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Assessing the impact of parental involvement on scaling agricultural technologies from school garden to home farm in Cambodia

Gracie Pekarcik,[a] * David Ader,[b] Tom Gill,[c] and Jennifer Richards [d]
The University of Tennessee, Knoxville

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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 smallholder farmers. 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.

[a] * *Corresponding author:* Gracie Pekarcik, Graduate Research Assistant, Smith Center for International Sustainable Agriculture, University of Tennessee, Knoxville.

Pekarcik is now working as the study abroad coordinator for the Herbert College of Agriculture at the University of Tennessee, Knoxville; 101 McCord Hall, 2640 Morgan Circle Drive; Knoxville, TN 37996 USA; +1-865-974-7747; gpekarci@utk.edu

[b] Dr. David Ader, Research Assistant Professor/Assistant Director, Smith Center for International Sustainable Agriculture, University of Tennessee, Knoxville: 101 McCord Hall, 2640 Morgan Circle Drive; Knoxville, TN 37996 USA; dader@utk.edu

[c] Dr. Tom Gill, Associate Professor and Chair, Smith Center for International Sustainable Agriculture, University of Tennessee, Knoxville; 101 McCord Hall, 2640 Morgan Circle Dr.; Knoxville, TN 37996 USA; tgill4@utk.edu

[d] Dr. Jennifer Richards, Assistant Professor, Department of Agricultural Leadership, Education and Communication, University of Tennessee, Knoxville; 205 Morgan Hall, 2621 Morgan Circle Drive; Knoxville, TN 37996 USA; Jennifer.richards@utk.edu

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Author Note

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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 whether relationships between children, parents, and schools 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 high school. Results indicate that parents have a strong interest in school garden implementation and activities at their children's school, with 84% of 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 what they are learning at school (72%), indicating a potentially significant 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 homes' proximity to the school.

Keywords
Sustainable Intensification, School Gardens, Cambodia, Knowledge Transfer, Diffusion, Experiential Learning

Introduction and Literature Review

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. More than 70% of the Cambodian population is engaged in the agricultural 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. 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 depend on collective agriculture. Starvation, hard labor, knowledge destruction, and summary execution resulted in a nation severely lacking in intellectuals and teachers with sufficient content and pedagogy knowledge (Islam et al., 2017). As research has increasingly established causal linkages between food insecurity and global, national, and regional conflict, it is all the more necessary to address sustainability in Cambodia's agriculture sector (Martin-Shields & Stojetz, 2018).

This paper describes research supporting the Scaling Suitable Sustainable Technologies (S3-Cambodia) project, funded by the US Agency for International Development (USAID) Feed the Future Sustainable Intensification Innovation lab (SIIL). The research examines pathways for scaling suitable and sustainable technologies for smallholder, rice-based farmers. 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, across different agricultural spaces and serving different functions in livelihood strategies, to address seasonal "food gaps" (Ader et al., 2021).

Scaling SI Through School Gardens

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 through numerous means (Pretty, 2018; Pretty & Bharucha, 2014). Zurek et al. (2015) define SI as the "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).

While knowledge on SI technologies and practices is readily available, the actual dissemination of this knowledge and the subsequent adoption and scaling of SI technologies among smallholders continues to be a challenge globally. Barriers to adoption include but are not limited to weak social and capital networks, low-quality extension services, reliance on government support during crop failure, incidence of pests and diseases, resources constraints, lack of education, the inability to access markets, and the occurrence of climate shocks (Barrett et al., 2010; Jack, 2013; Kassie et al. 2015; Shilomboleni & De Plaen, 2019; Westermann et al., 2018). The key to addressing these gaps is to identify where farmers actually receive their information and distribute information through these networks. Cambodian youth serve as a potential 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 the analysis of student nutrition and vegetable consumption (Ferguson et al., 2019; Food and Agricultural Organization of the United Nations, 2004; Leuven et al., 2018; Ratcliffe et al., 2011; Schreinemachers 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 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 is 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 (Calub et al., 2019; Okiror et al., 2011; Sprague, 2016; Tabucanon & Mihara, 2016). Often, the implementation and scaling up of new technologies and innovations is met with apprehension due the economic, social, and health risks that come with crop failure (Shilomboleni & De Plaen, 2019; Westermann et al., 2018). School gardens provide a pathway to evaluate new technologies without personal risk. That being said, research has suggested using school gardens for this purpose 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 a comprehensive literature review of school gardens as a method for scaling SI technologies, key opportunities for and barriers to scaling were identified (Table 1; Pekarcik & Ader, 2021). Including 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 (Ferguson et al., 2019; Schreinemachers et al., 2017; Schreinemachers et al., 2019; Sprague et al., 2016).

While parents' participation is an important determinant of the success of school gardens and information transfer, parental inclusion had not been fully considered by the S3-Cambodia project. It was understood that the establishment of green labs at high schools creates a strong linkage between institutions (i.e., NUBB, UTIA) and the education system. Additionally, decades of literature on scaling have shown that individual households are able to share information through social networks to increase adoption throughout a community (Feder & Umali, 1993; Ramirez, 2013). What was not yet fully understood was the link between schools and households in Cambodia. Thus, this research assessed parents' perceived lev-

els of involvement in their child(ren)'s schools and daily lives to determine whether school facilities and instruction were a viable pathway for scaling to households in Cambodia.

Research Methods

Study Area and Population

Primary data was collected from parents, principals, and students of three separate high schools in three *khum*s (communes) of Cambodia in the Battambang and Banteay Meanchey provinces. The data was collected through orally conducted one-on-one surveys and semi-structured key informant interviews (Table 1). Battambang and Bantaey Meanchey are both located in northwest Cambodia and are the 5th and 8th largest provinces by population, respectively (National Institute of Statistics, 2019). Battambang 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). Very similar to Battambang Province, Bantaey Meanchey has a rice-focused economy based on small-scale agriculture. 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).

Data Collection and Analysis

Survey Data

A cross-sectional survey instrument was developed to assess parental perceptions of their involvement in their child(ren)'s lives and schools. Survey questions were modeled on parent/guardian survey questions from a range of literature on school garden scaling (Pekarcik & Ader, 2021). Survey development and design was strongly influenced by Sprague et al.'s (2016) parent/guardian survey on barriers to and opportunities for scaling through instructional school gardens (p. 73). An advisory team with expertise in international agriculture research reviewed the survey and made recommendations to ensure content validity. Survey questions 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 generally and related to education. To account for educational and programmatic differences between the schools, 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 1). At the time of survey, Banan did not have any agriculture-based programming or a distinct school garden. Sampov had had a school garden on its grounds in the past, but it had since fallen out of use. Sampov now had access to a school garden through the Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE-SAIN). Rongko had access to a technology park with specialized life skills training curricula in nursing, music, English, computer science, small-systems machinery, and, as of 2020, agriculture. Comparing the results of the survey across schools with different levels of agricultural education sought to provide a holistic assessment of relationships and knowledge transfer between parents, children, and schools.

All three of the selected high schools had established connections with the S3-Cambodia project and NUBB. Households for parent surveys

Table 1. Characteristics of High Schools Included in School Garden Surveys

School	Commune, District	Province	Students Enrolled	Life Skills Training Provided
Sor Kheng Kanteu II High School (Banan)	Kantueu Pir, Banan	Battambang	1,300	None
Hun Sen Sampov High School (Sampov)	Phnum Sampov, Banan	Battambang	1,418	School Garden—*Agriculture*
Rongko High School (Rongko)	Chamnaom, Mongkol Borey	Banteay Meanchey	1,208	Technology Park—*Nursing, Small Systems Machinery, Computer*

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 from the combined 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 socioeconomic status. A sample size of 60 students per school was selected because it kept the study within its 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 that agreed to participate, 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. Research questions and objectives were evaluated through an SPSS 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 whose children attended each high school.

Key Informant Interview Data

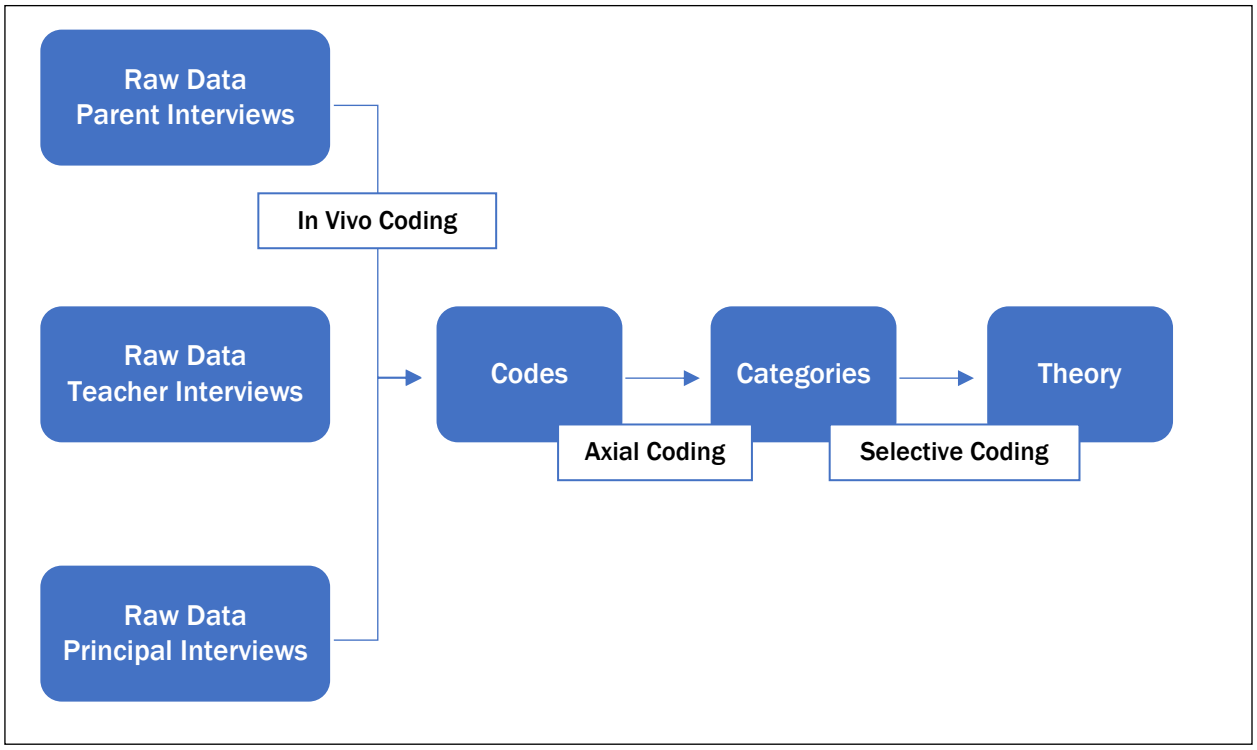
Household surveys were followed by in-person key informant interviews of parents, principals, and teachers at each of the three high schools. Three parents at each of the high schools were identified based on their perceived level of involvement in their child's life and schooling, for a total of nine parents interviewed. From each high school, selected parents included one parent who had relatively low involvement, one parent who had relatively average involvement, and one parent who relatively high involvement. Involvement levels were determined by comparing the number of "yes" responses across surveys and grouping each survey into one of three categories: low, average, and high. In addition, the principal and two teachers were interviewed at each school, for a total of three principals and six teachers. Interviews were semi-structured, recorded, and lasted approximately 30 minutes. Parent interviews built upon survey questions and sought to gain a deeper 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. Principal and teacher interviews built upon parent interviews. Their questions focused on their perceptions of parental involvement in the school, student-parent relationships, and student agricultural interest.

The data gathered from the key informant interviews was analyzed through a grounded theory analysis. The goal was to develop deeper understanding of the transfer of knowledge from the school garden to home farm. A method of qualitative research, grounded theory allows for the study of a process or phenomenon by collecting and analyzing 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 three rounds of coding, using NVivo. The first round utilized in vivo coding to determine initial codes. The in vivo coding assigned a label or "code" to a word or phrase from the interview transcripts. This was followed by axial coding, which used the 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 1).

Assumptions and Limitations

The research plan assumed that a singular parent of each student would provide survey and interview responses when the enumerator 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. 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

Figure 1. Grounded Theory Coding Process for Key Informant Interviews



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 US researchers were unable to be present in Cambodia during survey enumeration because of COVID-19 pandemic travel restrictions, it cannot be known definitively whether survey responses came from parents or 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 who was present at the household at the time added comments into the conversation, regardless of whether they were the parent/guardian being interviewed. Cambodia is a 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. The survey and interviews retain validity because the research purpose was to determine the scalability of SI technologies to households (not only parents), with adults learning from children being identified as a key avenue to do so. For consistency, the term "parent" throughout the following text encompasses both parents and guardians unless the adult is specifically described.

Results and Discussion

Survey Results

In total, 178 parents were surveyed. Of these, 62 were 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 the availability of parents on the day of surveying. Rongko had over 60 responses because some households wanted both parents to interviewed. Sampov had fewer than 60 responses due to some sampled households not having a parent/guardian available to take the survey.

Parent-School Visitation

Across the schools, fewer than half of parents

(43.5%) had visited the school their child(ren) were attending (Table 2). The percentage of parents who had visited the school was highest (50%) at Sampov and lowest (35.5%) at Rongko. The most common reason parents visited the school their child(ren) attended was because they had been specifically invited to the school and/or they attended a particular event. This was most common at Banan, where 92.6% of parents who had visited reported being invited to the school and 85.6% reported they had attended a particular event at the school. Additionally, parents at Banan were the most likely to have volunteered (48.1%) at the school. The least frequent reason across the schools that parents had visited was because they worked at the school. Parents at Rongko were least likely of all parents who had 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 who had not visited the school their child(ren) were attending, the majority wanted to visit the school (69.9%) yet felt too busy to visit (75.4%; Table 2). Additionally, the majority of parents felt they needed an invitation from the school (59.4%) in order to visit. Of the parents at Banan who had not visited the school, the majority reported that they wanted to visit the school but felt they needed an invitation and felt too busy to visit. Sampov had the lowest percentage of parents who reported being interested in volunteering at the school (17.9%) or who reported 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 needed an invitation to visit, and feel too busy to visit (Table 2).

Parent-Child Relationship

The majority of parents across the schools stated they have a significant conversation (10+ minutes) with their child at least once per week (84.5%) or day (57.4%; Table 3). 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. Parents claimed to have fewer daily significant conversations, dropping 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%. Further, the majority believed that they can learn from their children (64.6%) and actively discuss with their children what they are learning at school (71.7%). By a smaller margin, the majority of parents (58.5%) knew what their child wanted to be when they grow up. Parents at Rongko were the most likely to believe that they can learn from their children and to discuss with their children what they are learning at school. Parents at Sampov were most likely to know what their child wanted to be when they grow up.

Table 2. Parent School Visitation Trends and Motivations by School

	Banan %	Sampov %	Rongko %
Parents who have visited the school	*n* = 27	*n* = 28	*n* = 22
Specifically invited to the school	92.6	60.7	81.8
Attended a particular event	85.2	64.3	72.7
Pick child up from school	33.3	57.1	31.8
Volunteered at the school	48.1	35.7	27.3
Worked at the school	14.8	25.0	4.5
	Banan %	**Sampov %**	**Rongko %**
Parents who have not visited the school	*n* = 33	*n* = 28	*n* = 40
Want to visit the school	66.6	60.7	82.5
Interested in volunteering	30.3	17.9	85.0
Feel they need an invitation	57.6	35.7	85.0
Too busy to visit	63.6	75.0	87.5

Table 3. Parent and Child Relationship Indicators by School

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

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 (Tables 4–6). In total, 84.6% parents were interested in visiting a school garden, 62.2% were interested in volunteering at a school garden, and 73.8% were interested in taking classes at a school garden. Of the three schools, Rongko had the highest number of parents who stated a desire 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 (Table 4). 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 (Table 5). The reported transfer of knowledge from accessible school gardens at Sampov was relatively low, with only 1.8% of parents reporting that their child had 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 were uncertain whether 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 their household did not have a farm or garden. Concerning Rongko annex questions, almost all parents (95%) wanted to see a garden implemented at the school (Table 6). Of Rongko parents, 33.8% knew that the school had access to a tech park, and 14.5% had visited the tech park. Reported agricultural learning from the tech park was low, with

Table 4. Annex Questions—Banan

	Frequency	% (*n* = 60)
Interested in visiting a school garden	48	80.0%
Interested in volunteering at a school garden	34	56.7
Interested in taking classes at a school garden	39	65.0
Had learned new things from child sharing about school	35	58.3
Wanted a school garden implemented	50	83.3

Table 5. Annex Questions—Sampov

	Frequency	% (*n* = 56)
Interested in visiting a school garden	46	82.1%
Interested in volunteering at a school garden	33	58.9
Interested in taking classes at a school garden	37	66.1
Knew school has access to a garden	37	66.1
Had visited the school garden	10	17.9
Child had learned new information from the garden	1	1.8
Parent had learned new information from the garden	9	16.1

Table 6. Annex Questions—Rongko

	Frequency	% (*n* = 62)
Interested in visiting a school garden	57	91.9
Interested in volunteering at a school garden	44	71.0
Interested in taking classes at a school garden	56	90.3
Knew school has access to a tech park	21	33.9
Had visited the tech park	9	14.5
Child had learned new information from the tech park	16	25.8
Parent had learned new information from the tech park	8	12.9
Wanted a school garden implemented	59	95.2

25.8% of parents stating that their child learned new farming techniques from the tech park. Knowledge transfer to parents was also low, with 12.9% of parents reporting having learned new farming techniques from the tech park.

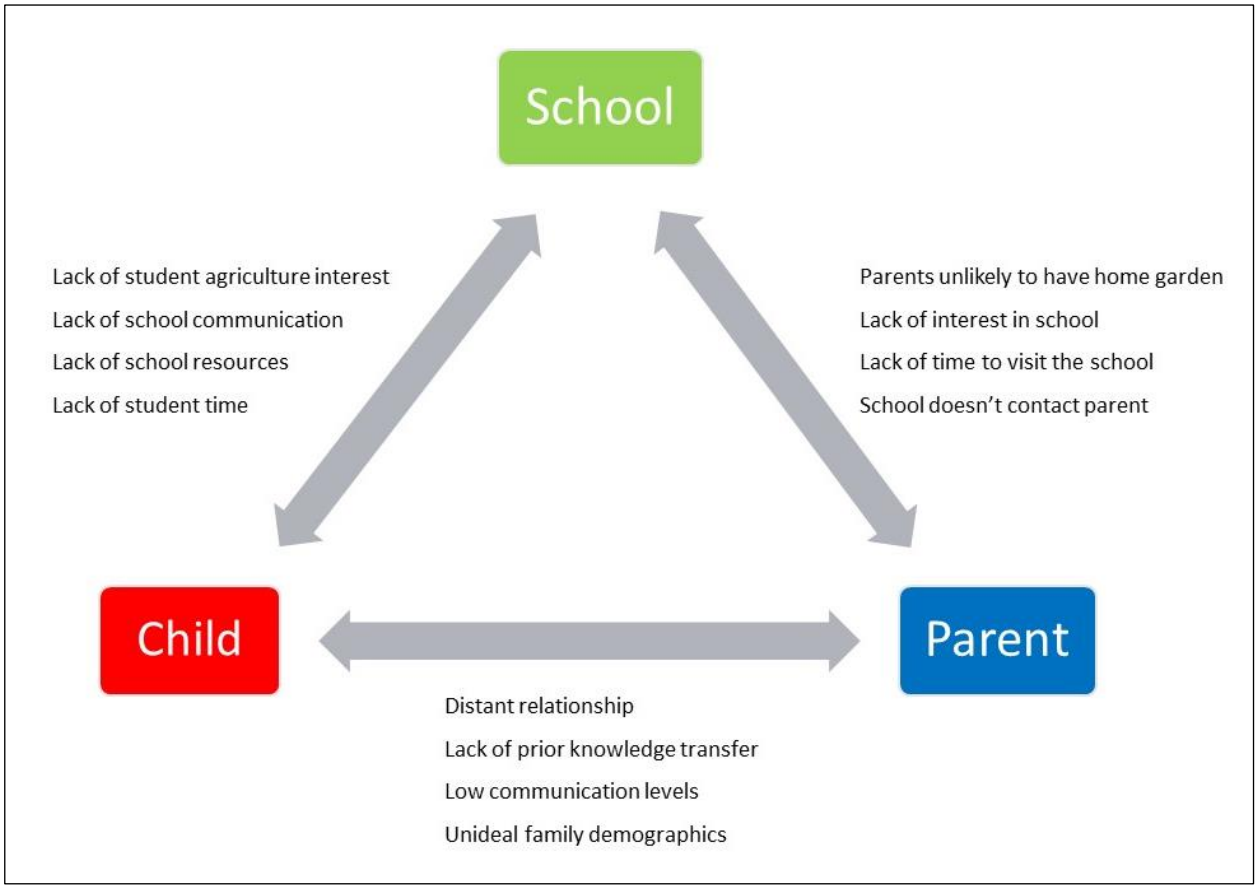
Key Informant Interview Results

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, knowledge, actions, and dispositions 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 for 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.

Barriers to Scaling

When it comes to key barriers to scaling, specific relationship factors were particularly influential (Figure 2). 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, Parent 1) stated regarding 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."

Figure 2. Barriers to Scaling Between Schools, Schoolchildren, and Parents through School Gardens



Additionally, the principals and teachers at each school indicated that for a school garden to succeed, the school would need more financial and human resources. A teacher at 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 guardian-child relationships, barriers to scaling included a distant relationship between child and guardian, a low level of communication, a lack of prior knowledge transfer experiences, and unideal family demographics. These barriers were particularly discernible when interviewing the parents who had been 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, Parent 1). Both of these individuals also claimed that they had never learned anything new from the high-schoolers.

These responses are worth noting, as a weak parent-child relationship prior to school garden implementation will hinder knowledge transfer to the parent (Pekarcik & 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" encompasses 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 the amount of arable land available on the household property. For instance, some households had absent parents or a high number of children, resulting in a 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 household in Banan was solely made up of medical professionals and indicated their son is likely to become a 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 was 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, Parent 2) 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 does not 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: calling the parents directly, having the student tell the parents to come, or 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.

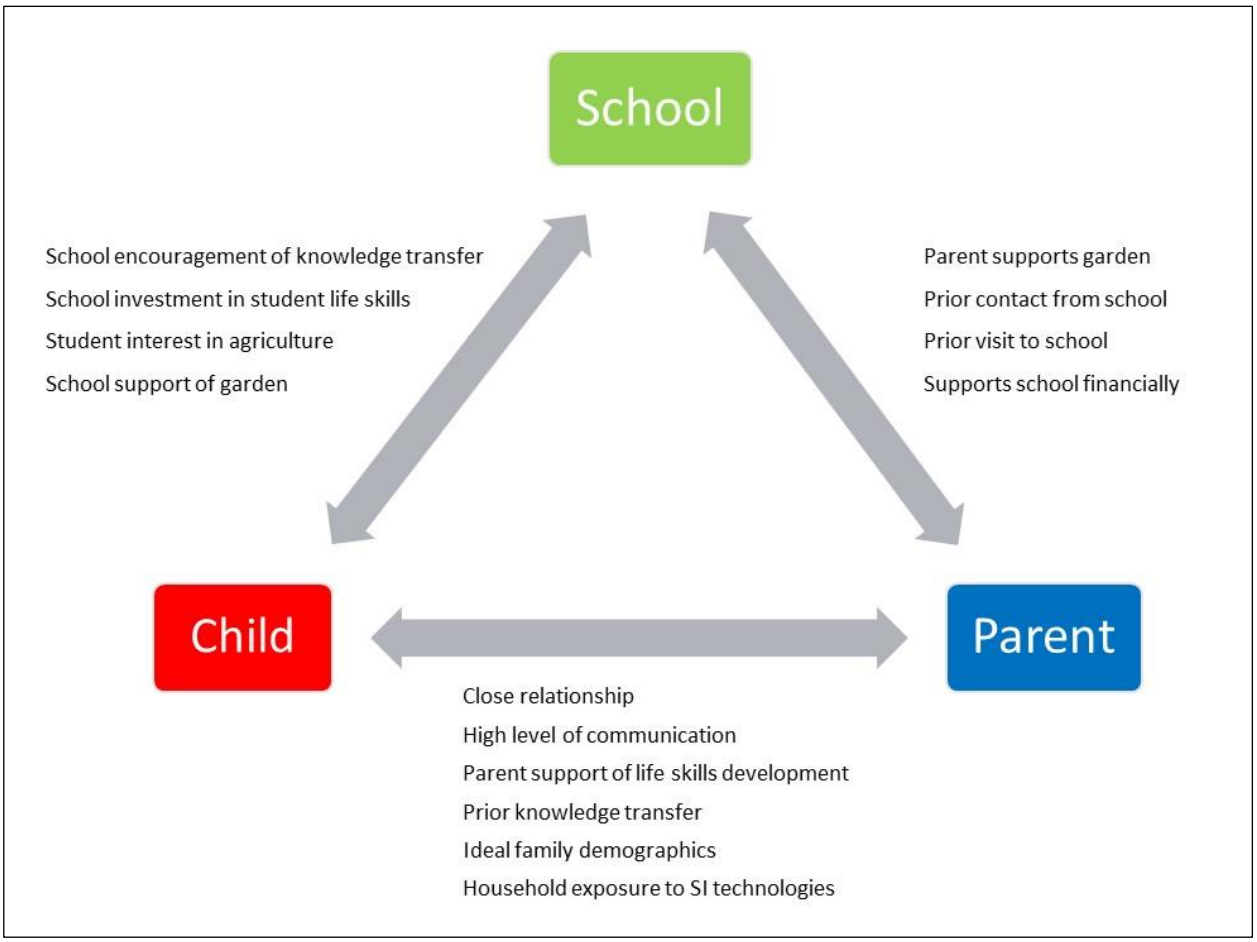
Finally, a parent not possessing a home farm or garden presented a barrier to the parent-school relationship. If a parent is unable to establish a home garden or uninterested in establishing one, there will be a be a very low likelihood of them adopting SI technologies, thus limiting scaling potential. 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 relationship factors between the parent, child, and school were particularly beneficial (Figure 3). 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 whether 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 had a high level of interest in agriculture, they were more likely to be actively involved in school garden activities. The greater their involvement in the garden, the more likely the students were to share 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 a calendar schedule for the students to work in the garden and participate in agriculture classes. This school support was supplemented by sufficient student interest in the program at Sampov. The principal 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 the child and the parent/guardian, high levels of communication, parent support of life

Figure 3. Opportunities for Scaling Between Schools, Schoolchildren, and Parents through School Gardens



skills development, prior instances of knowledge transfer, previous exposure to SI technologies, and ideal family demographics. Close relationships and high communication levels between the child and parent/guardian were prevalent among the parents identified as highly involved and average. A grandfather in Banan (Banan, Parent 3) 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 indicative of further information-sharing and adoption. The same grandfather (Banan, Parent 3) 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, Parent 3) stated that her sons taught her how to use the telephone and computer. These examples show that parents believe in learning from their children and suggests that parents will also be able to learn agricultural techniques from them. 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. 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 children 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, Parent 3) stated 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.

In addition, parental support of the garden was identified as a key opportunity for 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." Finally, some parents had invested in the school financially, and thus had 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 parents support prior projects suggests they would also be willing to financially support the garden and enhance scaling success.

Discussion

Parental Involvement in Educational Activities

Overall, slightly fewer than half of parents surveyed (43%) had visited their child's school. An even smaller percentage of parents had volunteered or worked at the school. Yet, of the parents who hadn't visited, the majority (71.3%) claimed they

wanted to visit the school. Additionally, results across schools suggested that parents generally had a strong interest in implementing, visiting, and volunteering at a school garden (Tables 4–6). 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 principals' and teachers' claims of ample opportunity for parental school involvement and actual responses from parents. With the implementation of the school gardens, there is potential for this gap to be closed and involvement standardized across households, particularly if the curriculum includes parent and community education. Concerning involvement in experiential learning activities at the school, parental awareness and engagement is present but limited. Only 34% of parents at Rongko were aware that the school has access to a tech park, and fewer than 15% have visited it. As for Sampov, 66% of parents were aware that the school has access to a school garden, and just under 18% had visited the school garden project. That being said, it is worth noting that both the tech park and school garden are both located off-campus, limiting access to and awareness of these life skills development opportunities.

Generally, parents' involvement in their children's schools and lives varied between regions, with the location of the households influencing family social ties and parents' proximity to the school. Of the three schools, Rongko had the lowest percentage of parents who had visited the school, at 35.5%, while Sampov had the highest, 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 in 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 to 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 70–75% of students coming from farming families.

Parent Willingness to Learn from Children

Results indicate parents are actively involved in their children's lives (Table 3). Parents' perceived willingness to learn about new agricultural technologies from their child(ren) was promising. 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 at least once per week (Table 3). Furthermore, there was evidence that parents have learned general agricultural information from their child's school in the past, though this transfer of knowledge was limited. At Rongko, 13% of parents claimed they had learned new agricultural techniques from the technology park. Similarly, 16% of parents at Sampov claimed they had learned new farming techniques from the accessible school garden. Although they did not have prior agricultural activities to learn from, 58% of parents at Banan claimed that they had 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 and suggests the child may have played a role in that knowledge diffusion. While the limitations of past knowledge transfer were not assessed in this study, it is worth noting that the technology park at Rongko was used as a COVID-19 quarantine site and thus has been inaccessible to the school since 2020. Additionally, it is of note 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. Furthermore, 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 location-specific family social-ties levels, as survey results suggest parent-child communication is stronger at Rongko than at Sampov and Banan. 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. This is a key finding as it relates to the overall S3-Cambodia project. If the relationship between parents, children, and schools isn't strong enough to facilitate knowledge transfer, key changes would need to be made regarding green lab implementation and the scaling pathway goals of the S3-Cambodia project.

Conclusion

This research sought to assess the feasibility of using school facilities and instruction as a pathway to scaling agricultural technologies. Overall, results suggest that students will discuss school garden activities at home and that the 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 strong indicator that there will be a similar level of awareness of the new garden. Further, parents at all of the schools indicated a strong desire for a garden to be implemented at their child's school and a high interest in visiting and volunteering at the school (Tables 4-6). The more that parents are involved in and visit the school garden, the greater the scaling potential will be. Furthermore, S3-Cambodia green labs will likely be more conducive to scaling than prior experiential learning activities at the schools because knowledge transfer will be a key programmatic priority. 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.

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