the existence of non-solutions, the underdevelopment of certain areas of technoscience, and the exclusion of certain social groups as development actors.

The scholarly and policy implications of this research are profound. This research speaks to scholars of both practical and critical approaches in the realm of social studies of development problems. For practical scholars, the problem-solution constellation analysis highlights the limit of comparative analysis of solutions based on an individualist methodology. While this type of analysis usually aims to assess which solutions are more effective, it cannot identify potential interactions that may allow these coexisting solutions to work together or against each other historically. Furthermore, practical scholars usually consider the catalog of solutions as a list of projects that policymakers could mobilize at any time. However, my analysis points out that policymakers did not select projects from their catalogs; each project brought policymakers into their configuration in specific ways. This finding also suggests that these agrifood solutions on the catalog are not equally plausible for the same kind of policy mobilization or scaling up. Ultimately, for practical scholars conducting comparative analyses of coexisting solutions, the existence of shared infrastructures may push them to confront whether it is meaningful to compare these solutions without considering the factors contributing to the coexistence of *these* solutions.

For critical scholars, the findings in this research could help steer critical analysis away from focusing on the most contentious technology *only*. When critical scholars center on a specific solution, they sometimes miss the point that what is important is not only the "destruction" of this controversial solution but also the "destruction" of the *targeted social problem*. Instead, the problem-solution constellation analysis helps situate the contentious solution in relation to other coexisting solutions, providing another angle to examine the assumed importance and persisting existence of the contentious solution. Furthermore, the configuration analysis expands critical development scholars' attention to the actualization of agrifood solutions when technoscience intertwines with context-specific factors to become more complicated and extensive. Finally, the infrastructural analysis suggests that critical scholars consider whether the controversial aspects of the contentious solution may attribute to the shared infrastructure and also appear in other coexisting solutions.

In short, this research provides a fresh perspective on the relationship between identifying social problems and proposing solutions. Instead of rushing into solving problems, this research suggests that we pause and analyze the relationship or connection between framing the social problem and proposing solutions. We need to keep an open mindset to look for all possible solutions and analyze a specific solution alongside its *peer* solutions. Although technoscience may dominate the arena of proposed solutions, it is imperative to look beyond the label of emerging technology and pay more attention to what forms of situated

technoscience are produced when a solution proposal becomes operational. More importantly, keep in mind the *existence* of non-solutions – projects that do not appear in the current problem-solution constellation but may appear in history or exist outside the current constellation. To invite potential solutions to emerge, this research suggests that we scrutinize the power dynamics that shape the current problem-solution constellation and consider how to strengthen the shared infrastructure of coexisting solutions. Eventually, a more holistic view of the relationship between social problems and proposed solutions may cultivate a collective of solutions that could address the problem of malnutrition or other social problems more effectively.

Appendix

Appendix 1 List of Trips for My Fieldwork in the Philippines

Date	Length	Primary Fieldwork

Jun. 2016 – Jul. 2016	6 weeks	• **Pre-dissertation** study.
		  o Conversations with various agricultural, nutrition, and social scientists.
		  o Collection of secondary data.
		  o Attendance of forums, seminars, and a conference.
		  o Participant observations of various activities and spaces.
		• Explore and **establish the institutional arrangement** for my dissertation research.
		• **Invited talk**, titled "Agricultural Innovations and Alternative Food Movement for Nutrition Security and Rural Development: A Proposal for Eco-Social Design," at the Agricultural Systems Cluster, College of Agriculture, University of Philippines Los Baños.

0ct. 2017 – Mar. 2018	5.5 months	• Relocate to Los Baños, Laguna, the Philippines as a **visiting research fellow** in the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). • **Interviews** with key figures in the Brown Rice Campaign or the School Gardening Project. • **Attend public events** related to the Brown Rice Campaign, the School Gardening Project, or the Golden Rice Project. • **Attend internal meetings and visit schools** related to the School Gardening Project. • **Collect** historical **news articles** related to all five projects. • **Collect** historical **policy documents** related to agricultural and nutrition policymaking in the Philippines.

		• **Invited talk**, titled "From Food Security to Food and Nutrition Security: How to Rethink the Linkages Between Malnutrition and the Food System?" at SEARCA Agriculture and Development Seminar Series. • Finish a **policy brief** with a SEARCA colleague, titled "Adding Diversity as a New Dimension in the Food Security Framework," in the *SEARCA Policy Brief Series*.
Mar. 2018 – Jun. 2018	3 months	• Return to Taiwan. • Medical treatment and recuperation. • **Co-presentation** with a Filipino scholar at the 2018 Asia-Pacific Society for Agricultural and Food Ethics (APSafe) **Conference** in Taipei. The paper is titled "Linking School Gardening and Feeding Together: The Experience From SEARCA School and Home Gardening Project (SHGP)."
May 2018 – Jun. 2018	2 weeks	• Re-negotiate **the institutional arrangement** with SEARCA. • **Collect historical data** related to the Golden Rice Project, Brown Rice Project, or the Iron-Fortified Rice Project.
Sep. 2018 – Oct. 2018	4 weeks	• Help **organize** the International **Conference** on Nutrition-Sensitive Agriculture and Food Systems. • **Farm visit** and **interviews** of Moringa Production Project. • **Internal meetings** related to Moringa Production Project. • **Attend public events** related to Brown Rice Campaign, Moringa Production Project, or the Iron-Fortified Rice Project. • **Interviews** and **school visits** related to the School Gardening Project.
Oct. 2018 – Nov. 2018	3.5 weeks	• **Attend, present a paper, and moderate a plenary session** in the International Conference on Nutrition-Sensitive Agriculture and Food Systems. • **Internal meetings** and **Interviews** related to Moringa Production Project.
Nov. 2018 – Dec. 2018	4 weeks	• **Attend** the 3-day Organic Moringa Production **workshop**. • **Interviews** related to the Brown Rice Campaign, Iron-Fortified Project, and Moringa production, or the Golden Rice Project

		• **Facility Visits** related to the Brown Rice Campaign or the Golden Rice Project.
Feb. 2019 – Mar. 2019	2.5 weeks	• **Give an expert presentation** titled "Social Considerations towards Inclusive, Healthy and Sustainable Food Systems" at *Understanding the Philippine Food Systems for Better Food Security and Nutrition: An Expert's Consultation on Food Systems*, organized by International Institute of Rural Reconstruction (IIRR) & International Center for Tropical Agriculture (CIAT). Silang, Philippines, February 27, 2019. • **Interviews** with NGO officials about nutrition policymaking.
Apr. 2019 – May 2019	3.5 weeks	• **Interviews** related to the Moringa Production Project or the Golden Rice Project. • **Collect scientific journal articles and policy documents** related to all the projects.
Jun. 2019	2 weeks	• **Interviews** related to the School Gardening Project. • **Collect policy documents** related to all the projects.
Jul. 2019	2.5 weeks	• Attend the National Nutrition Seminar. • Visit the FNRI facility • Collect policy documents related to School Gardening. • Wrap up my fieldwork. • Move out from the Philippines.
Jul. 2019 – Now	--	• Maintain connections with key figures of all the projects. • Process and analyze data. • Update the development of all the projects constantly via various online channels.

Appendix 2 The annual theme of the National Nutrition Month

	The annual theme in Filipino	English Translation
1976	Maximum utilization of local resources	Maximum utilization of local resources
1977	Strengthening the nutrition program at the barangay level	Strengthening the nutrition program at the barangay level
1978	Ugnayan ng kabataan sa nutrisyon	Children's relationship with nutrition
1979	Malusog na bata, malusog na bansa	Healthy children leads to a healthy country
1980	Wastong nutrisyon, landas tungo sa magandang kinabukasan	Good nutrition is the way to a better future
1981	Nutrisyon at kaunlaran	Nutrition and progress
1982	Nutrisyon at kabuhayan sa kaunlaran	Nutrition and livelihood for development
1983	Tiyakin ang kinabukasan, wastong pagkain ay kaugalian	Make good diet a habit for a good future
1984	Wastong nutrisyon sa sariling pagsisikap	Achieve good nutrition through perseverance
1985	Increased family productivity for economic recovery	Increased family productivity for economic recovery
1986	Sa lakas ng sambayanan, wastong nutrisyon ang kailangan	Good nutrition is needed for society's strength
1987	Sa pagbubuklod ng diwa at bisig, wastong nutrisyon makakamit	With mind and body, right nutrition is at hand
1988	Nutrition in development	Nutrition in development
1989	Sapat sa sustansiya, lakas ng pamilya	Good nutrition is your family's strength
1990	Malnutrisyon: tuklasin at pugsain	Understand and eliminate malnutrition
1991	Sa sama-samang pagkilos, malnutrisyo'y malulutas	Together we can solve malnutrition
1992	Karapatan ng bawa't Pilipino, wastong nutrisyon ay matamo	Every Filipino has a right to good nutrition
1993	Higit sa lahat, pagkaing sapat – para sa lahat	Enough food for everyone is of utmost importance
1994	Prutas at gulay ng bayan, taglay ay lakas at yaman	The country's food and vegetables hold the key to health and wealth
1995	Buto at ngipin patibayin, gatas ating inumin	Strengthen our bones and teeth by drinking milk

1996	Kapag kumain nang sapat, wastong timbang ang katapat	Eating the right foods is the road to ideal weight
1997	Kalusugan tiyakin sa masustansiya at ligtas na pagkain	Ensure your health by eating safe and healthy food
1998	Fortified foods kainin, dadgag sustansiya'y kamtin – selyong sangkap pinoy hanapin	Gain added nutrition by eating fortified foods -- look for the "Sangkap Pinoy" seal
1999	Pagkaing sapat siguruhin, wastong nutrisyon ating kamtin	Make sure to eat right to achieve good nutrition
2000	Wastong nutrisyon: alamin at gawin	Good nutrition: understand and do it
2001	Wastong nutrisyon: alamin at gawin at palaganapin	Good nutrition: understand, do, and share it
2002	Pagkain at paglaki ay bantayan, upang ang wastong nutrisyon ay kamtan	Watch the children's food and growth to achieve good nutrition
2003	Kabataan palusugin, isulong ang breastfeeding	Encourage breastfeeding and nourish children
2004	Breastfeeding Panatilihin, Dagdagan nang Wastong Pagkain	Retain breastfeeding, supplement it with good food
2005	Batang May Kinabukasan, Sa Wastong Nutrisyon Simulan	Let's start a child's future through good nutrition
2006	Kumain nang Right, Para Maging Batang Bright	Eat right to be a bright kid
2007	Healthy lifestyles ng kabataan, Landas sa Kinabukasan	The children's healthy lifestyles lead to their good future
2008	Sa wastong nutrisyon ni mommy, *siguradong* healthy *s i* baby	Ensure your baby is healthy by eating right, mommy
2009	Wastong Nutrisyon Kailangan, Lifestyle Diseases Wakasan	Let's end lifestyle diseases by eating right
2010	Sa Pagkaing Tama at Sapat, Wasttong Timbang ni Baby ang Katapat	With eating right and sufficiently, your baby's ideal weight is at hand
2011	Isulong and Breastfeeding-Tama, Sapat, at Eksklusibo (TSEK)	Encourage breastfeeding - right techniques, sufficient and exclusive breastfeeding
2012	Pagkain ng Gulay Ugaliin, araw-araw itong ihain	Make eating vegetables a habit, serve vegetables everyday
2013	Gutom at Malnutrisyon, Sama-sama Nating Wakasan	Let's end hunger and malnutrition together
2014	Kalamidad Paghandaan: Gutom at Malnutrisyon Agapan	Be ready for calamities: combat hunger and manutrition early

2015	Timbang Iwasto, sa Tamang Nutrisyon at Ehersisyo	Achieve ideal weight through good nutrition and exercise
2016	First 1000 Days ni Baby Pahalagahan, Para sa Malusog na Kinabukasan	Value your baby's First 1000 days for its healthy future
2017	Healthy Diet, Gawing Habit -- For Life!	Make healthy diet your habit for life
2018	Ugaliing Magtanim, Sapat na Nutrisyon Aanihin	Plant your food and harvest good nutrition
2019	Kumain nang wasto at maging actibo…Push Natin ito!	Eat right and be active -- we can do this!
2020	Batang Pinoy SANA TALL… Iwas stunting, SAMA ALL	May Filipino kids be tall… Everyone should avoid stunting

Appendix 3 List of Organizations Involved in the 2018 UPLB-NSA Conference

Academia - UPLB	the Interdisciplinary Studies Center on Food & Nutrition Security, College of Agriculture and Food Science
	Institute of Crop Science, College of Agriculture and Food Science
	Agricultural Systems Institute, College of Agriculture and Food Science
	Institute of Food Science and Technology, College of Agriculture and Food Science
	Institute of Human Nutrition and Food, College of Human Ecology
	The Department of Development Broadcasting and Telecommunication, College of Development Communication
	Institute for Governance and Rural Development, College of Public Affairs
	College of Engineering and Agro-Industrial Technology
	College of Arts and Sciences
	Philippine Genome Center, Office of the Vice President for Academic Affairs
	Office of the Vice-Chancellor for Research and Extension
Academia - Other	Cavite State University
	Central Luzon State University
	Bicol University
Academia - Foreign	Mahidol University, Thailand
	Agriculture and Forestry University, Nepal
	National Taiwan University, Taiwan
Philippine Government	Bureau of Agriculture And Fisheries Standards Divisions, Department of Agriculture
	Philippine Crop Insurance Corporation, Department of Agriculture

	Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development, Department of Science and Technology
	Small Business Corporation, Department of Trade and Industry
	the Nutrition Information and Education Division, National Nutrition Council
	Agricultural Sciences Division, National Academy of Science and Technology Philippines (NAST Phil)
	Province of Cavite Government
	Senate Committee on Agriculture and Food, Senate of the Philippines
Foreign government	Research and Development Center for Social Welfare, Ministry of Social Affairs of the Republic of Indonesia
International Development Agency	FAO Philippines
	FAO Regional Office for the Asia Pacific
	World Food Program Philippines
	Asian Farmers' Association for Sustainable Rural Development
	International Institute of Rural Reconstruction (IIRR)
	SEARCA
Local NGO (business-sponsored)	Jollibee Group Foundation
	Moringaling Philippine Foundation Inc.
International research center	Healthier Rice Breeding Group, International Rice Research Institute (IRRI)
	The World Vegetable Center
	The World Fish Center
Local research center	Integrated Rice-based Agribiosystems, Philippine Rice Research Institute (PhilRice), Department of Agriculture
	Rice Chemistry and Food Science Division, Philippine Rice Research Institute, Department of Agriculture
	Food and Nutrition Research Institute, Department of Science and Technology
Local Business	Sagip Environment, Inc.

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