Assessing the Impact of Parental Involvement on the Scaling of Agricultural Technologies from School Garden to Home Farm through Experiential Learning

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I am submitting herewith a thesis written by Gracie Pekarcik entitled "Assessing the Impact of Parental Involvement on the Scaling of Agricultural Technologies from School Garden to Home Farm through Experiential Learning." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Leadership, Education and Communications.

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Assessing the Impact of Parental Involvement on the Scaling of Agricultural Technologies from School Garden to Home Farm through Experiential Learning

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“And whatever you do, in word or deed, do everything in the name of the Lord Jesus, giving thanks to God the Father through him.” Colossians 3:17
ABSTRACT

Cambodia is a predominantly rural nation with a heavy dependence on agriculture, particularly smallholder rice farming systems. While several sustainable agricultural technologies have been successfully piloted on research stations or with small numbers of early adopters, questions remain on how to extend these technologies to large numbers of resource-poor smallholders. The Scaling Suitable Sustainable Technologies Project (S3-Cambodia) seeks to examine pathways for scaling sustainable intensification (SI) technologies to smallholder farmers. One of the identified pathways to scaling SI is through the education system. Cambodian youth serve as an entry point to extend target technologies to farm families through experiential learning opportunities in schools by establishing “green labs,” featuring school gardens.

This research study seeks to support the desired outcomes of the S3-Cambodia project by assessing Cambodian parental involvement in their children’s lives and school activities. While students can serve as agricultural education sources for their homes and communities, there is a need to determine if school-child-parent relationships in Cambodia are strong enough to facilitate this knowledge transfer. Primary data was collected from 178 parents whose children attend three separate high schools in three districts of Cambodia through one-on-one orally conducted surveys. These were supplemented by key informant interviews of selected parents, teachers, and principals at each of the high schools. Results indicate that parents have a strong interest in school garden implementation and activities at their children’s school, with 84% parents interested in visiting a school garden. Additionally, the majority believe that they can learn from their children (65%) and actively discuss with their children about what they are learning at school (72%), indicating a high likelihood of knowledge transfer from a school garden. Yet, parents’ involvement in their children’s schools and lives varies between regions, with the rurality of the households influencing family social ties and parents’ proximity to the school.

Overall, the presence of and differences between parent-child-school relationships in various regions of Cambodia will inform how S3-Cambodia implements and monitors green labs. As such, findings are significant to the objectives of S3-Cambodia and the general body of knowledge on scaling through education.
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CHAPTER ONE
INTRODUCTION AND GENERAL INFORMATION

Introduction and Background

Background

Cambodia is currently undergoing rapid economic and social changes as the young population moves beyond decades of war and transitions to more democratic institutions and free market policies. Despite strong economic growth and poverty reduction, Cambodia remains a predominantly rural country with a weak educational system and economic dependence on agriculture. Currently, more than 70% of the Cambodian population is engaged in the agriculture sector (Ran et al., 2013). These are mainly rural households, with high levels of poverty and food insecurity, and they face ever-changing circumstances, exacerbated by climate change. There are increased causal linkages between food insecurity and global, national, and regional conflict, making it all the more necessary to address sustainability in Cambodia’s agriculture sector (Martin-Shields & Stojetz, 2018). This is particularly pertinent for Cambodian youth as “a transformed agricultural sector will increase economic opportunities for young people and help ameliorate the global migration crisis, minimize recruitment into terrorist and criminal organizations that threaten global and US national security, and promote food security and social stability in politically precarious regions.” (Yeboah, 2018)

Furthermore, the Cambodian education system has been weakened by the effects of war and genocide in the country. During the 1970s, under the Khmer Rouge, the people of Cambodia were forced to live communally and survive through collective agriculture. Starvation, hard labor, knowledge destruction, and summary execution resulted in a nation severely lacking in intellectuals and left few teachers with minimal content and pedagogy knowledge (Islam et al., 2017). While the country has worked hard to overcome its difficult past and has made significant improvements in education, there are still significant gaps. Current reviews of secondary school curriculum have found that it, “is of low quality, is only weakly linked with higher education, and provides little relevant knowledge and skills to meet market demand” (Kitamura et al. 2016). Historical and current Cambodian pedagogy is based around didactic teaching methods in which the students are passive receivers of information (Ogisu, 2016). Chet et al. (2014) in their review of the Cambodian educational pedagogy for Khmer, math, and science prescribe an overhaul of the current curricula to include more student-centered, experiential pedagogical practices.

Since 2015, the University of Tennessee Institute of Agriculture (UTIA) has worked with Cambodian partners to pilot new agricultural practices to address food insecurity, poor nutrition, and poverty. This research supports the Scaling Suitable Sustainable
Technologies (S3-Cambodia) project led by the Smith Center for International Sustainable Agriculture (Smith Center, 2020). S3-Cambodia is a 3-year project (2020-2023) funded by the US Agency for International Development (USAID) Feed the Future Sustainable Intensification Innovation lab (SIIL) to examine pathways for scaling suitable and sustainable technologies for smallholder, rice-based farmers. The S3-Cambodia project seeks to advance the capacity and roles of scaling agents in technology diffusion through applied research, technical assistance, curricula development and organizational strengthening.

S3-Cambodia works to scale three sustainable intensification (SI) technologies to farmers: vegetable grafting, cover cropping, and wild gardens. These innovations promote the diversification and resilience of smallholder systems by introducing new sources of income and nutrition during seasonal “food gaps,” across different agricultural spaces and serving different functions in livelihood strategies (Ader et al., 2021). Cambodian youth serve as an entry point to extend target technologies to farm families through experiential learning opportunities in schools by establishing “green labs”, featuring school gardens.

School gardens have been established as a successful learning tool to provide experiential agricultural education and food system training within primary and secondary schools across the globe. Yet, current research on school gardens prioritizes analysis of student nutrition and vegetable consumption (Ratcliffe et al., 2011; Schreinemachers et al., 2019; Leuven et al., 2018; FAO, 2004; Ferguson et al., 2019). Less examined is the potential of school gardens to serve as forums for knowledge and skill transfer to households and communities (Cramer et al., 2019). Through S3-Cambodia, students will receive a combination of hands-on training in SI practices and STEM-based instruction in SI principles. The long term anticipated goal is that this preparation will culminate in the establishment of student home gardens featuring SI technologies. The process of technology evaluation and diffusion will be supported by applied, participatory research on the agronomic and nutritional qualities and marketing potential.

Thus, the S3-Cambodia project seeks to leverage students’ potential to be agents of change in their homes and communities by engaging them in experiential learning around school gardens. Using knowledge gained through school garden education, students can serve as credible sources of information to their parents on best agriculture practices (Okiror et al., 2011). Yet, research suggests this is often dependent upon the parent’s involvement in their child’s life and schooling. In particular, social capital (parental beliefs, social networks, and trust) has been identified as a predicator of parental involvement in Cambodian children’s education. (Eng et al., 2014)

In light of this, the following research seeks to support the desired outcomes of the S3-Cambodia project by assessing perceived levels of parental involvement in their children’s lives and schools. While students have significant potential to be agents of change in their homes and communities, there was a need to determine if school-child-
parent relationships in Cambodia are strong enough to facilitate this knowledge transfer. In the context of the whole S3-Cambodia project, this research will provide baseline data from which later stages of the project can measure actual transfer of knowledge of SI technologies from school to household.

**Purpose and Objectives**

The S3-Cambodia project seeks to promote the adoption of SI technologies through various pathways, including scaling from school garden to home farm. Most research and knowledge streams on viable SI technologies are developed in universities and research institutions. For S3-Cambodia, this includes the National University of Battambang (NUBB) the Royal University of Agriculture (RUA), and UTIA among others. However, of the large body of agricultural knowledge held in research institutions, universities, public offices, and libraries worldwide, very little gets into the hands and minds of smallholder farmers (Elly & Silayo, 2013). This is an issue as steady flows of accurate, understandable, and factual information from the educational system to farmers is necessary for meaningful progress in agricultural production (Sani et al., 2015). Thus, the question becomes how to get this information out of academia and into the hands of the local community.

S3-Cambodia has identified high schools as a viable pathway through which to disseminate this information. The establishment of green labs at high schools creates a strong linkage between institutions (i.e., NUBB, UTIA) and the education system (Figure 1). Additionally, we know from decades of scaling literature that individual households are able to share information through social networks to increase adoption throughout a community (Feder & Umali, 1993; Ramirez, 2013). What we do not yet fully understand is the link between schools and households in Cambodia (Figure 1). While the participation of parents is an important determinant of the success of school gardens and information transfer, parental inclusion has not been fully considered by the S3-Cambodia project. Thus, this research focuses on parents’ perceived levels of involvement in their child(ren)’s schools and daily lives to determine if schools are a viable pathway of scaling to households in Cambodia. This research has the potential to improve programmatic outcomes for the S3-Cambodia project and contribute to the body of knowledge on experiential learning, information transfer, and household decision making.

**Research Question**

What is the feasibility of using school facilities and instruction as a pathway to scaling agricultural technologies?
Figure 1: Knowledge Flow from Academic Institutions to the Wider Community through S3-Cambodia
Objectives

1. Assess current perceptions of parental involvement in educational activities at Sor Kheng Kanteu II High School, Hun Sen Sampov High School, and Rongko High School
2. Document current adoption of classroom-based knowledge, attitudes, and practices at parent’s homes, especially those related to SI technologies
3. Determine parents’ perceived willingness to learn about new agricultural technologies from their child(ren)
CHAPTER TWO
LITERATURE REVIEW

Historical Context

Agriculture in Cambodia

Currently, more than 70% of the Cambodian population is engaged in the agriculture sector and agriculture accounts for 23% of the nation’s GDP (Chhuor, 2017). Agriculture in Cambodia primarily consists of wet season rice, cassava, maize, vegetables, and fish farming systems. Their pervasive lowland rice-based systems are frequently characterized by lack of diversity and low productivity (Eliste & Zorya, 2015). While agricultural production has been a staple of Cambodian livelihoods for centuries, the structure and landscape of these systems have been drastically affected by power changes in the nation.

The physical geography of Cambodia is made up of a complex network of lakes and rivers that provide ideal conditions for cultivating rice, making it the nation’s primary agricultural product since the 9th century. As such, through much of Cambodian history and in many regions present-day, subsistence paddy rice farming served the primary means of agriculture and was the backbone of rural livelihoods (Slocomb, 2010). While it is not the only crop being cultivated in Cambodia, it is by far was the fundamental crop for many and produces the majority of farm family income. Prior to the 1970s war era, rice production primarily occurred in the populous center and southeast regions of the country as well as the more rural, yet equally productive, northwest region. Cultivation of paddy rice required extensive planning, coordination, and control over land, material, and labor (Cotton, 1985). From 1945 to 1970, estimates of production indicate that total cultivated paddy area grew, but yield in terms of product actually declined. Production gradually increased in the 1960s but on a very minimal scale, with agricultural production per person growing by an average one per cent annually (DeFalco, 2013). In general, cultivated areas grew in line with population growth, but did not exceed it. The average wet season rice yields stagnated around 1.3 tons per hectare. Where irrigation and fertilizer were used, this yield increased to 2-2.5 tons per hectare. However, the area under intensification was very small.

While rice was the staple crop, some farmers during the pre-war era chose to supplement their production with cash crops such as maize, pepper, or soybeans (Slocomb, 2010). Rubber was also a highly cultivated cash produce for export but was primarily grown on large-scale commercial plantations. In fact, rubber and rice were considered the pillars of economic development and independence in the 1960s. However, no household-scale rubber production (< 100 hectares) was occurring at this time. Regions with particular success in cash crop production were those along the banks of the Mekong and the Bassac where market gardens proliferated (Slocomb, 2010). These polyculture systems produced a variety of crops for local and foreign markets alike. Establishment of these
systems was encouraged by government incentives which exempted land for rubber production and other rural properties from land tax for a specified number of years depending on the crop planted. This was intended to encourage production of cash crops for export such as rubber, tea, coconut, mulberry, and cashews.

Then, upon gaining control of the country on April 17th, 1975, Pol Pot and his CPK government (known as the Khmer Rouge) set about implementing its radical overhaul of the nation through a version of extreme socialism, targeting use of the agricultural sector. On May 20, 1975, the Khmer Rouge laid out their fundamental regime policies to achieve their “Super Great Leap Forward” for a utopian agrarian-socialist state (Slocomb, 2010). Through these policies they created farming and labor cooperatives, abolished money and private property, and established communal eating and living (DeFalco, 2013). Anything that was considered privately owned or individualized was banned, including cultivating of private subsistence gardens, private ownership of food, private ownership of livestock and poultry, and foraging for alternative food sources (i.e., wild food plants) (DeFalco, 2013; Slocomb, 2010). In their drive to push communism forward, traditional practices and knowledge of subsistence gardening and foraging were disregarded.

Instead, to achieve their desired nation state, all national resources were concentrated around rice production. The Khmer Rouge’s draft economic plan entitled “Four-Year Plan to Build Socialism in All Fields” established rice as the “capital base” of the revolution (DeFalco, 2013). The goal was to produce enough rice to have food sovereignty in Cambodia while at the same time producing enough surplus to fund economic development within the next 10-15 years (DeFalco, 2013; Slocomb, 2010). As such, their national plan was to triple the national rice production to an average of three tons per hectare of cultivated land. This would be achieved through the production of two to three crops per year: a wet season crop, a recession crop, and a dry season crop. In reality, this goal was next to impossible to achieve as the nation had never reached anywhere near that level of production.

However, the Khmer Rouge believed they could overcome these barriers and achieve production targets through revolutionary willpower and the implementation of military-style agricultural “offensives” throughout the country (DeFalco, 2013). These offenses primarily manifested through a nationwide system of forced labor. Much of this labor was used to develop large-scale hydraulic projects in an attempt to overcome water issues that the Khmer Rouge saw as a limiting factor to agricultural development. Extensive networks of dams and canals were constructed and large swaths of land were deforested to convert historically dry or unproductive land to agriculture (Cotton, 1985). The goal was to create a national system of dikes, canals, and dams to capture and redistribute seasonal monsoon water year-round (DeFalco, 2013). Pol Pot claimed in a September 1978 speech that his government had constructed enough dams, reservoirs, and canals to irrigate 700,000 hectares of land, an almost ten-fold increase of 1968 irrigation (Slocomb, 2010). However, the actual number and success of these systems is not truly known. Most of these construction projects were rushed forward with poor planning and implementation, resulting in flawed projects that quickly collapsed, failed, or
deteriorated; not to mention the thousands of lives lost from overwork, starvation, and accidents constructing these water projects (DeFalco, 2013). Unfortunately, a lot of these new networks of water were necessary not only to increase production but also to reroute water because previous paddy systems had been radically changed. Overhauling the traditional paddy system of smallholder plots spread across the countryside in a variety of shapes and sizes, paddy fields were redistributed into kilometer-square units divided into single hectare sections. Khmer Rouge leaders had believed this would allow for easier transition to full mechanization of rice. In actuality, it required greater labor and higher costs for the redistribution of water systems and new series of rice paddy walls that interfered with irrigation channels. Rice production was also inhibited by lack of fertilizer provided by the remine and the loss of draft animals for production from the US bombing campaign in the early 1970s. In the end, rice production was largely unsuccessful. Official records state that Cambodia’s 1975 rice production had dropped by eighty-four percent compared to the 1970 crop and estimates suggest production throughout the regime years only ever totaled about half of pre-Khmer Rouge levels (Slocomb, 2010). This further contributed to starvation and widespread famine as alternative food sources such as foraging and production had been banned. Approximately 10-20% of Cambodia’s population is estimated to have died of starvation and/or disease during this time (DeFalco, 2013).

The Cambodian government, economy, and landscape were vastly different in the immediate aftermath of the Khmer Rouge. The population took a drastic hit as a result of the Cambodian genocide and the conditions of living under the Khmer Rouge regime. An estimated 750,000 to 3,331,678 died of execution, disease, overwork, or starvation, the wide range being due to lack of complete census records (Slocomb, 2010). Population didn’t rebound again with the same vigor until the 1990s when it grew 40% over a decade. Under the newly established People’s Republic of Kampuchea (PRK) and eventually the 1989 established State of Cambodia, the agricultural landscape began to slowly regain its bearing.

Throughout this timeframe agriculture maintained its hold on the Cambodian economy, accounting for approximately 50% of the nation’s GDP, and 82% of the workforce in the rural sector was engaged in agriculture (Slocomb, 2010). Yet, a range of issues were undermining the success of the agricultural sector including: lack of irrigation infrastructure, poor marketing, lack of transportation and distribution networks, administrative issues including graft and political interference, and a need for public and private investment. In the direct aftermath of the Khmer Rouge, much of the agriculture sector became focused on addressing the high levels of starvation and food insecurity across the country (Slocomb, 2010).

At the start of PRK rule, fewer than half a million hectares of rice-producing land, all in Battambang province, were under its nominal control. With newly freed Cambodians returning back to their original land, the 1979 rice crop was planted sporadically (DeFalco, 2013). Only a third of paddy land, totaling approximately 875,000 hectares,
had been planted by August 1979. While impossible to know how much was produced during this year, one estimate places the national rice crop at 265,220 tons, totaling only about 20% of typical prewar yields. This lack of production severely threatened the already fragile food security situation and stability of the state. To address gaps in production, the PRK implemented a goal of cultivating 2.5 million hectares of paddy land for an idealized 3 million tons of paddy, including both wet and dry season. Some incentives and resources were offered to farmers such as the subsidizing of chemical fertilizers that farmers could get through the province or district agricultural office (Lando & Mak, 1994).

That being said, total rice production eventually rebounded to pre-Khmer Rouge levels and by the end of the PRK regime in 1989, Cambodia was again reaching self-sufficiency in rice production with yields comparable to 1967. Over the next decade (1989-1999), total harvested area grew from 1,861,000 hectares to 2,079,400 hectares (Slocomb, 2010). While these figures indicate growth, the increase was relatively small compared to the population growth of over 3 million people over the same decade. A 1994 survey of lowland rice farmers across three provinces found that most farmers could only produce enough rice for subsistence due to poor yields and small landholdings (Lando & Mak, 1994). Many farmers cited this as the primary reason for favoring seed varieties with marketed high-yield volume. Additionally, farmers reported preferring to plant varieties known to be of good eating quality over varieties with beneficial agronomic adaptation such as tolerance for standing in deep water or fast maturing.

Similar to rice, cash crop production changed during the PRK and initial years of the State of Cambodia. In response to high starvation rates following the Khmer Rouge regime, President Heng Samrin in 1979 advocated for cultivation of fast-maturing root crops (i.e., cassava) (Slocomb, 2010). At this time, supplementary root crops and wild food plants were available as starvation foods for rural residents, but were unavailable to urban and peri-urban residents. The hope was that by increasing cash crop production, more supplementary food options would be available to those residing in urban areas and subsequently death by starvation would be reduced.

After the disintegration of PRK, during the early years of the State of Cambodia, crop production apart from rice was limited. Maize and rubber accounted for 60,000 hectares and 37,000 hectares, respectively in 1999 (Slocomb, 2010). Other than lentils, sesame, and cassava, which served as food and short-term industrial crops, few other cash crops were produced. Overall, the diversification of crop production and cultivation was minimal. The scale of the diverse polyculture market gardens seen prior to the Khmer Rouge regime was gone as production of jute, pepper, cotton, tobacco, and other traditional cash crops all declined.

In general, the Khmer Rouge had a significant impact on crop diversity in Cambodian agricultural systems. Pre-Khmer Rouge systems had a wide variety of cash crop and polyculture market gardens production as well as wide-ranging knowledge on wild food
plants and foraging. Unfortunately, such levels of agricultural diversity were not seen in post-Khmer Rouge systems. One reason for this was simply the intentional choice to focus on rice, maize, and rubber for quick food and cash procurement in the direct aftermath of the regime. The PRK needed to provide for the people of Cambodia quickly and efficiently and they saw putting resources into a few key crops as the best method to do so. Another reason for the lack of diversity was the choices made by the Khmer Rouge in their attempt to create a communist society. The choice to focus on rice as the backbone of the economy, abolish or destroy all individual gardens and agricultural property, and ban foraging for food created an overall loss of access to and knowledge of diverse crops systems and wild food plants.

Currently, agriculture in Cambodia has been described as “a system in transition” (Eliste & Zorya, 2015). Agriculture continues to be the economic backbone of the nation with over 70% of the population being engaged in the agriculture sector in some fashion. The sector primarily consists of rain-fed paddy rice, with the average farmer having one hectare of land (Eissler, 2021). Other agricultural activities of the average smallholder include some livestock production, wild food collection, trade, and vegetable or palm sugar production. The agriculture sector averaged 5.3% growth per year from 2004-2012, but this growth has slowed to approximately 1% per year from 2013 to present day. In general, agriculture is becoming less important to the overall GDP and total labor force than in the past. Despite this decreased share of GDP, agricultural land and labor has increased in productivity through the 21st century. Other recent successes of the agriculture sector include increases in annual agricultural gross production for paddy rice, cassava, sugarcane, and vegetables as well as increased farm wages as a result of higher rice prices that stimulated production (Eliste & Zorya, 2015). Unfortunately, there are also a number of challenges that exist with the current agricultural system. For one, agricultural growth has primarily occurred due to farmland expansion rather than intensification. This has resulted in increased deforestation, threatening the nation’s biodiversity and sustainable agriculture practices. Additionally, this growth is slowing dramatically with recent years averaging a less than 1% growth rate. The aforementioned wage income increases of farmers has mainly occurred for those able to expand their farmland for greater production, an activity unavailable on smallholder farms with limited income and space on their average 1-hectare landholdings to expand. As such, those without plot size changes have not had their wages increase at the same rate of larger-scale producers. Thus, vulnerability is overall greatest among these 1-hectare or less smallholder farms, as their productivity remains low.

Furthermore, another challenge within the current Cambodian agriculture system is the continued overall lack of diversification. From 2007-2011, paddy rice covered 2.63 million hectares of Cambodia, accounting for up to 90% of cultivated land (DeFalco, 2013). While the focus on rice and a handful of promising cash crops was beneficial for livelihoods in recuperating and rebuilding from the Khmer Rouge, it is no longer serving the Cambodian population. There is a distinct need to increase diversity and regain traditional knowledge lost during the Khmer Rouge regime. The Cambodian National
Strategy for Food Security and Nutrition advocates for increased food availability and access through a diversification of food systems (RCG, 2019). Diversification improves human nutrition, restores degraded landscapes, increases income, improves productivity, and meets the needs of an urbanizing consumer base (Eissler, 2014; Seng, 2014). Moving forward, scholars suggest the nation should transition away from the monoculture systems it established during the Khmer Rouge era and back to the traditional polyculture systems the nation was accustomed to prior to the 1970s.

Yet, a significant challenge exists in that a key tenant of Khmer Rouge was the demolition of the education system. Much of this occurred through the intentional destruction of knowledge as Khmer Rouge embarked on in their attempt to create “Year Zero” for Cambodia, referring to Pol Pot’s declaration to end over two thousand years of Cambodia history and start over (Clayton, 1998). The educational system was ravaged by the genocide as those viewed as educated were either killed or fled the country and a drastic amount of records and literature were destroyed (Jeong, 2014). Physical educational infrastructure was a prime target for destruction, literacy education beyond the lowest grade was abolished, and any formal schooling with Western influence was eradicated. All universities except one were destroyed and thus higher education all but disappeared from the scene. Basic reading and writing existed to some extent in the regime’s agricultural collectives but it was extremely unstructured. Importantly, it is estimated that almost three-quarters of the educated population of Cambodia were killed or fled the country as refugees during this time (Dy, 2004; Duggan, 1996). This population consisted of teachers, students, professionals, and intellectuals. This loss of human capital impacted not only classical education but also cultural and indigenous knowledge and practices, much of which included agricultural tradition (Finn, 2012).

**Scaling through Education**

**Sustainable Intensification (SI)**

SI is a promising vehicle to increase productivity and diversification for smallholder farmers in Cambodia and the wider Southeast Asia region (Petersen & Snapp, 2015). Both an approach and a goal in itself, SI is a relatively open concept, encompassing systems in which yields are increased without adverse environmental impact or additional land use. Rather than focusing on production goals, SI emphasizes a wide set of drivers and goals that can be achieved by numerous means (Pretty & Bharucha, 2014; Pretty et al., 2018). Zurek et al. (2015) define SI as, “production of more food on the same piece of land while reducing the negative environmental impacts and at the same time increasing the contributions to natural capital and flow of environmental services” (p. 24). This has been further expanded to include social issues, economics, and the human condition as non-environmental factors for a balanced application of SI processes (Musumba et al., 2017).
SI is well suited for settings where farmers have small (1-hecatare or less) plots, limited access to inputs, and may be averse to the larger restructuring of production systems, making it a key intervention for Cambodian agriculture. While it was necessary for Cambodia to expand and intensify production in the years immediately following the Khmer Rouge regime to mitigate starvation and get the nation back on track, there also needs to be a concerted effort to sustainably intensify production for environmental longevity. The recent slowdown in agricultural growth in Cambodia may signal a potential longer term-term decline in productivity. With an increasing youth and urban population, there is a distinct need to increase agricultural productivity on less land. As such, Cambodia needs to focus on scaling up the sustainable intensification of agriculture rather than focusing on the continued expansion of farmland.

While knowledge on SI technologies and practices is readily available, the actual dissemination of this knowledge and subsequent adoption and scaling of SI technologies among smallholders continues to be a challenge globally. Barriers to adoption include, but aren’t limited to, weak social and capital networks, low quality extension services, reliance on government support during crop failure, incidence of pests and diseases, resource constraints, lack of education, inability to access market, and the occurrence of climate shocks (Kassie et al. 2015; Shilomboleni & De Plaen, 2019; Westermann et al., 2019; Barrett, Carter, and Timmer, 2010; Jack, 2013). The key to addressing these gaps is to identify where farmers actually receive their information and enter into those networks to strengthen their effectiveness.

Scaling SI through School Gardens

School gardens are a well-known tool to develop agricultural education curriculum and food system knowledge within primary and secondary schools worldwide. Current research on school gardens is primarily focused on improving student nutrition and increasing vegetable consumption (Ratcliffe et al., 2011; Schreinemachers et al., 2019; Leuven et al., 2018; FAO, 2004; Ferguson et al., 2019). Less examined is their potential to be agents of food system reskilling and knowledge transfer to the wider community (Cramer et al., 2019). Yet, students have significant potential to be agents of change in their homes and communities. Using knowledge gained through school garden education, students can serve as credible sources of information to their parents on best agriculture practices (Okiror et al., 2011; Sprague, 2016; Tabucanon & Mihara, 2016; Calub et al., 2019). Often, implementation and scaling up of new technologies and innovations is met with apprehension due to fear of the economic, social, and health risks that come with crop failure (Shilomboleni & De Plaen, 2019; Westermann et al., 2019). School gardens provide a pathway to evaluate new technologies without personal risk.

Understanding the process of and barriers to scaling are not newly developed streams of social science research. Feder & Umali (1993) in their literature review of agricultural innovation adoption during the prior decade detail risk, information availability, credit, and farm size as major factors influencing farmer adoption of new technologies. This
understanding of risk severely limits ability to scale new agricultural technologies that can be used to improve livelihoods and combat impacts of climate change. Often, scaling is described as either ‘scaling up’ or ‘scaling out’. ‘Scaling up’ can be likened to the act of increasing, often in terms of number, speed, size, etc. On the other hand, ‘scaling out’ refers to the act of expansion, such as the spread of a particular technology to new geographical locations (Wigboldus et al., 2016). For these research purposes, the distinction will be combined into the phrase ‘scaling up’ which covers the expansion, replication, and adaption of successful technologies, practices, or innovations to reach a greater number of people (Finn, 2012).

In a comprehensive literature review of school gardens as a method for scaling SI technologies, key opportunities for and barriers to scaling were identified (Pekarcik & Ader, 2021) (Table 1). Inclusion of parents in the learning process and upkeep of school gardens was found to be a key component in assuring a successful and scalable school garden. Active parent involvement increased the likelihood of knowledge transfer from students to parents. Schreinemachers et al. (2017) in their assessment of a pilot school garden program in Bhutan highlighted the positive impact of the program’s inclusion of parental involvement throughout the learning process. Parents were involved through land preparation, crop care, material provision, and student advising. Additionally, teachers took the time to visit parents at home and encouraged the use of home gardens. The authors determine the impact to be that parents were highly accepting of the school garden and families increased their knowledge about sustainable agriculture and nutritious food. Along the same lines, Schreinemachers et al. (2019) in their study on school gardens in Burkina Faso involved parents through contributions in determining garden vegetables choice, volunteer garden upkeep, land preparation, and fencing. The authors determined the impact of parental involvement to be that children’s knowledge about agriculture, food, and nutrition improved. However, the scope of the study did not directly assess changes in attitudes and behavior of children, teachers, or parents. The authors specifically describe the need for such a component to be included in future study design. Sprague (2016), in her case study analysis of school garden program in Pittsburgh, PA, states that parents should be engaged in school garden improvements as, “they play the significant role of making the many possible connections between school family and community...” (pg. 123). Conversely, barriers to scaling arise if parents are uninterested and unable to commit the necessary time and energy for school garden involvement. This is especially true if a teacher spearheading the school garden effort leaves the school. Ferguson et al. (2019) acknowledge that highly motivated parents/schools are necessary to keep school gardens going on their own if the project leader leaves.

Inclusion of parents in the learning process was directly tied to another identified best practice for scaling – the establishment of home gardens at the same time as or shortly after school gardens. The utilization of home gardens to test methods and technologies learned by children in school settings allows for streamlined transfer of knowledge and practices to the parents. This in turn increases usage of new agricultural technologies
Table 1. Best Practices and Primary Barriers to Scaling through School Gardens

<table>
<thead>
<tr>
<th><strong>Best Practices</strong></th>
<th><strong>Primary Barriers</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Including parents in the learning process and upkeep of school gardens</td>
<td>• Focusing on the ‘what’ and not the ‘how’ (i.e., scaling is not ‘one size fits all’)</td>
</tr>
<tr>
<td>• Establishment of home gardens alongside school gardens</td>
<td>• Social mores and the relationship between parent/child</td>
</tr>
<tr>
<td>• Establishment of hands-on, research-based agricultural curriculum in schools</td>
<td>• Poor capacity building for and involvement of school heads, teachers, and parents.</td>
</tr>
<tr>
<td>• Collaboration and commitment among all stakeholders</td>
<td>• Lack of social, human, and/or economic capital</td>
</tr>
<tr>
<td></td>
<td>• Unintegrated commitment and partnership among stakeholders</td>
</tr>
</tbody>
</table>
on a larger scale within households and communities. Calub et al. (2019) in their School-Plus-Home Gardens Project (S+HGP) in the Philippines found that through this methodology, the school gardens became learning laboratories; a place where both students and parents learned about appropriate technologies and practices relevant to sustainable intensification, organic agriculture, edible landscaping, climate change, and the interconnection of food and nutrition. Likewise, Okiror et al.’s (2011) study on school gardens in eight Ugandan schools shows how home gardens allow for the transfer of knowledge from student to parent. The authors find that students were able to effectively pass along their new agricultural knowledge to their parents despite potential barriers such as language constraints, timidness, and social mores. This was accomplished by providing visible examples of agricultural techniques to parents through their home gardens, showing income earned from sale of grown vegetables, and increasing the amount of food eaten at the household level. The likelihood of adoption of these new agricultural practices by parents was improved when inputs (seeds, chemicals, etc.) were provided for home garden projects. Conversely, barriers to scaling arose if parents lacked inputs, household land size was small, or there was a poor relationship between parent and child. Social mores of respect between parent and child could limit youth’s confidence or ability to share knowledge with their elder (Okiror et al., 2011). In a similar fashion, Tabucanon & Mihara (2016) acknowledge in their study on Education for Sustainable Development (ESD) that transfer of knowledge on sustainable agriculture was passed on successfully to both farming and non-farming parents. However, they note that knowledge transfer is better streamlined if children’s parents themselves are farmers, as conversations and practices can be naturally continued at home and parents have some level of farm inputs available.

Building a successful school garden curriculum and then teaching said curriculum is only possible through collaboration and commitment among all stakeholders. Stakeholders include, but are not limited to, teachers, parents, students, school leadership, local government, policymakers, local community members, and research organizations. Without all school garden stakeholders working together, barriers to scaling become paramount. For example, Tabucanon and Mihara (2016) use a multi-stakeholder networking approach in their study and impress upon readers that it produces, “awareness-raising and learning among farmers, curriculum transformation in schools, and implementing the notion of sustainable livelihood” (p. 4). SEARCA (2020) also highlight the necessity of stakeholder collaborations in their briefing of the ‘International Conference on School Gardens: Leveraging the Multifunctionality of School Gardens.’ The editors describe lack of partnership and leadership between academia, local government, policymakers, schools, parents, and teachers as a key barrier to school garden start-up and maintenance.

Sprague (2016) proclaims that collaboration and commitment among school administrators, teachers, parents, garden coordinators, and community volunteers is necessary for the scaling of an instructional school garden. She introduces the necessity of a reliable system to track levels of stakeholder commitment, capacity, and confidence.
– dubbed the 3Cs. The 3C approach uses a framework that provides a 3C score that serves as, “a measurement of readiness for change or improvement of a given stakeholder group, arrived at and agreed upon by the stakeholder group” (p.131). Sprague claims this framework serves as a research roadmap with realistic, actionable timelines that do not cause stakeholders to overextend themselves, creating a balanced, scalable school garden system.

Further, a key barrier to scaling was found to be poor capacity building for and involvement of school heads and teachers. At SEARCA’s ‘International Conference on School Gardens: Leveraging the Multifunctionality of School Gardens’, capacity building was a key discussion point with overall issues/challenges section including, “capacity building for school heads, teachers, and parents as part of social and technical preparation to school gardens” (SEARCA, 2020, p. 68). This was often founded in lack of adequate training for teachers and administration working with school gardens. DeMarco (1997) found in his study on factors affecting elementary school teachers’ adoption of school gardens into curriculum that teachers’ education and knowledge on gardening principals was essential for implementation. However, their knowledge was found to be considerably lacking. In his survey of 236 teachers in the United States, only 18 (8%) indicated that, “their training was sufficient to successfully handle school gardening with their students and no further training was necessary” and 217 (92%) stated they felt additional training was needed.

In order to apply best practices and avoid the barriers to scaling, S3-Cambodia seeks to incorporate the findings from the literature. For example, home gardens will be implemented alongside school gardens as a key project activity. It will be done to increase learning and to allow school communities to evaluate new practices before applying them at the field or farm scale. Additionally, hands-on, research-based agricultural curriculum will be developed and applied in the pilot high school schools. As part of its youth development strategy, the project will work hand-in-hand with the Cambodian Ministry of Education, Youth, and Sport (MOEYS) to develop new 4-H style\(^1\) curriculum and adapt existing curriculum to provide agricultural-based STEM instruction that can be scaled nationally. Additionally, S3-Cambodia implements the best practice of providing financial assistance to the schools for the startup and upkeep of the school gardens. As a USAID funded project with additional leveraged funds, S3-Cambodia is able to provide the necessary monies to establish green labs, trainings, and necessary inputs. To assure green lab infrastructure and curriculum will be maintained after project close, the project will provide training, supplies, curriculum, and government support to Cambodian educators. Furthermore, S3-Cambodia will assure collaboration and commitment among stakeholders through adhering to its detailed capacity building plan. This plan includes collaboration and mentorship with project counterparts (CE-SAIN, RUA, UBB), a train-the-trainer program, and direct engagement with end-users. However, not finalized in the project implementation is parental involvement. As the project moves forward, acknowledging how to incorporate parents
into implementation of school gardens should be a key goal. The question remains as to what level of involvement Cambodian parents have in their children’s lives and schools.
CHAPTER THREE
MATERIALS AND METHODS

Study Area and Population

Primary data was collected from parents, principals, and students of three separate high schools in three khums (communes) of Cambodia through one-on-one surveys and semi-structured key informant interviews conducted orally. Sor Kheng Kanteu II High School (Banan) is located in the Kantueu Pir commune of the Banan district in Battambang province and has 1300 students enrolled. Hun Sen Sampov High School (Sampov) is located in the Phnum Sampov commune of the Banan district in Battambang province and has 1418 students enrolled. Rongko High School (Rongko) is located in the Chammaom commune of the Mongkol Borey district in Banteay Meanchey province and has 1208 students enrolled. The locations of the high schools are highlighted in Figure 2.

Battambang and Banteay Meanchey are both located in northwest Cambodia. Battambang Province is the fifth largest province by population in Cambodia, comprised of 14 districts, 96 sub-districts, 789 villages, and a total population of 987,400 according to the 2019 census (National Institute of Statistics, 2019). As of 2019, Sampov district has a total population of 37,323 and Banan district has a total population of 86,486. This province, known as “the rice bowl of Cambodia,” is characterized by its smallholder rice-based economy supported by the tropical climate, fertile, soils, and sufficient water and irrigation capacities (Shapiro et al., 2021). The city of Battambang is located in this province and is within 40 minutes of both Sampov and Banan districts by motorbike. While it is the second most populous city in Cambodia and a center of economic growth, Battambang is a comparatively unhurried, conservative town with far less urban development and western influences than the capital city of Phnom Penh (Han & Lim, 2019). Bordering Battambang Province to the South and Thailand to the North, Banteay Meanchey Province is the eighth largest province in Cambodia, comprised of seven districts and two municipalities, 55 sub-districts, 654 villages and a total population of 859,545 according to the 2019 census (National Institute of Statistics, 2019). The Mongkol Borey district has a total population of 187,286 as of 2019. Very similar to Battambang Province, Banteay Meanchey has a rice-focused, small-scale agricultural-based economy. Livelihoods in both provinces are supported by rice production, fruit and vegetable production, fishing, wage work, and collecting wild food and forest products (Hought et al., 2012).
Figure 2: High School Locations
Survey Data Collection and Analysis

Survey Instrument

A cross-sectional survey instrument was developed to assess parental perceptions of their involvement in their child(ren)’s lives and schools (Appendix 1). Survey questions were developed by modelling parent/guardian survey questions from a range of school garden scaling literature (Pekarčík & Ader, 2021). Survey development and design was strongly influenced by Sprague (2016)’s parent/guardian survey on barriers to and opportunities for scaling through instructional school gardens in Pittsburgh, PA (pg. 73). Original survey instrument design included an individual survey for each high school. Survey questions were reviewed by S3-Cambodia partners at UTIA and the instrument was revised to have one cohesive survey that sought to measure parents’ perceptions of their current involvement in educational activities at their child’s school and their perceived communicational levels with their child both in general and regarding educational topics. This allowed for the ability to accurately compare results across schools and streamline survey answers. To account for educational and programmatic differences between the schools, additional questions sought to document parental adoption of classroom-based SI knowledge and evaluate the feasibility of implementation or scaling up a school garden. The survey instrument included a separate annex of questions for each school based on the agricultural education programming, or lack thereof, available at the school (Table 2). Final survey questions and instructions were translated into Khmer by a S3-Cambodia field technician to assure for linguistic accuracy. Following translation, a Zoom (Zoom Video Communications Inc., 2016) meeting was held to back-translate the Khmer version into English assure questions were matching the original English versions while keeping with linguistic and cultural appropriateness. The final Khmer version was developed from this meeting and provided to survey enumerators.

Annex 1 questions were given to parents of children who attend the S3-Cambodia affiliated school, Banan (Appendix 1). While the high school has wild food plants (WFP) planted on the school ground, it does not currently have any agriculture-based programming or a distinct school garden. As such, it is being assessed as a site for S3-Cambodia green lab implementation. Annex 1 questions sought to measure the perceived extent to which general knowledge has been transferred from school to home and determine parents’ interest levels implementing and being involved in a school garden at Banan. The purpose of this being to determine how effective transfer of knowledge could be through a school garden at Banan. If parents are already unlikely to be interested in or influenced by their child(ren)’s school activities, then there may be barriers to scaling of new technologies through youth. Likewise, if parents aren’t interested in implementation or involvement in a school garden, barriers to scaling may increase further.

Annex 2 was given to parents of children who attend Rongko High School which is affiliated with the Southeast Asia Prayer Center (SEAPC) through their Banteay Meancheay Arise program. SEAPC is a 501(c) non-profit that has been located in....
<table>
<thead>
<tr>
<th>School</th>
<th>District</th>
<th>Province</th>
<th>Life Skills Training Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sor Kheng Kanteu II High School (Banan)</td>
<td>Banan</td>
<td>Battambang</td>
<td>None</td>
</tr>
<tr>
<td>Hun Sen Sampov High School (Sampov)</td>
<td>Sampov</td>
<td>Battambang</td>
<td>School Garden - Agriculture</td>
</tr>
<tr>
<td>Rongko High School (Rongko)</td>
<td>Mongkol Borey</td>
<td>Banteay Meanchey</td>
<td>Technology Park - Nursing, Computer, Small Systems Machinery</td>
</tr>
</tbody>
</table>
Cambodia since 1976 (https://seapc.org/) (Appendix 1). With extensive knowledge of the region and a direct request from the Cambodian government in the early 2000s, SEAPC began working with the Rongko cluster schools in the Banteay Meanchey province to develop educational curriculum and train local teachers. With the success of their program, they were commissioned in 2014 to expand the program to the entire province through Banteay Meanchey Arise, reaching 488 public schools and 130,000 students. Specific high schools in the program, of which Rongko is one, have access to technology parks with specialized training curricula in nursing, music, English, computer science, small-systems machinery, and, as of 2020, agriculture. Rongko High School is set to be the site of the program’s newly piloted agricultural program with the development of a hydroponics system and garden on the school grounds. Annex 2 questions sought to measure the extent of the parents’ perceived involvement in the school technology park, adoption of new technologies as a result of the technology park, and their interest level in implementing and being involved in a school garden at Rongko. The experiential learning through SEAPC technology parks is parallel to the goals and setup of S3-Cambodia's green labs, and thus surveying parental involvement in these established programs would inform parental involvement considerations in S3-Cambodia school garden projects.

Annex 3 was given to parents of children who attend the S3-affiliated school, Hun Sen Sampov High School (Appendix 1). This school is located close to a school garden through the Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE-SAIN) technology park. CE-SAIN is a scaling partner of S3-Cambodia that manages a network of agricultural research stations in Cambodia. Their “tech parks” will serve as hubs for scaling activities under S3-Cambodia. Additionally, Sampov has had a school garden on its ground in the past, but it has since fallen out of use. Annex 3 questions measure the extent of the parents’ perceived involvement in school garden activities, adoption of new agricultural technologies as a result of the school garden access, and their interest level in being involved in a school garden at Sampov. Evaluation of this data specifically informed future school garden implementation and activities through S3-Cambodia green labs to assure best practices for scaling. Comparing the results of the survey across the schools with different levels of agricultural education sought to provide insights on how to strengthen S3-Cambodia’s existing and planned green labs at secondary schools in Cambodia. Overall, analyzing the results of the survey complemented by the three annexes provided a holistic assessment of relationships and knowledge transfer between parents, children, and schools.

Data Collection

The original plan for data collection was to travel to Cambodia during August 2021 and conduct my surveys with a team of hired student enumerators from NUBB. In the case that travel was prohibited to Cambodia throughout August, my backup plan was to postpone data collection until Fall semester 2021 and conduct my in-country research while simultaneously completing my graduate coursework online. In the case of
continued COVID-19 disruptions, and travel was still not possible by a deadline of October 1st, the last resort plan was to entrust the team of hired enumerators to collect my survey data. During Fall of 2021, Cambodia experienced a COVID-19 surge and thus the country shut down and borders remained closed to foreigners. As a result, the original plan for data collection was not able to be achieved and, in order to assure timely data collection, I instructed the student enumerators to conduct the surveys on behalf. A team of six student enumerators from NUBB collected the survey data over a span of two months (Figure 3). Members of the BC Arise team also assisted in collecting survey data for Rongko. The enumerators and BC Arise team members were trained on research ethics and procedure in Khmer by field technicians.

All three of the selected high schools have established connections with the S3-Cambodia project and NUBB. Households for parent survey were identified through a stratified random sampling of 60 students from the 10th and 11th grades at each of the high schools. The number of students in these two grades at Banan, Sampov, and Rongko were 536, 703, and 391, respectively. All of the students were in the age range of 16 to 20. The stratified sampling took into account the multiple villages that feed into each of the high schools, as villages in a single district vary in rurality and socio-economic status. A sample size of 60 students per school was selected because it keeps the study within time and resource limits while also staying proportional to the total student population size. The students were sampled from only the 10th and 11th grades because the 12th graders were focused on national exams.

For each selected student, enumerators contacted the phone number provided by the school for the household and requested to visit the household and survey a parent/guardian. Enumerators visited the households which agreed to participate, for a total of 178 households. Surveys lasted approximately 20 minutes, began with a verbal consent statement, and were conducted orally in a one-on-one setting to account for the literacy capabilities of participants (Figure 4). Parents were provided with a small gift of a box of surgical masks and hand sanitizer for their participation. Parents in Rongko were surveyed on October 16, 2021, by a team 10 enumerators who each surveyed 6 households. Parents in Banan and Sampov were surveyed on November 2 and 3, 2021 by a team 10 enumerators who each surveyed 5-6 households per school.

**Analysis**

My research questions and objectives were evaluated through an SPSS (IBM Corp., 2020) analysis of survey responses. The descriptive statistics of survey responses were analyzed for each school individually and across schools to determine trends within and between parents who children attend each high school.
Figure 3: Field Technicians Training Student Enumerators

Figure 4: Rongko High School Parent Survey
Key Informant Interviews and Analysis

Parents

Household surveys were followed by in-person key informant interviews of parents at each of the three high schools in Cambodia throughout January 2022. Three parents at each of the high schools were identified based on their perceived level of involvement in their child’s life and schooling from their survey responses, for a total of nine parents interviewed. From each high school, selected parents included one parent that had relatively low involvement, one parent that had relatively average involvement, and one parent had relatively high involvement.

Interviews were semi-structured, recorded, last approximately 30 minutes, and were conducted with the assistance of a NUBB English student who served as a translator for parents that did not speak English. The interviews built upon survey questions and sought to gain more in depth (beyond just yes/no) knowledge of parents’ involvement in school activities, their relationship with their child, their interest in and knowledge of new farming methods, and their thoughts on school gardens (Appendix 2). Parents received another box of masks and bar soap as a gift for their time.

Principals and Teachers

Key informant interviews were conducted for the principal and three teachers at each of the three high schools (Figures 5 and 6). In total, three principals and nine teachers were interviewed. Interview preference was given to biology and earth science teacher as they would be most likely to assist with a school garden. These interviews were semi-structured, recorded, last approximately 30 minutes, and were conducted the assistance of the NUBB English student. Interview questions and responses were translated in real time to allow me to ask any additional questions that flowed from the structured ones. The principal and teacher interviews built upon parent interviews with questions focusing on their perceptions of parental involvement in the school, student-parent relationships, and student agricultural interest. While parents can speak to their personal involvement levels, principals had a different perspective of parental involvement based on their role at the school. Having principal and teacher interviews supplement the parent interviews assisted in developing a full knowledge base for the best practices and barriers to scaling agriculture technologies through school gardens, specifically regarding parental involvement.
Figure 5: Principal Interview at Banan

Figure 6: Teacher Interview at Rongko
Analysis

The data gathered from the key informant interviews was analyzed through a grounded theory analysis with the goal to develop deeper understanding of the transfer of knowledge from the school garden to home farm. Grounded theory is a method of qualitative research that allows for the study of a process or phenomenon from collection and analysis of real-world data. From an inductive rather than deductive approach, new theories are derived from the gathered qualitative data (Urquhart et al., 2010). Key informant interview responses were analyzed through NVivo (QRS International Pty Ltd., 2018) with three rounds of coding (Appendix 3). The first round utilized in vivo coding to determine initial codes. In vivo coding assigned a label or “code” to a word or phrase of interview transcripts sections. This was followed by axial coding, which used initial codes and grouped them into logical categories. Finally, selective coding was used connect all of the categories together around one core category, serving as the grounded theory emerging from the research (Figure 7).

Assumptions and Limitations

A few assumptions and limitations are necessary to be aware of for effective analysis of and conclusions made from survey and interview data. First, the research assumes that survey and interview respondents answered truthfully and to the best of their ability. Parents, teachers, and principals may have had the desire to provide information or answers they assumed the enumerator or interviewer wanted to hear. That being said, parents that served as key informant interviewees were able to clearly expand upon the responses which they provided in the original survey two months prior. There were no glaring inconsistencies in parent key informant interview responses that indicate they had been untruthful in survey responses. Additionally, survey and interview responses did not yield only positive responses. The reporting of strained relationships between some parents and the school or their child, as well as the existence of clear subset of uninvolved parents, indicates that survey questions were answered truthfully.

Secondly, the research plan assumed that a singular parent of each student would provide survey and interview responses when the research teams visited the households. In reality, this was unlikely to have been the case for all households based upon livelihood activities, parents’ job requirements, and the number of single-parent households. During the follow-up key informant interviews, I learned that if a parent had not been available to answer survey questions when an enumerator visited the household, the enumerator surveyed any available adult at the household. This included grandparents, aunt, uncles, and older siblings. Some of these adults were in fact the primary guardian of the selected students, but this was not the case for all households. Due to the fact that I was unable to be present in Cambodia during survey enumeration, I cannot know for sure which survey responses were parents and which were another household adult. In actuality, it is likely that multiple household adults were present during the survey even if the responses were only recorded for one parent/guardian. During key informant interviews, any adult that
**Figure 7. Grounded Theory Coding Process for Key Informant Interviews**
was present at the household at the time added comments into the conversation, regardless of whether they were the parent/guardian being interviewed. This is very typical of a Cambodian household as Cambodia is collectivist society with strong loyalty to family and community. As such, these group responses were allowed to occur due to the need to be culturally sensitive and for data to reflect the true dynamic of Cambodian households. Thus, the survey and interviews retain validity because the research purpose is to determine the scalability of SI technologies to households, with adults learning from children being identified a key avenue to do so. If responses were gathered from present adults living in the household, the scalability of SI technologies from school garden to the home will still be understood, potentially to an even greater extent.

Finally, an overarching limitation during research was the ongoing COVID-19 pandemic. While surveys and key informant interviews were anticipated to be conducted during August of 2021, data collection had to be postponed to October/November for surveys and January for key informant interviews due to COVID-19 travel restrictions. Furthermore, some households were hesitant to welcome strangers to their homes or communicate one-on-one with enumerators based on COVID-19 concerns. All households were given the choice whether or not to participate in surveys and interviews. The research team was sure to adhere to all COVID-19 precautions including face masks, social distancing, and sanitizing writing tools and hands between each household visit.
CHAPTER FOUR
RESULTS AND DISCUSSION

Survey Results

In total, 178 parents were surveyed with 62 being from Rongko High School, 56 from Sampov High School, and 60 from Banan High School. Small variances in the number of parents surveyed per school were due to availability of parents on the day of surveying. Rongko had over 60 responses due to some households desiring for both parents to be interviewed. Sampov had under 60 responses due to some sampled households not having a parent/guardian available to take the survey.

Parent School Visitation

Across the schools, less than half of parents (43.5%) had visited the school their child(ren) attends (Table 3). The percentage of parents who had visited the school was highest (50%) at Sampov and lowest (35.5%) at Rongko. Across the schools, the most likely reason parents had visited school their child(ren) attends was because they were specifically invited to the school and/or they attended a particular event. This was most common at Banan where 92.6% of parents reported being invited to the school and 85.6% reported they had attended at particular event at the school. Additionally, parents at Banan were the most likely to have volunteered (48.1%) at the school. On the other hand, the least likely reason across the schools that parents had visited was because they worked at the school. Sampov had the greatest percentage of parents reporting they had worked at the school at 25.0% of those who had visited. A marginal number of parents reported visiting the school because they pick their child up from school (40.7%) or because they have volunteered at the school (37.0). Parents at Rongko were least likely of all parents who have visited their child(ren)’s school to have picked their child up from school, volunteered at the school, and/or worked at the school.

Of the parents that had not visited the school their child(ren) attends, the majority wanted to visit the school (69.9%), yet felt too busy to visit (75.4%) (Table 3). Additionally, the majority of parents felt they need an invitation from the school (59.4%) in order to visit. Of parents at Banan who had not visited the school, the majority reported that they want to visit the school, feel they need an invitation to visit, and feel too busy to visit. Sampov had the lowest percentage of parents who reported being interested in volunteering at the school (17.9%) and reporting feeling they need an invitation to visit the school (35.7%). On the other hand, Rongko parents who had not visited the school were the most likely to want to visit the school, have an interest in volunteering at the school, feel they need an invitation to visit the school, and feel too busy to visit the school (Table 3).
Table 3. Parent School Visitation Trends and Motivations by School

<table>
<thead>
<tr>
<th>Parents who have visited the school</th>
<th>Banan %</th>
<th>Sampov %</th>
<th>Rongko %</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 27</td>
<td>n = 28</td>
<td>n = 22</td>
<td></td>
</tr>
<tr>
<td>Specifically invited to the school</td>
<td>92.6</td>
<td>60.7</td>
<td>81.8</td>
</tr>
<tr>
<td>Attended a particular event</td>
<td>85.2</td>
<td>64.3</td>
<td>72.7</td>
</tr>
<tr>
<td>Pick child up from school</td>
<td>33.3</td>
<td>57.1</td>
<td>31.8</td>
</tr>
<tr>
<td>Volunteered at the school</td>
<td>48.1</td>
<td>35.7</td>
<td>27.3</td>
</tr>
<tr>
<td>Worked at the school</td>
<td>14.8</td>
<td>25.0</td>
<td>4.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parents who have not visited the school</th>
<th>Banan %</th>
<th>Sampov %</th>
<th>Rongko %</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 33</td>
<td>n = 28</td>
<td>n = 40</td>
<td></td>
</tr>
<tr>
<td>Want to visit the school</td>
<td>66.6</td>
<td>60.7</td>
<td>82.5</td>
</tr>
<tr>
<td>Interested in volunteering</td>
<td>30.3</td>
<td>17.9</td>
<td>85.0</td>
</tr>
<tr>
<td>Feel they need an invitation</td>
<td>57.6</td>
<td>35.7</td>
<td>85.0</td>
</tr>
<tr>
<td>Too busy to visit</td>
<td>63.6</td>
<td>75.0</td>
<td>87.5</td>
</tr>
</tbody>
</table>
**Parent and Child Relationship**

Results indicate parents are clearly involved in their children’s lives (Table 4). The majority of parents across the schools had a significant conversation (10+ minutes) with their child at least once per week (84.5%) or day (57.4%). Additionally, the majority believe that they can learn from their children (64.6%) and actively discuss with their children about what they are learning at school (71.7%). By a smaller margin, the majority of parents (58.5%) know what their child wants to be when they grow up. Parents at Rongko were the most likely to believe that they can learn from their children and discuss with their children about what they are learning at school (Table 4). Parents at Sampov were most likely to know what their child wants to be when they grow up. At both Rongko and Banan, approximately 90% of parents had a significant (10+ minute) conversation with their child at least once per week, compared to 73.2% of parents at Sampov. Concerning significant conversations at least once per day, this dropped to 50% and 63.3% at Rongko and Banan, respectively. The percentage change was not as drastic for Sampov, but still dropped to 58.9%.

**Parent SI Knowledge and Interest**

Across the schools, parents’ current knowledge of and interest in SI technologies was varied (Table 5). Only 28% and 17% knew about grafting and cover cropping, respectively, and fewer than 10% of parents used either technology. A greater number of parents were familiar with WFP (66%) and a majority already grow them at their household (86%). Parents at Banan were most likely to know about and use both grafting and WFP. Parents at Sampov were most likely to know about cover cropping (17.9%), though Rongko parents were most likely actually to use the practice (9.7%).

Across the schools, the majority of parents reported using WFP at their household (85.9%). Interestingly, a lower percentage of parents reported knowing about the practice of selling WFP for profit (66.4%). The discrepancy in responses regarding knowledge of WFP is likely due to the use of the term “for profit” in the question language. While many households grow and use WFP for personal household consumption, few cultivate WFP for the purpose of sale. According to a Banan parent interview (Banan, Parent1), knowledge of WFP is from traditional generational practices. She and her family pick WFP from the forest near their house, using them solely for household consumption. One parent at Rongko (Rongko, Parent2) stated in a key informant interview, “I only think about the rice field as farming for profit. I have WFP growing to eat, but I don’t intentionally grow or sell it.”
### Table 4. Parent and Child Relationship Indicators by School

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Banan % (n = 60)</th>
<th>Sampov % (n = 56)</th>
<th>Rongko % (n = 62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents who have a significant convo (10+ min) 1x/day</td>
<td>63.3</td>
<td>58.9</td>
<td>50.0</td>
</tr>
<tr>
<td>Parents who have a significant convo (10+ min) 1x/week</td>
<td>90.0</td>
<td>73.2</td>
<td>90.3</td>
</tr>
<tr>
<td>Parents who know what their child wants to be when they grow up</td>
<td>45.0</td>
<td>66.1</td>
<td>64.5</td>
</tr>
<tr>
<td>Parents who child discusses at home what they are learning at school</td>
<td>66.7</td>
<td>67.9</td>
<td>80.6</td>
</tr>
<tr>
<td>Parents who believe children can teach them new things</td>
<td>50.0</td>
<td>69.6</td>
<td>74.2</td>
</tr>
</tbody>
</table>

### Table 5. Parent Knowledge of and Interest in SI by School

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Banan % (n = 60)</th>
<th>Sampov % (n = 56)</th>
<th>Rongko % (n = 62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents who know what grafting is</td>
<td>30.0</td>
<td>25.0</td>
<td>27.4</td>
</tr>
<tr>
<td>Parents who use grafting</td>
<td>5.0</td>
<td>0.0</td>
<td>3.2</td>
</tr>
<tr>
<td>Parents who know what cover crops are</td>
<td>15.0</td>
<td>17.9</td>
<td>17.7</td>
</tr>
<tr>
<td>Parents who use cover crops</td>
<td>8.3</td>
<td>3.6</td>
<td>9.7</td>
</tr>
<tr>
<td>Parents who know about selling WFP for profit</td>
<td>73.3</td>
<td>67.9</td>
<td>58.1</td>
</tr>
<tr>
<td>Parents who use WFP</td>
<td>88.3</td>
<td>83.9</td>
<td>85.5</td>
</tr>
</tbody>
</table>
Parent School Garden Interest

Results across schools indicate that parents generally have a strong interest in school garden implementation and activities at their children’s school (Table 6). In total, 84.6% parents are interested in visiting a school garden, 62.2% are interested in volunteering at a school garden, and 73.8% are interested in taking classes at a school garden. Of the three schools, Rongko had the highest number of parents want to visit, volunteer, or take classes at a school garden.

In the Banan annex questions, 83% of parents reported wanting to see a garden implemented at their child’s school. As for Sampov annex questions, 66.1% of parents knew that the school had access to a garden and 17.9% had visited the garden. Reported transfer of knowledge from accessible school gardens at Sampov was relatively low with only 1.8% of parents reporting that their child learned new farming techniques from the garden, 33.9% reporting that their child had not learned new farming techniques from the garden, and 60.7% reporting that they don’t know if their child learned from the garden. Likewise, only 16.1% parents reported they had learned new farming techniques from the garden and 35.7% stated they don’t have a farm or garden. Concerning Rongko annex questions, almost all parents (95%) wanted to see a garden implemented at Rongko. 33.8% of parents knew that the school has access to a tech park and 14.5% had visited the tech park. Reported agricultural learning from the tech park was low with 25.8% parents stating that their child has learned new farming techniques from the tech park. Knowledge transfer to parents was also low with 12.9% parents reporting having learned new farming techniques from the tech park.

Key Informant Interviews

Using a grounded theory approach, key informant interview data was categorized through three coding rounds to develop an overarching theory on the potential of scaling SI technologies to parents through school gardens in Cambodia. From interview responses, it was found that scaling potential is dependent upon child-school relationships, parent-child relationships, and parent-school relationships. For each relationship pair, there are knowledge, actions, and dispositions that predict scaling success. As a whole, these create a framework of key barriers to and opportunities for scaling SI technologies through school gardens. Thus, this research theorizes that if the opportunities to scaling can be leveraged and the barriers to scaling minimized, there is a high likelihood that SI technologies can be scaled from school garden to home farm in Cambodia.
Table 6. Parent School Garden Interest by School

<table>
<thead>
<tr>
<th></th>
<th>Banan % (n = 60)</th>
<th>Sampov % (n = 60)</th>
<th>Rongko % (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interested in visiting a school garden</td>
<td>80.0</td>
<td>82.1</td>
<td>91.9</td>
</tr>
<tr>
<td>Interested in volunteering at a school garden</td>
<td>56.7</td>
<td>58.9</td>
<td>71.0</td>
</tr>
<tr>
<td>Interested in taking classes at school garden</td>
<td>65.0</td>
<td>66.1</td>
<td>90.3</td>
</tr>
</tbody>
</table>
Barriers to Scaling

When it comes to key barriers to scaling, specific relationship factors were particularly influential (Figure 8). Concerning child-school relationships, the strongest barriers to scaling were a lack of student interest in agriculture, a lack of student time, a lack of school communication, and a lack of school resources. Parents, principals, and teachers all noted a lack of agriculture interest from a certain subset of students. One guardian at Sampov (Sampov, Parent1) stated of her nephew who lives with her, “[My nephew] is not interested in agriculture. It is hard work and the young generation doesn’t see agriculture as a good career.” This is a significant barrier, for if students aren’t interested in agriculture, they are less likely to be actively involved in a school garden and share learned information with their parents. Additionally, the principal and teachers at each school indicated that for a school garden to succeed, the school would need more financial and human resources. At teacher Rongko (Rongko, Teacher1) stated, “First, we need to have a plan. There should also be a key person and a budget to run [the garden]. We also need to take time to train the people who want to do it and learn agriculture.” As the teacher noted, without proper financial and programmatic planning support, success of the garden and transfer of knowledge to parents will be limited.

As for parent-child relationships, barriers to scaling included a distant relationship between child and parent/guardian, a low level of communication, a lack of prior knowledge transfer, and unideal family demographics. These barriers were particularly discernible when interviewing the parents identified as having low involvement based on prior survey responses. One parent at Banan (Banan, Parent 1) stated of her relationship with her sons, “The children just come home from school to eat and then they go off. They don’t spend much time at home with the family. They come to eat and ask for money for materials to study.” Likewise, one guardian stated of her nephew, “We are not very close. We only talk a little when we eat breakfast together before he leaves for school. He mainly stays in his room” (Sampov, Parent1). Both of these individuals also claimed that they had never learned anything new from the high schoolers. These responses are an issue as a weak parent-child relationship prior to school garden implementation will hinder knowledge transfer to the parent (Pekarčík & Ader, 2021). If communication is low and the relationship is strained between a parent and a child, their willingness to learn and share from one another will also be diminished. Furthermore, unideal family demographics can contribute to low likelihood of scaling. The term ‘unideal’ encompassed a range of factors not specifically measured in survey responses, but gathered from key informant interviews as being a limiting factor to scaling. This included anything from parent occupation to number of children in the household to whether the high school student was a boy or a girl. For instance, some households had absent parents or a high number of children, resulting in low likelihood of child-parent communication. Other households had no farming background or access to land that would provide a need or opportunity to learn from a school garden. For example, one particular household in Banan was solely made up of medical professionals and indicated
Figure 8. Barriers to Scaling Between Schools, School Children, and Parents through School Gardens
their son is likely to become as doctor as well (Banan, Parent 2). As such, although they have high involvement in their son’s life, their interest in and likelihood of learning from a school garden is low.

Looking at parent-school relationships, barriers to scaling included a lack of parent interest in the school, a lack of time to visit the school, a lack of contact from the school, and a low likelihood of the parent having a home garden. One parent (Sampov, Parent2) highlighted many of these barriers stating, “I am busy and the school has never called me to ask me to go. No one helps me at the farm because my children prioritize their studies, so I am very busy doing all the rice farming on my own.” Interestingly, the claim from some parents that the school doesn’t contact them conflicted with principal and teacher statements that they contact parents regularly for ceremonies and parent-teacher meetings. A teacher from Banan (Banan, Teacher1) stated that the school contacts parents in one of three ways: (1) calling the parents directly, (2) having the student tell the parent to come, or (3) contacting the chief of the village to find the parents and invite them. However, based on parent responses it is clear there is a gap between school and parent communication, particularly for rural parents who lack cell phone access.

Finally, a low likelihood of the parent having a home garden was a parent-school relationship barrier because a key tactic of the S3-Cambodia project includes establishing home gardens alongside school gardens for parents and students to test out SI technologies. If a parent is unable to or uninterested in establishing a home garden, there will be a very low likelihood of adoption of SI technologies, thus limiting scaling potential. Factors contributing to a lack of home garden implementation included no agricultural land, poor soil and water resources, low interest in agriculture, and old age.

**Opportunities for Scaling**

When it comes to key opportunities for scaling, specific parent-child-school relationship factors were particularly beneficial (Figure 9). Concerning child-school relationships, opportunities for scaling included school support of garden, school investment in student life skills development, and student interest in agriculture. A strong predictor of success was if the school had buy-in from leadership, access to necessary resources, a plan in place, and the desire to see students gain life skills from the garden. Additionally, if students have a high level of interest in agriculture, they are more likely to be actively involved in school garden activities. The greater their involvement in the garden, the greater the likelihood of students sharing this information at home.

The principal at Sampov particularly exemplified these positive drivers. At the time of the interview, which coincided with the planting of garden, he already had identified a pilot class of 15 students and had set up calendar schedule for the students to work in the garden and participate in agriculture classes. Due to a limited number of available teachers at the school, the principal himself had committed to teaching these classes. If the pilot class is successful, the school has plans to then scale up to two full classes of 43
Figure 9. Opportunities for Scaling Between Schools, School Children, and Parents through School Gardens
students, for a total of 86 students. When asked why this garden is important to him, the principal stated, “It will be really good for my students [to have a school garden] so that when they finish school they will know how to work in agriculture and have strong life skills…I want these 15 students to learn agricultural life skills to build them up and to teach their parents about new agriculture technologies.” He also stated, “My school is a good place to have the agriculture program because it is located right near the market. When we produce grafted tomatoes, vegetables, and other WFP, we can easily sell them at the market.” This school support was supplemented by sufficient student interest in the program at Sampov. The principals stated that when he proposed the idea of having a school garden to his class of 43 students, 20 of them were interested in being involved and learning more about agriculture. The support of the principal and interest of the students indicates a strong opportunity for successful scaling at Sampov.

Looking at parent-child relationships, opportunities for scaling included close relationships between child and parent/guardian, high levels of communication, parent support of life skills development, prior instances of knowledge transfer, previous exposure to SI technologies, and ideal family demographics. Close relationships and high communication levels between child and parent/guardian were prevalent among the parents identified as highly involved and average. A grandfather in Banan (Banan, Parent3) stated, “I am close with my granddaughter and I share knowledge with her. I tell her all about social life…I help her with her schoolwork when she doesn’t understand. When she comes home from school, she tells me about what she has learned and I teach her more about history.” Close relationships and high levels of communication are indicators that the child will discuss at home what they are learning at school and thus increase likelihood of SI technology scaling. Additionally, from the above household and others there was evidence of prior knowledge transfer that is indicative of further information sharing and adoption. The same grandfather (Banan, Parent3) shared that, “[My granddaughter] told me about the WFP at the school and I told her to get involved and help at the WFP garden.” Likewise, a parent at Rongko (Rongko, Parent3) stated that her sons taught her how to use the telephone and computer. The belief in and evidence of parents learning from children suggest that parents will also be able to learn agricultural techniques from their children. Furthermore, there were ideal family demographics that provided opportunities for scaling such as household members being farmers and the household having a smaller number of children. According to Rongko’s principal, due to their rural location about 90% of students come from farming families. Most of these parents are rice farmers and would benefit from exposure to vegetable farming, as right now they import most of their produce from Battambang. There are key opportunities to scaling through these rural farming households as they would benefit the most from SI technologies.

Concerning parent-school relationships, opportunities for scaling included prior contact from the school, prior visits to the school, parent support of a school garden, prior donations to the school, and school encouragement of knowledge transfer. The primary avenues the school provides for parents to visit are the opening ceremony, awards
ceremonies for high academic achievement, and parent-teacher meetings. Some parents also pick their child up from school or visit for sporting events. Responses suggest that if parents are directly invited for specific event, they are more likely to come, even if they live farther from the school. Although he is a rural farmer, the grandfather from Banan (Banan, Parent3) states that, “I went to visit the WFP garden at the school. I have also gone to parent-teacher meetings and the opening ceremony. It is not hard for me to visit the school and I am happy to see the WFP garden at the school.” Furthermore, parental support of the garden was identified as key opportunity to scaling. Most parents acknowledged their desire to see a garden at their child’s school and an enthusiasm over the skills their child and they themselves will be able to learn from it. One parent from Sampov (Sampov, Parent 3) stated, “Yes, it will be very good. I am very happy that the school will have a garden because I love agriculture and growing crops. I will be happy to see the garden succeed and produce vegetables.” This parent, although she is not a farmer, said she will definitely visit the school garden. When asked if she would to like to help volunteer at the garden, she enthusiastically asked, “When?”, saying she very much wants to visit and is ready to go anytime the school asks.

Finally, some parents have invested in the school financially, and thus have a stake in seeing it succeed. According to the principal at Banan, “Parents support the school financially through items such as the back wall, the small road at the school, the seating area, and the flowers planted at the school.” The evidence of prior project support from parents suggests they will also be willing to financially support the garden and enhance scaling success.
CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Objective 1

My first objective was to assess current perceptions of parental involvement in educational activities at Sor Kheng Kanteu II High School (Banan), Hun Sen Sampov High School (Sampov), and Rongko High School (Rongko). Overall, slightly less than half of parents (43%) have visited their child’s school. An even smaller percentage of parents have volunteered or worked at the school. Yet, of the parents who haven’t visited, the majority (71.3%) claim they want to visit the school. Additionally, the majority have an interest in visiting and/or volunteering at a school garden (Table 6). This indicates that there is likely a disconnect between parents’ desire to be involved in their child(ren)’s school activities and the opportunities that are provided for them to do so. This gap is highlighted by the discrepancies between principal/teacher interview claims of ample opportunity for parental school involvement and actual responses from parents.

Concerning involvement in experiential learning activities at the school, parental awareness/engagement is present but limited. Only 34% of parents at Rongko are aware that the school has access to a tech park and less than 15% have visited it. However, it is worth noting that SEAPC tech parks became COVID quarantine sites during the pandemic, and thus ability to visit and learn from the tech parks was very limited from 2020-2022. As for Sampov, 66% of parents are aware that the school had a school garden and just under 18% had visited the prior school garden project.

In general, parents’ involvement in their children’s schools and lives varies between regions, with the rurality of the households influencing family social ties and parents’ proximity to the school. The more rural the district where the school is located, the less likely the parents have visited the school, the more likely they have a strong relationship with their child, and the more likely they are interested in learning from a school garden. Of the three schools, Rongko had the lowest percentage of parents who had visited the school at 35.5%, while Sampov had the greatest at 50%. Rongko and Banan both had noticeably higher rates of weekly and daily parent-child communication than Sampov (Table 8). This is likely due to rurality, as most households at Rongko are located a greater distance from the school building and the majority of residents in the commune where the school is located are rice farmers. Conversely, Sampov is located in a peri-urban commune and is the school situated closest to Battambang city. According to principal and teacher estimations, anywhere from 50-80% of students at Sampov come from farming families, as opposed to an estimated 90-95% of students at Rongko. Banan is in the middle with estimates anywhere from 70-75% of students coming from farming families. In all, rurality tended to be the greatest limiting factor in differences between parental involvement in school activities across the schools.
Objective 2

My second objective was to document current adoption of classroom-based knowledge, attitudes, and practices at parent’s homes related to SI technologies. In general, results indicated that few parents had prior knowledge of SI technologies. Parents at Sampov had the greatest awareness of SI technologies, but were the least likely to actually use these technologies (Table 5). On the other hand, parents at Rongko and Banan were most likely to have used an SI technology before, but a smaller percentage were familiar with each technology. The SI technology least likely to have been used was vegetable grafting and the most likely to have been used WFP. Across the schools, there was a clear disconnect between growing for profit, aka “farming” and just naturally growing it on the property or cultivate for household consumption. While many parents are familiar with and use WFP regularly, they do not actively cultivate and “farm” their WFP for profit. This highlights a gap in production and a key reason why the S3-Cambodia project is targeting WFP as a promising SI technology. If parents can capitalize on actively growing and cultivating these plants, they can increase household income and nutrition.

Of the parents that did have prior SI technology knowledge, present data does not suggest they had learned this information from their child’s school. These results are not a significant concern as S3-Cambodia green labs were planted shortly after survey and interview data collection. As such, there is little likelihood that parents would have learned about S3-Cambodia’s target SI technologies at the school at time of data collection. A follow up survey to measure parent’s knowledge of and use of target SI technologies will be necessary at a later project date. That being said, there is evidence that parents have learned from general agricultural information from their child’s school through, even if it was limited. At Rongko, 13% of parents claimed they have learned new agricultural techniques from the technology park. Similarly, 16% of parents at Sampov claimed they had learned new farming techniques from the prior school garden. Although they didn’t have prior agricultural activities to learn from, 58% of parents at Banan claimed that they have learned new information from their child sharing what they have learned at school. This indicates that classroom-based knowledge, attitudes, and practices have and can be adopted at parents’ homes.

Objective 3

My third objective was to determine parents’ perceived willingness to learn about new agricultural technologies from their child(ren). This objective was promising as the majority of parents believe they can learn from their child, discuss with their child what they are learning at school, and have a significant conversation once per week or day (Table 4). Furthermore, the outcomes of objective 2 are also applicable to the outcomes of objective 3 as the results that describe parents having learned from the school suggest child may have played a role in that knowledge diffusion. However, it is worth noting that while most parents indicated that they have or can learn from their children, during key informant interviews parents had a difficult time recalling a specific time their child
had taught them something new. Additionally, there was again a discrepancy between schools with 74% of parents from Rongko believing they can learn new things from their child as opposed to 70% and 50% at Sampov and Banan, respectively. This may be due to rural family social ties levels, as survey results suggest parent-child communication is stronger at Rongko than at Sampov and Banan. All that being said, if the majority of parents believe that they can learn from their children, it is likely that scaling from children to parents through school gardens is possible.

**Research Question**

The overarching research question seeks to assess the feasibility of using school facilities and instruction as a pathway to scaling agricultural technologies. The first three objectives all influence the outcome of the research question, with their results together determining the scaling feasibility. Overall, results suggest that students will discuss school garden activities at home and that transfer of knowledge is possible. Not only are parent-child relationships strong enough to facilitate this bond, but prior knowledge dissemination from schools to parents suggests success. For instance, the fact that 66% of parents at Sampov knew about the prior garden is a good indicator they will know about the new one. Further, parents at all of the schools indicated a strong desire to have a garden implemented at their child’s schools and a high interest in visiting and volunteering at the school (Table 8). The more that parents are involved in and visit the school garden, the greater scaling potential will be. Furthermore, S3-Cambodia green labs will likely be more conducive to scaling than prior experiential learning activities at the schools. For example, Rongko’s technology park is not located on the school campus, making it more difficult for students and parents to interact with educational activities. The S3-Cambodia school garden will be located on the school campus, providing potential for more involvement and knowledge dissemination through direct daily interaction. Considering all of the above, if proper steps are taken to assure barriers to scaling are minimized, using school facilities and instruction as a pathway to scaling agricultural technologies in Cambodia is highly feasible.

**Recommendations**

Based upon the above outcomes and conclusions, the following are recommendations for the S3-Cambodia project to ensure ideal circumstances for scaling are in place moving forward.

**Banan**

Parents at Banan were highly interested in visiting and learning from a school garden, yet the least likely to believe that they could learn new information from their child. As such, the school should provide classes for parents at the school garden, as their belief systems indicate they are more likely to learn from a teacher than their child. S3-Cambodia should plan and prioritize curriculum for joint parent-child learning.
opportunities, which are more likely to spur knowledge transfer. Ideally, these would occur as weekend or evening trainings that are outside of normal school and working hours to increase participation. Otherwise, parents can simply be invited to weekly classroom activities at the school garden. Increasing opportunities and avenues to learn from and alongside one’s child will enhance knowledge dissemination at Banan.

**Sampov**

Of the three schools, Sampov had the weakest parent-child relationships. As such, interventions should be put in place to encourage parent-student communication. For example, the school could increase the number of parent-teacher meetings and include the child at the meeting. Additionally, avenues to get parents to visit the school should also be prioritized in the same way as described above for Rongko. Based on Sampov survey results, parents having visited the school had the greatest statistically significant influence on parents’ interest in visiting and volunteering at a school garden as well as the belief children can teach parents new things. As such, every parent should be personally invited to a school garden event.

Furthermore, S3-Cambodia should create a demonstration plot for parent use at Sampov as 36% reported not having a farm or garden. This could be an additional plot added at the school solely for parent use, a section of the currently planted garden, or even a garden planted at a second location for community usage. If parents are interested in learning about SI technologies but are not able practice using them due to lack of resources or fear of risk, then scaling will difficult. The ability to use a practice demonstration plot may further encourage parents to establish a garden at their household.

**Rongko**

Due to the fact that Rongko had the lowest parent involvement levels at the school, yet the highest parent-child communication levels, interventions should be put in place to increase parent access to the school. Most parents at Rongko have not yet visited the school, but indicated a high interest level in visiting the school and accessing a school garden. As such, specific invitations to visit the school garden should be disseminated to parents of students that attend Rongko. These invitations should account for rurality and technology access of parents. If parents do not have access to a cell phone for contact, house visits should be made to personally invite the parents to visit the school.

In addition, the majority of parents at Rongko are farmers and are thus highly motivated to increase their agricultural productivity. These parents will benefit greatly from SI technologies transferred through a school garden, and are likely to be the most heavily invested in learning from a school garden. Connecting to the key project activity of S3-Cambodia to implement home gardens alongside school gardens, students at Rongko should be given propagated plants to attempt to grow at the home farm or garden as soon
as possible. Based upon research results, the establishment of home gardens alongside school gardens is most likely to be success at Rongko and thus should be prioritized and implemented in a timely manner.


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Attitudes, and Behaviors Associated with Vegetable Consumption. *Health Promotion Practice, 12*(1), 36–43. doi: 10.1177/1524839909349182


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APPENDICES
Appendix 1: Survey Questions

Questions for all households

1. Have you ever visited your child(ren)’s school?
   a. Yes
   b. No

If the respondent answers ‘Yes’ to question 1, please ask questions 2-6 Otherwise, skip to question 7.

2. Have you visited your child(ren)’s school because you were specifically invited?
   a. Yes
   b. No
3. Have you visited your child’s school for a particular event?
   a. Yes
   b. No
4. Do you pick your child up from school?
   a. Yes
   b. No
5. Have you ever volunteered at the school?
   a. Yes
   b. No
6. Have you ever worked at the school?
   a. Yes
   b. No

If the respondent answers ‘No’ to question 1, please ask questions 7-10. Otherwise, skip to question 11.

7. Do you want to visit your child(ren)’s school?
   a. Yes
   b. No
8. Do you feel you need a personal invitation to visit the school?
   a. Yes
   b. No
9. Do you feel too busy to visit the school?
   a. Yes
   b. No
10. Would you be interested in volunteering at the school?
    a. Yes
    b. No
Continue asking all households:

11. Do you have a significant conversation (10+ minutes) with your child at least once a week?
   a. Yes
   b. No

12. Do you have a significant conversation (10+ minutes) with your child at least once a day?
   a. Yes
   b. No

13. Do you know what your child wants to be when they grow up?
   a. Yes
   b. No

14. Does your child(ren) discuss at home what they are learning at school?
   a. Yes
   b. No

15. Do you believe child(ren) can teach their parents new things?
   a. Yes
   b. No

16. Are you familiar with vegetable grafting?
   a. Yes
   b. No

17. Do you use this technology on your farm?
   a. Yes
   b. No

18. Are you familiar with cover cropping?
   a. Yes
   b. No

19. Do you use this technology on your farm?
   a. Yes
   b. No

20. Are you familiar with the practice of growing local wild food species for profit?
   a. Yes
   b. No

21. Do you use this practice in your household?
   a. Yes
   b. No

22. Would you be interested in visiting a school garden?
   a. Yes
   b. No

23. Would you be interested in volunteering at a school garden?
   a. Yes
   b. No
24. Would you be interested in attending farming classes at a school garden?
   a. Yes
   b. No

Annex 1. Sor Kheng Kanteu II High School Questions

1. Have you learned new information as a result of listening to your child(ren) share about what they are learning at school?
   a. Yes
   b. No
2. Would you like to see a school garden implemented at your child(ren)’s school?
   a. Yes
   b. No
3. Anything else you would like to share? ___________

Annex 2: Rongko High School Questions

1. Do you know your child(ren)’s school has access to a technology park?
   a. Yes
   b. No
2. Have you ever visited the technology park?
   a. Yes
   b. No
3. Has your child(ren) learned new farming techniques since participating in the school technology park?
   a. Yes
   b. No
   c. I don’t know
4. Have you begun using any of these new farming techniques on your farm/garden?
   a. Yes
   b. No
   c. I don’t have a farm or garden
5. Would you like to see a school garden implemented at your child(ren)’s school?
   a. Yes
   b. No
6. Anything else you would like to share? ___________

Annex 3: Hun Sen Sampov High School Questions

1. Did you know your child(ren)’s school has access to a school garden?
   a. Yes
b. No
2. Have you ever visited the school garden?
   a. Yes
   b. No
3. Has your child(ren) learned new farming techniques since participating in the school garden?
   a. Yes
   b. No
   c. I don’t know
4. Have you begun using any of these new farming techniques on your farm/garden?
   a. Yes
   b. No
   c. I don’t have a farm or garden
5. Anything else you would like to share? __________
Appendix 2: Semi-Structured Interview Questions

Principal Questions

1. How involved are students’ parents in your school and its activities?
2. Does your school provide ways for parents to be involved in school activities?
3. How would you describe student relationships with their parents?
4. How would you describe student interest in and knowledge of agriculture?
5. How does/would having a school garden impact your students?
6. How does/would it impact parents’ involvement at the school?
7. What would be the barriers to establishing a garden at your school?
   7.1. For Hun Sen Sampov, what are the strengths and weaknesses of the school garden

Teacher Questions

1. How involved are students’ parents in your school and its activities?
2. How would you describe student relationships with their parents?
3. How would you describe student interest in and knowledge of agriculture?
4. How does/would having a school garden impact your students?
   4.1. How does/would it impact parents’ involvement at the school?
5. What would be the barriers to establishing a garden at your school?
   5.1. For Hun Sen Sampov, what are the strengths and weaknesses of the school garden
6. Would you or any of your coworkers have interest in being involved in a school garden?

Parent Questions

1. Why have or haven’t you visited your child(ren)’s school?
2. How involved are you in your child(ren)’s school and its activities?
3. Does your child(ren)’s school provide ways for parents to be involved in school activities?
4. Can you describe something your child has taught you?
5. How would you describe your relationship with your child(ren)?
6. How would you describe your interest in and knowledge of agriculture?
   6.1. What about new farming methods?
7. How would you describe your child(ren)’s interest in and knowledge of agriculture?
   7.1. What about new farming methods?
8. What would be/are the strengths and weaknesses of a garden at your child’s school?
9. How would you like to be involved in a school garden, if at all?
## Appendix 3: NVivo Coding Rounds

### Round One Coding: In Vivo

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Vita

Gracie C. Pekarcik was born in Pittsburgh, Pennsylvania on May 1, 1998. She attended the Pennsylvania State University from 2016-2019, graduating with a Bachelor of Science in Community, Environment, and Development with a focus on International Development as well as a minor in International Agriculture. Upon the completion of her undergraduate degree, which coincided with the emergence of the COVID-19 pandemic, Gracie continued her undergraduate research work as a contracted employee for the Water, Energy, and Food Nexus in Africa Initiative at Penn State. In July of 2020, she decided to continue her academic pursuits with the acceptance of a graduate research position with the Smith Center for International Sustainable Agriculture at the University of Tennessee, Knoxville. In this position she engaged in a variety of international agriculture research activities such as the S3-Cambodia Project, The Farmer-to-Farmer Cambodia Project, the Food-Energy-Water to Support Sustainable Urban Systems Project, and UTK Food, Agriculture, and Natural Resources Challenges in Guatemala Study Abroad. In May of 2022, she graduated with a Master of Science in Agricultural Leadership, Education, and Communication from the University of Tennessee, Knoxville.