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A food-system approach to addressing food security and chronic child malnutrition in northern Vietnam

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Abstract

Despite recent improvements in health, Vietnam continues to face significant problems with food security and chronic malnutrition among children. In the Northern Mountainous Region, small-scale farmers and ethnic minority groups are particularly hit hard. Anemia is present in almost half the local population of children under two, and close to 20% of children experience stunted growth. Anemia and stunting can cause irreversible deficiencies

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Note

Ryerson University was recently renamed to Toronto Metropolitan University.

in learning and child development. Fortification of food products that are complementary to breast milk has been identified as an option to intervene and tackle chronic child malnutrition, particularly in situations requiring rapid results. Our paper describes how the ECOSUN project addressed food security and chronic child malnutrition in northern Vietnam (Lào Cai, Lai Châu, and Hà Giang provinces) using a food-system approach to design and implement a viable and sustainable value chain for fortified complementary foods. Through public-private partnerships, the project procured locally grown crops from small-scale women farmers to produce affordable fortified complementary food products in a small-scale food processing plant. Social marketing campaigns and nutrition education counseling centers supported product distribution through local vendors while emphasizing and promoting the value of fortified foods for healthy child development. The ECOSUN project also aimed to contribute to the broader goal of transforming the local economy. The process, lessons, challenges, successes, and methods employed to assess and test the delivery mechanisms of the project can offer insights to researchers, program implementers, and decision-makers involved in research-integrated development projects embedded in local socio-ecological systems.

Disclosures

The National Institute of Nutrition Centre for Scientific and Technological Service in Nutrition and Food (NINFOOD) operates as a business subsidiary of the Vietnam Ministry of Health's National Institute of Nutrition (NIN). NINFOOD specializes in the research, development, manufacturing, distribution, and sale of fortified foods, including a high-energy bar used to help treat severe acute malnutrition among children and adults, such as those living with HIV. While its business model ensures sustainability, it is ultimately guided by the mandate of NIN and the Vietnam Ministry of Health to work in the best interest of the people of Vietnam to promote their good health. It is also a member of the Scaling Up Nutrition (SUN) Network in Vietnam.

The ECOSUN project titled "Scaling up small-scale food processing for therapeutic and complementary food for children in Vietnam" was partially funded through a contribution by Global Affairs Canada and the International Development Research Centre (IDRC) under the Canadian International Food Security Research Fund Phase-2 (grant no. CIFSRF 108124).

Keywords

Purchasing Behavior, Food Security, Food-system approach, Local Food Supply, Malnutrition, Marketing and Distribution, Nutrition Education, Public Private Partnerships, Sustainability, Vietnam

Introduction and Literature Review

High economic growth and rapid reductions in poverty rates marked the past three decades in Vietnam. These advances are reflected in national health statistics, including the nutritional status of children. Between 1990 and 2016, stunting declined from 56.5% to 24.3%, while underweight dropped from 51.5% to 13.8% among children under the age of five (Berger et al., 2013; Ministry of Labour-Invalids and Social Affairs & UNICEF Viet Nam, 2017; National Institute of Nutrition, 2016; P. H. Nguyen et al., 2011). However, in recent years the rate of improvement in health has slowed, as more complex situations affecting remote and hard-to-reach populations defy broader national policies. As a result, Vietnam continues to face significant problems with chronic malnutrition among women and children, particularly in rural areas and among ethnic minority groups of the Northern Mountainous Region (NMR) (Mbuya et al., 2019; McBride et al., 2018), posing a challenge to those engaged in improving the country's public health status. The ethnic minority groups (e.g. H'mong, Tày, and Dao peoples) predominant in the NMR live in remote areas and depend mostly on subsistence farming (Bonnin & Turner, 2012; Son & Kingsbury, 2020). The lowlands of the NMR are mainly populated by Kinh, the dominant majority group in Vietnam, while Tày dwell in mountain valleys, and Dao and H'mong live at middle and higher altitudes, respectively. Dao, Tày and H'mong people grow paddy rice on terraced hills, grow maize, rear livestock, maintain home gardens, conduct small-scale barter and trade, and cultivate fruit-tree plantations in mountain forests (Bonnin & Turner, 2012; Son & Kingsbury, 2020; Trincsci, 2017). Although the de-collectivization of agriculture in Vietnam through successive land reforms has enabled crop diversification and production for individual profits, farming households face high rates of poverty and food insecurity (Bonnin & Turner, 2012; Scott, 2003). Agriculture in the NMR is particularly vulnerable

to drought, flooding, soil erosion, and landslides. Furthermore, agricultural extension services are limited, and markets to buy inputs and sell produce are hard to reach, particularly at higher altitudes (Pham et al., 2019; Son & Kingsbury, 2019). Challenges like these put farming households at risk of food and income shortages. To cope with such shortages, the quantity of food eaten is often reduced, and nutrient-dense foods such as animal-source foods rich in iron, zinc, and protein are substituted with cheaper foods rendering malnutrition, particularly in children, inevitable (Son & Kingsbury, 2019). Stunting and undernutrition rates are three times higher among children in mountainous areas compared to lowland areas (McBride et al., 2018). The NMR provinces of Lào Cai, Lai Châu, and Hà Giang bordering China present some of the highest levels of chronic child malnutrition in the country, requiring greater effort and more focused attention (see Table 1).

Inadequate breastfeeding and poor complementary feeding practices[1] are major factors contributing to poor development among Vietnamese children (P. H. Nguyen et al., 2011; Phu et al., 2010). Changes to local and regional food systems and supply have increased the availability and consumption of highly processed and refined foods that are energy-dense but nutrient-poor, which, when consumed by infants, hamper proper development and increase the risk of stunting (Binns et al., 2020). Common complementary solid foods in Vietnam include rice porridge, gruel, noodles, vegetable pastes, flour-based traditional foods, and commercially prepared packaged cereals, only some of which are fortified with minerals and vitamins (Binns et al., 2020). Strategies to encourage exclusive breastfeeding for the first six months of life and promoting high-quality complementary foods and feeding practices after that are essential to prevent stunting and wasting in order to guarantee healthy growth and development in infants and young children (Binns et al., 2020; Graziose et al., 2018).

Fortifying food with micronutrients has been identified as an intervention option (along with supplementation and increased dietary diversity) to tackle malnutrition, particularly in situations requiring rapid results (Binns et al. 2020; Timotijevic et al., 2013). In regions where rice is a dietary staple, rice-based fortified cereal is a cost-effective option to reduce micronutrient deficiencies and anemia by providing additional dietary iron (Awasthi et al., 2020; Fiorentino et al., 2018). An efficacy study by Awasthi et al. (2020) found that rice-based cereal fortified with a low to moderate dose of iron was safe for infant consumption. Children who consumed the fortified cereal also had better blood-iron status and development in language, motor skills, and socio-emotional and adaptive behaviors when compared to children who did not consume it. However, despite evidence of potential efficacy (Awasthi et al., 2020; Campos Ponce et al., 2019; Okeyo, 2018; Phu et al., 2010), there are challenges surrounding food-fortification strategies to address child malnutrition. One challenge is the technical feasibility of developing food products that are not only safe and meet the nutritional needs of the target population, but are also socially accepted by the

Table 1. Nutrition Profile of Provinces in the Northern Mountainous Region of Vietnam, 2013

Issue	Lào Cai	Lai Châu	Hà Giang
Prevalence of women aged 15–49 years with chronic energy deficiency	13.7%	11.9%	12%
Prevalence of stunting (low height for age), children under 5 years	37.3%	36.8%	35.4%
Prevalence of underweight (low weight for age), children under 5 years	22.1%	23.9%	23.5%
Prevalence of wasting (low weight for height), children under 5 years	4.9%	4.9%	9.8%
Proportion of children 6–23 months with minimum acceptable diet	42.5%	47.8%	59.8%

Source: NIN et al., 2014.

[1] Complementary feeding is the process when infants and young children eat foods and liquids along with breast milk to meet their nutrient and growth needs.

intended consumers. Often the fortification of staple foods is a joint effort between public, private, and civil society, where local farmers and food processors are involved in the production and processing in compliance with government regulations, nutritional standards, and appropriate marketing guidelines (Lalani et al., 2021; Van Liere et al., 2017). However, to produce high-quality fortified foods, local small and medium-sized businesses need support from credible technical agencies to address challenges related to sourcing raw materials that meet safety standards, defining product composition, operating at scale, and ensuring quality and control (Van Liere et al., 2017).

Proposed fortification strategies must also consider the contexts of child-feeding practices and be appropriately tailored for the proper utilization and consumption of the products (Champion & Seidel, 2015; Gillespie et al., 2019). This includes, importantly, the concern of not having fortified complementary food (FCF) undermine breastfeeding. The appropriate production, distribution, acceptability, price, and ability of FCF to reach the target population must also be considered (Leyvraz et al., 2017; M. Nguyen et al., 2016; Van Liere et al., 2017).

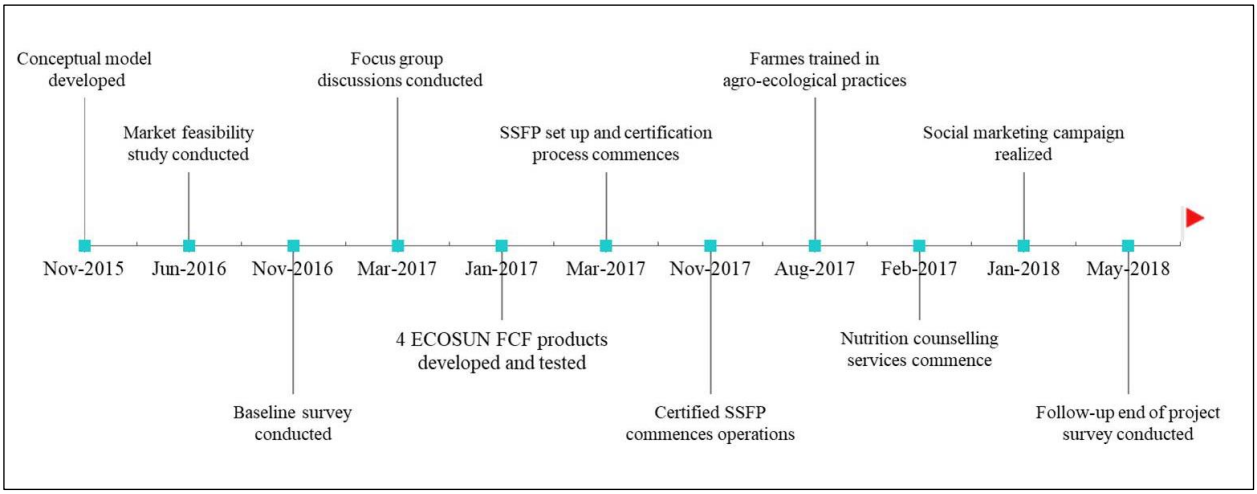
As food systems connect directly to the processes of poverty reduction, strategies for improving nutrition, and enhancing agricultural sustainability, decision-makers, researchers, and public-health implementers can adopt a food-system approach to make sense of transitions in diets, use resources sustainably, and support social inclusion in low- and middle-income countries (LMICs) (Brouwer et al., 2020), such as Vietnam. A food-system approach assesses links between food activities, markets, and institutional networks, as well as nutrition, socio-economic, and environment outcomes (Brouwer et al., 2020).

The National Institute of Nutrition (NIN), a department of Vietnam's Ministry of Health, is responsible for facing the challenge of continuously improving the country's nutritional status. NIN leads national nutrition surveillance and research, designing public health programs and nutrition interventions that focus on the first thousand days of life, as well as informing national policy on these topics. NIN's Centre for Scientific and Technological Service in Nutrition and Food (NINFOOD) is its research and development arm that specializes in applying food-safety and food-science technology to produce food products that enhance and improve the nutritional status of vulnerable groups (M. Nguyen et al., 2016). When NINFOOD piloted local production, distribution, and sale of micronutrient powder (branded as Bibomix) using the public-health system, they found successful uptake by increasing the capacity of health workers to counsel on child-feeding practices and fortifying complementary food at home (M. Nguyen et al., 2016).

A partnership between NIN and the Centre for Studies in Food Security (CSFS) at Ryerson University[2] in Canada led to the development and implementation of the ECOSUN project "Healthy Farm, Healthy Food, Healthy Kids" that ran from November 2015 through June 2018. With the ultimate goal of reducing levels of food insecurity and chronic child malnutrition in Lào Cai, Lai Châu, and Hà Giang provinces, the objective of the ECOSUN project was to increase local availability and utilization of fortified complementary foods for children aged 6 months to 5 years by establishing a local, small-scale processing facility. The core strategy in the ECOSUN project used a food-system approach that focused on developing FCF from locally produced crops for distribution in targeted areas of the three provinces, accompanied by nutrition-education counseling to promote optimal complementary feeding practices (see Figure 1 for project timelines and milestones). The ECOSUN project team and authors of this paper were made up of program implementers and researchers from NIN, NINFOOD, and academic subject experts from the Centre for Studies in Food Security (CSFS) at Ryerson University. The CSFS engages academic, government, and civil society in dialogue and research to take an interdisciplinary and systems approach to addressing the health, social justice, environmental, sustainability, and socio-cultural aspects of food security. Through the partnership with NIN, the CSFS supported the

[2] As of April 2022, Ryerson University was renamed Toronto Metropolitan University.

Figure 1. ECOSUN Project Timeline



ECOSUN project with conceptual design, research dissemination, capacity building in food security, and knowledge exchange.

This paper describes the process undertaken by the project team to design and implement the ECOSUN project to address food insecurity and chronic child malnutrition in northern Vietnam while looking to overcome the many challenges surrounding a food-fortification strategy. The conceptual model followed in the project, research undertaken to assess its effectiveness, and project activities are explained in the next section. Many of the research components and findings are already published or in production; however, they are referenced in this article as they offer insights on successes and challenges and make up a cohesive part of the project.

Methods

The Conceptual Model

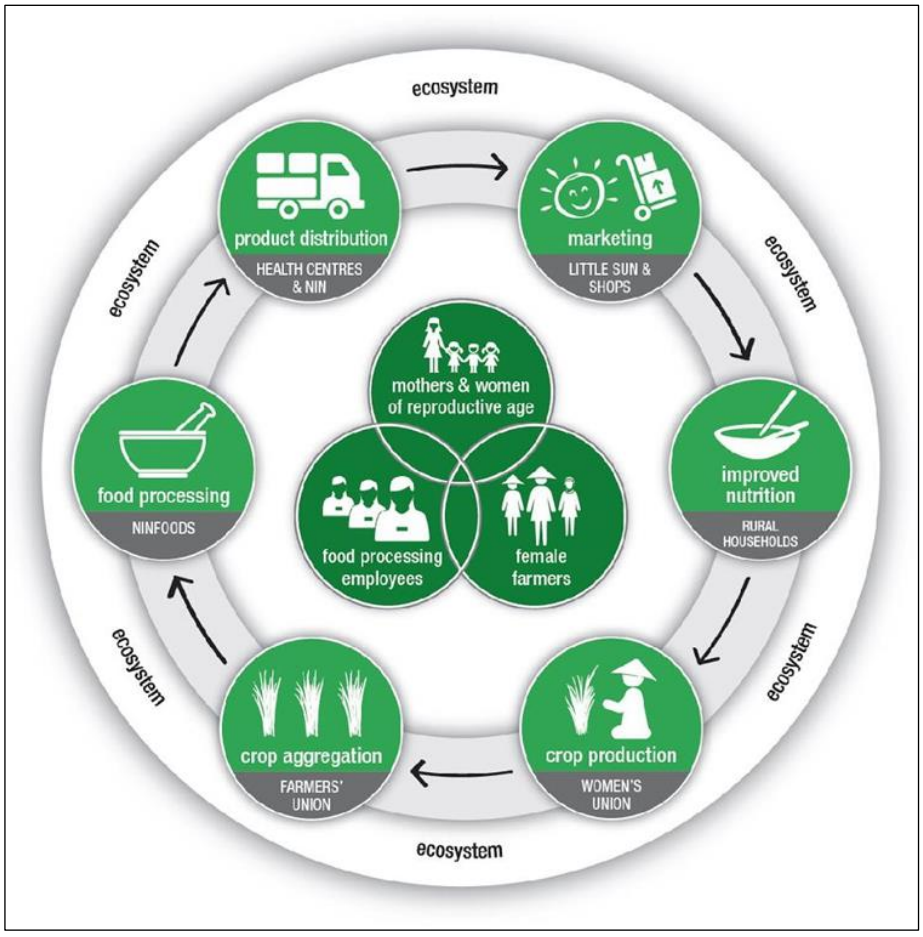
While a food-based approach to increasing dietary diversity without the need for supplements or fortified foods would be ideal to combat chronic child malnutrition, the research literature shows the reality that diets based on local foods alone often fail to ensure the desired results (Ferguson et al., 2019; Morris, 2018). Reasons for this include local food preferences for nutrient-poor foods, customary diets, and the low availability of high-quality animal-based foods. Quite commonly, a major reason for child malnutrition among low-income populations is the inability to access nutrient-dense foods for a diverse diet that are often available through markets but at prices unaffordable to the target population. That is, a major reason for child malnutrition is poverty leading to food insecurity.

Thus, the challenge to overcome high levels of child malnutrition passes through both the inadequate local availability (the supply side) of nutrient-rich foods, to the inadequate access to and consumption (the demand side) of appropriate diets. It is a challenge involving the whole food system. Addressing one part of this system is often not enough. For example, developing a quality fortified product to address micronutrient deficiencies will not be enough if that product cannot reach the target population (due to problems with distribution) or if it is not accepted by consumers (due to particular preferences). Even when accepted by consumers and available in local markets, low-income populations may have difficulty including the product in their regular diets.

With these challenges in mind, the ECOSUN team developed a conceptual model of a food-system approach (Figure 2) to guide implementation of the project. The main elements of the conceptual model include (1) attention to the local food system embedded into a particular socio-ecological system, and (2) the positioning of women at the center of the project activities. It was important to combine local solutions that address the socio-eco-

nomic context of nutritional problems along with an understanding of the need to develop the local economy as a long-term, sustainable way to address food security and child malnutrition. The project team focused on developing interventions that would contribute to the broader goal of transforming the local economy and reducing poverty rates. Recognizing the dominance of small-scale family farms in the region's agricultural production, the team proposed using local crops as the basis for developing fortified food products. It further proposed processing the products in local facilities, with local workers, and distributing it with support from local health units and local commercial shops. That is, the fortified complementary foods to be introduced to help fight child malnutrition would not be imported or produced in large urban centers, but rather be part of the local economy and support local food security.

Figure 2. ECOSUN's Conceptual Model



There were many reasons for positioning women at the center of the project. The nutritional status of a child is closely linked to the mother's own physical and mental health (Ruel & Alderman, 2013). Furthermore, children's health has been positively linked to mothers' education and nutritional knowledge (van den Bold et al., 2013), as well as women's empowerment (Cunningham et al., 2015). Moreover, as a large proportion of subsistence farmers in the region are women, the design of the project focused on women and recognized their many roles as primary caregivers of children, as local food producers, and even their dominance as health providers in the local health sector.

Representing the local food system as a circular flow within a given socio-ecological system, ECOSUN's conceptual model highlights the importance of local crop production and aggregation (facilitated and supported by local Women's unions[3] and/or farmers' unions) to supply basic raw material for local food processing. NINFOOD would oversee the processing and then distribute the products through local health centers and commercial shops. Together with NIN, these outlets would promote the new products, which would be incorporated into children's diets. This circular flow is completed with improved nutrition

[3] Women's unions in Vietnam are socio-political groups established at the national, provincial, and local levels to promote women's affairs, give women voice, develop their economic empowerment, and promote the development of women's groups.

enhancing the health and productivity of local workers.

Site Selections

Nine communes in Lào Cai, Lai Châu, and Hà Giang provinces were chosen as project implementation sites. In each province, three communes located within one district were identified. Accordingly, the communes of Trinh Truong, Ban Vuoc, and Quang Kim were selected from Bat Xat District of Lào Cai. The communes of Sin, Ban Giang, and Ban Hon were selected from Tam Duong District in Lai Châu. And the communes of Dao Duc, Trung Thanh, and Viet Lam were chosen from Vi Xuyen District in Hà Giang province. The districts and communes were selected based on having similar characteristics for population density, area, number of women of reproductive age (15 to 35 years), percentage of children less than 2 years of age, socio-economic status, proportion of agricultural producers, and climate patterns (Brown et al., 2019a). Agriculture is the primary source of income for 70.7% of women in these communes. The population profile consists of multiple ethnic minorities such as Giáy, Tày, Dao, H'mong, Nhung, Tha, Lu, and other small groups (Brown et al., 2019a).

Research Methods

As a research-for-development project, activities with measurable outputs and outcomes were carried out as well as research-based components using mixed methods. NIN staff implemented the project and conducted research with direct support from one Ryerson University staff member who is fluent in Vietnamese and based in Vietnam. While research processes are often linear and controlled, project implementation is an iterative process subject to innumerable external variables. The ECOSUN conceptual model helped visualize the points of entry for various research components, thus resolving tension and creating cohesion between research processes and project implementation. Between 2016 and 2018, the team monitored project implementation by record-keeping during activities, annual review meetings, and site visits. Mixed-methods research was employed to either inform or evaluate changes in prevalence of child malnutrition and food security before and after project activities. Quantitative studies by means of baseline and follow-up surveys, as well as an acceptability trial conducted alongside qualitative methods (using focus group discussions and key informant interviews) helped illuminate local complementary feeding practices, the role of women inside and outside their homes, crop profiles, and market feasibility. The research studies, their methodology, analyses, and findings are documented in separate reports and publications (Brown et al., 2019a, 2019b; A. T. Nguyen et al., 2018; Do Huy et al., 2018).

As part of the project's monitoring and evaluation processes, 24 policymakers and 22 agricultural extension staff (from provincial people's committees, departments of health, reproductive health centers, district health centers, commune health centers, education department, agriculture departments, and agriculture promotion centers) engaged with and contributed to review meetings, key informant interviews, and focus groups.

The project and its protocol for research components were reviewed and ethics approval was attained first through the research ethics board of the National Institute of Nutrition of Vietnam (August 4, 2016) and subsequently through the research ethics review board of Ryerson University in Canada (REB 2016-314). Participants provided voluntary and informed consent in writing prior to participating in the research components. Where children were involved, primary caregivers gave voluntary, written, and informed consent.

Baseline and follow-up surveys were conducted within approximately one and a half years of each other at project sites in order to evaluate changes in the prevalence of malnutrition and food security in Lào Cai, Lai Châu, and Hà Giang and test for factors related to the food systems approach (Brown et al., 2019a; Do Huy et al., 2018). Child-caregivers living in the project communes were randomly sampled during baseline (N=799 pairs) and follow-up (N=995 pairs) and assessed on measures of food security, child nutrition, hygiene, crop production, and women's roles. Sample sizes were determined using a confidence level of 95%. Children who fell within the ages of 0 to 24 months were included. Blood samples of children 6-11 months old were also collected. The follow-

up study also included a follow-up cohort of 147 children from the baseline assessment (Do Huy et al., 2018). The surveys used the Household Food Insecurity Access Scale to measure changes in the prevalence of household food security status of the caregiver-child pairs over time (Coates et al., 2007). Nutrition-related factors were assessed using core indicators for knowledge, attitudes, and practices in complementary child feeding,[4] child anthropometrics, and hemoglobin measures (World Health Organization [WHO], 2010). The baseline and follow-up surveys also assessed the role of women as related to local agriculture and food security using questions from the Abbreviated Women's Empowerment in Agriculture Index (Malapit et al., 2020). Logistical regression analysis was performed on the baseline data to explore factors associated with the nutrition status of children (Brown et al., 2019a).

Following the baseline survey, qualitative research helped round out the picture on local knowledge, attitudes, and practices related to child feeding; challenges women farmers faced integrating into the local food supply chain; and the role of women in decision-making within and outside the household, particularly as it relates to child feeding practices and crop production. Two focus-group discussions were held in each of the three provinces with a total of 63 smallholder farmers (41 of whom were women). In each province, three agro-ecological extension workers also took part in the focus groups. Key informant interviews were conducted with local agricultural extension workers, health service administrators, and an employee from the local Women's Union.

Project Activities

This section describes how the different parts of the conceptual model of the food system manifested in the project activities.

Product development: The ECOSUN fortified food products

Micronutrient fortification of foods is not new to some locations in Vietnam (Laillou et al., 2012; Phu et al., 2010). In the past two decades, NINFOOD has collaborated with international partners to develop, test, and evaluate several fortified products with proven efficacy to meet the needs of different malnourished populations (Food and Nutrition Technical Assistance III Project [FANTA], 2014; M. Nguyen et al., 2016). NINFOOD's laboratories and processing plant in Hanoi have established a quality control, Hazard Analysis Critical Control Points system (HACCP), following international standard protocols to ensure food safety while processing, as well as the quality of raw materials and the correct composition, seal integrity, packaging, and labeling of products (Schauer et al., 2017). NINFOOD is certified under both Codex Alimentarius and ISO 22000:2005 global standards.

Under the ECOSUN project, the challenge for NINFOOD was to develop products to met three requirements. First, products had to present a nutrient composition that addressed the main nutritional needs of infants and young children in Lào Cai, Lai Châu, and Hà Giang. The anthropometric indicators and hemoglobin blood tests for children from the baseline study established that the population of the northern provinces, particularly young children, had a high risk for iron and zinc deficiencies (Laillou et al., 2012; A. T. Nguyen et al., 2018). Second, local crops should be used as the basis to produce the fortified foods. Third, the new products had to be accepted and used by local consumers.

Guided by these criteria and the Global Alliance for Improved Nutrition (GAIN) macro/micronutrient recommendations for FCF formulations (GAIN, 2010), NINFOOD developed three lines of products under the ECOSUN label:

1. *Chao Ngon fortified instant porridge (fortified with iron and zinc)*
   This fortified extruded rice cereal is meant to serve as the basis for meals, which would also include home-grown vegetables and a protein. This cereal is ready 3 minutes after adding boiling water, reducing the caregiver drudgery associated with making porridge.

[4] Core indicators on knowledge, attitudes, and practices in complementary feeding include acceptable diet, minimum meal frequency, minimum dietary diversity, and time when complementary feeding was started (UNICEF & WHO, 2010).

A 30-gram serving of Chao Ngon has been fortified with 0.9 mg of iron and 0.45 mg of zinc. Each serving provides 118 Kcal of energy and 2.7 g of protein.

2. *VICA freeze-dried vegetable powders (fortified with a premix of calcium, vitamin D3, magnesium and zinc)*
   Four local vegetables (mushroom, sweet leaf [*Sauropus androgynous*], pumpkin, and carrot) were chosen for processing, prior to the addition of the micronutrient premix formulation, based on the taste preferences and local crops women farmers produced. VICA vegetable powders can be added to the Chao Ngon instant porridge and other foods for fortification. Researchers at NIN determined the composition of the products by considering the required dietary allowance (RDA) for children of complementary feeding age. A 3-gram serving sachet packet provides 12% of the RDA levels of calcium, vitamin D, magnesium, and zinc.

3. *VICA lipid protein packets (made from milk protein and soybean oil)*
   These are to be used in cases where there is low availability or affordability of natural protein sources. The packet contained vegetable oil, whey, soy protein, powdered egg whites, yeast extract, E 635 flavoring, salt, lecithin, chicken flavor, powdered pepper, garlic, onion, and vitamin E. Each 10-gram packet provides 54 Kcal of energy, 4.1 g of protein, and 4 g of lipids.

NINFOOD tested acceptability of the ECOSUN products among the local target population using the Saleable Acceptability Trial Model and Just-About-Right rating scale (Brown et al., 2019b). Primary caregivers of students at a kindergarten in Bat Xat district in Lào Cai province tried the Chao Ngon porridge and VICA vegetable powder with their children (*N*=126 pairs), the majority of whom were between the ages of 9 and 60 months All the products received high points on overall acceptability, smell, taste, texture, and aftertaste. Testers also showed high satisfaction for consistency, fat content, and saltiness for each FCF. Satisfaction ranged from 81% to 92% (Brown et al., 2019b).

The frequency and time of use was also determined during the acceptability test. About 55% of participants said they use instant porridge several times per month, and 21% said they use it for their children several times per week. Frequently eaten instant porridge brands, few of which are fortified, were also identified to determine competitors in this local market (Brown et al., 2019b). Furthermore 58% of participants said that 3000 to 5000 VND (US$0.13 to US$0.22 cents) is an acceptable price for the product, and about 19% said that 2500 to 3000 VND (US$0.11 to US$0.13) is an acceptable price (Brown et al., 2019b).

Food processing: Public-private partnership

A key element of the project was the setting up of a local small-scale food processing (SSFP) facility in Lào Cai to produce two of the ECOSUN products: the Chao Ngon fortified instant rice porridge and the VICA vegetable powders.[5] The northern region of Vietnam is known for rice and vegetable production, most of which is grown by smallholder family farmers. NINFOOD's previous research on efficient and effective food processing methods of producing instant flours and other foods through small-scale extrusion cooking served as the basis for establishing the local SSFP facility in Lào Cai (Phu et al., 2010). Extrusion cooking followed by milling is a versatile and low-cost food processing technique that allows for consistent product quality. The process can ensure uniformity of the final product and can increase the shelf-life and transportability of food.

There were several innovative features in this component of the project. Prominent among those was the establishment of a public-private partnership (PPP) between NINFOOD and a local food business enterprise, the Thuy Dung Company, led by a local businesswoman. Long-term contracts be-

[5] The VICA protein/lipid sachets packets continued to be produced in the central NINFOOD facility in Hanoi. These require higher hygiene standards due to a high risk of product contamination.

tween a private party and a government entity characterize PPPs. Viable PPPs have been identified as key factors in the successful implementation of large-scale food-fortification programs in many countries of the global north (Timotijevic et al., 2013), but their record in developing countries presents mixed results (Champion & Seidel, 2015; Hoddinott et al., 2015).

From the perspective of NIN and NINFOOD, the primary attraction of a PPP was the sustainability of local production and distribution of ECOSUN products beyond the life of the project. Given the conceptual model, it would not make sense to have the products processed centrally in Hanoi. The alternative, creating a subsidiary NINFOOD plant in Lào Cai, would require too many resources, beyond what NIN had available from both the Ministry of Health and international funders. Furthermore, the PPP could be seen as part of the private-sector development strategy included in the government's economic plan (Asian Development Bank [ADB], 2012; Schaumburg-Müller, 2005). For the Thuy Dung Company, the advantage was the potential for profits from being the only supplier of ECOSUN products in the region. The possibility of market expansion beyond the three provinces was an added attraction.

NINFOOD and the Thuy Dung Company signed a formal 10-year contract to cost-share the establishment of the SSFP plant, which included renovating the firm's 3,200 square-foot facility, as well as operating costs. Ultimately responsible for the quality and safety of the final packaged products, NINFOOD developed the licensing agreement and established food production protocols. Eight hired plant workers completed training on Hazard Analysis Critical Control Points (HACCP) procedures and food safety standards. NINFOOD also designed the factory space to be ISO 22000–compliant and commissioned customized extrusion and freeze- drying equipment.

The ECOSUN SSFP facility in Lào Cai province was officially opened in November 2017 after receiving the certification from the Ministry of Health. It has a daily production capacity of 300 kg of fortified instant rice porridge and 10,000–12,000 VICA packets by processing 60 kg of vegetables per hour.

Crop production and aggregation

As part of its 10-year contract with NINFOOD, the Thuy Dung Company committed to purchasing vegetable crops from a local agricultural cooperative, the Song Kim Collective. This arrangement introduced a strategy of indirect public food procurement to favor local small family farmers.

In recent years, public food procurement from smallholder farmers has been pursued as a policy strategy to strengthen rural livelihoods and promote rural development (Miranda, 2018). The idea is to expand market opportunities for smallholder producers, and also reduce the uncertainties and risks associated with market participation. When successful, it is hoped that the additional income generated through public procurement schemes will increase household food consumption and dietary diversity, and even generate some spillover effects in local economies.

Key to the success of such strategies is for the smallholder production to be compatible with the food baskets or menus in demand from public procurement. Under the ECOSUN project, that condition was met by design, with products developed according to crops already being produced in the region.

However, a major hurdle in successful public food procurement strategies is often the inadequate capacity of smallholder farmers to meet the demand with high-quality products in sufficient quantities. In the case of the ECOSUN project, vegetables to be used in the formulation of the FCF products have to be produced under strict good agricultural practices and be supplied in reliable quantities for smooth operation of the SSFP plant. The question is, can smallholder farmers meet the supply and quality demands created by public food procurement?

The literature suggests crop aggregation through farmer cooperatives assists in guaranteeing a more reliable supply (Miranda, 2018). The Song Kim Collective, comprising 17 local smallholder farming families, is an agricultural cooperative recently formed with the intention of meeting that demand challenge. Moreover, in terms of guaranteeing the quality of products needed, 450 women farmers in the nine project communes of the three provinces completed

training on good agricultural practices through the ECOSUN project.

Food distribution, marketing, and counseling

Each woman farmer trained on good agricultural practices received samples of ECOSUN products, including key nutrition messages. This was part of the social marketing strategy to promote greater acceptance of the new products in the region. In this case, having the products in their hands and learning about their importance for children's health also instilled a sense of pride among the women farmers, showing their value as a key link between the production of quality crops and the quality of the food to be given to their own and other families.

Consumer taste testing during the acceptability trial suggested the potential for easy acceptance of the ECOSUN products by the local population (Brown et al., 2019b). However, as it is necessary to contextualize FCF products for the local food environment and ensure their appropriate use with children (Gillespie at al., 2019), care was taken to appropriately tailor the distribution, marketing, and counseling of mothers about the new products, considering the local context of infant and young child feeding practices in the region. Labeling and marketing were developed to comply with the International Code of Marketing of Breast-Milk Substitutes (WHO, 1981), and three main strategies for the promotion and initial distribution of the products were established.

Little SUN Nutrition Education Counseling Centers. Logistical regression analysis performed on the baseline data to identify significant predictor variables for malnutrition indicated that engagement by caregivers in nutrition education counseling in the three months prior correlated with decreased stunting rates in children under the age of 2 (Brown et al., 2019a). As part of a previous project with the Scaling-Up-Nutrition (SUN) movement and Alive & Thrive, an international nongovernmental organization dedicated to improving the nutrition of infants and young children, NIN had been establishing a series of nutrition education counseling centers (Little Sun Nutrition Education Counseling Centers) located at provincial, district, and communal health centers throughout the country to promote exclusive breastfeeding and improve complementary feeding practices (Rawat et al., 2017). Once the baseline survey was completed, 15 new nutrition education counseling centers were established throughout the three northern provinces as key partners in the distribution of the ECOSUN products. The modus operandi of these counseling centers is to support individualized services with mass media campaigns aimed at creating greater demand for their services and promoting better feeding practices. Thirty-six health workers at the 15 Little Sun centers were trained on infant and young child feeding practices and preparing the ECOSUN products (Chao Ngon instant porridge and VICA vegetable powder) using regular local foods to teach mothers during counseling sessions. One-to-one as well as group nutrition education counseling sessions were held with pregnant or nursing women and mothers with children under the age of two.

Preschools as institutional buyers. As part of the distribution strategy, NIN targeted local kindergartens and preschools in project areas with a high prevalence of malnourished children. Normally, preschools in poor areas run snack programs partially subsidized with government funds. With support from the private partner Thuy Dung Company, NIN negotiated with the local education departments to use the government subsidies toward purchasing ECOSUN Chao Ngon instant porridge in bulk for distribution to 21 preschools in Lào Cai, Lai Châu, and Hà Giang.

Mixed marketing methods. Local wet markets, shops, pharmacies, and potential consumers in Bát Xát District in Lào Cai took part in a market feasibility survey to assess the potential market for complementary foods and to assess the crop-production patterns of women farmers (NIN, 2016). The findings from the feasibility study concluded the sites were appropriate based on the local retailers' base and women farmers looking for stable markets for their produce. The study demonstrated significant buy-in from local government (NIN, 2016). Despite the potential of institutional buyers, much of the sustainability of

the ECOSUN project depends on the success of its products in the regular marketplace. In launching the products, NINFOOD engaged in numerous promotion activities in the three northern provinces. An ECOSUN brand identity developed with the tag line "Healthy Farm, Healthy Food, Healthy Kids" captured the project's underlying food-system approach. Promotion and marketing activities included community events, billboards, showcase booths, and promotional items such as insulated travel cups to prepare the fortified foods.

Results

After 32 months of setting up the model and putting it in motion, a viable value chain for fortified foods was fully functional and showing many signs of positive influence (see Appendix).

The local food processing plant was operationalized to serve as a stable purchaser, creating a value chain for local crops and contributing to successful partnership models, i.e., through private-public sector collaborations. This included a 10-year public-private partnership between NIN and Thuy Dung Company entailing a procurement contract with the Song Kim Collective of local smallholder farmers.

Between November 2017 and May 2018, the operational SSFP produced 4,795 kg of Chao Ngon instant fortified food product that were supplied to marketing promotion activities, local vendors, and kindergartens. VICA production commenced in April 2018 and the factory yielded 30,000 sachet packs over two months. One Chao Ngon serving packets costs 2500 VND (US$0.11) and one VICA powder packets costs approximately 3,600 VND (US$0.16), depending on the flavor. During marketing events alone, 2,913 consumers purchased 28,133 packets of Chao Ngon and 2,741 sachets of VICA.

Local public institutions successfully promoted demand for the products and knowledge regarding the value of FCF. Thirty-six health workers at the 15 Little Sun centers across the three provinces reached 14,438 children under the age of 2 by providing 10,561 family nutrition-education counseling sessions during the project. Table 2 summarizes the counseling services provided.[6] School meal programs in 21 preschools in Lao Cai served the Chao Ngon instant fortified rice porridge to 2,552 children (aged up to 60 months).

The individual and family nutrition-education counseling sessions, training workshops for farmers, and marketing events reached approximately 20,000 rural women who were using the ECOSUN fortified complementary foods for their children.

The findings from comparing the baseline and follow-up data revealed the following changes in the prevalence of chronic child malnutrition, food security, and complementary child feeding after applying the ECOSUN conceptual model in the project communes.

Prevalence of chronic child malnutrition. The initial analysis of the follow-up data found a decline in malnutrition rates when compared to the baseline survey. The prevalence of underweight in sampled children at the project sites dropped from 17.2 % to 13.9 % (i.e., a 3.3 % reduction) and wasting decreased from 7.9 % to 3.4 % (Do Huy et al., 2018). It should be noted that a time frame longer than the project duration of two years would be needed to measure improvements in stunting in children. Typically, the prevalence of moderate stunting among the follow-up sample of children was found to be 20.8 % while 8.1 % of children were severely stunted. When broken down by province the stunting rates in each province were similar, hovering around 28% (Do Huy et al., 2018).

Food security. The Household Food Insecurity Access Scale used to assess the prevalence of perceived household food insecurity and to detect changes in their situation over time with respect to the dimension of access (Coates, Swindale, & Bilinsky, 2007) found fewer households reported feelings of uncertainty and anxiety over food at follow-up. The prevalence of worrying about not having enough of food among respondent households was 38.2 % at baseline but reduced to 22.5% at follow-up (Do Huy et al., 2018).

The prevalence in the perception among

[6] Two Little Sun centers were closed due to building renovations.

households that food is of insufficient quality, which includes dietary diversity, nutritional adequacy, and preferences, also showed improvements at follow-up. The number of people reporting that their household *must eat a limited variety of foods due to lack of resources* was 36.6 % at baseline but reduced to 20.2 % at follow-up. The prevalence of *limiting dietary preferences due to lack of resources* was cut in approximately half from 42% at baseline to 20.4% at follow-up. A similar result was seen in the prevalence of households that reported *having to eat foods that they did not want to eat due to a lack of resources to obtain other types of food.* The prevalence of this measure was 34.3% at baseline but declined to 17.1% at follow-up (Do Huy et al., 2018).

Food insecurity due to perceived insufficient quantity of food within households was less prevalent than perceptions of insufficient food quality among the population both at baseline and follow-up (Do Huy et al., 2018). The changes in the prevalence of these perceptions between baseline and follow-up were also much smaller. At baseline approximately 15% of the population reported *food shortages in the previous year* and *had to eat a smaller meal than needed because there was not enough food*. The follow-up study found that both these measures declined by only 4% (Do Huy et al., 2018). At baseline, 7.4% of the households reported *having to eat fewer meals in a day due to insufficient food at home*. The prevalence reduced by only 1.1% at follow-up. In addition, 7.4 % of households also *reported times when there was no food to eat due to lack of resources to get food* at baseline. The prevalence of this measure reduced slightly at follow-up to 5.3% of households. Lastly, while only 1.3 % of households reported *going to sleep at night hungry because there wasn't enough food* at baseline, the prevalence of this measure in the population doubled at follow-up to 2.6%.

Improved complementary feeding practices. With regard to complementary feeding indicators among the sampled child-caregiver pairs, between baseline and follow-up only slight increases were seen in the in prevalence of consumption from four or more food groups during mealtime, *minimum meal diversity,* from 44.4% to 47.9%, as well as in the prevalence of the minimum recommended number of times complementary foods were eaten, *minimum meal frequency,* from 73.3% to 78.8% (Do Huy et al., 2018). It is noteworthy that while three-fourths of the sampled population can feed their children at least the minimum recommended number of times, less than half of them are able to give foods from four or more food groups during complementary feeding. The *minimum acceptable diet indicator* (which is a composite indicator of *minimum meal diversity* and *meal frequency*) increased only by about 1% between baseline and follow-up, from 43.1% to 42.3% (Do Huy et al., 2018).

However, complementary feeding timing, which is the timely introduction of complementary foods at 6 months, is highly prevalent. At baseline it was practiced by just over 80% of the sampled population, and the prevalence increased to 100% by follow-up (Do Huy et al., 2018). The prevalence of consuming iron-rich complementary food increased more than 10%, from 57.9% to 72.9%. This is a promising finding given the key role of iron in child growth and development, and prevention of anemia (Do Huy et al., 2018).

Discussion

In their assessment of 32 highly cited international studies on food systems, Brouwer, McDermott, and Ruben (2020) noted that the majority of literature examined linear and generic views of supply-demand networks that focus on supporting food production, agri-food supply chains, and markets and the institutional food environment. They found that only a small portion of the literature focused on the relationship between nutrition and health results, the role of consumer choice motives (social, economic, biological, and psychological) as potential food system drivers, or related implications for nutrition and health that arise from recent changes in eating habits, such as the increased consumption of ultraprocessed foods.

The learnings from the ECOSUN project contribute to filling the above-mentioned gap in the literature. The project focused on a circular food-system approach to sustainably increase local fortified complementary foods and decrease childhood malnutrition. An integrated and systemic approach was expected to not only improve the local availability of high-quality fortified comple-

mentary foods among malnourished and food-insecure children, but also incorporate sustainable livelihoods that involve the local community, local producers, local businesses, local health services, and other local partners (local governments, preschools, etc.).

NINFOOD successfully developed three products under the project, two of which used local crops and were processed in the local small-scale food processing facility in Lào Cai. The private-public partnership established with a local businesswoman was crucial for the longer-term viability of these initiatives. NIN also successfully collaborated with provincial and local government departments in the three provinces to provide nutrition-counseling sessions through the Little Sun centers, supply ECOSUN instant porridge to preschools (serving over 2,500 children), promote marketing activities in communes, and train women farmers in good agricultural practices. Materials on child feeding for minority groups were also adapted to serve the specific needs of ethnic minorities in the areas of project implementation. Acting as a policy- influencer at the national level, NIN used the lessons from the ECOSUN project to directly support Vietnam's National Plan of Action for Nutrition (NPAN)[7] 2018- 2020, which calls for improvements in legislation to ensure food security for poor and disaster-affected areas (Ministry of Health [Vietnam], 2018).

Despite significant accomplishments, the project faced many challenges during its three-year (2015–18) implementation. Partnering with the private sector, bidding for tenders, and equipping and operationalizing small-scale food processing plants through private tenders were completely new areas for NIN staff. The bidding procedure and laws in Vietnam presented an administrative challenge as they translated into complicated and time-consuming processes. Despite presenting a steep learning curve for the project team members and delaying operationalization of the SSFP facility, NIN staff is now familiar with and has the know-how to partake in future bidding for tenders to partner with the private sector.

Establishing competitive market prices for the ECOSUN products was another challenge. Given its proximity to China, the region has a frequent influx of cheap, easy-to-prepare, and tasty instant foods that are poor in nutritional value. The initial prices for the FCF products, while still slightly higher than nutrient-poor competitors, were considered appropriate given their perceived better quality.

Lào Cai, Lai Châu, and Hà Giang are located in the Northern Mountainous Region, where the target communities have limited road access. This made finding distributors for the ECOSUN products difficult in the short time frame of the project. However, as the project revolved around testing a food-system model while partnering with the private sector, it was a "learn-as-you-go" process. Furthermore, through the 10-year agreement signed between Thuy Dung Company and NINFOOD, the partners will continue to build and refine the marketing strategy to increase product demand. So far, NIN has leveraged Little SUN nutrition centers to promote the products, while NINFOOD identified nearby local vendors to sell them. Plans for further distribution of the products include hospitals as well as preschools and Little SUN centers in other provinces. The partners also plan to sell in urban areas, where distribution will be easier and the products can be sold at a premium. This price discrimination strategy will help offset costs in rural areas, which could be higher due to higher transportation expenses. NIN and NINFOOD have learned that flexibility is critical in promoting the product and creating demand, noting that what works in one commune may not work in another.

The comprehensive nature of the food-system approach necessitated collaborating with a variety of sectors. However, the lack of partnerships with multiple national-level actors in addition to NIN was a limitation of the project. Nevertheless, NIN successfully collaborated with government, health service, and civil society organizations at the provincial and commune level to conduct workshops in good agricultural practices, set up Little Sun counseling centers, and supply school meal programs in preschools.

[7] NIN is the government agency appointed to lead the development of NPAN.

Conclusions

More than one solution often is needed to address food security and malnutrition, particularly in children. A food-system approach can improve the understanding of complex causalities between public-policy interventions and private investment decisions and enable insights into impact pathways that lead to multiple food-system outcomes for different stakeholders (Brouwer et al., 2020). It provides the basis for a comprehensive set of interventions. The conceptual model designed for the ECOSUN project helped us to organize and systematically tackle the various facets of a food-system approach to set up a viable food-fortification strategy that would support local food security and improved nutrient status in infants and young children. It also identified various local stakeholders and actors who need to be involved in the process and mapped how to engage local smallholder producers, both as suppliers and consumers, particularly women as they are often farmers as well as mothers.

According to Shilomboleni and De Plaen (2019), one of the key lessons in scaling up research-for-development innovations in food and agricultural systems is ensuring that innovations are embedded within local socio-ecological systems. Overall, strategies for overcoming the challenges and guaranteeing the uptake of the FCF innovations introduced in the ECOSUN project were grounded in the local food-system model that the project team developed. That approach, more than the individual activities, is the project's main characteristic and contribution.

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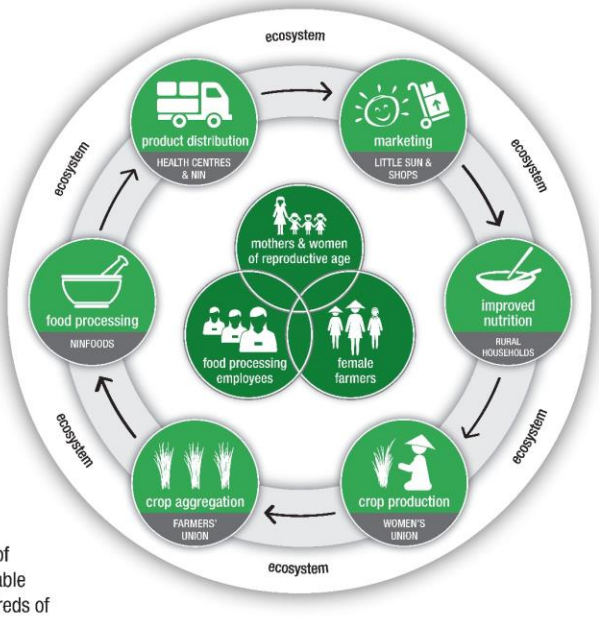
Appendix. ECOSUN Handout (Front and Back)

Scaling Up Local Production of Fortified Foods in Vietnam to Improve Food Security and Nutrition

Ryerson University | VDD

Cải thiện An ninh thực phẩm hộ gia đình phụ nữ nông thôn nghèo thông qua mô hình chế biến thực phẩm dinh dưỡng qui mô nhỏ ở Việt Nam



SUMMARY

Researchers from Vietnam and Canada are tackling poverty and malnutrition among women and children with fortified foods that use locally grown crops, local manufacturing facilities, and local distribution channels. The project is focused on three provinces of northern Vietnam: Lao Cai, Lai Chau, and Ha Giang.

PROJECT DESCRIPTION

Vietnam's National Institute of Nutrition (NIN) is working with Ryerson University's researchers to bring sustainable solutions to rural Vietnam. These include the direct procurement of crops from smallholder women farmers, the decentralized production of fortified foods in small local food processing facilities, and a reliable commercial supply chain that sees products purchased by hundreds of nutrition counseling centres.

The Vietnam Women's Union will act as the main liaison with the women farmers who will receive training on agro-ecological practices, post-harvest handling, food safety, and how to form producer associations.

EXPECTED RESULTS

+ Improved livelihoods, nutrition and food security for thousands of rural Vietnamese
+ Increased health and productivity
+ Reduced post-harvest losses; increased shelf-life of foods
+ Reduced reliance on imports of fortified foods
+ Reduced local prices of nutritious foods for young children
+ Established reliable market for female farmers to sell local crops and support income generation
+ Local job creation, with particular focus on women
+ Evidenced-based model to inform development and implementation of national food security policies such as Vietnam's National Nutrition Strategy

PROJECT TEAM:

Ryerson University, Canada
Cecilia Rocha, PhD (PI); Fiona Yeudall, PhD RD; Andrea Moraes, PhD; Yvonne Yuan, PhD; Thomas Tenkate, PhD; Melody Mendonça, MHSc.

Viet Dinh Duong (National Institute of Nutrition, Ministry of Health), Vietnam:
Nguyen do Huy, PhD (PI); Phuong Huynh, PhD; Do Thi Bao Hoa, MSc. Matthew Brown, MSc.

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Global Affairs Canada | Affaires mondiales Canada | IDRC | CRDI | Canada

STRATEGY

Using a food systems approach, the project comprises three main components:

1. The direct procurement of crops from small-scale women farmers;
2. The decentralized production of fortified complementary foods for children in a small-scale food processing (SSFP) facility;
3. The distribution of the products to nutrition counseling centres and local vendors.

NINFOOD, a business oriented subsidiary of NIN, developed the ECOSUN product line of fortified complementary foods for children and ran acceptability tests in local communities within the project sites in northern Vietnam. The two main products are CHAO NGON instant rice porridge fortified with Iron and Zinc, and VICA vegetable powders fortified with multiple micronutrients (Calcium, Magnesium, Manganese, Zinc and Vitamin D).

OUTCOMES

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