

Surveying Local Community Members on the Viability of Mitigating Anemia in Ica, Peru, through School Gardening

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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ABSTRACT

Anemia remains one of Peru's most pressing public health issues, affecting a significant proportion of the country's population. The disease's impacts on the physiological and cognitive development of young children affected by it are substantial, and often irreversible when they attain adulthood. Mitigating the disease's impacts will result in significant economic benefits by increasing the nation's productivity and eventually minimizing healthcare-related costs. To support the current efforts undertaken by the Peruvian government in mitigating the incidence of anemia, the data proffered in this thesis suggest that the organic school garden, or the *huerto escolar* in Spanish, in Ica, Peru, is a culturally appropriate system that could supplement these approaches by making communities more cognizant of the importance of a balanced diet and a healthy environment for children's holistic development through the more hands-on learning approaches it provides. However, there exists a lack of field data in developing countries like Peru on the scale of impacts of agroecological projects like organic school gardening on school children's nutrition status and overall health.

To answer this thesis' research question, "What is the opinion of experts and community members in Ica, who are part of school gardening projects, on the *huerto escolar's* efficacy to mitigate the prevalence of anemia in the region?", a systematic scoping review on school gardening projects' impact on the nutrition status of schoolchildren, and particularly the impacts on anemia, together with key-informant interviews consisting of experts and community members with experience working with *huertos escolares* were conducted. The quantitative evidence from the systematic scoping review performed on the impacts of school gardening on children's dietary choices and overall health is conflicting and inconclusive. However, the key-informants involved in the *huertos escolares* together with the qualitative evidence examined in the systematic scoping review unanimously suggest that the implementation of school gardening programs has an important role in reducing micronutrient deficiencies as they facilitate stakeholder collaboration, community engagement, provide a more hands-on approach to education, and transdisciplinary research, which are all crucial in improving the efficacy of micronutrient deficiency mitigation measures at the community

level. If eventually proven effective using mixed research methods and more robust study designs over larger sample sizes, the *huertos escolares* could be pivotal in addressing some of Peru's systemic public health issues like anemia. Increased public awareness and education on the threats posed by anemia and on the ways in which the multidimensional benefits of school gardening could help mitigate the disease's incidence are also warranted. The involvement of civil societies like non-governmental organizations in the implementation of the *huertos escolares* and the scientific community like public health units in impact evaluation processes is also critical to formalize this agricultural approach to promote food security and safeguard human wellbeing in rural communities of Peru given the lack of municipal support and integrated approaches to addressing this systemic public health issue. This is necessary to provide some sort of relief to schoolchildren suffering from the disease.

Keywords: anemia, agroecology, sustainable agriculture, resilience, huertos escolares, school gardening, education, theory of change, municipal governance, school feeding program, ecological restoration, nutrition, malnutrition

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Chapter 1: Research Context

1.1 Research Context

Over 1.62 billion people globally, including 600 million children, suffer from anemia induced by micronutrient deficiencies (Kahane et al., 2013). Although developing countries have made progress in reducing micronutrient deficiencies by increasing access to healthcare, food availability and addressing socioeconomic disparities that perpetrated their incidence (Underwood, 2000), anemia remains one of Peru's most pressing public health issues affecting a considerable proportion of the country's population (Alcazar, 2013; Acosta, 2011) which include 34% of children up to 5 years old (Berky et al., 2020). The negative effects of this disease on the cognitive development, stunting, overall productivity of children, and the broader economy through healthcare-related expenditure are substantial (WHO, 2010). Costs are also incurred by the state when students require additional years of schooling due to the disease's impact on their ability to learn (Alcazar, 2013). If left untreated during childhood, a critical developmental period, anemia increases a child's susceptibility to chronic diseases like diabetes, stroke, and heart disease in adulthood (Alcazar, 2013). A stunted woman is also more susceptible to giving birth to an infant with a low birth weight which makes the child more prone to cognitive impairment and growth retardation later in life (Alcazar, 2013) and decreased work productivity in adulthood (Berky et al., 2020). These physiological impacts of anemia further perpetuate the cycle of malnutrition and poverty (Ozaltin et al., 2010). Poverty results in reduced food consumption often paired with a monotonous nutrition regime that lacks micronutrient variety (Thompson, 2011). Proper nutrition habits and adequate access to essential micronutrients from an early age helps reduce the physiological impacts of anemia, particularly in anemic women who are more at risk due to biological factors (Thompson, 2011).

An integrated strategy to address anemia is yet to be implemented on a national level in Peru due to a lack in political will, administrative constraints, and corruption (Acosta, 2011). Although the Peruvian government has invested significant monetary resources towards nutrition programs to address malnutrition altogether, these programs tend to have limited continuity as pilot projects and often not reach the targeted populations over a timeframe to

yield significant impacts (Acosta, 2011). Using nutrition-based strategies through agriculture to complement the current efforts of the Peruvian government could present other sustainable avenues to improve the nutritional status of children in rural areas. A nutrition-based strategy aims to enhance the nutrition status of a target population by improving the availability and access of a diet that is rich in essential micronutrients necessary to mitigate deficiency diseases (Thompson, 2011). This thesis posits that increasing the consumption and availability of nutritious foods, together with nutrition education of what a well-balanced diet entails through school gardening could provide children suffering from anemia with some sort of relief from the disease's implications.

I am curious to determine how organic agriculture in the form of the *huerto escolar*, translated from Spanish as school garden, could be implemented in schools of Ica, Peru, to mitigate the disease's incidence. Horizonte Corporativo uses agroecology through the implementation of the *huertos escolares* in rural areas of Ica to promote the conservation of the region's native plant species and more organic forms of agriculture. The *huertos escolares* are used to teach schoolchildren about local biodiversity and the fundamental links existing between proper nutrition habits, biodiversity conservation, and organic agriculture. The *huerto* is an organic and traditional agricultural system in Peru that does not rely on agrochemical inputs and favors crop diversity (Beresford-Jones et al., 2010). Elevated levels of crop diversity in traditional agricultural plots enhance ecosystem functions (Smith et al., 2008), increase the genetic variety of crops (Altieri, 2004) and stabilize yields in the long term (Wilson et al., 1988). The NGO also strives to form strategic partnerships with public institutions and private companies to source resources and support in the absence of municipal support. Given the state's systemic inability to enact and sustain effective strategies to mitigate the disease's incidence (Alcazar, 2013), I explore how more community-based approaches to agriculture, and specifically agroecology through the *huertos escolares*, could reduce the prevalence of the disease in the region in a more localized manner to supplement the current efforts employed by the Peruvian state to address the issue.

1.2 The Research Question:

What is the opinion of experts and community members in Ica, who are part of school gardening projects, on the *huerto escolar's* efficacy to mitigate the prevalence of anemia in the region?

1.3 Normative Assumption Underpinning Research

Reporting one's assumptions at the outset of a study is a key tenet of confirmability in qualitative research (Miles & Huberman, 1994). As such, I disclose that the following normative assumption underpins my research agenda and influenced my overall research enterprise: that communities must be stakeholders rather than the subjects of socio-environmental policy, and that a more inclusive approach towards natural resource management, and specifically agriculture, would yield more equitable and sustainable outcomes for the biophysical and social environment. This thesis is also underpinned by the assumption that access to adequate food and nutrition is a fundamental human right.

As I am particularly interested in community-based farming strategies to safeguard ecological and community health in third world countries. Based on the evidence provided by Alcazar (2013), I also argue that current trends on the effects of anemia in Ica and eventually Peru will be exacerbated in a 'business-as-usual' approach. Therefore, due to the short- and long-term implications of the disease on the population and the broader economy, its mitigation should be prioritized in public policy.

CHAPTER 2: Literature Review and Conceptual Framework

2.1 Section 1: Literature Review

2.1.1 The Importance of Traditional and Organic Agriculture in Peru's Public Health Measures

Ending chronic malnutrition by 2030 (SDG number 2) will not be possible under a 'business as usual' approach with the current structure of food systems (FAO, 2017). As the global demand for food is forecasted to increase exponentially over the next decades, sustainably intensifying crop production on existing lands is the most practical solution to reducing malnutrition (Kahane et al., 2013), with the benefits of polyculture, agroecology, and agroforestry on ecological processes, native biodiversity, pest management (Altieri, 1995; Khan & Pickett, 2004; Blair, 2009) and natural capital (Perrings et al., 2006) well-articulated. Traditional agricultural systems provide a wealth of knowledge on sustainable crop production where systemic financial resource constraints persist (Altieri, 1995). Biodiverse agricultural systems are also essential in mitigating noncommunicable and chronic diseases (Beaglehole & Yach, 2003). As such, this thesis investigates how scaling agroecological knowledge through school gardening could play a vital role in providing nutrition-based ecosystem services to students while sustaining important ecological processes

Agroecology links ecology and agriculture and serves as a powerful tool for sustainable development (Stassart et al., 2012). Agroecology promotes a more integrative and sustainable approach to agricultural production that addresses social and ecological needs, prioritizing human health and consolidating diverse and sustainable agro-landscapes (Altieri & Nicholls, 2020). It is a model that reaches out of the boundaries of the resource-intensive agricultural sector as we know it. As current food production models of capitalist economies are increasingly being recognized as unsustainable by the international community, formally institutionalizing agroecology and increasing education on agroecological knowledge is required to transition from current food system models centered on profitability to ones that are also concerned not only with economic viability but also social wellbeing. By investing directly in agroecological pedagogy through school gardening in schools, a gradual transition to

a more sustainable and equitable approach to food production could occur (Roscioli, 2020). Agroecology is also an agricultural practice that prioritizes crop variety, the continuity of ecological processes, and biodiversity (Altieri, 1995). It refers to a more integrative and sustainable approach to agricultural production that prioritizes human health and consolidates diverse agro-landscapes (Altieri, 1995). Given the regular contact that occurs between children and teachers, schools are convenient places to introduce interventions promoting healthier nutrition habits. It is also important for teachers to understand the basic principles of agroecology and proper nutrition habits to effectively disseminate knowledge to the students so that they would appreciate the intrinsic value of a diverse agroecological system and its contributions towards their own development.

The core components of agroecology are integrated land-use systems that preserve agrobiodiversity, maintain species diversity, and ecological processes to render ecosystems serves that strengthen the resilience of local communities (Altieri, 1995). Globally, agroecology currently contributes to the realization of several Sustainable Development Goals (SDGs) including zero hunger (SDG 2), and good health and wellbeing (SDG 3). Agroecology can bridge social and ecological dimensions through sustainable agricultural systems that provide long-term and holistic solutions to poverty and malnutrition (HLPE, 2019). The *huerto escolar* provides many of those features as small-scale and sustainable agricultural system in Peru that is maintained without the use of synthetic inputs and provides nutritious crops to households (Beresford-Jones et al., 2010) and supports local biodiversity (Pecho et al., 2010). In comparison to the unsustainable export model practiced by large agribusinesses in Ica that negatively impacts the productivity of the region's landscape through underregulated exploitation of its aquifers (Damonte, 2019), the *huerto* renders several ecosystem services as a traditional agricultural system, including carbon sequestration, nutrient cycling, soil contaminant reduction and purification of water, and the provision of healthy produce, without the use of synthetic fertilizers (Beresford-Jones et al., 2010). Other features of traditional approaches to agriculture include healthy pest management and soil nutrient cycling resulting from spatial crop mixes (Altieri, 1995). Traditional farming systems also permit farmers to cope with changes in agricultural policies, taxes, and fluctuations in market prices

(Alcorn, 1984). More localized farming approaches are particularly important in situations like the global COVID-19 pandemic where supply chains of produce were constrained globally, thus depriving communities (Altieri & Nicholls, 2020). Traditional ecological knowledge should be recognized and valued in addressing public health issues. However, the importance of using traditional agriculture to mitigate the incidence of deficiency diseases resulting from malnutrition is overlooked (Kahane, 2013).

Agroecological practices in Latin American countries have induced substantial and tangible impacts on resource conservation, crop productivity and food security (Altieri & Toledo, 2011). Scaling agroecology involves several synchronized transitions at multiple dimensions and scales from political, sociocultural, biophysical, and economic standpoints (Parmentier, 2014; Nicholls & Altieri, 2018). These shifts are necessary to increase the participation of local communities in the production, distribution and consumption of produce derived from the food system (Valdiva-Diaz & Le Coq, 2022). It is therefore necessary to identify some of the key barriers and opportunities for scaling agroecology within the Peruvian context to eventually facilitate the emergence of resilient and sustainable agriculture systems that provide several benefits to local communities. These barriers are also applicable to Ica's context. These include a lack of consumer awareness of the environmental benefits proffered by agroecological produce, the lack of incentives provided by the state to local farmers for engaging in more sustainable forms of agricultural production, and the lack of local leaders who can provide training and assistance to farmers willing to adopt such practices (Valdiva-Diaz & Le Coq, 2022). Other barriers reported by Valdiva-Diaz and Le Coq (2022) in Peru included the lack of collaboration between farmers and the academic sector to integrate traditional farming knowledge into modern practices to eventually influence policy making, the lack of access to native seedlings, and little economic insurance for crop protection to farmers in the event of adverse natural phenomenon like climate change (Valdiva-Diaz & Le Coq, 2022). Therefore, the Theory of Change provided by this thesis (Figure 1) highlights the potential pathways that could be explored to circumvent some of the barriers faced by proponents aspiring to scale agroecology in the context of Ica, specifically to mitigate the prevalence of anemia in Ica through the *huertos escolares*.

If the community members agreed, this thesis' results could support school gardening projects in Ica and highlight their capacity to provide adequate nutrition to students suffering from anemia and other deficiency diseases. Additionally, I believe this research would compel policymakers to introduce more holistic and integrated health and nutrition programs in schools like school gardening if the results are favorable. This is because significant impacts on the nutritional and developmental aspects of children occur when education programs are designed in a way that integrates practical approaches to proper nutrition habits through a unified approach of relevant actors (DiGirolarmo, 2014). Furthermore, the results could further mobilize local NGOs, ecologists, medical practitioners, and communities in Peru by making them more aware of the opportunities presented by the *huerto escolar* to promote sustainable food systems for rural communities and show how this system could be a suitable pre-cursor to the full suite of changes needed to effectively mitigate anemia in Peru.

2.1.2 The Role of School Gardening in Promoting Resilient Socioecological Systems in Ica, Peru

Integrating the benefits associated with diversified and small-scale agriculture to improve the health and resilience of rural communities in current food systems is fundamental for sustainability (Beresford-Jones et al. 2010; Kahane et al., 2013). Although Ica's commodity-based agricultural industry continues to boom and facilitate economic growth in the region at unprecedented rates (Damonte, 2019), poverty in Ica is still prevalent (Beresford-Jones et al., 2010). School gardening was endorsed by the United Nations Children's Fund (UNICEF) and the FAO as an applied projects to support malnutrition reduction strategies since the 1950's (Sottile et al., 2016). Therefore, this thesis examines how a more participatory approach to school gardening with local communities of Ica could incrementally reverse the ongoing dislocation of Peruvian society from traditional forms of agriculture, the consequential loss of cultural attachment to the land due to an industrialized food production model that is void of consideration for ecological sustainability, and how the *huerto escolar* could facilitate schoolchildren's access to a healthier and more nutritious diet.

Anemia mitigation through school gardening through multi-sectoral collaboration of actors each driven by their respective rationales. Adequate levels of financial, ecological, social, physical, and human capital are necessary to implement and sustain projects in individual sites. For instance, *huertos escolares* could be sustained using low-technology methods with minimal irrigation inputs as many of the native species are adapted to the semi-arid conditions of the region (Beresford-Jones et al., 2010). As appealing as this sounds, however, many schools in secluded areas do not have access to pipe-borne water. Therefore, modern irrigation technologies will have to be integrated into this traditional farming system in settings where resource or financial constraints exist.

To address the knowledge gap existing between the implications of ecological restoration on public health issues like anemia, the *huerto escolar* could provide researchers with opportunities to generate new data and make policy makers more aware of nutrition-sensitive agricultural systems' potential in addressing deficiency diseases. Acting as a knowledge interface, the *huerto escolar* could be instrumental in bridging the gaps existing between public engagement, policy, and practice in natural resource management in Peru. As the resilience of communities is reflected by ecosystem health, and the wellbeing of ecological and human systems is inextricably linked (DeClerck & Wood, 2015), it is anticipated that the research findings would support the establishment of the ecologically resilient *huerto escolar* for the students' holistic development.

The *huerto escolar* could also permit the multidimensional impacts of agroecology to reach the students more efficiently. Consideration in the future should be given to determining ways to effectively communicate the benefits of this restoration approach to both scientific and non-scientific audiences to facilitate the emergence of more sustainable agricultural methods and secure the necessary capital to implement these restoration projects. Quantifying the potential benefits of the *huerto escolar* on the wellbeing of students in through appropriate indicators will be key in influencing policies, securing funding, mobilizing local communities, and encouraging the participation of the private sector.

2.1.3 Prior Efforts for Anemia Mitigation in Peru

Horizontal coordination between non-governmental agencies and the governmental sector was key to the success of policies implemented to reduce malnutrition in Peru between 2005 to 2010 (Acosta, 2011). One of those policies includes the 2006 Child Nutrition Initiative, which stimulated more local government involvement in food security initiatives by promoting proper nutrition habits through education campaigns (Acosta, 2011). However, the continuity of such programs is curtailed given state's systemic neglect to monitor efforts, limiting the efficacy of those interventions (Alcazar, 2013) and has been further compounded by a politically fragmented landscape (Acosta, 2011). Overall, sustainably developing Ica's agricultural sector has been described as an onerous task as the current policies, market forces and institutional arrangements favor the monoculture model (Damonte, 2019).

Alcazar (2013) found that the impacts of anemia on cognitive degeneration in the early stages of childhood and the consequent lack of productivity in adulthood costs Peru approximately 0.33% of its annual GDP. Therefore, due to the short- and long-term implications of the disease on the population and the overall economy, its mitigation should be prioritized in public policy. Recommendations were made by Alcazar (2013) and Acosta (2011) that more efforts to decentralize resources to local authorities to address malnutrition were necessary to attain the intended beneficiaries of those programs. However, community engagement by rural municipalities in the design, implementation, and monitoring of strategies to mitigate anemia and other deficiency diseases is not common practice in Peru, with little empirical research done on the opportunities presented by these approaches to this day.

As rural communities of Peru with high a prevalence of malnutrition are the intended beneficiaries of these programs, they should be active contributors and not mere subjects of socio-environmental policy to increase impact. For instance, the work done by Horizonte Corporativo shows how the private sector, NGOs, government agencies, and the affected communities can collaborate in the coordination and implementation of *huertos escolares* to attain conservation targets. As such, the ways in which the *huertos escolares*' viability to

improve the health status of school children suffering from malnutrition should be explored. If proven effective, broader institutional changes will be required to mobilize municipal support and the physical resources necessary to implement and sustain the projects. School nutrition programs, combined with appropriate nutrition-sensitive social protection policies, can play a crucial role in helping vulnerable communities to access nutritious foods, while simultaneously ensuring that students are well and educated on healthier nutrition habits (FAO, 2017).

2.1.4 The Nexus between Biodiversity, Ecological Restoration, and Human Health in the *Huertos Escolares*

School gardening is not formally recognized as an anemia mitigation tool in Peru. Since this thesis explores the viability of using school gardening to mitigate this disease's incidence in both theory and practice without the valuable institutional support of municipalities in Ica, it is perceived that the mechanisms proposed to reduce the disease's incidence through school gardening, revealed by the key-informant interviews and the systematic scoping review in this research, would only work if they were linked to the current efforts of NGOs like Horizonte Corporativo who are using this approach to mitigate biodiversity loss. This is done through ecological restoration of perennials native to Ica and intercropping them with other leguminous and fruit crops in school gardening plots to introduce biodiverse agrosystems and reinstate the ecosystem services they provide to school children. Although school gardening is not a strategy that falls explicitly under the umbrella of ecological restoration, NGOs like Horizonte Corporativo use ecological restoration to introduce *huertos escolares* that provide both pedagogical and nutritional benefits to schoolchildren in rural areas of Ica. A point could also be made that anemia mitigation through the *huertos escolares* is an indirect benefit of those current activities and is an opportunity that is not being exploited.

Ecological restoration is used in schools and communities globally for school children and communities to learn about environmental equity and sustainability policies (Ferris et al., 2001), biodiversity loss, invasive species, and pollution prevention (Hall & Bauer-Armstrong, 2010). With the active participation of communities, ecosystem restoration in Ica helps to retain traditional knowledge and agricultural expertise, helps locals reconnect with their

cultural heritage, and facilitates the production of sustainable forest products (Beresford-jones et al., 2010). Given the close interconnectedness of ecological and human health crises (Breed et al., 2020) and specifically the prevalence of poverty and deforestation in Ica (Beresford-Jones et al., 2010), the *huerto escolar* could provide a space where various disciplines from the scientific community like ecologists and public health experts could educate communities on the interdependencies that exists between human health and a resilient environment. The transdisciplinary research present in this novel approach to anemia mitigation will be important considering that the involvement of various groups from the scientific community and the public sector would be key to sustaining engagement in those projects.

Transdisciplinary research shows the positive correlation that exists between ecosystem and human health, and how outcomes in both domains could be enhanced through ecological restoration (Aronson et al., 2016; Breed et al., 2020). Ecological restoration integrates human agency with natural processes and is used to restore the provision of ecosystem services in regions where biological diversity and ecosystem function have been negatively impacted by unsustainable land-use practices which also threatens human wellbeing (Chazdon & Benayas, 2017). Independent actors engaging in ecosystem restoration in Ica should consider school the gardening approach as those sites provide a space where those activities could be sustained with the help of teachers who are invested in environmental concerns. School gardens also provide a platform where independent actors driven by the same rationale could collaborate with other parties could share their experiences which facilitates collaborative learning on how this system could be optimized to mitigate the disease's incidence. The financial constraints in carrying out community- and environmental-based projects to enhance public health in Ica however are abundant and often prevent those initiatives from evolving from pilot projects. Therefore, due to the lack of municipal support and engagement for anemia mitigation in Ica, the degree of success of school gardening to reduce the disease's incidence depends on the activities of independent organizations like Horizonte Corporativo and the availability of resources to carry out school gardening activities for biodiversity loss mitigation purposes, and for actors to capitalize on the opportunity to mitigate anemia stemming from those activities.

2.2 Section 2- Conceptual Framework- The Theory of Change

The conceptual framework of this thesis takes the form of a Theory of Change. A conceptual framework was selected as opposed to an existing theoretical framework as the implications of school gardening on public health issues like anemia are yet to be investigated and supported by robust empirical evidence. A Theory of Change is a process that facilitates learning at multiple scales which consists of analyses of proposed actions and intended outcomes, and it also considers the implicit and explicit assumptions about how those actions and consequential end results are interrelated (Armitage et al., 2019). This makes it a suitable framework to explore the suitability of school gardening as a novel approach to anemia mitigation in Ica's context. It is a continuously evolving tool as it encompasses continuous learning between all the actors involved (Barnett and Gregorowski, 2013).

The Theory of Change in this thesis examines how a more localized approach to reduce the prevalence of anemia through school gardening complements the current efforts employed to address the issue. The rationale behind this Theory of Change is to encourage actors interested in anemia mitigation in Ica to consider the multidimensional benefits of school gardening and show how this model could achieve this thesis' aspirational outcome for Ica, which is for the region to be anemia-free. It is intended that this Theory of Change could support the creation of *huertos escolares* in Ica as a pre-cursor to the full suite of changes needed to address anemia in the region, and eventually be replicated to other regions of Peru.

The broader aspirational outcome of this Theory of Change is for more inclusive approaches to agriculture and natural resource management to safeguard human wellbeing in Latin American countries. For Ica specifically, the aspirational outcome of this Theory of Change is for the region to become anemia free. Community and school gardening are one of the many pathways that could facilitate the realization of this outcome through a more agricultural lens. Through school gardening activities, children prone to malnutrition could educate themselves on the importance of proper nutrition habits and the implications of a balanced diet for their own development.

2.2.1 Core strategies, Pathways and Intermediate steps needed to achieve an Anemia-Free Ica

There are various pathways in which school gardening could positively influence the development of children. These pathways include increased academic achievement through more creative learning methodologies adapted to the local context, increased consumption of nutritionally diverse foods through increased exposure to the crops yielded by school gardening, through nutrition education, and the increased participation of families and community in the activities and a consequential greater sense of attachment to the school. Policies should be accompanied by societal norms that support healthy eating. Furthermore, when a school provides healthy food options and engaging learning activities, student nutrition behaviors are more likely to be change favorably (Bandura, 1997). In Ica, NGOs like Horizonte Corporativo play a crucial role in influencing the structures and their processes to realize nutrition-related goals in schools through advocacy, lobbying, and capacity-building initiatives in schools and communities given the absence of higher levels of government. Actors should also be cognisant of the broader structures and processes that should be transformed to achieve the long-term aspirational outcome of this thesis, and the Theory of Change is a valuable tool to determine these changes in the initial stages of research.

Conceptually framing school gardening programs' effects is important to inform practice and to develop robust empirical literature on the programs' efficacy to enhance a child's holistic development (Ozer, 2007). As such, Ozer's (2007) school gardening model was also considered in designing this Theory of Change. One that is child focused, this model juxtaposes the child within microsystems and the wider context that include the school setting, the community, and the household within Ica, in which the interactions between the system and the child shape their behavior and the other system components over time (Ozer, 2007). In Ica's context, changes in the schools setting induced by the introduction of school gardening activities may initiate processes of change in the child dietary habits and cognitive function, and eventually other domains like at the household level and beyond. Ozer (2007) also posits that the child is influenced and shaped by the different contexts and processes they are nested in which include government policies, societal norms, and public institutions like schools. In

Ica's context, changes in the school's setting induced by integrating school gardening activities may initiate processes of change in the child's dietary habits and cognitive function, and eventually at the household level and beyond, thus influencing other domains like poverty mitigation and attitudes towards the environment. Juxtaposing the child as being nested in sub-systems in Ica's context is also useful to highlight some of the causal links and pathways existing between the actors and processes in the context influencing their well-being visually.

Interventions are the building blocks and procedures required to attain a specific long-term goal that a group of stakeholders will engage in through a suite of context appropriate strategies, while activities are the specific actions that constitute the interventions, strategies entail using a diverse set of tools in coordinating a sequence of interventions to achieve the outcomes desired (Clark & Taplin, 2012). Based on preliminary examination of the literature of prior efforts for anemia mitigation in Peru, community outreach, school gardening and broader policy reforms in the agricultural and education sectors will be necessary to achieve this framework's aspirational outcome, which is for Ica to become anemia free. Table 1 summarizes the main interventions and assumptions that would facilitate the emergence of an anemia-free Ica, together with the indicators used to evaluate the success of these interventions as they are implemented, while Table 2 shows the feedback loops existing between the processes and the outcomes generated from their synergy.

Intervention	Assumption	Indicator
Policy reforms and school curriculum changes	<ul style="list-style-type: none"> - Political commitment and mobilization for nutrition enhanced at the national level. Policy framework supporting effective government institutions and reducing malnutrition in rural areas introduced. - Policies will support school gardening projects with more urgency and support from municipalities. Policy makers will be motivated to source and supply necessary agricultural infrastructure and other necessary capital. - The <i>huerto escolar</i> will be integrated in the school curriculum as a pedagogical tool for anemia mitigation in Ica. 	<ul style="list-style-type: none"> - Partnerships strengthened between the public and private sector and institutional platforms strengthened to support the wellbeing of students and native biodiversity. Student's grades will reflect engagement in projects.
School Gardening	<ul style="list-style-type: none"> - Native crops will thrive in school gardening sites, and school personnel will be engaged to maintain those plots with the training provided by the proponents. - The rationale for this intervention here is that if crops containing the essential micronutrients can be made available and be distributed equally, then students will have a healthier diet and experience a healthier lifestyle and be more productive. 	<ul style="list-style-type: none"> - Nutrient cycling, soil organic matter (SOM), species richness and abundance, positive anthropomorphic outcomes like reduced stunting rates.
Education and Outreach	<ul style="list-style-type: none"> - Educating communities about the importance of proper nutrition habits will cause them to change their consumption choices and make healthier ones. - Communities will become more cognizant of the nutritional benefits of consuming organic produce. Intermediary groups (the private sector, public health agencies, and researchers) will engage more in collaboration, sharing of technologies and information. 	<ul style="list-style-type: none"> - Consumption changes, increase in environmental stewardship and stewardship intentions determined by using a mix methods approach.

	<ul style="list-style-type: none"> - Teachers and community members will become more engaged in projects. Behaviors can be changed through context appropriate information sharing strategies that circumvent the local barriers to adopting desirable behaviors. 	
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Table 1: Table showing the main interventions, the associated assumptions of the interventions and respective indicators used to measure success

Structures	Processes
Municipalities of Ica and the Ministry of Education	Laws, policies, and funding
Private sector	Corporate responsibility initiatives
Public health agencies	Administration of health services and educational programs
Schools	Providing a space for learning and the holistic development of children

Table 2: Table showing the some of the key structures and their respective processes in Ica

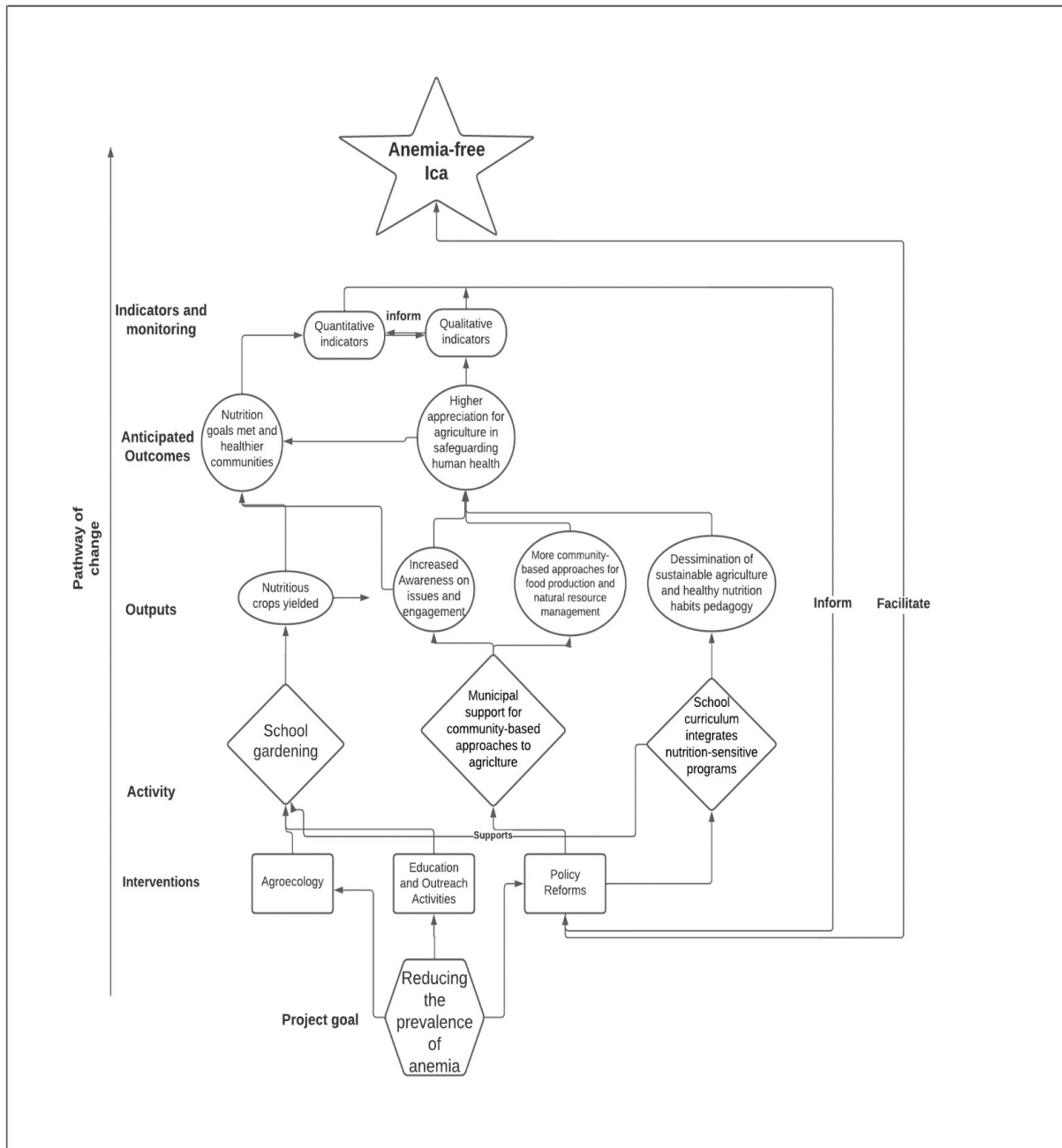


Figure 1: Diagram showing the anticipated Pathway of Change and anticipated causality and feedback loops existing between the suggested interventions

2.2.2 Critical reflection on Theory of Change

Mapping out the links, pathways, and feedback loops between the perceived interventions necessary to mitigate anemia was useful to identify the roles key actors should assume to achieve this thesis' aspirational outcome through the *huertos escolares*. Conceptualizing this framework was also useful to become more cognizant of the processes perpetuating the prevalence of anemia and provided a more systematic description of the adjustments required to achieve a more desirable end state in the region. Additionally, this framework was useful to conceptualize a set of assumptions that would provide an enabling environment for school gardening programs to potentially have a positive impact on anemia mitigation measures, together with the uncertainties associated with the assumptions that actors should consider when making informed decisions.

The assumptions presented in this Theory of Change would foster an enabling environment for NGOs like Horizonte Corporativo to sustain the *huertos escolares* for anemia mitigation in addition to the current their current biodiversity conservation objectives. It is important for those actors to consider the external factors, wider institutional processes, and uncertainties that would influence the school gardening programs' success and their impacts in the long term. Given that uncertainty is inevitable in natural resource management despite the abundance of knowledge on environmental issues (Dewulf & Biesbroek, 2018), considering current healthcare and agricultural policies that would facilitate or impede the long-term viability of the programs from an institutional standpoint and the availability of capital and biophysical resources in each school is key to the longterm efficacy of the *huertos escolares*. Equally important is considering the locally defined perceptions of the disease's impacts and the *huerto escolar's* suitability to mitigate its incidence. Influencing the behavior of intermediaries and beneficiaries to support the proposed initiatives is not a straightforward process and special consideration will be required to determine ways in which to provide incentives to maintain engagement over time and eventually scale the projects if proven effective. This is because a person's behavior is more likely influenced by the presence of incentives in comparison to methods that appeal to personal values and attitudes (Aronson, 2008). Proponents in ecological restoration can achieve end-goals when lessons are learned

from past failures, and when these lessons are shared with all actors involved in a timely and strategic manner (Cooke et al., 2020). As there could be many uncertainties associated with this novel approach to safeguard human through school gardening in Ica surrounding its efficacy and long-term viability, school gardening proponents from organizations like Horizonte Corporativo should engage community members and teachers in impact evaluation and monitoring processes as they are key actors in this proposed intervention. The lessons learnt from those evaluation processes should be documented and shared to other communities throughout the region and broader scales through appropriate communication platforms for other proponents to mitigate avoidable pitfalls.

Finally, the linear model employed by the Peruvian state to mitigate anemia that mainly involves supplementation and school feeding programs should transition to a more holistic approach that explores the potential of organic agriculture in safeguarding human health, and the ways in which these systems could be linked to optimize the efforts. School nutrition programs, combined with appropriate nutrition-sensitive social protection programs, play a crucial role in helping vulnerable communities to access nutritious foods, while simultaneously ensuring that youth are properly fed and educated about good nutrition habits (FAO, 2017). Incorporating nutrition-smart agriculture through the *huerto escolar* would not only permit students to become more educated on healthy eating habits but also allow researchers to determine what the other benefits of community-based gardening exist in third-world countries to safeguard the wellbeing of communities with a high prevalence of anemia. Furthermore, collaboration and research should not be solely confined to the scientific community but should seek to inform and mobilize the local people who must be onsite and engaged if trends in anemia are to be eventually reversed in the region.

CHAPTER 3: METHODS

3.1 Overview

My research question is, “What is the opinion of experts and community members in Ica, who are part of school gardening projects, on the *huerto escolar’s* efficacy to mitigate the prevalence of anemia in the region?”

I used two main qualitative methods to answer this exploratory research question. The first method entailed a systematic scoping review of the existing literature on school gardening projects to address deficiency diseases in developed and developing countries. I also conducted a series of interviews with key-informants in Ica which followed a semi-structured format. The Ica region in Peru served as a case study since the interview questions sought to determine the key barriers and opportunities presented by the adoption of the *huertos escolares* in anemia mitigation according to the key-informants’ perspectives. Furthermore, I also drew on other settings, contexts, and case studies in the systematic scoping review to compare school gardening experiences aimed at achieving nutrition-related objectives and relate them to Ica, which is the focal point of this study.

Baseline comparisons of test scores and anthropomorphic measurements like stunted growth over several academic years are some of the more quantitative approaches used to assess the impacts of school gardening projects on student wellbeing. It was initially intended to use similar quantitative methods in addition to in-person semi structured interviews to answer the research question. However, given the limitations imposed by the COVID-19 pandemic relating to international travel restrictions, virtual semi-structured interviews of key-informants were determined to be the most reliable and valid data collection method to capture the present realities of Ica through the participants’ perspectives, in comparison to other qualitative methods like structured interviews, surveys, and questionnaires.

3.2 The Case Study:



Figure 2: Map showing the location of Ica, the research region highlighted, on Peru's coast. Sourced from Google Maps

Given the prevalence of anemia in Peru, devising more solutions to mitigate the negative impacts of such nutrition disorders are of utmost importance. While working through the Uniterro program with the nongovernmental organization (NGO) Horizonte Corporativo in Ica, Peru in 2020 through the Uniterro program, I performed research on the prevalence of

anemia and noticed that stunted growth in students and high absenteeism levels were some of the impacts of the disease articulated by Acosta (2013) that were apparent. Ica is a semi-arid region situated on the southern coast of the country with widespread deforestation and biodiversity loss in the region (Beresford-Jones et al., 2010). Adequate anemia prevention is also not currently delivered within the power of local authorities in Ica because of a lack of financial capital, mismanagement of resources, and corruption, which will require some form of intervention from higher levels of government. The experiences provided by the key-informants in the interviews conducted in a semi-structured format were useful to obtain a more in-depth understanding of issues presented by the lack of institutional support and could provide other researchers with insights on how those could be circumvented in other regions with similar biophysical conditions and institutional processes to Ica.

3.3 Underlying Epistemology:

Since I am interested in understanding the perception of experts and community members on the efficacy of the *huerto escolar* in mitigating anemia, interpretivism is my underlying epistemology. An interpretivist method in this context would be higher in validity than a positivist method as it would provide deeper insights behind people's actions and motives. Compiling local perspectives is essential in aiding communities in Ica to create long term solutions, in addition to school gardening, that would be suitable and viable given the neglect of local municipalities to tackle the issue. For sampling methods, I use convenience sampling to collect information from the target population, which include teachers, experts from NGOs, the municipal corporation and community members of Ica that I worked with from September 2019 to March 2020. These persons represent a diverse range of disciplines and are guided by multiple rationales to address anemia.

3.4 Systematic Scoping Review:

The primary purpose of a systematic scoping review is to survey the key concepts that underpin a research field and examine the main types and sources of empirical evidence available in that area. They are also useful for answering a set of well-defined research questions. In a systematic scoping review, the reasons for including or excluding studies are

informed by the research questions and made explicit by the researcher during the reporting process (Higgins & Green, 2011). As this thesis examines the potential benefits of community-based agriculture systems like school gardening in developing countries to safeguard community health, the relevant literature that would provide valuable insights to answer the research question was examined to determine whether the interview data arrive at similar or diverging conclusions compared to the literature.

A systematic scoping review would be more suitable to answer my research question than a traditional literature review and a systematic literature review. A traditional literature review's primary goal is to gather evidence to support a specific viewpoint or to situate one's research within an existing corpus of knowledge, whereas, in a systematic scoping review, the process begins with a set of well-defined research questions to be eventually answered by the review. A systematic scoping review gathers all evidence related to the research questions and are performed in a way that is reproducible, transparent, and as unbiased as possible. Conversely, searches in traditional literature reviews have been critiqued for not being fully comprehensive and influenced by what the researcher is already familiar with.

In a systematic literature review, attempts are undertaken to locate all published literature based on the research questions, and the reasons for including or excluding resources are documented and disclosed by the researcher. However, given that this thesis considers experiences related to school feeding programs and agroecology in the context of mitigating nutrition-related deficiencies, a systematic scoping review was considered to more suitable given its more expansive inclusion criteria. Systematic literature reviews are commonly used to test the effectiveness, meaningfulness or appropriateness of a certain practice or treatment and eventually inform practice (Pearson et al, 2005). However, systematic scoping reviews are more concerned with exploring the viability of a certain intervention and discussing the concepts and characteristics arising from this inquiry. This tenet of a systematic scoping review makes it a suitable method for this thesis as I am probing the opinions of community members, whose perspectives would have to be investigated further to adequately inform practice. Additionally, systematic scoping reviews are typically

used to fill knowledge gaps and provide recommendations for practice, which is also the main purpose of this research project.

The systematic scoping review was useful to determine whether the literature aligned with the student researcher's intuition and perception of the issue based on their experience working in Ica. The systematic scoping review also permitted me to gather relevant principles, frameworks and strategies that can further refine the research and potentially enhance its external validity and transferability. It was particularly useful in situating this thesis research in the broader sustainability context of food security and public health policy, and in informing the way in which the interview questions were structured, and the way the interview data were coded. Concepts and theories obtained from the systematic scoping review also influenced the way in which the interview questions were structured. Furthermore, given that the evidence on school gardens' impacts on mitigating malnutrition and specifically anemia requires more rigorous research, a systematic scoping review of related studies is useful to determine which study designs are most favorable to discover the benefits of those programs on key parameters, then scale those programs if the results are favorable.

3.5 The Selection Criteria in The Systematic Scoping Review

An extensive search of peer-reviewed literature on sustainable agriculture and its potential to meet nutrition needs in Latin America and other developing countries, specifically within the context of school gardens, and to mitigate anemia was performed. The systematic scoping review included peer-reviewed articles with qualitative and quantitative evidence on the use of school gardens to meet nutrition targets. Some of the databases used were Web of Science, JSTOR, University of Waterloo Library Resources, Google Scholar, PubMed, and Education Full Text as of 1992 to determine if empirical data exists on the impacts of agroecology, specifically school gardens, on nutrition outcomes in Latin America. Originally, only papers that performed systematic scoping reviews were selected. However, this search yielded 6 articles and as such, the search was expanded to papers that used other methods but only selected if they were explicit with their research design. Papers with the terms 'agroecology', 'nutrition', 'traditional agriculture', 'school-based nutrition programs' and

'school gardens' were examined. These terms were scrutinized as this research is situated in sustainability issues relating to human health and sustainable agriculture, and specifically nutrition-related programs in schools.

There is currently no corpus of knowledge on the implications of sustainable agriculture on anemia in Latin American countries, but papers exploring other benefits associated with school gardens from those territories, including Mexico (Ferguson et al., 2019) and Uruguay (Roscioli et al., 2021) were selected. As such, the geographical scope of this study was expanded to consider school gardens experiences from other countries and continents which included Australia (Sommerset et al., 2015), the United States (Oostindjer et al., 2017), and Spain (Espinet & Amat, 2013). Articles mentioning indicators to measure success associated with this approach with sufficient depth and detail on the methods and their interpretation were selected.

Papers that also disclosed the characteristics of the population being studied and disclosed the impacts of school gardening activities on desired variables were selected. The quantitative studies were only further considered if a control group was compared to the groups taking part in the gardening activities. Qualitative studies however, whose conclusions were derived from the perceptions of participants and author's themes, were not subjected to this criterion. Studies that were not explicit with their methodologies and indicators were excluded from the analysis. Studies that used mixed approaches were particularly important to determine if changes in the variables observed resulted from school gardening programs, or influenced by external factors, or a combination of both.

The literature which met the selection criteria were thoroughly scrutinized to determine if robust evidence supports the benefits of agroecology on nutrition outcomes and environmental stewardship intentions. Case studies in those papers were also examined, together with reference lists to check for additional sources. The quantitative and qualitative findings on the successes and opportunities of school gardens as a tool to mitigate malnutrition in the long term were then narratively synthesized in different sections below. The qualitative data, mostly based on the participant's perceptions on the efficacy of school

gardens to me, contributed to the development of this thesis's conceptual framework. Qualitative methods used in the articles reviewed included focus groups, semi-structured interviews, questionnaires, and case studies, while some of the quantitative methods included academic scores, Individual Diet Diversity Scores (IDDS) and surveys.

The literature on school feeding programs was also examined and subjected to the selection criteria. School feeding programs are proven to increase academic achievement, improve cognitive abilities and reduce absenteeism, and the possibility of linking school gardens directly to those programs is increasingly being scrutinized (Bundy et al., 2012). Insufficient consumption of fruits and vegetables in children and adolescents on the other hand is linked to lower health and academic outcomes, and overall quality of life (Neumark-Sztainer et al., 1996). Perceptions are favorable in terms of the school garden's ability to aid students suffering from micronutrient deficiencies through food and nutrition education, but the possibility of linking this approach to current school feeding programs in Latin American countries is yet to be explored and supported by robust empirical data.

The literature on the impact of school gardens on education outcomes was also examined as higher test scores in school are associated with higher cognitive ability, which is highly influenced by healthy nutrition habits (Berezowitz et al., 2015). Academic scores are particularly relevant to this study as indicators in the long term as the negative impacts of anemia on cognitive abilities, absenteeism, and academic performance in Peru are well documented (Alcazar, 2013). As school gardens have contributed to improvements in the latter (Somerset et al., 2004; Ozer, 2007; Hutchinson et al., 2015) and are themselves variables that impact the former, the ways in which school gardens could reduce malnutrition and impact academic performance and overall quality of life should be considered. Articles examining the impacts of higher levels of nutrient diversity facilitated by school feeding and school gardening programs were also considered. This is because high rates of anemia and other micronutrient deficiencies are influenced by low dietary diversity (Gonsalves et al, 2020).

3.6 Interviews in a Semi-Structured Format

Interviews are useful in conservation issues to better understand the beliefs, values, and motives underlying the position of relevant actors and stakeholders (Young et al., 2018). The focus of the research in interviews is placed on the perception of the participants and permits an in-depth analysis from a smaller sample size (Young et al., 2018). Since I am looking at a small sample size and using verbal data, this method would be most suitable to answer my research question. Interviews are also useful when participants cannot be directly observed (Creswell, 2003), which is useful in this remote research format. Given the novelty of this research, interviews also allow for the emergence of themes and revision of questions throughout the research process. The semi-structured were also useful to verify the assumptions made in the Theory of Change (Figure 1).

Semi-structured interviews combine characteristics of unstructured and structured formats and permit a researcher to spontaneously probe the participants for topics relevant to them (Fedy, 2021). Semi-structured interviews offer more breath, depth, and flexibility than structured interviews, and provide more room for comparability than unstructured interviews (Fedy, 2021). Specifically, semi-structured interviews of key informants are most suitable for this research as they offer some form of flexibility to the researcher by probing the participants for emerging topics that could contribute to this thesis while maintaining some form of consistency across all interviews. Semi-structured interviews also permit the researcher to develop a rapport with the participants. As I am familiar with the current situation of Ica, the semi-structured format permitted me to have a better grasp of current institutional processes that influence the students in the region. Key informant interviews also help increase engagement and interest about an issue and provide the researcher with the opportunity to establish and strengthen relations with the key informants (UCLA, 2004).

Failure to reach data saturation negatively impacts the validity of a study (Fusch & Ness, 2015). However, as study designs are not universal and there is no one-size- fits-all technique to attain data saturation, a study using fewer data sets does not mean that it is lower in validity than one with more (Fusch & Ness, 2015). As this thesis focuses on a specific

case and not looking at all of Peru or other coastal regions of the country, a large sample size was not required, as it was not anticipated that a substantial number of opinions would be obtained.

3.7 Interviewing Key Informants

Interviewing key informants permits a researcher to gather information from various stakeholders, including professionals and community leaders, who possess firsthand knowledge about a particular issue and therefore could provide key insights on the nature of the problem and recommend solutions (UCLA, 2004). This method is useful in obtaining information about a specific problem faced by a community consulting a diverse set of experts well-informed on the matter. Key informant interviews are commonly used in the Sustainable Livelihoods Approach framework of development, which provide researchers with a more thorough of the present realities faced by NGOs, local communities, and other actors whose concerns are often overlooked (Krantz, 2001). Interviews of community members of Ica are particularly relevant, as they have first-hand experience with some of the school gardening projects currently implemented. As those individuals are well-informed and actively engaged in school gardening efforts, they will provide specific understanding and key insights on the viability of this localized farming approach in mitigating the prevalence of anemia not only in the region of Ica, but in other regions of Peru.

Interviewing key informants in this case study permitted me to better understand the rationale and motivation behind the efforts of proponents working with the *huertos escolares*. The interview questions were structured using deductive analysis of journal articles in the systematic scoping review, which encapsulated key themes that would best answer the research question of this thesis and aimed to encourage the participants to elaborate on the values, beliefs, and assumptions guiding their actions. In addition to the pre-determined themes obtained from deductive analysis, narrative analysis was used to make sense of the interviewees' individual responses, and to highlight novel themes and points of contention between the interview data and the findings of the systematic scoping review.

3.8 Assumptions of my Semi-Structured Interviews:

1. The identified key informants will provide information based on their experiences with the *huerto escolar* that will be relevant to the research question.
2. I have identified the appropriate target population who possesses the knowledge required to answer the research questions.
3. Experts and community members carrying out these projects have valuable insights on the local conditions and the key barriers that currently exist in adopting the *huerto escolar* in schools of Ica.

3.9 Ethics Approval

The interview data were collected between January and February 2021 following the approval of a University of Waterloo's Ethics Committee of the research methods on December 17th, 2021 (REB #43932).

3.10 Recruitment

A total of 7 participants who resided in the districts of Santiago and Parcona in Ica, Peru, were initially contacted via email. This number of participants included 5 people that I was already familiar with after working with the NGO Horizonte Corporativo from September 2019 to March 2020, representing the element of convenience sampling. Although a sample universe of 7 seems small, this thesis's goal was not to make sweeping general claims in Peru beyond Ica's context. Furthermore, participants were only selected if they currently have or have had experience working with the *huertos escolares*. The cultural awareness I developed over my time working in Ica and my pre-existing professional relationship with some of the interview participants permitted me to develop a cordial relationship with them. The pre-existing relationships between the potential participants and the student researcher based on their

volunteering experience working in Peru was instrumental in developing a cordial and professional relationship with the participants. The participants were informed in the information letter that no compensation nor remuneration would be obtained from either party for any exchange of ideas or materials, and that no contractual obligations would be present. As such, the participants were free to decline or accept to take part in the research without any repercussions. Additional potential participants were contacted through contact information made available on various social media platforms and websites.

Participants were selected if they were involved with school gardening initiatives in Peru from a labor, academical or policy standpoint. Referral contacts were also obtained through snowball sampling, where initial participants would provide suggestions on other participants of interest. Some of the initial participants then offered to contact the other potential participants on the student researcher's behalf to determine if they would be interested in taking part in the study.

A total of 10 virtual interviews were conducted via Zoom with video and audio recordings taken with the participants' consent. This sample consisted of participants representing a diverse range of professions including teachers, medical professionals, a member of the local municipality of Ica, a member of the Local Educational Management Unit of Ica (Unidad de Gestión Educativa Local-UGEL), and the Regional Directorate of Education of Ica (Dirección Regional de Educación de Ica-DREI).

3.11 Analysis of Interview Data

Firstly, the interview data were manually transcribed and translated from Spanish to English. No dictation software was used for transcription as the student researcher is fluent in Spanish. When the translated interview data were transcribed initially, quotes and phrases relating to the pre-determined themes found in the systematic scoping review were selected and grouped into distinct categories to determine if points of contention or contradictions were apparent. The analysis of the interview data focused on identifying insights on key

themes encapsulated by the research question, which included: (1) the opportunities proffered by school gardening in Ica in reducing anemia and the current barriers that may impede the efforts, (2) the resources required to implement and sustain school gardening programs, (3) the indicators used to measure the success of existing school gardening programs, (4) which native crops to Ica could be used to mitigate the disease's incidence, and (5) the suitability of the *huerto escolar* as a long-term solution to anemia in Ica.

3.12 Limitations:

Primarily, it is important to consider the ways in which I the interviewer could have influenced the responses of interviewees. Interview characteristics, like gender and race, typically affect the responses received, particularly when sensitive topics are mentioned (Fedy, 2021). The fact that I am not a native Spanish speaker, nor a Peruvian, could have impacted the attitudes of the respondents during the interviews and inadvertently influence their responses. It was challenging at times to set up interviews with participants who were hard to reach or busy given the remote research format of this study. Intra- and inter-interviewer variability is also more prevalent in semi-structured interviews compared to structured interviews (Fedy, 2021). All interview participants in z sample may also not be as equally aware, perceptive, and articulate on the issues being addressed by a researcher (Creswell, 2003). Furthermore, a researcher should remember that the perspectives provided by key informants of a specific context are not necessarily representative of quantifiable truth. Furthermore, although semi-structured interviews allow a researcher to develop a rapport with participants, it is important for the researcher to be cognisant that this could be a source of bias (Fedy, 2021). Reduced external validity and non-generalizability of results to a larger population and area are common limitations of qualitative research with a small sample size which is also relevant to this research's context. Interpretivist approaches like interviews also have lower reliability as they are difficult methods to replicate. Additionally, interpretivist methods are critiqued to lack objectivity as the interventions can be influenced by a researcher's personal assumptions and their theoretical perspectives. Furthermore, determining the 'right' number of key informants in a sample size remains a contentious issue in qualitative research (UCLA, 2004).

CHAPTER 4: Results and Discussion

4.1 Summary of Outcomes:

In this section, I summarize the outcomes and then will guide readers on the evidence that underpins this summary.

This thesis sought to determine what the locally defined perspectives are on the *huerto escolar's* potential to mitigate anemia in Ica in addition to the studies done on school gardening programs' impacts on the holistic development of children, particularly those affected by the disease. The quantitative evidence from the systematic scoping review on school gardening's potential to attain nutrition targets in globally is inconclusive and often conflicting on the programs' impacts on certain characteristics of school children. The qualitative evidence proffered from the anecdotal experiences of the interview participants and in the qualitative studies reviewed however, is promising. It was also determined that more rigorous mixed methods over larger sample sizes are required to increase research validity in school gardening impacts on students' holistic development.

School gardening in rural areas of Ica could be a favourable approach to promote the holistic development of children, but more empirical evidence is necessary to determine whether the impacts of these activities to address anemia are significant enough to eventually scale these projects in the long-term be officially regarded as a sustainable development tool. Additionally, more research is needed on the types of crops that could thrive in the semi-arid conditions of the region and provide the essential micronutrients to students, the current institutional processes that curtail the current efforts by lobbying actors like *Horizonte Corporativo*, and the ways in which actors could further engage in transdisciplinary research to move beyond the constraints of the linear pathways of the current strategies. To ensure the longevity and success of school gardening programs for pedagogical and nutrition goals, the barriers in Ica to scale these activities that include an inflexible school curriculum, the absence of committees in schools to champion the initiatives and proper training of teachers should be

addressed. Furthermore, more research is required to increase the awareness of communities on both the disease's implications on children's holistic development and the ways in which organic school gardening could mitigate these effects to increase engagements in the projects.

4.2.1 Section 1- Systematic Scoping Review Findings

A total of 30 studies were obtained through the keywords outlined in selection criteria mentioned previously. Articles that did not meet the section criteria described were excluded, together with study duplicates. A total of 10 studies that met the eligibility criteria were shortlisted and critiqued in section 3.1. The findings were then applied to the context of the *huerto escolar* in Ica in the concluding section of this systematic scoping review.

Author	Study Design	Location	Methods Used	Sample Size	Demographic	Length	Main Study Findings
Roscioli et al. (2021)	Nonrandomized	Montevideo, Uruguay	Surveys, Focus groups	665	Primary school children	2 months	Increase in agroecological knowledge, consumption of vegetables
Ferguson et al. (2019)	Nonrandomized	Chiapas, Mexico	Interviews, Focus groups, participatory experience	38	Primary schoolchildren, teachers	2 years	Small impact on schoolchildren's diet quality and school gardening knowledge but substantial positive impact on their sense of attachment to their school
Amat and Espinet (2013)	Nonrandomized	Valleneu, Spain	Formal and Informal Interviews	6	School teachers, parents	4 years	School gardening has a positive effect on community cohesion
Oostindjer et al (2017)	Nonrandomized	Global	Cross-national comparative framework	Not specified	N/A	N/A	School gardening leads to overall improvement in dietary consumption and

							nutrition status
Landry et al (2017)	Randomized	Texas, United States	Surveys, questionnaires , clinical measurements	4,239	Grades 3-5 schoolchildren, parents	3 years	School gardening paired with nutrition education and cooking in school leads to improvements in dietary choices of children.
Ohly et al., 2016	Nonrandomized	Global	Systematic literature review	40	N/A	N/A	School gardening may provide a range of health benefits to participating adults and schoolchildren
Davis et Al (2015)	Nonrandomized	Global	Systematic literature review	13	N/A	N/A	School gardening could have a positive impact on fruit and vegetable consumption, and wider positive implications on wider environmental and public health outcomes

Table 3: Table Showing Studies Reviewed, their Study Design, and the Main Outcomes.

4.2.2 School Gardening in the Latin American Context

Overall, perceptions of the importance of school gardens to attain environmental and nutrition targets are evolving. Community and school gardens in Latin American countries like Mexico are receiving more attention in response to health and environmental crises (Ferguson et al., 2019) and in developed countries like the United States (Hoover et al., 2021). Many organizations have made agroecology an integral aspect of education in Latin American regions, which has revived interests in community- or school-based gardening work to meet a broad range of environmental and human objectives (Ferguson et al., 2016). Although the benefits of agroecological systems on the economic and nutritional well-being of peasant communities in marginal environments like semiarid areas have been proven (Altieri, 1995), the benefits of agroecology on specifically mitigating anemia, however, remains to be explored. Altieri (1995) highlights several cases where NGO-led programs that used agroecology had positive impacts on food security in several South American countries, including Peru. Although preliminary qualitative analyses suggest that these programs optimized the regeneration and use of local resources, improved soil fertility, enhanced pest regulation and employment since the 1990's (Altieri, 1995), more research on the potential impacts of these interventions on human health specifically is required to this day.

Ferguson et al. (2019) highlight some of the successes, opportunities, and constraints for scaling agroecological activities to meet pedagogical and nutrition goals given the current structure of the education system in rural areas of Mexico. Although the study's central objective was not explicitly centered on agroecological practices to address deficiency diseases, the study suggests that integrating agroecology into school curriculums could expose students to healthier nutrition habits and sustainable agricultural practices from an early age, which is relevant to this thesis. The researchers' primary motivation behind the LabVida program was to train teachers to revive biocultural heritage and interest in agroecological knowledge by implementing school gardens and involving communities in the process (Ferguson et al., 2019). The modules in the integrative curriculum entailed modules on agroecological practices for promoting nutrition and health through crop diversity and the benefits of school gardening on environmental stewardship intentions (Ferguson, 2019).

Although Ferguson et al. (2019) determined that the educators' knowledge of ecological processes in agroecology did not show significantly improved following the implementation of the program, the educators' perception of traditional knowledge improved together with its value and contributions to education. Changes to the teachers' own eating habits were also notable. Ferguson et al.'s (2019) LabVida experience in Mexico, participants in Sommerset et al.'s (2019) study suggested that improvements in the students' confidence and self-esteem were observed after the students were exposed to when learning about permaculture and proper nutrition habits, and as such invested more time in the school gardens. The use of multiple research methods in this study and communication channels in this study were key in engaging stakeholders in the research process and increased the external validity of the research.

Noteworthy in the LabVida case was the claim made by Ferguson et al. (2019) that the school gardening activities facilitated a "dialogue of knowledges" (p. 735); which Ferguson et al. (2019) describe as the inclusion of knowledge and experiences from women and indigenous groups whose views are often marginalized in natural resource management affairs. Likewise in Ica, gender-responsive activities that promote the participation of girls in the *huerto escolar* could yield transformative impacts on a personal level in terms of engagement and self-esteem. Part of the successes of this project could be attributed to the collaboration of a multidisciplinary team representing various schools of thought. The evidence proffered in the LabVida Case study also demonstrates how the school garden has the potential to mobilize resources to improve literacy on agroecology and nutrition by providing schoolchildren with practical approach to what is taught in the classroom. A similar approach to nutrition education and agroecology could be taken in Ica through the *huerto escolar* to achieve anemia mitigation goals in addition to the current focus on conservation through school gardening by the local municipality and NGOs like Horizonte Corporativo.

The successes of school gardening in relation to community cohesion and increased appreciation for agroecological practices in the LabVida program led to the creation of the International Network of School gardens (redhuertos.net) in 2010, a platform designed for proponents to share their experiences associated with the implementation of school gardens

and ways to scale these activities (Ferguson et al, 2019). Such networks could be pivotal in forming alliances globally while making empirical findings and anecdotal experiences on the benefits proffered by school gardens readily available to audiences worldwide. Ferguson et al (2019) used interviews, surveys, and focus groups to answer a well-defined research question, which was to determine the barriers and opportunities present in the Chiapas region in Mexico, to scale agroecological learning through school gardening. A time frame was also provided by the researchers on the study's duration, which lasted from the 2012-2013 to the 2013-2014 school year. By using thematic coding of the qualitative data generated, the researchers reported that although teachers' knowledge on ecological processes did not show substantial improvement following the implementation of the LabVida program, teachers' perception on the value of using traditional knowledge in lesson plans became more favorable, and eating habits improved. Overall, the study's data collection and analysis processes were well reported and suggests how using multiple research methods is important to determine whether an intervention has a similar effect on different variables. However, using another school as a control would have been useful to determine the impact significance of the Labvida program on the variables observed.

Roscioli et al. (2021) sought to determine whether school gardening programs founded on agroecological principles impacted the educational abilities, agroecological knowledge, and consumption choices of primary school children aged 9-12 in Montevideo, Uruguay. The researchers employed a mixed-methods approach that included an online survey and focus group discussions. In total, 862 school children were administered a survey, and 18 focus group discussions were conducted with them. They found that the 'Programa Huertas en Centros Educativos' (The Garden Program in Education Centers) had a small impact on schoolchildren's diet quality and school gardening knowledge but had a substantial positive impact on their sense of attachment to their school. The authors declared that various econometric techniques were used to assess the impacts of the school gardens. Econometric methods involve statistical tools and quantitative data to test or develop new hypotheses in finance or economics (Hayes, 2021). Variables observed in the focus groups included environmental practice and agroecological knowledge while the quantitative analysis used

additional explanatory variables like institutional data available online, in addition to the survey data obtained in the study. Overall, the methodology and data analysis procedures were well-detailed, and any potential sources of bias were declared. Using a quantitative approach determined that the program had little influence on children's nutrition diversity and the likelihood of applying what they learned at home but showed a positive impact on their retention of ecological and agroecological knowledge. By using a theory of change as their conceptual framework, the authors suggested that this phenomenon was most likely attributed to the lack of community involvement, limited physical space, and lack of harmonization of the present school curriculum. The qualitative data proffered by the students suggested that the atmosphere in the schools was more enjoyable and conducive to learning (Roscioli et al., 2021). The study would have benefitted from interviews of persons in charge of overseeing the projects and would have been useful to verify those assumptions by being provided with immediate perceptions.

4.2.3 The Barriers Faced by School Gardening Programs in Promoting Agroecology and Healthy Nutrition Habits

Qualitative data from teachers in Sommerset et al. (2005) suggest that improvements in the overall health of children through school gardens could be achieved by the supply of nutrient-rich fruits and vegetables yielded from them, and through the immersive learning environments they provide on nutrition and environmental sustainability. Through surveys and open-ended questionnaires distributed to schools that met the stipulated selection criteria, teachers suggested that school gardens were essential in supporting healthier consumption habits, peer interaction, a supportive environment for the children, and a willingness to try other foods (Sommerset et al, 2005). Sommerset et al. (2005) also suggest that school gardens may result in increased community cohesion and enhance social and psychological wellbeing. Like the LabVida Case in Mexico presented by Ferguson et al (2019), the data suggest that classroom-based nutrition education paired with school-gardening increases information retention among students, especially those with special needs and disruptive behavior patterns which is also in accordance with Blair (2009) and Ozer's (2007) findings of school

gardening's impacts on student's social behaviors and academic achievements. However, these claims need to be supported by further research empirical research to determine how those mechanisms would work. Nevertheless, the qualitative evidence by Sommerset et al. (2005) provided valuable insight into the barriers that impeded the effectiveness of school gardening projects on nutrition and education targets which included lack of environmental awareness, vandalism, and lack of funding, which shows the value of using interviews in this type of research.

Ohly et al. (2016) performed a systematic literature review on school gardening's impacts on the wellbeing of students and the factors that promote and impede the success of those programmes. From the 40 articles analyzed, the evidence from articles that used quantitative methods to determine changes in fruit and vegetable consumption (n=21) was characterised by the authors as poor given that the data was self-reported and "limited" (p.1). Conversely, the authors described the evidence from qualitative studies (16) had more quality, which suggests that children and adults who participate in school gardening activities could experience an array of health benefits. No specific comments were on the quality of the evidence proffered from the studies that used mixed methods (n=3), however, the articles that used both qualitative and quantitative methods allowed for the authors to not only determine the statistical significance of school gardening activities on health parameters, but also to capture the factors that promoted and hindered the success of the programs which included an over-dependence on external volunteers and lack of external funding. Therefore, more research is required on ways in which school gardening programs could gradually become independent and self-sufficient. The authors provided a succinct explanation of the inclusion and exclusion criteria for the articles, the criteria used for quality appraisal, the geographic and demographic characteristics of each study, and the study design of each selected article.

4.2.4 The Impacts of School Gardening on Community Cohesion

Amat and Espinet (2013) aimed to determine if a school gardening project in a rural community north of Barcelona, Spain, could further facilitate community cohesion, and uncover some of the barriers that would impede these efforts. The authors performed 6 key-informant interviews of teachers and parents in formal and informal formats, ranging from high to low levels of practical experience with agroecology and school gardening. Although a sample size of 6 in Amat and Espinet's (2013) study seems small, it is not in this context as the school was in a small rural community in Spain and they did not make sweeping general claims beyond the case, which is the same position as my thesis. The result from their interviews suggested that the school garden had great efficacy in strengthening community relationships through the participation of students and their families in school by providing a space where they can learn together and interact outside the home. Overall, the study's data collection and analysis methodologies were well-articulated. However, the study could have benefitted from also using quantitative methods to verify those claims further.

4.2.5 The Impacts of Linking School Feeding Programs and School Gardening Activities on Children's Dietary Choices and Nutrition Status

Integrating school gardening in learning, increasing parent involvement in children's academic life, and introducing school meal feeding programs had significant impacts on the nutrition status among schoolchildren in various European primary schools (Oostindjer et al., 2017). Oostindjer et al. (2017) conducted a systematic literature review of studies done on school feeding programs through a cross-national comparative framework and focused on how those programs impacted the health outcomes of schoolchildren. The evidence from their analysis suggests that school feeding programs could facilitate healthier and more sustainable societies by promoting better consumption behaviors in children when paired with adequate nutrition education, but more robust research designs are required overall to support this claim in the long run (Oostindjer et al., 2017). The authors also claimed that school gardening plots could increase the availability of more sustainable food options and influence the

consumption choices of children when paired with proper school feeding programs (Oostindjer et al., 2017). However, the authors did not provide a clear description of how those 2 strategies could be linked through policy or practice. Although school gardening was not the focus of the article, an opportunity is presented to researchers to determine how school gardening programs could aid attain nutrition targets through the crops yielded from the garden, the more practical approach to nutrition education they provide, or a combination of both. This is because school gardens promote a more conducive environment to learning (Roscioli et al., 2021), and the nutrition choices of children are influenced by the consumption patterns that the school environment promotes (Wansink, 2004).

Davis et al. (2015) conducted a systematic literature review of studies examining the ways that school gardening programs impact the dietary choices of school children. Thirteen studies were examined after a thorough and well-defined selection criteria, and their study designs were well-articulated, but did not mention any assessment of the evidence's quality in comparison to Oostindjer et al.'s (2017) appraisal of the qualitative and quantitative data. Four of the studies analysed showed that no effect occurred on children's consumption of fruits and vegetables following the implementation of school gardening programs, but 6 other studies reported an increase in consumption. However, 7 out of 8 studies that assessed preference for vegetables due to school gardening showed an increase in preference for them. Overall, there was a consensus in the qualitative studies examined that school gardening yields desirable outcomes in the holistic development of primary school children and promotes positive environmental and public health outcomes through increased parental involvement in learning activities through the hands-on learning approach provided by the gardens, and increased food provision by them. However, not all the programs analyzed in Davis et al. (2015) resulted in increased consumption of vegetables by schoolchildren. This discrepancy opens a door to many questions. As such qualitative research methods like interviews of key informants in research contexts like these would be useful to determine if this lack of efficacy in influencing dietary choices could be due to external variables.

Landry et al. (2021) aimed to determine the impacts of the TX Sprouts program on schoolchildren's diet choices in Texas in the United States. This one-year nutrition cluster

randomized control, school gardening and cooking program aimed to improve the nutrition status of schoolchildren by influencing their dietary choices. Eight schools were assigned randomly to the program while eight others served as a control group and were studied from 2016-2019. During this time, training on school gardening, cooking and nutrition was provided to Garden Leadership Committees set up by the program managers in the intervention group. Outcome measurements included baseline comparisons of indices like the Health Eating Index prior to and following the implementation of the program activities between the control and intervention schools. Other quantitative methods including surveys and questionnaires distributed to parents and students. They found that the students in the intervention group consumed less added sugar and more vegetables after the program's implementation than the control group, and suggest that nutrition interventions, school gardening and cooking activities in schools could positively influence the consumption behavior of children.

This was concurrent with Savoie-Roskos et al.'s (2017) findings in a systematic literature review of studies examining school gardening's implications on children's propensity to consume more fruits and vegetables. Savoie-Roskos et al. (2017) analysed 14 articles, 10 of which determined that the increase in fruits and vegetable consumption of schoolchildren was statistically significant. Overall, Landry et al.'s (2021) study articulated their data analysis process clearly and the emphasis on quantitative methods provides a blueprint for program managers in Peru, if a similar trial is eventually conducted there, to follow to determine whether the influence of school gardening on key parameters is significant or influenced by external factors. The study could have benefitted from interviews to determine if external variables like parental influence or socioeconomic factors played an important role in influencing children's propensity to consume more responsibly within this context.

4.2.6 The Importance of using Mixed Methods and Adequate Sample Sizes to Evaluate School Gardening Impacts on Schoolchildren

Blair (2009) performed a systematic literature review of studies examining school gardening impacts on various parameters of primary school children in the United States. The

review's goal was to determine if the experiential education provided by school gardens could yield observable and measurable impacts on students' behaviors and academic achievements. A total of 20 articles were reviewed after providing well-articulated inclusion and exclusion criteria. The qualitative evidence from the review suggested that school children benefit from school gardening by supporting better environmental and social behaviors. Quantitative studies showed a narrower scope of benefits compared to the qualitative evidence, which include improvements in dietary choices and higher academic achievement in science subjects but did not show that social behavior or environmental attitudes of schoolchildren does not consistently increase through school gardening.

The observation that the quantitative studies did not impact schoolchildren's social behavior or environmental attitudes contrary to the more enthusiastic and optimistic views offered in the qualitative studies is intriguing. Blair (2009) also noted that the quantitative studies reviewed lacked robust sampling processes and randomly assigned control groups. This is particularly important when making conclusions as a systematic bias exists in data collection; quantitative research methods offer results that are higher in validity. To remedy aid in this discrepancy, Blair (2009) highlights Ozer's (2007) recommendation, which suggests that using a mixed methods approach including quantitative and qualitative techniques while foregrounding direct observation is necessary as implementing school gardens is not a uniform process. However, both study types in the review suggested that teachers' enthusiasm is indispensable in sustaining student engagement in the projects in the long run. Finally, Blair (2009) recommends that validated research instruments and well-designed longitudinal studies combining quantitative and qualitative elements with suitable designs should be used to improve schoolgardening outcomes research and generate rigorous empirical evidence to impact education policy, and eventually obtain more funding for the projects.

Ozer (2007) conducted a systematic literature review of school gardening programs in the United States to determine the programs' impacts on the holistic development of schoolchildren. After a rigorous screening process of the literature using a well-detailed selection criterion, 5 studies were reviewed which included quasi-experimental, pre-post, and pilot study designs. The quantitative evidence proffered regarding school gardening programs'

impacts were inconclusive and conflicting on variables like children's propensity to consume more vegetables and levels of environmental stewardship after engaging in school gardening activities. However, the anecdotal accounts provided by the policy makers, teachers, and school garden coordinators from the qualitative evidence in the review emphasize on the programs' ability to positively impact those variables among many others (Ozer, 2007). Determining the ways in which the mechanisms behind those claims work however is yet to be investigated and opens more discussions on study designs and methods that should be used to quantify them. Those claims and observations provided by actors involved in school gardening provide potential pathways for further research. Like Blair (2009), Ozer (2007) suggests that larger samples and more rigorous evaluation procedures are required to evaluate the impacts of school gardening on school children's nutrition status and cognitive development, and to increase research validity overall.

Ozer (2007) suggests that using multiple approaches to gather data on school gardening's impacts at the student and school level would be useful to reinforce the convergence of validity proffered by the various methods used. Overall, using mixed methods approaches like triangulation, which entails sourcing information and analyzing data through different methods, permits a researcher to determine whether the methodologies arrive at similar or different conclusions (Carter et al., 2014). Triangulation is also commonly used to enhance data credibility and dependability, which increases the research's external validity (Creswell, 2009). To address the conflicting findings between the qualitative and quantitative evidence on school gardening's impacts as observed in Blair's (2009) analysis, Ozer (2007) recommends that using a combination of quantitative and qualitative methods would be important to capture the new processes and social conditions produced by school gardening programs and compare those to initial baseline assessments prior to the programs' implementation. Therefore, using different methodologies to eventually test this thesis's hypothesis, that school gardening could play a role in mitigating anemia in Ica, without the resource and time constraints of a master's thesis will be useful to produce empirical evidence to support the opinion of the key informants. If the results are favorable and more research is

done over larger sample sizes, school gardening activities can be eventually scaled for the children’s benefit.

School Gardening Outcome	Studies
Promotes Healthier and More Sustainable Communities	Oostindjer et al (2017), Davis et al. (2015), Ohly et al. (2016)
Fosters a supportive learning environment	Sommerset et al (2005) Ozer et al. (2007), Roscioli et al. (2017), Ferguson et al. (2019)
Increases community cohesion	Sommerset et al (2005), Blair (2009), Amat and Espinet (2013)
Provides a more holistic approach to learning	Sommerset et al (2005), Roscioli et al. (2017), Landry et al. (2017)
Leads to overall improvement in dietary consumption and nutrition status	Sommerset et al (2005), Ozer (2007), Davis et al. (2015), Oostindjer et al. (2017), Landry et al. (2017)

Table 4: Table Summarizing the Main Benefits of School Gardening Activities and the Studies Supporting those Claims from the Systematic Scoping Review

4.3.1 Section 2: Discussion of My Systematic Scoping Review Results

This systematic scoping review scrutinized studies relevant to disseminating agroecological knowledge and practice through school gardening, and this approach’s historical and potential efficacy in mitigating malnutrition and diseases like anemia. Simultaneously, the quality of the methodologies and evidence provided by the articles that met the selection criteria was assessed. Given the heterogeneity of the research methods and experimental designs of the studies selected for review, comparing the studies’ results was challenging. Additionally, judging a study’s quality solely because it was randomized or not was not deemed necessary as many of the school gardening programs were adopted voluntarily by schools. Instead, the review uncovered some of the key barriers and opportunities that school

gardening programs face in promoting healthier consumption, which is relevant to this thesis' research question.

The qualitative evidence proffered by the systematic scoping review provided key insights into school gardening's multidimensional benefits and its potential to achieve nutrition targets through a more localized approach. The qualitative evidence on school gardening suggests that the *huerto escolar* could proffer solutions to issues relevant to the realities of Ica relating to malnutrition and be an effective pedagogical tool for native biodiversity conservation. Specifically, perspectives unanimously agree that public institutions like schools should take the initiative to address malnutrition when governmental support lacks, and that school gardens provide a medium to achieve those objectives. This is in addition to benefits relating to levels of environmental awareness, academic performance, and student engagement in learning activities demonstrated from more quantitative analyses. Although the qualitative research provided a series of public health benefits that could be linked to school gardening with some expectations that may seem idealistic in the long run, there is a lack of quantitative evidence demonstrating the improvements in children's social behavior and levels of environmental stewardship through school gardening activities. Therefore, to support the qualitative evidence highlighting the benefits offered by the school gardens, more robust quantitative evidence is required (Ohly et al., 2016). Many of the qualitative studies self-reported results and used small sample sizes and convenience sampling, which may put into question the reliability and validity of the positive outcomes reported in the perspective of the wider scientific community.

Roscioli et al. (2021) suggest that more independent and external assessments of agroecological projects in schools of developing countries are necessary as most impact monitoring and evaluation of those projects done to promote wellbeing is conducted by the project proponents, and thus be subjected to bias (Roscioli et al., 2021). Further investigation of the effectiveness of school-based nutrition programs on health outcomes like stunting and other anthropomorphic measures of young children, particularly adolescents, is also required (Oostindjer et al., 2017) together with the barriers that hinder the maintenance of school gardens and the factors affecting their longterm viability (Hoover et al., 2021). For instance,

Savoie-Roskos et al., (2017) recommend that future studies on fruits and vegetable consumption that include randomized designs and control groups should be at least a year to generate more evidence on the topic. As such, two key questions arose from the systematic scoping review: why is insufficient focus being placed on quantifying the long-term benefits of school gardening given the abundance of qualitative data that support those programs to reduce malnutrition? Could it be due to the global prevalent popularity of large-scale and commodified agricultural industry that has incrementally eroded humans' relationship with their natural environment and food system?

Perceptions obtained from the qualitative evidence in the studies of this systematic scoping review suggest that school gardens are ideal channels through which healthier nutrition habits and environmental awareness among students and the wider community could be enhanced, with further opportunities presented for agroforestry and medical research. Quantitative studies also suggest that school gardens could play an important role conserving genetic diversity and the cultural importance of native plant species (Grazioli et al., 2020) and positively influence food preferences and nutrition status overall (Thompson, 2011). Traditional communitybased gardens or '*milpa*' in Mexico for example provide a diverse set of nutritious fruits and vegetables native to the area to its users (Loyo, 2016). Like the *huerto* in Ica, the *milpa* is a sustainable farming system that hosts a variety of crops on the same plot that facilitates soil nutrient cycling and yields healthy crops. Traditional farming systems have higher genetic diversity making the plots more resilient and resistant against pests (Altieri, 2004), and do not rely on synthetic pesticides or fertilizers which eliminates the risks of groundwater contamination (Altieri, 2004; Altieri & Koohafkan, 2008; Roark, 2020). These systems do not adversely impact the ecological integrity of the original ecosystem as they resort to techniques that sustain biological processes and optimize the production unit yielded (Altieri, 1995; Pulido et al., 2008).

In addition to the spiritual and economic benefits that could arise from traditional agriculture highlighted by Pulido et al. (2008) through a series of correlation analyses, the prospective ecological benefits of such systems provide an opportunity to scale agroecology (Ferguson et al., 2020), as further dialogue between farmers and ecologists could lead to a

more participatory approach to develop and enhance small-scale agriculture. This is crucial given the urgency of food insecurity and malnutrition on a global scale (FAO, 2017; Oenema et al., 2020). To maximize diversity on the nutritional composition of crops in school gardens, plants that are well-suited to the school's present capacities and able to meet nutritional needs adequately should be selected and could be provided by local nurseries through strategic partnerships (Grazioli et al, 2020).

4.3.2 The Opportunities Presented by School Gardens for Education and Community Cohesion

School gardening and agroecological pedagogy are increasingly being recognized as viable educational methods to promote sustainability globally (Roscioli et al., 2021). Furthermore, in developed and developing countries, school gardening projects have improved the consumption habits of schoolchildren by pairing nutrition education with immersive hands-on learning approaches provided in the gardens (Davis et al., 2015; Bhattarai & Schreinemachers, 2020). School gardens in Mexico for instance have been common practice since the early twentieth century used to engage students in more action-oriented approaches to learning (Loyo, 2016). By broadening the thesis' scope to geographical locations outside of Latin America, a more diverse set of recommendations and insights was obtained to support the adoption of the *huerto escolar* in schools in Ica. The premise that this more hands-on approach to learning could have a long-term impact in developing countries on the health status of children as they proceed into adolescence and adulthood by influencing their consumption behaviours though, particularly those suffering from anemia, is yet to be supported by robust empirical evidence.

The systematic scoping review revealed that school gardening programs could impact nutrition habits and academic achievement through various pathways. School gardens offer an opportunity to bring those multidimensional interventions into fruition and play a key role in disseminating cross curricular pedagogy. Exposing students to a variety of crops and educating them about the essential micronutrients they contain from an early age regularly could facilitate the emergence of a generation of healthy consumers and shape sustainable food

choice behaviors (Thompson, 2011; Suarez-Balcazar et al., 2014; Oostindjer et al., 2017). Qualitative data from Ozer (2007) also suggests that school gardening activities strengthen children's sense of attachment to their school as they find refuge in the physical space provided by the school gardens. Ozer (2007) also found that children feel a sense of agency over their actions and well-being by partaking in school gardening activities and as such are more committed to the gardens' maintenance.

Nutrition education is a valuable tool to increase school children's consumption of a more diverse diet filled with essential micronutrients, resulting in improved cognitive ability (Grover & Choudhary, 2017; Landry et al, 2021), while lower health status is often linked to lower literacy levels (Somerset et al., 2005). Levels of dietary diversity and dietary quality are also positively influenced when high degrees of diverse agricultural production systems are prevalent (Kumar et al., 2015). Healthy eating habits in early childhood tend to persist into adolescence and adulthood when taught at an early age (Graham et al., 2005; Oostindjer et al., 2017). Therefore, the more hands-on learning approach to learning about nutrition that occurs in school gardens could make students suffering from anemia and other deficiency diseases with lower cognitive abilities more cognizant of the consequences of their consumption habits on their health. Furthermore, the positive outlook offered by the participants in the qualitative studies examined in the systematic scoping review on school gardens' potential as learning tools to surpass epistemological limitations in nutrition pedagogy suggests that this system's role should be explored further

The project-based learning that occurs in school gardens also lays the foundation for students to better understand the links that exist between the sociocultural and ecological aspects of sustainability (Ferguson et al., 2019). School gardens are ideal places to expose students to interdisciplinary content through active participation in the activities, which has shown to increase motivation and commitment to learning (Berezowitz et al., 2015). Although research on the efficacy of ecological restoration and agroecology programs in schools of developing countries focuses on outcome variables like resourcefulness, motivation and information retention, there is no published empirical data on this system's viability as a long-term solution to malnutrition and specifically anemia. Therefore, additional evidence on the

effectiveness of school gardens on children's dietary outcomes is required to scale these programs (Berezowitz et al., 2015; Hunter et al., 2020).

School gardens also offer platforms through which nutrition information could be more efficiently retained by the students (Grover & Choudhary, 2017; Landry et al., 2021) and increase community cohesion by providing an opportunity for parental involvement in children's schooling (Hill et al., 2004; Amat & Espinet, 2013). School gardening also has the potential to positively impact the holistic well-being of students through several interdependent domains, reinforcing the role that the school environment is a fundamental setting for their development (Ozer, 2007). They are also an agricultural production system yielding nutritious crops to students where access may be constrained by socioeconomic factors. This suggests that the *huerto escolar* in Ica could also provide an interface where scientific research on nutrition, ecological processes, and local knowledge could interact and yield positive outcomes for the students from academic and health standpoints. Such pedagogical strategies founded on more transdisciplinary learning approaches would favor a more holistic and critical line of thinking compared to the more technocratic and linear approach associated with the current school curriculum in Peru.

Given that the positive impacts of school gardens on cognitive abilities, student engagement and cohesion in the classroom at the primary school level are increasingly being recognized (Kibett & Kathuri, 2005; Sommerset et al., 2004; Landry et al, 2021; Hoover et al, 2021), Peru's Ministry of Education should consider formally integrating the *huerto escolar* into the school curriculum. More resources should be allocated for the implementation and continuity of the school gardens, which would permit students to be in direct contact with a food production system that is tailored to their nutritional needs. However, lack of community interest (Burt et al., 2019) lack of trained personnel, and low teacher engagement (Hoover et al., 2021) are some of the common barriers encountered when attempting to facilitate this transition in the delivery of nutrition pedagogy through school gardening. However, the bulk of the literature on the mechanisms to overcome barriers faced by school gardening programs is based in developed countries like the United States, in comparison to Latin American countries like Peru.

Overall, an explicit focus on agroecological pedagogy in primary schools could result in a gradual transition to a more participative, socially, and ecologically mindful agricultural system (Roscioli et al., 2021). School children should be envisioned as the pioneers of this transition and education has a central role in this process by producing generations that are more mindful of sustainability. In Ica, exposing school children to a diverse array of nutritious native crops in the *huerto escolar* could influence their food choices in the long term, and permit them to appreciate the cultural significance of those crops. Thus, agroecology could be used as a policy tool for sustainable development and to facilitate lasting change in Ica, and beyond.

4.3.3 The Efficacy of School Gardening Programs to Reduce Micronutrient Deficiencies

Food-based approaches should underpin current nutrition initiatives and medical systems used to mitigate anemia in developing countries, as proper nutrition habits and adequate access to essential micronutrients from an early age aid to alleviate the physiological impacts of the disease (Thompson, 2011). To support the current efforts undertaken by the Peruvian government in mitigating the disease's incidence by providing supplements to the population, this thesis suggests that school gardening could underpin these medical approaches by making communities more aware of the importance of a nutritious diet and a healthy environment for good health.

Children are more likely to consume more fruits and vegetables and able to make healthier nutrition choices when they grow their own crops due to the sense of pride attained from such accomplishments (Ozer, 2007; Gonsalves et al., 2020). Evidence from Hunter et al. (2020) suggests that this phenomenon results from the children's increased exposure to the food system, the social interaction taking place in cooking activities in schools, and the more 'hands-on' learning approach that school gardening offers to students of different cultural groups and the opportunity presented to students of various learning abilities to partake in activities. Although school gardening activities increase children's environmental awareness in developing countries, there is a lack of empirical data that substantiates the impact of

traditional agriculture programs on the nutrition status of children, and their levels of consumption of nutritious crops in those territories (Schreinemachers et al., 2020) including Peru. The benefits of school nutrition programs are also enhanced when they are integrated into wider national social programs and implemented as multi-sectoral interventions, creating positive feedback loops and synergies with existing development initiatives (Oenema et al., 2020). For instance, the school garden in Nepal was conceptually appealing to private and public actors in Nepal as it corresponded to the government's strategies to reduce malnutrition, and as such these programs were scaled in various regions of the country (Bhattarai & Schreinmachers, 2020). However, school feeding programs are also not typically linked with school gardening, as school feeding is delegated to the Ministry of Education, whereas school gardening falls under the jurisdiction of the Ministry of Agriculture (Gonsalves et al., 2020). Furthermore, approval from the Ministry of Education is often required prior to integrating nutrition-based agriculture in the school curriculum which is a cumbersome process (Talavera & de Juras, 2020).

Although supplement use has proven to be a cost-effective way to reduce micronutrient deficiencies in many developing countries, engaging in agricultural-based approaches like community gardening could be pivotal in mitigating the impacts of chronic malnutrition (Underwood, 2000). A key concern that is yet to be substantiated in the literature, however, is the school garden's ability to provide a consistent and sufficient supply of nutritious crops for the children's benefit. For instance, data collected between the start and end of the 2014-2015 school year in Nepal suggest that larger areas are necessary for school gardens to have a significant impact on the daily nutrition needs of primary school children in addition to the pedagogical aspects (Bhattarai & Schreinamchers, 2020).

4.3.4 The Importance of Training and Strategic Partnerships to Sustain School Gardening Programs

For school gardens to yield the desired impacts on the children's nutrition status, teachers will have to assume their role as project facilitators. For school gardening to be

scaled, teachers will be charged with overseeing program pathways as they are responsible to promote learning as coordinators of the agroecological projects (Espinet & Amat, 2013; Oenema et al., 2020). They will also have to be provided with the necessary training in the fundamentals of agroecology in relation to nutrition, as students who are taught by teachers trained in this field tend to have higher attitude scores and nutrition knowledge in comparison to those who aren't (Graham et al., 2005). This is important as teachers who participated in workshops in participatory planning gained the confidence to conduct seminars themselves with personnel in the school in charge of school feeding programs in the Philippines, then proceeded to engage families in the school gardening projects (Blesilda et al., 2020).

Agroecology training to teachers in my study in Ica is not currently delivered by government institutions and is predominantly undertaken by NGOs like Horizonte Corporativo and private institutions supporting school gardening efforts. This is particularly cumbersome in situations where school personnel develop a dependency on the organization spearheading the project and ultimately do not become fully autonomous in the management of the gardens where teachers' commitment is low given the lack of personal interest and incentives. The school gardening projects' primary focus in Ica is also mainly to achieve conservation targets, and some do not evolve beyond. However, the *campesino* culture in the rural areas of Ica is prevalent given the presence of several largescale agricultural companies operating in the region and as such, many parents and teachers in the region have a basic understanding of agricultural practices.

The evidence in the systematic scoping review also alludes to the importance of strategic partnerships between relevant actors in the activities generating the desired impacts of school gardening programs on the schoolchildren's wellbeing and sustaining the projects. Stakeholder collaboration in school gardening programs in rural regions could help develop and strengthen relationships with other community actors (Emekauwa, 2004). Stakeholder collaboration in school gardening programs in Ica involves a diverse range of actors that include teachers, community members, NGOs, and private institutions whom each has a key role in sustaining and monitoring the projects and assessing their efficacy to reduce biodiversity loss through strategic partnerships.

4.4.1 Section 3- Interview Results

4.4.1.1 The questions in this section were structured to obtain contextual information on the *huerto* and the candidate's perception on its implementation, and specifically to gauge the participant's perception on *huerto's* suitability to address anemia.

Most participants mentioned that the projects were introduced for educational reasons given the extensive research already done on the pedagogical benefits of school gardening activities, and specifically as an instrument to increase environmental awareness of the students in Ica. Teachers mentioned that the NGOs main goal was to specifically contribute to the restoration and conservation of native plant species to the region and increase public knowledge of agroecology through a traditional agricultural system known as the *huerto escolar*. Participants #2 and #5 mentioned that Horizonte's commitment to not using agrochemicals was appealing to them as this would be contradictory to principles of organic farming and agroecological practices, particularly considering the negative perception of the large-scale exportation model prevalent in the region,

"...centered on economic profit and complete disregard for ecology, and that cannot be sustained naturally by Ica's environment." Participant 2.

Participants also hinted at the pedagogical benefits of school gardening, in the sense that they offer a multidisciplinary approach in learning about different subjects relating to communication, English, maths, geography and cultural heritage. Participant 2 mentioned that students also learn about reptiles, birds and other fauna that return to school gardening areas after being reforested, which acts as an indicator of a biodiverse ecosystem and species richness. The participant also mentioned that a culture of agricultural work in this area exists, and these provide platforms for parents to transfer their knowledge to their children. The students' curiosity is awakened, and they go home and tell the parents how they've learned to irrigate, make organic fertilizer, and even teach the parents.

All 10 participants emphasized on the fundamental importance of proper nutrition for the neurological, cognitive, and physiological development of children before 3 years old, as it is difficult to reverse the deficiency diseases later in life resulting from malnutrition in the

initial stages of child development. 4 participants also spoke about the *huerto's* contribution to children's sense of attachment to their school and the system's ability to contribute towards community cohesion. Participant 10 noted,

"The huerto gave us the space, the opportunity for the students to involve themselves in their education, for the teachers to become closer to the students. Students developed closer interpersonal relationships that cultivated values like tolerance and respect."

Participants 4 and 7 worked with school gardening projects in two separate schools in Casma, a region north of Ica with similar biophysical conditions. Although the participants originate from a region outside of the boundaries established at the beginning of the thesis, it is believed that considering the experiences of school gardening projects in other regions of Peru could provide valuable insights on possible points of contention between the systematic scoping review's findings and increase this thesis' replicability in other regions. Both candidates mentioned that the project's main goal was to address issues of poverty, malnutrition, and food insecurity in the region, but only candidate 4 indicated that school gardening was introduced to specifically address anemia as a unified approach.

4.4.1.2 The participants' perceptions on the *huerto escolares'* suitability to address anemia.

The questions in this section gaged the participants' perception on *huerto's* suitability to address anemia. There was a consensus amongst the participants that the *huertos escolares* were suitable as they allow students to immerse themselves in a hands-on approach to learning about their natural environment." and show how a healthy and thriving environment could lead to a better quality of life overall by providing natural and healthy products to schoolchildren. Participants also mentioned that school gardening is an effective way to integrate the student into the environment where the food they consume comes from, and understand the nutritional value they contain, which according to them further motivates them to learn about the nutritional value the crops contain.

Four participants, 2 who were teachers and 2 representatives from the UGEL and DREI respectively, expressed that they would like to see more greater food diversity in state-led school feeding programs like Qaliwarma. A social protection program introduced by the Peruvian government in 2012, Qaliwarma's intended purpose was to provide nutritious foods to children during the school year, like the Vaso De Leche program previously discussed. Many households depend on this program to meet the daily nutrition requirements of school children. The participants also stated that school gardening could support the program by providing a diverse array of crops like spinach, beet and corn to the meals provided by the program that already lack a variety of essential micronutrients and minerals.

Participants 1, 3, 6 and 10 mentioned that schools in rural areas of Ica have large areas to cultivate, which provide an opportunity for parents to transfer knowledge to their children given the existing and strong *campesino* culture passed over generations given the booming agri-business industry in the region over the past century. Participants 3 also expressed that students' curiosity is awakened and they go home and tell the parents how they've learned to irrigate, make organic fertilizer, and even teach the parents, fostering a culture for students to cultivate their own food and know of the nutrition benefits. Participant 3 also mentioned that the sunny condition in Ica favors the growth of crops and the quality of the aquifer water suitable, but that the availability of this water decreasing given the intensive activities of large agricultural companies in the region.

Participants 1 and 10 hinted that the benefits of school gardening go beyond its multidisciplinary approach to education, stating that students learn about values, virtues, camaraderie, and their natural heritage. Specifically, they learn about dealing with complex issues like climate change and their agency over their own futures. Many of the participants mentioned some of the natural products obtained from organic agriculture in the school such as the huarango honey, mangoes, and native medicinal plants to name a few.

4.4.1.3 The roles of the major actors involved in the *huerto escolares*

The questions in this section were to determine the role of the most influential actors in the school gardening activities, and the best ways to increase their participation and

collaboration, according to the participants. Active or past involvement with school gardening was one of the criteria for selecting interview participants. As such, each participant represented the interests, although not as a full representative sample, of the institutions they worked for which included schools, independently contracted engineers, NGOs, Ica's local public health unit, the Educational Board of Ica, and the Local Educational Management Unit of Ica. Furthermore, participants were asked about strategies they believed to be most effective in boosting community and parental involvement in the activities, as this was determined as a precursor to successful school gardening projects in the systematic scoping review.

Eight of the participants used the term 'facilitator' and 'guides' to describe the role of teachers in augmenting the sphere of influence of the *huerto escolar* in the pedagogical and nutrition arenas. A participant justified this claim as the students follow their teachers' examples, and those teachers are the mediums transmitting the information that the NGOs develop to the students and ensuring the continuity of the projects. One participant, a member of Horizonte Corporativo, further explained that teachers need to be the coordinators between the school and the community as nowadays, parents working with kids in these activities is more secondary for them given the number of hours they work and the intensive nature of the labor.

Participants were also questioned whether training on agroecology and organic farming was provided to the teachers. When asked about the roles of the various actors, participants stressed the necessity for 'strategic partnerships' and 'alliances' between them. Participants mentioned that the involvement of local universities, ecologists, private companies, and NGOs is effective once they approach the problem on a unified front. School gardens were described by participant 4 as the place where the interests of these various groups intersect and recounted their experience in Casma where the alliance formed between the local health authority and the agrarian university was pivotal in terms of providing training to teachers and soliciting the support of the local municipality. NGO members also mentioned that they were responsible for providing the teaching materials and training to teachers who were willing and enthused by the work and stressed the importance of teachers' willingness to educate themselves in those themes given the lack of government involvement. They

mentioned that they were heavily reliant on the willingness of teachers to carry out the project based on their personal level of attachment to the activities. This is particularly important following the closure of the project after 2 or 3 years when the school is expected to carry out the activities autonomously.

Participants also questioned about the barriers that are encountered when working with teachers and encouraging them to participate. All participants mentioned that low salaries were the main factor limiting the participation of teachers in school gardening projects, in addition to some teachers prioritizing other activities. All participants mentioned that it is unrealistic to expect all teachers to work in the gardens on weekends without additional pay. Six participants also mentioned that it was difficult to engage parents in these activities as most of them in rural areas of Ica work extensive hours as laborers for the agricultural companies in the area, sometimes on weekends. It was also suggested that the lack of awareness of proper nutrition habits further compounds this issue. The NGO members, participants 2,3 and 5, further stated that it is their intention that school gardening would cultivate a more health- and environmentally- conscious culture in the homes, that the skills and knowledge would not be confined solely to the classroom but also be transmitted to the entire community and engage them. To this end however, participant 10 suggested that some parents feel that school gardens in fact serve as a distraction from what could be learnt in the classroom.

4.4.1.4 The required changes in the current curriculum

In this section, participants were asked if they believed if the school curriculum and present policies made special accommodation or is sufficiently tailored to facilitate the emergence of an anemia-free Ica specifically through the education sector. Participants were also questioned whether they believed that formally integrating the *huerto escolar* in the present curriculum would be a practical way of scaling agroecology and organic farming in Ica, to which they all agreed. However, a lack of coordination and communication between institutions resulting in redundancy between existing programs, misallocation of funding for environmental projects by the municipality.

There are many stakeholders who wish that schoolchildren would learn about different themes like conservation, but the present curriculum is not sufficiently developed to integrate those themes in a structured and consistent way, according to participant 6. The participant from Horizonte Corporativo further stated that a lack of coordination exists between stakeholders and various ministries who carry out campaigns in water conservation practices and sustainable agriculture curtail the impacts of those interventions by operating in isolated silos.

According to participant 5 from the Educational Board of Ica stated that the institution's premise for supporting school gardening was to support the implementation of more contextualized teaching methodologies to address local environmental issues. Participant 6 from the Local Educational Management Unit of Ica mentioned that there is some coordination that takes place between the Ministries of Culture, Education and Agriculture, but the problem is that municipalities don't appreciate the benefits of school gardening, and when they receive the funding, it used for other purposes. Both representatives also revealed that mitigating anemia through school gardening did not fall within their institutions' portfolio, but rather left to the Ministries of Health, Education and Agriculture for review. Participants also mentioned that this system was also not part of their modus operandi for mitigating the disease's incidence apart from projects like Qaliwarma and Vaso de Leche.

Participants 6 and 7 mentioned that in the current national curriculum for primary and secondary education, teachers have access to a budget to contextualize their lessons through different pedagogic strategies once they could prove that it is beneficial and mobilize the students' competencies. Both participants disclosed however that the amount they receive is insufficient to purchase materials and resources to sustain the *huerto* in the long run. Participant 6 mentioned that teachers who are fully invested in activities like school gardening often find creative ways to maximize the potential of this budget in creative ways like school gardening, but it is common for teachers in Ica to be transferred to other schools after just a few years, which deals a blow to the continuity of the gardens. Participant 3 also noted that the *huerto's* care is often entrusted to teachers from the STEM background, but this does not

necessarily mean that those teachers are personally invested in the issues that the garden is supposed to address, which is why Horizonte Corporativo provides training to all teachers.

Participant 2 stated that if it weren't for the pandemic, an official allocation of funds would have been made for the creation of *huertos escolares*, composting, and recycling in schools at the national level as the benefits provided by the *huertos* was increasingly being recognized, and more school-based environmental programs received funding.

4.4.1.5 Respondents' perceptions of native plant species and other crops in the *huertos escolares*

In this section of the interview, participants were asked about crops, and specifically native species, used in the *huerto* that can thrive in the semi-arid conditions of Ica while providing the essential micronutrients to mitigate the diseases' prevalence.

The *huerto escolar* implemented by Horizonte Corporativo have section dedicated specifically for native plant species of Ica, and the motive behind this strategy was of interest to the student researcher. Participants then took this opportunity to elaborate on their knowledge of organic and sustainable agriculture practices and provided many examples of plants in the *huerto escolar* which they believed were essential in mitigating anemia in Ica which included beetroot, radish, and spinach. Other native plant species mentioned by participants include the *pacay (inga feuillei)*, *tonus (pluchea chingoyo)* and the Peruvian uña de gato (*uncaria tomentosa*) which are known for their medicinal benefits according to local traditional beliefs.

Many of the participants spoke about the holistic benefits of the huarango tree, a cultural symbol of Ica. Some of the benefits mentioned include its ability to thrive to semi-arid conditions, its propensity to increase water use efficiency, and other products derived from it like its honey and flour. The NGO members, participants 2,3 and 5, stated that training was provided to the teachers about the reasons why certain crops were selected based on the organization's goals to promote greater awareness on conservation practices and the wellbeing of the students which included intercropping and the importance of a nutrient-diverse diet. Finally, all participants were probed on the role that plants and crops had in *the*

huertos escolares to address the disease's incidence. Participants mentioned products like algarrobina and other biproducts of the huarango according to local traditional medicine ways.

4.4.1.6 The source of resources and capital, and the lack of municipal support in the projects

In this section, participants were questioned on the resources they believed to be necessary to establish and sustain school gardening programs, and whether they believed sufficient financial support was provided by the local municipalities and government. This included how resources are procured and by whom, as a precursor to determining its economic viability in the long term. According to the framework introduced in this thesis, school gardening projects require adequate amounts of natural, physical, human, social, and financial capital to influence the current institutional structures and processes that would impact the vulnerability context at hand: the rural communities of Ica and specifically, the individual student.

The importance of 'strategic partnerships' and 'alliances' between the private sector, schools and nongovernmental organizations was stressed several times by participants 1,6,7 and 10 when questioned about the source of materials, finances for labour costs, and crops, due to negligent municipal support of rural communities in Ica. Member of Horizonte Corporativo, participant 3, stated that their organization provides the school at the start of the school year with the physical tools and training, as most of the teachers have experience in field work, saving in training costs. Participants 5 and 6, representing Educational Board of Ica, and the Local Educational Management Unit of Ica respectively, disclosed these institutions do not provide direct support to the procurement of materials and admitted that most school-based nutrition programs are undertaken by local private-public partnerships and the government through programs like Qaliwarma. Those institutions are primarily concerned with actors in the education sector complying with formal agreements and goals set out by the Ministry of Education and issues relating to sewage systems and teachers' unions.

Some participants reflected that teachers' low salaries further compounded the issues perpetrated by the lack municipal support of school gardening, and that the project's viability is ultimately determined by the commitment of the teachers. Participants 1 and 7 who are schoolteachers mentioned that no financial assistance nor technical was provided by the government besides small grants obtained by the advocacy efforts of Horizonte Corporativo.

All but one participant reported that municipal support for school gardening projects in Ica was negligent. Participant 4, a former principal of a school in the Casma region, reported differently on the involvement of the local municipality. They stated that the alliances formed stretched beyond the private sector and nongovernmental organizations, which included the local agrarian university providing training on organic agriculture to teachers and parents, and the local municipality supplying the necessary tools like shovels and irrigation materials given that there was an environmental program dedicated to school gardening.

4.4.1.7 Financial viability of the *huerto escolar* in the long run

Participants were then asked about the financial viability of the *huerto escolar* in mitigating the disease's prevalence, to which they unanimously agreed, citing the cultural suitability of the model (participants 1,4), its potential in strengthening household and community bonds (participants 1,2,4,10), the holistic nutrition status of students (participants 1,2,4,6,7,10). Participants 1 and 3 also mentioned that the *huerto escolar* follows an organic agricultural model that does not require the purchase and application of agrochemicals, but rather on natural fertilizers like mulch.

Participant 10, a teacher in Casma, mentioned that there are ways to monetize the produce yielded by the garden. For instance, mangoes produced by the garden were sent to a company in Lima to produce artisanal ice cream and dehydrated mangoes to be resold by the school, with all proceeds returning to the maintenance of the school garden in Casma. Participant 1 also mentioned the possibility of selling the excess organic fertilizer and recycling materials to a local depot in Casma based on their experience.

Although participant 2 agreed to this proposition, they alluded to the individual characteristics, capacities, and limitations of each school pertaining to personnel, soil health, and water availability that would limit the longterm viability. Additionally, only participant 3, representing Horizonte Corporativo, mentioned the difficulties of schools operating independently after the closure of projects, as teachers often become too dependent on NGOs, as sufficient funding is not obtained from the government. When probed further on surpassing this issue, the participant posited that a school's vision must align with the partners they are working with and would only be efficient in the long run if government policies support them. Participants 1,7 and 10 also alluded to the COVID19 pandemic, which restricted their access to the gardens, the resulting inflation of the necessary materials and the suspension of Qaliwarma, as factors to consider when determining the financial viability of the system.

4.4.1.8 Measuring success of school gardening programs and the indicators used

Participants were then invited to elaborate on the financial, ecological, and/or anthropomorphic indicators used to measure the success of the *huerto escolar*. Participants from Ica generally used a more visual approach to assessing the success of the *huerto escolar* by looking at its physical state, engagement in maintaining the garden, and the knowledge displayed by students on conservation issues, sustainable agriculture, and other pedagogic themes.

Participants 1,7 and 10 who are teachers stated that all monitoring activities were left up to Horizonte. Participant 3 from Horizonte Corporativo indicated that most the NGOs engaged in school gardening do not focus on anthropomorphic benefits of school gardening nor the involvement of health specialists given the emphasis on conservation issue. The participant mentioned that this would be important to gather more institutional support for scaling school gardening in the region. Weekly monitoring visits by Horizonte would entail maintenance of irrigation systems and compliance with recycling and composting practices. Participant 3 added that even if they had records of the nutrition status in school children, determining if improvements in the metrics used like the BMI or blood pressure were caused

by direct effect of the school gardening act activities on consumption behavior, or due to other factors relating to access to clean water, dietary supplements, or sanitary habits would still be an onerous task. The willingness of parents to allow their children to undergo tests such as blood sampling is another factor to consider according to participant 3.

Participant 2, a free-lance environmental engineer contracted by Horizonte Corporativo, reflected that the recycling and composting characterization indicators were increasingly favorable in one of the schools that Horizonte, which according to them was positively correlated with the students' participation in school gardening activities. Participant 4 from Casma was the only candidate spoke about using anthropomorphic indicators with the assistance of a local public health unit, as reducing anemia was the primary reason for initiating the *huerto escolar* in their school. The participant mentioned that a committee comprised of parents and teachers was set up to oversee the technical aspects of the garden. The medical staff came back every 7 months to review the medical charts of the students, and each indicator showed promising signs based on baseline numbers taken from the initiation of the project after the sensibilization session conducted by the public health unit in 1996.

4.1.1.9 Scaling the activities and the role of the *huerto escolar* in sustainability

Finally, the participants were probed about ways they believe school gardening and agroecology could be linked to existing programs like Qaliwarma, and the role of school gardening in addressing malnutrition and food insecurity in Peru eventually. Overall, there was a consensus that the *huerto escolar* has the potential to reduce malnutrition in rural areas in addition to other societal and institutional changes. These changes include adjustments to current school-feeding programs like Qaliwarma, greater commitment from different actors to collaborate closely to achieve similar targets, better education on proper nutrition habits, and sensitizing the public on the threats posed by anemia and the appropriate mitigation measures.

Participants 1,6 and 7 mentioned that the model fits well in Ica's rural culture and provides a practical approach to what is taught in the classroom. Participant 6 further added that a more solution-oriented approach related to the context of Ica is needed given the

present's system linearity that limits the ability of contemporary issues to be integrated into the lesson plans. Additionally, participant 10 suggested that teachers must be willing to communicate with each other and it must begin with the head of the school, as the culture of corruption and distrust in Peru is strong.

Greater commitment is necessary from the private sector to actively engage and educate communities given the government's negligence, according to participant 3. This includes a change in consumer behavior given the lack of awareness on the implications of an unbalanced diet. For instance, participant 2 highlighted that people have this misconception that a glass of milk and meat has more iron than plant-based produce, reiterating the necessity for scientific evidence adapted and made available to the community. Many of the workshops and programs hosted by the Ministry of Health are often conducted as pilot projects with no continuity, according to participant 3.

The importance of actors collaborating and aligning their methodologies to avoid redundancy in achieving an ambitious public health goal cannot be overstated, according to participants 4 and 10. Participant 4 added that task delegation at all scales must be clear and all actors should be informed and engaged through sensibilizing sessions on the goals of programs, similar to the one conducted in Casma in 1996 which they described as the critical point to their success in reducing the incidence of anemia. Participant 1 reflected on the high levels of anemia reported in their school in 2016 and expressed how the combination of the Qaliwarma program and the *huerto escolar*, originally intended to achieve conservation targets, resulted in most anemic cases in the school to be resolved. In concordance with participants 3,4,6 and 10, they suggested that the government needs to play a part and incentivize schools with adequate space to establish these gardens as they are indispensable in championing proper nutrition in rural regions of Peru, where malnutrition is most prevalent.

4.5.1 Section 4- Interview Results Discussion

The systematic scoping review data and the interview data suggest that research gaps exist between school gardening and anemia mitigation in Ica in both theory and practice. The anecdotal experiences narrated by the interview participants on the positive impacts of school

gardening were accompanied by much optimism about their ability to address the public health issue outlined in this thesis but are not supported by robust empirical evidence, which was a similar observation in the systematic scoping review. Regardless of territory, more research is required on testing school gardening impacts at the individual and school levels and determining the most optimal processes and practices that would promote beneficial outcomes, and sustain them in the long term (Ozer, 2007). In Peru specifically, determining the potential impacts of school gardening on anemia levels would require a shift from the current focus on achieving conservation goals through those activities to one that considers public health and other issues relevant to the context at hand.

The evidence proffered in this research is in accordance with Ozer's (2007) findings, that schools are an ideal setting for human development, and that school gardening could indirectly facilitate the emergence of mediational pathways to increase parental involvement and boost student engagement thus enhancing academic performance. Similarly, all 10 interview participants expressed that the *huerto escolar* could be a viable method of mitigating anemia in Ica in the long run by providing students with a space to learn about proper nutrition habits, and for them to develop environmental values by learning about their natural world. Additionally, its ability to provide crops through organic methods and little to no input from agrochemicals according to several participants (#1,3,8,10) makes it an economically viable method of food production, and a way to instill important environmental values in the schoolchildren.

4.5.2 The Successes of Casma's School Gardening Program

Burt et al. (2019) found that school gardening committees are crucial to mobilize stakeholders and volunteers and sustain engagement in the activities, delegating tasks and responsibilities in a clear manner, thus ensuring the school gardening project's continuity. These committees can identify issues in real time, determine ways to encourage teachers to engage in the activities, and organize fundraising and community outreach events. Concurrently, participant 4 in Casma suggested that the school gardening committee they

appointed achieved similar feats and were also instrumental in ensuring that tasks were clearly articulated and allocated and that activities were programmed throughout the school year.

The proposition that the involvement of the local community in the design and implementation of the projects is paramount for success (Sottile et al., 2016) was exemplified in participant 4's experience in Casma. The sensibilization session spearheaded by the local health unit of Casma described by participant 4 in their school was a pivotal point in addressing the physiological impacts of anemia in students by mobilizing parent, teachers, and other community members as active contributors to the project. This is congruent with the normative assumption made in this thesis in relation to people being active contributors to socio-environmental rather than subjects, highlighting the necessity for more community-based solutions in areas like Ica where the methodologies employed by various actors to achieve an anemia-free Ica are incongruous with those employed by higher levels of government in Peru. As per the normative assumption that rural communities must be active in the design of socioenvironmental policy, active participation of teachers, parents and community members is indispensable to facilitate a long-lasting transition towards a natural-resource management paradigm that is cognizant of ecological and human health.

4.5.3 Linking the *Huertos Escolares* to Existing School Feeding Programs like Qaliwarma

The introduction of the *huerto escolares* according to the interview participants was primarily to address the loss of native plant species in Ica. Although the main purpose of the *huerto escolares* in schools were to address conservation issues by introducing environmentally friendly agricultural systems that would cultivate a generation more cognizant of environmental interests, all participants agreed that the conditions necessary for this system to reduce anemia are present. All participants also suggested that the *huerto escolar* should be scrutinized further to supplement nationally coordinated school feeding programs like Qaliwarma, which falls under Peru's Ministry of Development and Social Inclusion's jurisdiction. Therefore, to strengthen the link between Peru's existing food and nutrition programs and its health sector, public health interventions should be linked with more

nutrition-based provision services to have a more substantial effect on children's nutrition status.

A suite of various nationally coordinated school feeding, and supplementation programs were introduced in the decades that followed Rogers et al.'s (2002) proposition that the past successes of decentralizing school feeding programs in various regions of Peru should be explored further. Although effective in the short term, the long-term efficacy of programs such as the Child Nutrition Initiative (CNI) in 2006, *Comedores Populares* and *Vaso de Leche* was significantly curtailed as they failed to address the fundamental issues that perpetuate the disease's incidence which including poverty and lack of public awareness (Acosta, 2011). In the long term, more decentralized and localized malnutrition mitigation strategies should be explored given the insufficient impact of those nationally coordinated programs, which would entail providing more resources and legal authority to municipalities and could be key in reducing the incidence of anemia and developing institutional capacity to sustain those projects. In the meantime, 3 interview participants suggested that failure to link current school feeding initiatives to the *huertos escolares* could be a missed opportunity to increase the sphere of influence of these programmes.

Oostindjer et al. (2017) suggest that more research is necessary to determine if school feeding programs have a significant impact on the eating habits and health of children, and their physical health when attaining adulthood. However, research also suggests that pairing nutrition education with school gardening, and linked to current meal plans, could be winning a combination for nutrition targets (Gonsalves et al., 2020). Supplement use has proven to be a cheap and effective way to reduce micronutrient deficiencies in many developing countries but could be amplified through the collaboration of actors in more agriculture-based approaches like community gardening (Underwood, 2000). Therefore, strategies used to mitigate the impacts of anemia like stunting in children in Peru should not solely rely on supplementation (Rogers et al., 2002), but also should consider more community-based outreach and education programs together behavior change campaigns that promote healthier nutrition habits (Acosta, 2011). These behaviors change strategies should be informed by the research done on the available resources, specific practices, and cultural, social, and physical constraints

existing locally (Rogers et al., 2002). Through project-based learning in the school gardens, relevant to the social realities of the context and facilitated by teachers knowledgeable in agroecology, school gardens could act as a suitable channel to facilitate and achieve desirable nutrition outcomes in the intended target group. Some of the pathways that could work in Peru to attain these objectives through school gardening discussed in the systematic scoping review include higher awareness levels in communities of what constitutes a balanced diet, and the Peruvian government formally recognizing the *huerto escolar* as a nutrition-based program in addition to existing initiatives like Qaliwarma. Six of the interview participants proposed the possibility of linking existing school nutrition programs like Qaliwarma to school gardening to increase the dietary diversity of school children.

Although the impacts of Qaliwarma on the nutrition status of Peruvian school children have been significant in its 10-year existence in reducing the national anemia index in Peru and improving students' educational experiences through an enhancement in their ability to focus and learn (Diaz, 2020), the government should re-evaluate its current legal and administrative framework to boost its efficacy in mitigating anemia provided to the children does not actually harm them. This is considering an incident in 2020 where cans imported from the United States intended for the consumption of children under the program were chemically compromised and posed significant threats to children in the early stages of their development (Diaz, 2020). To address the lack of nutrient variety in current school feeding programs like Qaliwarma, more stringent requirements should be established so that local producers, enterprises, and companies who adhere to food quality standards and acquisition procedures are awarded the contracts. Furthermore, Qaliwarma use the *huertos escolares* program in some districts, but the continuity and overall success of those programs is dependent on the commitment of the persons in charge of those in individual sites. As Qaliwarma falls under the jurisdiction of Peru's Ministry of Development and Social Inclusion, more effort is required by the Ministry to investigate the pedagogical and nutritional benefits of the *huertos escolares* to increase multi-sectoral engagement in the projects and scale them.

When smallholder farming is linked to school meals, supply chains can be shortened, and food procurement diversified, which in turn supports more sustainable agricultural

systems, and if formally institutionalized, could be integrated into wider social-protection programs at the national level (Oenema et al., 2020). School feeding programs like Qaliwarma offer policymakers with an opportunity to create partnerships with local farmers in Ica who pursue organic agriculture to supplement the meals with healthy produce, offering schoolchildren a more nutritious diet, offer additional income for the farmers, and ultimately supporting more sustainable agricultural practices in the region. Although the Peruvian government in 2017 renewed its commitment to address anemia by introducing legislation that made the disease's incidence an intersectoral priority (Berky et al., 2020), this legislation does not explicitly endorse linking school feeding programs, school gardening, and local farmers to mitigate the disease's prevalence, and how they can be integrated into existing programs like Qaliwarma. Additionally, the overall effectiveness of existing government programs is curtailed by the lack of proper monitoring and assessment criteria at the national and regional levels to assess their efficacy, which reiterates the need for more involvement of communities in monitoring activities for program efficacy and durability (Berky et al., 2020). This is congruent with Participant 3's comment from Horizonte Corporativo who suggested that small-scale organic farmers could also be sub-contracted as new suppliers by the local municipality for schools under the condition that they practice organic farming, in accordance with the NGOs *modus operandi*.

4.5.4 The Importance of Transdisciplinary research and Collaborative Learning

Stakeholders are limited in their individual capacity to solve complex sustainability challenges (Armitage et al., 2019) and as such, this thesis' conceptual framework advocated for the importance of transdisciplinary research in achieving the desired outcomes on children's health by engaging in school gardening projects in Ica's rural schools. This is especially relevant as school gardens act a platform for various actors from both the scientific and non-scientific community representing the interests of school children to interact and employ a methodologically pluralistic approach to achieve common goals. Acting as a knowledge interface, the *huerto escolar* is also instrumental in bridging knowledge and communication gaps existing between public engagement, policy, and science in natural resource management.

They could also provide a place where a sense of connectedness to the environment could be developed (Twiss et al, 2003). Participant 10 noted,

“The huerto gave us the space, the opportunity for the students to involve themselves in their education, for the teachers to become closer to the students. Students developed closer interpersonal relationships that cultivated values like tolerance and respect.”

The successes of school gardening in schools of Casma and Ica as described by participants 4 and 1 respectively in relation to the students’ attachment to their school, together with the improvements in their physical health and education reaffirm that achieving success in school gardening is more likely when actors collaborate from the planning stages to the monitoring phases of the activities. Social capital, which encompasses the networks that exist between a person or groups in each society, is enhanced through ecological restoration when community members work together, which could yield positive impacts on public health (Aronson et al., 2016). As such, to address public health issues like the prevalence of anemia that are influenced by multiple socioeconomic variables and complex issues like systemic poverty, emerging scholars should be trained to work and communicate across disciplinary boundaries.

In the Master of Environmental Studies program at the University of Waterloo, the School of Environment, Resources and Sustainability foregrounds transdisciplinary research in their graduate courses, describing the concept as a more integrative and holistic method to address wicked problems relating to food insecurity, poverty, and climate change. Training scholars in transdisciplinary sustainability is required to address complex socioecological challenges as stakeholders are limited in their individual capacity to solve them (Armitage et al., 2019). Both the interview and systematic scoping review data allude to the importance of transdisciplinary research in achieving the desired outcomes on school children’s wellbeing through school gardening. Enquist et al. (2017) describes the transdisciplinary approach as,

“...the nexus where knowledge meets action and is situated at the intersection of a broad spectrum of institutions and information pathways where scientists, practitioners, and stakeholders work together to build trust and to develop ideas, products, and outcomes that

are accessible, actionable, shaped by all participating parties, and can be readily used in decision making.” (pg.541).

Schools can aid in fostering partnerships with community partners in rural regions and facilitate further research on natural resources between researchers from various disciplines (Emekauwa, 2004). Transdisciplinary research and collaboration involving health care practitioners, professionals, and restoration scientists are recognized as important prerequisites for any public health objective to succeed through conservation approaches (Aronson et al., 2016; Breed et al., 2020). The synergy resulting from unified approaches between actors representing various disciplines to achieve a common goal could help bridge the existing gaps between the domains of restoration ecology, public health, and ethics. Health professionals and restoration ecologists should take part in collaborative learning to create long-lasting partnerships and create a shared understanding for more effective interventions (Breed et al, 2020). Public participation and environmental education are also essential in facilitating long-lasting change toward an ecosystem restoration practicum that is more mindful of human health (Aronson et al., 2016), which is a core aspirational outcome of this research, using a school gardening approach.

Acosta (2011) suggests that stunting rates in Peru induced by anemia are a symptom of persistent cumulative deprivations relating to adverse economic status and inadequate educational opportunities. Mitigating the risks imposed by these systemic issues on children’s wellbeing through school gardening requires close collaboration with the medical community to incorporate suitable indicators to quantify the benefits of this approach on students’ health and compel local authorities to support this approach to mitigating anemia. Qualitative analysis of persons involved in these projects as shown in this thesis could also be useful in understanding the drivers underlying the disease’s prevalence locally and tailor school gardening activities accordingly. As observed in participant 4’s experience in Casma, parents, and teachers were well-sensitized on the potential benefits of school gardening when presented with scientific research by the local health authority, which catalyzed the required investments in time and financial resources by multiple actors. This led to a dramatic reduction of anemia levels in the school over the decade that followed, which was determined by

consistent hemoglobin tests and the incidence of stunting in children at the start and end of academic terms. The involvement of the public healthcare workforce in conservation efforts could also facilitate the inclusion of those activities in discussions surrounding socioeconomic and environmental policy, by communicating and interpreting scientific research in a way that is appreciated by the public (Aronson et al., 2016). Therefore, collaborations and strategic partnerships between ecologists, communities, and health specialists in Ica could provide further insight and empirical evidence to support the establishment of school gardens which could incrementally influence the perception that Peruvians of their natural environment and its ability to address public health issues like anemia.

4.5.5 The Creative Educational Opportunities Offered by School Gardens and Their impacts on Schoolchildren's Character

A shift away from current education systems that deliver subjects in isolated silos to models that provide hands-on problem-solving opportunities relevant to the students' reality could minimize the risks imposed by systemic issues like poverty and chronic malnutrition. Learning about agroecology and applying its principles through experimental learning develops a child's critical thinking abilities about how sustainable agriculture is practiced and its implications on their own development (Roscioli et al., 2020). School gardening and agroecological pedagogy are increasingly being recognized globally as viable educational methods to promote sustainability (Roscioli et al 2021). Furthermore, in developed and developing countries, school gardening projects have helped improve the nutrition habits of schoolchildren by pairing nutrition education with immersive hands-on learning approaches (Somerset et al, 2015; Schreinemachers et al., 2020).

School gardens in Mexico for instance, have been a common practice since the early twentieth century used to engage students in more action-oriented approaches to learning (Loyo, 2006). By broadening the scope to geographical locations outside of Latin America, a more diverse set of recommendations was obtained to support the adoption of the *huerto*

escolar in schools in Ica. The premise that this more hands-on approach to learning could have a long-term impact in developing countries on the health status of children into adolescence and eventually adulthood though, particularly those suffering from anemia, is yet to be supported by robust empirical evidence.

The project-based learning that occurs in school gardens lays the foundation for students to better understand the links that exist between the socio-cultural and ecological aspects of sustainability (Ferguson et al., 2019). School gardens are ideal places to expose students to interdisciplinary content through active participation, which has shown to increase motivation and commitment to learning (Berezowitz et al., 2015). Although research on the efficacy of ecological restoration and agroecology programs in schools of developing countries focuses on outcome variables like resourcefulness, motivation, and information retention, there is no published empirical data on this system's viability as a long-term solution to malnutrition and specifically anemia. More evidence on the effectiveness of school gardens on children's dietary outcomes is also required to scale them (Berezowitz et al., 2015; Hunter et al., 2020).

Participant 5 who works for the DREI (Dirección Regional de Educación de Ica) expressed that incorporating the *huerto escolar* would be an onerous task to specifically address anemia as the current focus for school gardening in Ica is geared towards biodiversity loss mitigation, and that this approach for nutrition education has not been formally recognized by the state, although local perceptions of the system's suitability are favorable. Furthermore, Hoover et al. (2021) found that the assumption that teacher engagement in school gardening would be bolstered if the system were to be recognized formally in the school curriculum needs to be assessed given that teachers already have low salaries. This claim was also made by 6 of the interview participants in this study, 2 of whom suggested that a formal integration of the *huerto escolar* would result in a more direct and effective approach to reducing malnutrition that is prevalent in Ica. Additionally, most of the low cost or free school gardening curriculum made available online to schools of the United States do not focus on nutrition and health in comparison to the attention given to implications of school gardening on the dissemination of STEM pedagogy. Similar resources are not made available to

Peruvian schools at the same scale and therefore, more research is required on the specific mechanisms necessary to facilitate the integration of the system in the curriculum within the Peruvian context.

School gardening projects could also make students feel more attached to their school and make them more likely to adopt the institution's values and visions (Resnick et al., 1997; Ozer, 2007). A study conducted by the National Longitudinal Study of Adolescent Health in 2007 showed that adolescents who took part in school gardening showed lower levels of aggression and emotional distress and reported feeling more connected to their school (Resnick et al., 1997). Attile et al. (2016) also found that teachers and students were more engaged in school gardening when crop varieties and garden management methods were most aligned with the context's culture. This analysis suggests that a bond that may be formed in this microsystem between the teachers and students through school gardening and the strengthening of values relating to proper nutrition and environmental stewardship intentions could serve as a key process in fostering more resilient rural communities in Ica.

4.5.6 The Importance of Indicators to Quantify School Gardening Impacts on Children's Health

Although systematic scoping review suggests that school gardening's potential to specifically achieve nutrition targets is generally inconclusive and requires research designs that are more rigorous over larger sample sizes, the qualitative evidence proffered by the interviews on school gardening outcomes is promising. The evidence of school gardening activities in improving socioecological sustainability have been mostly anecdotal and not sufficiently supported by an equivalent amount of empirical evidence, and therefore, a more subjective assessment of program efficacy was a phenomenon apparent in the interviews. Using an epistemological pluralism approach, one that entails a mix of qualitative and quantitative methods to test a hypothesis, is therefore recommended to assess the impact of school gardening on the intended beneficiaries to increase research validity and eventually influence policymaking. This is fundamental since it is more likely that transformational changes in governmental processes, policies, institutions, and human behavior would occur when the links between ecological and human health are made explicit and supported by

robust empirical evidence (Breed et al., 2020). If school gardening for anemia mitigation is eventually proven effective through indicators in Ica, a robust empirical base could be formed, and the interventions could be replicated in other regions of Peru.

School gardening objectives in developing countries, generally focus on increasing the availability of food to children, are often not made explicit amongst actors and institutions (Sottile et al., 2016), which makes it more difficult to formally integrate school gardening activities in the school curricula (Sottile et al., 2016). Participant 3 suggested the lack of public engagement, support from government organizations, and unclear approaches to attaining objectives in school gardening programs limits the continuity and impact of those activities. Additionally, participant 3 from Horizonte Corporativo mentioned that school gardening programs are often conducted as pilot projects that last no more than 3 years. Limited program continuity is further compounded by the lack of intersectoral involvement from institutions that possess the empirical expertise to assess success and publish findings and consequentially, success is often subjectively determined by the proponents of school gardening projects. Participants #3 and #6 also argued that the lack of coordination between organizations aiming to achieve a similar objective often curtails the effectiveness of the interventions. Participant #3 further added that this communication barrier is also present at various scales; from task delegation between teachers in a specific school to nationally coordinated programs spearheaded by Peru's Ministry of Education, the Ministry of Agriculture, and the Ministry of Development and Social Inclusion.

The close collaboration between Casma's public health unit and Participant 4's school provided anthropomorphic data from children that quantified the school gardening's activities impacts on their health. Besides the indicators used by the local health unit of Casma mentioned by participant #4 which included the Body Mass Index (BMI), hemoglobin levels, and heights to measure stunting levels induced by anemia, participants who were NGO members and schoolteachers relied on their own observations to evaluate success. These included the ways in which the children performed in schools, their interpersonal relationships with their peers and the aesthetic state of the garden. Participants who were teachers (N=4) also mentioned that school gardening had an evident and positive impact on the willingness of

students to consume vegetables when they were involved in the planting and maintenance processes, an observation congruent with Gonsalves et al. (2020) and Huys et al. (2017).

“There was less violence, the rashes on the students’ faces were disappearing, the obesity rates weren’t as high. A local supermarket also reported to us that parents were buying more fresh produce after being made aware of what was taking place. Overall, there was general sense of happiness.” - Participant 4

Establishing benchmarks for both social and ecological parameters is important to assess the efficacy of conservation interventions and should be incorporated along with a project’s duration (Prach et al., 2019). Furthermore, it is important for scientists and proponents to collaborate from the inception of a project to cogenerate relevant indicators or metrics to assess the success of the intervention overall (Cooke et al., 2020). Establishing indicators congruent with the initial objectives of the school gardening in Ica is necessary to compare program efficacy between different school gardening projects, determine which approaches are most suitable to achieve those objectives, and to obtain additional financial support if results are favorable.

Once the effectiveness of these agroecological interventions in attaining initial goals relating to nutrition status are made known and made available to policymakers, an opportunity to scale these activities to other schools and regions of Peru could arise. In accordance with Altieri (1995), 7 interview participants suggested that scientists must collaborate to measure the successes or failures of these agroecological projects. For instance, the involvement of public health officials in Casma’s school allowed for key parameters of children’s health to be measured and compared to baselines consistently and to determine whether the key attributes responded positively or negatively to the *huerto escolar*. Additionally, the mobilization of parents, teachers, and the local public health unit before the implementation of the *huerto* was key in ensuring that this was not another pilot project that would be eventually neglected by a general lack of engagement.

Overall, given the lack of field data in both developed and developing countries, more research on quantifying the impacts of agroecological projects like organic school gardening on the nutrition status of schoolchildren and adolescents, and specifically anemia is necessary. Assessing micronutrient status in human nutrition is not a straightforward process as determining anemia levels is highly contingent upon other factors besides anemia prevalence including deficiencies in copper and folic acid, tuberculosis, and the reproductive demands of women (Nubé & Voortman, 2011), and wider socioeconomic factors like poverty (Berezowitz et al., 2015). As such, it is important for these programs to be regularly evaluated and monitored in collaboration with the scientific community which could inform future programs in other regions if proven effective. The *huerto escolar* would also permit the results of scientific research to reach the students, who are the intended beneficiaries of this thesis in an impactful way. The evidence could then provide advocacy groups with the evidence necessary to spur the local municipalities to further support efforts to mitigate anemia in the region.

4.5.7 Addressing the Barriers Impeding the Efficacy of School Gardening Projects on Schoolchildren's Well-Being

The qualitative and quantitative studies in the systematic scoping review revealed that school gardening yields positive impacts on academic performance (Berezowitz et al, 2015), willingness to learn (Blair, 2009; Ohly et al., 2016), and consumption choices of children (Thompson, 2011). Evidence also suggests that school gardens could also impact their environmental stewardship intentions, and self-esteem levels (Somerset et al, 2005), and improve their social development (Berezowitz et al., 2015). However, more research is required in identifying strategies and barriers to sustaining school gardening activities successful in improving the general health of school children and maximizing their overall reach (Davis et al, 2015; Hoover et al, 2021).

More robust data collection methods in school gardening programs are also required to enhance their effectiveness and appraise their role in sustainability efforts, as their absence take away the multidimensional benefits they can have on society (Sottile et al., 2016).

Although the school gardening strategies' main goals examined in the systematic scoping review were not to specifically address anemia, the detailed description of the study design provided by researchers to measure outcomes relating to health status could be eventually applied to more quantitative study designs to test the hypothesis posited by the studies in the systematic scoping review: that school gardening in Ica could be effective in mitigating anemia, in addition to the other more empirically demonstrated and consistent benefits of school gardening relating to academic performance (Berezowitz et al., 2015; Roscioli et al., 2017).

The evidence from the interviews suggests that the projects' success is dependent on the teachers' commitment to act as facilitators of the activities. Low salaries, lack of personal interest in environmental projects, and lack of awareness of the implications of anemia were some of the main factors discussed by the participants that impede the participation of teachers in the projects and the overall success of the school gardening activities. Aware of the financial constraints faced by teachers due to low salaries, participant 4 suggested that the presentation provided in 1996 on the threats posed to the children suffering from anemia would be the most suitable avenue to appeal to them and parents.

"We always intended for parents to be part of these activities, and it's been very difficult, but their participation is fundamental to the success of our efforts. Teachers are central in these activities; they need to educate themselves as there is no involvement from the government."

Participant 1

Designing education materials on agroecology in engaging and effective ways to encourage a more holistic understanding socio-ecological processes is challenging (David & Bell, 2018). Providing training to teachers and community members involved in the *huertos escolares* on those principles, overall, will be crucial for schoolchildren to assimilate and apply those mechanisms. The interdependencies that exist between natural resources, ecosystems, and wider society should be clearly articulated in undertaking conservation work with various stakeholders (Beresford-Jones et al., 2010), which is important when working with school gardening programs that aim to change nutrition behaviours and people's perceptions of their natural environment. Therefore, school gardening program leaders should design training

programs that would make teachers more capable of delivering lesson plans to children that make the links between sustainability, health, nutrition, and agriculture explicit to fulfill the intended objectives (Sottile et al., 2016).

Another key concern would be determining ways to spur the local authorities to integrate the *huerto escolar* into the current framework of anemia mitigation measures where the model is already employed by the DREI (Dirección Regional de Educación de Ica) for ecological restoration and conservation targets and conducted by NGOs like Horizonte Corporativo. Additionally, given the disparities in teachers' and students' commitment levels to the school gardening activities due to lack of personal interest or financial incentives as highlighted by 6 interview participants, more community-outreach and sensitizing activities are required to raise the awareness of all stakeholders on the long-term implications of the disease, together with the multidimensional benefits yielded by school gardening. The empirical evidence that supports the positive implications of school gardening activities on schoolchildren's learning outcomes should influence the way community outreach materials are designed and be delivered in a way that is adapted to the target audiences, ranging from the local farmer to the policymaker in Ica.

"We believed that these small-scale and organic plots serve the best interest of the environment and people in comparison to the large-scale system dominant in Ica. The fact that Horizonte wanted to show locals that they could use their environment for their benefit appealed to me, and I was onboard since they mentioned it to me the first time."- Participant 1

As it is common for school gardening projects to last up to 16 weeks (Savoie-Roskos et al., 2017), these projects together with impact evaluation programs and monitoring activities need to be carried out over several years if they were to determine if school gardening activities have a significant impact on the physiological, cognitive, and behavioral characteristics of schoolchildren. As the *huertos escolares* initiated by organizations like Horizonte Corporativo typically last no more than 3 years according to participant 3 from the

organization, training teachers on gardening monitoring procedures is important to maximize project continuity and reduce the dependence on external actors which was described as a barrier to school gardening effectiveness. Involving researchers from the scientific community is also important for conducting regular assessments with baseline condition comparisons to determine if a school gardening project is on track to meet its preliminary targets and its financial long-term viability.

Maintaining school gardens in the United States is expensive, often requiring frequent appraisals on their cost-effectiveness (Oostindjer et al, 2017). Experiences in the past decade in developing nations however show that the economic, social and health gains obtained from investing in needs-based nutrition programs like school gardens far outweigh the initial costs (FAO, 2017). When nutrition-specific interventions are enacted at appropriate scales and made a key objective in applicable sector policies, micronutrient deficiencies and stunting levels can be dramatically reduced soon, by nearly 20% (FAO, 2017). Therefore, nutrition-sensitive agriculture programs should be implemented and managed at the municipal level as these initiatives are best managed locally by collaborating actors (Gonsalves et al., 2020). Furthermore, to optimize the delivery of lesson plans, school gardening program leaders should design training programs that would make teachers more capable of delivering material to children that make the links between sustainability, health, nutrition, and agriculture explicit to further engage the students in the activities. (Sottile et al., 2016).

An intriguing observation made by Sottile et al. (2016) of an organic school garden is its ability to be established at relatively low costs and with minimal manual labour, while the emphasis on the input of organic fertilizer like compost presents an opportunity to instate a more optimal use of resources and reduce nutrient loss from the system. This was reaffirmed by interview participants who affirmed that the financial viability of the *huerto escolar* is ratified by the adaptation of native species to the semi-arid conditions (participants #1,2,5,6,10) of Ica and the abandonment of expensive synthetic fertilizers (#1,2,3,6,10). However, some of the main barriers mentioned by the participants in this regard were: 1) the costs of clearing debris from spaces in the schools, 2) the procurement of water pumps and drip irrigation materials, and 3) the lack of commitment by some teachers.

4.5.8 The *Huerto Escolar's* Ability to Reinstate Schoolchildren's Attachment to their Land and their Food System

Sottile et al. (2016) also found that youth in developed and developing countries are steadily becoming more distant and unfamiliar with the source of the food they consume, inducing a lack of appreciation of the importance of ecosystem complexity. Furthermore, traditional crop varieties intended to support ecological processes and ecosystem services in organic farming are perceived as unattractive, old-fashioned, and unprofitable compared to commodified-exportable crops (Kahane et al., 2013). It is possible that this detachment contributes to nutritional imbalances that result in diseases like anemia and the erosion of traditional culture in developing countries. Additionally, the large-scale agriculture model in Ica is founded on the accumulation of wealth and an under-regulated system of resource extraction inherited from the colonial epoch (Vera Delgado, 2015) which continues to widen the existing socioeconomic disparities induced by unequal water resource access in Ica (Oré, 2013).

On the other side of this production continuum lies the nutrition-smart agriculture model outlined by Swaminathan (2002), which aims to maximize agricultural intensification sustainably by using conservation agriculture methods with a focus on nutrition. This approach involves crop rotation, mulching, and intercropping (Beuchelt & Badstue, 2013) which are all features of the traditional *huerto*. The variety of plants utilized in this school gardening system in different sections allows facilitates its nutritional potential. More precisely, Swaminathan (2012, pg.2) describes nutrition-smart agriculture as a system that, "*involves the design and adoption of cropping and farming systems which can provide agricultural remedies to the prevailing nutritional maladies*". These features could be consolidated in existing *huerto escolar* as a suitable and context-specific approach to mitigating the disease's incidence in the target population while contributing to local conservation needs. Furthermore, in terms of supplementation, studies have shown that vitamins and minerals isolated in supplements do not have the equivalent effects of those obtained from fruits and vegetables (Thompson, 2011)

Traditional fruits and vegetable varieties play an important role in securing the health of indigenous and rural communities globally (Kahane et al., 2013). An emphasis on traditional crops also permits children to reconnect with traditional knowledge thus promoting a sense of biocultural heritage when such varieties are incorporated into school gardening plots (Gonsalves et al., 2020). However, as mono-cropping farming systems become increasingly mechanized and market demands soar, fewer crop varieties are produced which results in reductions in biodiversity levels and loss of traditional knowledge (Kahane et al., 2013). Exposing youth to traditional crop varieties through organic farming could incrementally reverse this loss of traditional knowledge by educating them on the contributions of these crops to a healthy diet and their functions in sustaining biodiversity (Reyes-Garcia et al., 2013) given traditional farming systems' benefits on pest regulation and soil nutrient cycling (Altieri, 1995). The emphasis currently placed on organic practices and the use of native species in the *huerto escolares* implemented by Horizonte Corporativo, together with the lesson plans designed by scientific experts, could make students more appreciative of traditional ecological knowledge and agricultural practices' value on their well-being. Instilling these values over generations could incrementally result in communities that are even more engaged in addressing systemic public health issues like anemia and understand how the *huertos escolar* could be at the vanguard of community-based interventions for the disease's mitigation given the lack of municipal support.

As one of the experiences provided by an interview in Armitage et al. (2019) relating to the public's attitude towards urban green spaces, public perception of school gardening projects and the importance of the native crops in this thesis's Theory of Change were identified as important leverage points in implementing and sustaining these activities in the long run. Therefore, actors need to find ways to make the communities more cognizant of the benefits of non-commodity crops in meeting nutrition outcomes and addressing future environmental challenges and articulating how integrating agriculture and biodiversity is beneficial for sustainable food production (Thrupp, 1998). An approach emphasizing community education to make Ica's population more cognizant multidimensional benefits of

school gardening is also necessary to eventually achieve this thesis's aspirational outcome, which is to eventually make the region anemia free.



Figure 3: Many schools and communities opt to burn plastics and other materials due to the absence and inconsistency of proper waste management plans by the local municipalities. On the left is an example of the 'Quemar es limpiar' (to burn is to clean) approach. Figure 4 (right) showing backhoe cleaning terrain. Soils like these covered with little vegetation and littered typically possess little to no organic matter. Pictures taken in the district of Santiago, Ica by Kealan Branellec, December 2019

4.5.9 Main Features of the *Huerto Escolar* and The Role of Native plants Species



Figure 5: Showing a huerto escolar in I.E La Maquina, Parcona District, Ica. Vegetables and fruits are intercropped in the middle, and perennials on the right. Photo taken by Kealan Branellec in February 2020

The pods and leaves of the huarango are rich sources of organic matter and nitrogen, and that can be used for mulching if left to decompose in-situ or for consumption by humans (Beresford-Jones et al., 2010). The huarango (*Prosopis limensis*) and another native tree called the pacay (*Inga feuillei*) have deep roots and consume water conservatively, provide natural forms of biocontrol, provide a windbreak system to mitigate wind-induced soil erosion, and promote nutrient cycling for the benefit of other nitrogen-fixing vegetables (Beresford-Jones et al., 2010). Additionally, participants 1,2 and 6 mentioned the healing properties of algarrobina, a product derived from the huarango. Algarrobina is a traditional medical tonic with a high vitamin B5 content used to treat anemia in women and children in Ica (Depenthal & Yoder, 2018). This product, however, has become less available in Ica given the extensive deforestation of the huarango for charcoal and domestic consumption of firewood (Depenthal & Yoder, 2018). Raising community awareness of this natural medicine by incorporating the huarango in the *huerto escolar* could provide children suffering from anemia with access to

this product while contributing to the current conservation efforts of this tree given its importance to ecological processes.

The cultural and ecological significance of the huarango, and its ability to thrive in the semi-arid conditions of Ica makes the tree a key element of agroecological systems in the region. The huarango's extensive root system increases moisture in the soil by capturing fog precipitation through its brachyblasts clusters with tiny fine hairs and leaflets (Beresford-Jones et al., 2009). Huarangos that have lived for over a thousand years have been discovered in Ica and are a cultural symbol in the region (Beresford-Jones et al., 2010). Participants 1, 2, 4, and 7 alluded to the importance of community events or *ferias* like the annual Huarango Festival to promote the cultural links that exists to the natural environment in Ica by celebrating the importance of the tree and its byproducts like algarrobina. Thousands of the tree's seedlings are distributed to the public at the Huarango Festival each year and is one of the leading methods to promote conservation efforts of the species according to participant 6.

As opposed to monoculture, intercropping and crop rotation of various crops enhance nutrition diversity and sustain soil fertility (Beuchelt & Badstue, 2013). Given the Ica's fragile desert ecology, combining native vegetation with crops is the most optimal form of sustainable agriculture as this facilitates nutrient cycling, enhances soil fertility, and supports ecosystem resilience (Beresford-Jones et al., 2010) while yielding crops beneficial to human health. As the region also experiences warm temperatures throughout the year, a substantial amount of water can be lost to evaporation. Therefore, the application of mulch from the huarango and other pruned vegetation can help in retaining moisture following flood irrigation which is a common practice in the *huertos escolares*. As using multiple cropping designs in traditional agriculture increases vegetation, thus protecting the soil and enhancing constant crop production (Altieri, 1995), using mixed cropping and crop varieties is important for not only the *huerto escolar's* durability but also for school children to access a diet that is more nutritionally diverse. Adapting to changing environmental conditions induced by climate change in arid regions like Ica should also encourage a focus on using native crops that are genetically adapted and would thrive with local soil and climatic conditions. The shift primarily entails moving away from the dominant unsustainable monoculture model driving biodiversity loss

and climate change, to one that localizes food production and promotes healthier consumption by prioritizing diversity (Altieri & Nicholls, 2020), and education plays a pivotal role in this shift (Roscioli et al., 2020).

For school gardening projects to thrive in Ica, personnel in charge of maintaining the plots require a basic understanding of irrigation techniques and soil management systems like organic mulching to maximize soil fertility in a region where soil organic matter is already lacking. Flood irrigation is currently the most viable method in schools according to participant 6 due to infrequent water availability in rural communities, and the financial inability of procuring more conservative forms of irrigation like drip irrigation technology. Some local farmers also add '*estiércol*' (manure), which is a mixture of decomposing organic materials used as organic fertilizer, which adds to the already lacking soil organic matter. Participant #1 mentioned that members of Horizonte Corporativo also provided training on how to produce organic fertilizers like '*biol*' using domestic materials with the students in a safe manner. High temperatures in the region also favor the decomposition of organic materials, which increases soil organic carbon content (SOC), stimulates microbial activity, and increases water holding capacity in the soil. Applying compost and organic matter heavily reduces the bioavailability and mobility of several inorganic toxins and permits microbial communities to thrive (Brady et al., 2019) which include microflora like mycorrhizae, macroinvertebrates like cicadas and earthworms, and nematodes (Heneghan et al., 2014) which are important for soil health.



Figure 6: (left): Using flood irrigation in the primary school of Santa Vicenta, Santiago, Ica. Figure 7 (right): showing the installation of pressurized drip irrigation in a school in a primary school in Parcona, Ica. Pictures taken by Kealan Branellec, February 2020

Chapter 5: Conclusion

5.1 Overall Conclusions and Opportunities for Further Research

The qualitative data from various territories in the systematic scoping review and the interviews of key-informant suggest that school gardens are increasingly being recognized as tools to address malnutrition, food insecurity and environmental degradation by equipping schoolchildren and communities with more creative and hands-on learning approaches to addressing those issues. Those perspectives offered in the systematic scoping review and the key-informant interviews suggest that more sustainable agriculture models like the *huertos escolares* should be explored safeguard Ica's socio-ecological resilience given the extent of ecosystem services degradation in the region and the prevalence of anemia. Furthermore, using Ica as a case study was useful in understanding the local barriers that some of the key-informants faced to achieve conservation and nutrition through the *huertos escolares*. To address some of those barriers, which included low awareness of anemia's long-term implications on children's wellbeing, together with the systematic lack of municipal support in the school gardening activities, the Theory of Change (figure 1) highlights various pathways like education and policy reforms to circumvent those barriers and achieve to eventually achieve an anemia-free Ica through agroecological practices.

A discrepancy exists between the state's economic interests and the vision of NGOs like Horizonte Corporativo to promote resilience from a both a social and ecological standpoint. Local municipalities are not delivering adequate support as the intermediaries between those entities, and 3 of the participants hinted at the role that private agricultural companies should assume given the systemic neglect of rural schools and communities by Ica's municipalities. Participant 4's experience in sensitizing the parents and teachers at their school in 1996 through the involvement of the local health authority of Casma, and the successes that followed, highlights the importance of education and outreach activities carried out by actors like the public health unit with the knowledge on the disease's implications and the resources for performing assessments provided by the state.

Rogers et al. (2002) also suggest that community outreach programs aimed at influencing the local perceptions of anemia, together with increasing the availability of poorer communities to health services and nutritious foods are necessary to mitigate the disease's incidence in the long-term in Peru, in addition to broader poverty alleviation and supplementation policies. McKenzie-Mohr (2011) found that perceptions can be changed through appropriate information-sharing strategies that circumvent the local barriers to adopting desirable behaviors. As observed in the LabVida case in Mexico (Ferguson et al., 2019), sharing these experiences through proper networks and communication tools like stories and analogies is important to disseminate research findings to diverse audiences, to impact behaviors, and increase engagement to eventually scale those activities.

Obtaining funding and scaling activities school gardening in the future remain the most challenging task according to the participants, and no concrete suggestions were provided from the journal articles or the interviews, particularly for a Latin American country like Peru that grapples with political disturbances, corruption, and misallocation of funds in municipal governance. The Red Internacional de Huertos Escolares (redhuertos.org) networked developed by Ferguson et al. (2019) in 2010 in the Lab Vida program was also consequential in circumventing the constraints of limited funding, a platform facilitating the exchange of information and experiences on strategies to increase community engagement in school gardening, and on technical information for the maintenance of the projects not only between participants and schools under the program's jurisdiction but also for persons who joined internationally. Subsequently, the Red Chiapeneca de Huertos Educativos (RCHE) was established in 2014 as a state-level network to promote indigenous food sovereignty and collaborative learning on agroecology. Similar networks could be pivotal for NGOs in Ica to increase community awareness of anemia's long-term implications, and this increase public engagement in the school gardening programs particularly when actors in the region act independently and consequently fail to optimize their processes that would otherwise occur through collaboration, according to participant 3.

Another insight provided by this thesis is the role that organic agriculture has in supplementing current public health measures to address micronutrient deficiencies like

anemia. The interviews revealed that, and particularly participant's 4 experience in Casma, suggest that the *huerto escolar's* potential to not only mitigate anemia but also strengthen community cohesion is an opportunity that should be capitalized in Peru. Participant's 4 experience with Casma's public health unit demonstrates that working with the scientific community is necessary to improve the efficacy and longevity of the projects for the students' health benefit. Additionally, broader governmental policies can help school gardening projects achieve nutrition targets in schoolchildren when provided adequate support (Ozer, 2007), the role of social institutions in increasing community awareness through suitable education campaigns to mitigate social and public health issues like food insecurity and anemia in a country like Peru where capitalist attitudes and economic profit are priorities, is indispensable. The perspectives provided by participant 10 indicate that formal organizational structures like schools provide a medium for scaling agroecology, which is of crucial importance in a region where biodiversity loss is on the rise.

"From the household to the teacher, to the university students; we are all playing an important part as facilitators of these projects and guiding the students. It's difficult because parents work all day during the week, so we need to look at weekends. But teachers are not always willing to take some time on weekends. But these gardens can provide a bonding space for the parents and the kids in addition to better nutrition by learning about agriculture together."-Participant 6

The school gardening experiences shared by the participants and the systematic scoping review demonstrate the value of situating the *huerto escolar* within the context of sustainable food systems and the potential benefits of those activities at the local and the global level. In Ica's context, the immediate returns from school gardening will provide some form of short-term relief to students suffering from anemia, leading to an improved quality of life for locals in the long run. This approach is necessary until a comprehensive transformation in government policy occurs in Peru where the links between ecological and human health are made explicit in theory and practice. Some of the experiences described in the interviews also

demonstrate how school gardens in Ica act as laboratories to learn not only about the natural sciences but also about their cultural heritage. The *huertos escolares* in Ica are important for making students more appreciative of the holistic benefits provided by sustainable agriculture which in turn would cultivate a wider culture in which communities would be more cognisant of the benefits proffered by a thriving natural environment.

Following the COVID-19 pandemic's impacts on food supply chains and human health globally, and particularly on the rural communities of developing countries, agriculture productions systems should to the restructured given the great deal of uncertainty arising from such sudden and unprecedented events. The declines in trade and travel imposed by restrictions impede the capacity to distribute fresh produce to poorer communities and their access to nutritious meals and ultimately leads them to consume processed foods with less nutritional value and as such increases the incidence of non-communicable diseases like anemia (Altieri & Nicholls, 2020). Participants (n=2) suggested that an eventual transition from a top-down, hierarchical approach to food production to a more participatory approach to organic farming like school gardening could play a crucial role in reducing malnutrition, sustaining the resilience of ecosystems, and restoring local's ancestral attachment to the land in Ica.

From another standpoint, school gardens can be considered as pathways to enhancing personal and community health and act as a mitigative measure rather than as a specific intervention, meaning that school gardening forms part of a continuum of agriculture-based systems aimed at improving the nutrition status of children (Davis et al., 2015). Agroecology programs initiated by non-governmental organizations in Latin American countries open new spaces for more participation which increases the efficacy of community-owned and grassroots solutions (Alteri, 1995). In the LabVida case in Mexico, qualitative data from teachers alluded to the potential of using school gardens to mobilize institutional support and resources that would improve literacy on agroecological practices and proper nutrition habits (Ferguson et al., 2019), which could be favorable in Ica to scale agroecological practices in the region and their implications for human health. NGOs like Horizonte Corporativo in Ica conduct similar projects with minimal municipal support but contribute meaningful research and

information on the environmental and human benefits associated with agroecology through organic school gardening, with an emphasis on the participation of the wider community. The qualitative data provided by the key informants in Ica suggested that the *huerto escolar* generates several benefits that go beyond the scope of anemia mitigation, but also their levels of environmental consciousness, their character development, and their academic performance, which are all crucial to mitigate the risks of systemic poverty present in the region's rural areas. These findings also informed the pathways that were highlighted in the Theory of Change (figure 1) to achieve an anemia-free Ica through a series of interventions and activities. The interventions included agroecology and education and outreach, with the constituting activities comprised of school gardening and municipal support for community-based approaches to agriculture respectively.

To surpass the limitations imposed by lack of funding and in methodological capabilities and technical expertise in the agroecology domain, more transdisciplinary research, and the establishment of networks at the regional level between the actors involved to support efforts are necessary to share experiences between actors (Altieri & Yurjevic, 1989). This is particularly important in a poor locale like Ica's rural areas to highlight the multidimensional benefits of school gardening on human health and positive and negative experiences with interested parties, where these programs are given little attention by the local municipalities and actors typically work in isolated silos. Potential research questions for a future researcher therefore could be: a) how this system could be implemented in the presence of systemic political corruption and neglectful municipalities, and the economic difficulties induced by the recent pandemic? b) how common goals among independent actors could be best realized through a multisectoral approach? Furthermore, how could the empirical evidence proffered by this research be translated into meaningful action?

A 'one size fits all' approach to school gardening as demonstrated in schools of California and Australia is top-down method with several limitations (Davis et al., 2015), as the degree of participation of actors and the wider community together with the availability of resources varies between all schools (Ozer, 2007). Furthermore, participant 2 suggested that each school is influenced by the realities of the wider community it is situated and reaffirmed

that a prescriptive approach to implementing school gardening does not exist, which is congruent with ecological restoration in practice. Proponents should consider the social, financial, and ecological constraints of individual sites (Miller & Hobbs, 2007) and as such, a case-by-case approach is required.

“We cannot replicate what is done in more urban areas in Lima, as it is a reality of its own. Education is a tool to develop oneself, and the huerto escolar acts is a living laboratory for both parents and children to learn about values and responsibilities they have towards their own development, and the ways they can contribute to the wellbeing of their natural environment. Anemia is a social problem that we need to address as a unified community.” Participant 10

As no prescriptive approach exists to establishing school gardening, projects should be implemented based on the availability of capital in each school and that curricular activities are aligned with the purpose of the school garden to ensure continuity. Community engagement is also necessary to ensure the continuity of restoration programs. Participant 4’s experience in Casma revealed how sensibilizing parents in 1996 and teachers through a was indispensable in mobilizing resources and commitment to address anemia through a multisectoral approach, where task delegation was clear, and the degree of success frequently assessed by the responsible actors.

Nevertheless, given the short- and long-term implications of anemia, its mitigation should be prioritized in public policy and the *huertos escolares* could be a promising avenue to facilitate the emergence of an anemia free Peru and a population more cognizant of the importance of organic agriculture and their culture. The Theory of Change (figure 1) in this thesis suggested that raising community awareness and bolstering municipal support in school gardening activities are indispensable to achieve this long-term aspirational outcome. These pathways were illustrated in the Casma context as described by participant 4. The school gardening success story grounded in multi-stakeholder collaboration with Casma’s public health unit highlighted by the participant suggests that strategic partnerships with the scientific community is also useful to evaluate school gardening impacts and engage other community actors in monitoring processes, which is helpful when uncertainties in municipal

support arise. The involvement of public health workers in the school of Casma and the mobilization of resources and support for school gardening activities shows how the public health sector could increase awareness of the importance of organic agriculture, and specifically, the *huertos escolares*, to address diseases like anemia and enact theory into effective practice.

School gardens are part of an emerging suite of localized approaches to food production that could serve the nutritional needs of communities and the ecological integrity of their natural environment, whose interests are often overlooked by centralized government institutions of developing countries like Peru. Even scientists from the ecological restoration discipline argue that ecosystems should be restored to meet the specific needs of communities instead of attempting to re-introduce past conditions (Choi, 2004; CBD, 2020). James (2011) also posits that those efforts should be designed and implemented with the participation of the intended beneficiaries. Therefore, students and the wider communities in Ica should be actively engaged and involved in school gardening programs as a more participatory approach to sustainable agriculture to safeguard their health and the resilience of their natural environment and understand the reciprocity that exists between them.

Even though Ohly et al. (2016) describe the wide array of school gardening benefits provided by qualitative data as idealistic, the need for countries like Peru to diversify their approaches to mitigating anemia through more localized approaches like community and school gardening is necessary to provide some form of short-term relief to those impacted by the disease, especially in rural areas of regions like Ica where poverty and malnutrition are prevalent. School gardening offers a physical space where nutrition and agroecological pedagogy delivered in the classroom could be put to practice in an immersive environment and make children more cognizant of the implications of a healthy environment on their health. The long-term viability of this approach to target malnutrition and specifically anemia is yet to be explored. Like Amat and Espinet's (2013) claim that the school garden is an interface where different methodologies to promote agroecological learning could intersect, the *huerto escolar* in Ica could present a platform where transdisciplinary research could provide proponents with valuable data to determine which interventions are most effective to mitigate

anemia. School gardens can also play a key role in municipality-wide nutrition policy to reduce anemia and other deficiency diseases, while compelling students to appreciate an agricultural system that considers local culture and biodiversity. Involving parents and families in school gardening and formally integrating the model in the school curriculum could provide opportunities to scale these activities and be recognized as long-term strategy to achieve the Sustainable Development Goals relating to hunger and education (goals 2 and 4 respectively), which was also a pathway identified in this thesis' Theory of Change (figure 1) as it relates to anemia mitigation in Ica through the *huertos escolares*.

“Just like the human body, schools are fundamental components of a thriving community and play a key role in this fight. We need to radically transform our education system and curriculum. NGOs like Horizonte serve as bridges to create alliances and their lobbying help to sensitize all sectors of society about the issue’s urgency.” - Participant 10

“What you are investigating is very important because a malnourished kid is one that will not develop properly in any aspect of their lives. These gardens are of significant value that both student and parent should be aware of proper nutrition habits and understanding why they are choosing the healthier options for their bodies, for their mental health.”- Participant 6

If this nutrition- and agricultural-based approach to addressing a public health issue like anemia is eventually proven effective through more robust empirical evidence, the evidence could spur municipal authorities to support similar farming practices that function in synchrony with ecological processes and prioritize the health of youth in the region’s rural communities, who are often neglected in comparison to their urban counterparts. It could then be linked to national and global efforts of organizations like the Food and Agriculture Organization of the United Nations (FAO) in strengthening policies for promoting food security and improving nutrition outcomes while facilitating international synergy of efforts in realizing the relevant Sustainable Development Goals (SDGs). Connecting these efforts to existing

institutions and frameworks would also help promote legitimacy. From a methodological standpoint, the most difficult challenge is going to be engagement, and organizing my efforts under the umbrella of these larger parent organizations like Horizonte Corporativo and school feedings programs like Qaliwarma could help facilitate that engagement. Finally, this thesis suggests that a transition from a top-down, hierarchical approach to food production to a more participatory approach to sustainable agriculture that is offered in the *huertos escolares* could play a crucial role in reducing chronic malnutrition while promoting the resilience of food systems, restoring ancestral attachments to the landscape, and highlighting the inextricable interdependence existing between human and environmental health.

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Appendices

APPENDIX A: Semi-Structured Interview Guide

Interview Questions

The questions in this semi-structured interview were conceptualized to be more acquainted with:

1. Some of the past successes and failures of the *huerto escolar* in Ica in meeting initial goals.
2. Determining the long-term viability of the *huerto escolar* to mitigate anemia and other deficiency diseases, based on the perception of the participant.
3. Determining whether these experiences and perspectives deviate from or align with the conclusion obtained from the systematic scoping review.

1. Obtain contextual information on the huerto and the candidate's perception on its implementation.

What was the main motivation behind the implementation of the *huerto* in the school?

2. Gaging the participant's perception on huerto's suitability to address anemia.

Do you believe this system is suitable to mitigate the prevalence of malnutrition and specifically anemia in school children? Why/why not?

In which ways do you think schoolchildren benefit from the *huerto escolar*?

3. Actors

What is the role of the major actors involved in the *huerto escolar*?

How important is the role of teachers as facilitators of this model? Are the teachers trained or expected to engage in the activities?

Would you agree that parents, families, and the wider community have an important part to play in the huerto escolar? Why/why not?

4. The curriculum and increasing engagement

Do you think that the Ministry of Education should formally incorporate the huerto escolar in the curriculum to increase its efficacy in meeting the initial goals set out?

What more do you think needs to be done to increase parent, teaching staff and community engagement in the project?

5. Role of Native Plant Species

Is there an emphasis on the use of native plant species in the huerto escolar and if so, why? Can you identify native plant species or any others that would be essential in reducing malnutrition, anemia, or any other deficiency diseases you are aware of?

6. Source of plants and necessary capital

Where are the crops obtained from? How does the school obtain the necessary materials (irrigation, labour and other) to sustain the project?

7. Financial feasibility and governmental support.

How financially viable is this system? Do you think schools receive enough financial support (if any) from the municipal authorities or the ministry of education?

8. Measuring Success and Indicators

What indicators (financial, ecological, anthropomorphic) are used to measure success of this project, and who is tasked with this responsibility?

Are there any past successes/failures of this project you can elaborate on?

9. Scaling the activities

Do you think the huerto escolar could be linked to wider current agricultural- and nutrition-based interventions at the municipal, regional, or national level? If yes, in what ways?

10. The Role of the Huerto Escolar in the Long Run

Where do you think this initiative fits in the theme of sustainability as it relates to reducing hunger and malnutrition in Peru?

11. Additional Remarks

Is there anything else you would like to add?

Spanish

1. ¿Cuál fue la principal motivación para la implementación del huerto escolar en la escuela?
2. ¿Piensas que este sistema es adecuado para mitigar la prevalencia de desnutrición y específicamente anemia ferropénica en escolares? ¿Por qué o por qué no?
¿De qué formas cree que los escolares se benefician del huerto escolar?
3. ¿Cuál es el papel de los principales actores activos en los proyectos de huerto?
¿Qué importancia tiene es el papel de los docentes como facilitadores de este systema? ¿Están los maestros capacitados, o se espera que participen en las actividades?
¿Estas de acuerdo en que los padres, las familias y la comunidad en general tienen un papel importante en el huerto? ¿Por qué o por qué no?
4. ¿Piensas que el Ministerio de Educación debería incorporar formalmente el huerto en el plan de estudios para aumentar su eficacia en el cumplimiento de las metas iniciales planificadas?
¿Qué más piensas que se debe hacer para aumentar la participación de los padres, los docentes y la comunidad en el proyecto?

5. ¿Hay un énfasis en el uso de especies de plantas nativas en el huerto y, por qué? ¿Podrías identificar especies de plantas nativas o cualquier otra que sea esencial para reducir la desnutrición, la anemia cualquier otra enfermedad por deficiencia?
6. ¿De dónde se obtienen los cultivos? ¿Cómo obtiene la escuela los materiales necesarios (riego, mano de obra y otros) para sostener el proyecto?
7. Piensas que este sistema es económicamente viable? ¿Cree que las escuelas reciben suficiente apoyo financiero (si lo hay) de las autoridades municipales o del ministerio de educación?
8. Qué indicadores (financieros, ecológicos, antropomórficos) se utilizan para medir el éxito de este proyecto y quién(es) tiene esta responsabilidad? ¿Hay algunos éxitos / fracasos pasados en que podrías elaborar?
9. ¿Piensas que el huerto podría estar vinculado a intervenciones más amplias basadas en la agricultura y la nutrición a nivel municipal, regional o nacional? Y si sí, ¿en qué formas?
10. ¿Dónde se encuentra esta iniciativa en el tema de la sostenibilidad en lo que respecta a la reducción del hambre y la desnutrición en el Perú?
11. Hay algo más que le gustaría agregar?

APPENDIX B: Sample of Interview Data Analysis

In this section, I provide a series of annotated interview questions and responses provided by one of the key-informants on January 10th, 2022. I also provide the rationale behind the ways some of the questions were structured. This excerpt was provided to show how the data was analysed based on the pre-determined frames obtained from the systematic scoping review, and how they linked to this thesis' research question. '

Interviewer: In what ways were you involved in school gardening projects? What was the main motivation behind the implementation of the *huerto escolar* in the school? (*Gaging the participant's perception on huerto's suitability to address anemia*)

Participant: As a schoolteacher, and in close collaboration with the local public health unit and other teachers, we decided that school gardening would be the best step forward to reduce anemia as the government had stalled in their efforts.

Interviewer: Do you believe this system is suitable to mitigate the prevalence of malnutrition and specifically anemia in school children? Why/why not? (*Gaging the participant's perception on huerto's suitability to address anemia.*)

Participant: I think so, the kids go home and teach their parents about what they learnt on sustainable agriculture. I think this system could have rippling effects throughout the community.

Interviewer: Is there an emphasis on the use of native plant species in the *huerto* and if so, why? Can you identify native plant species or any others that would be essential in reducing malnutrition, anemia, or any other deficiency diseases you are aware of? (*Probing participant for native crops they believe can be used for anemia mitigation, and their suitability within the context of the huerto escolar*)

Participant: Spinach, beetroot and tomatoes grow well here and are rich in minerals and vitamins. In terms of natives, the huarango comes to mind, many healthy products could be derived from it.

Primary Frame	Definition	Secondary Frame	Definition	Example
1. Participant's involvement and familiarity with the <i>huerto escolar</i> .	In what capacity did the participant work with the <i>huerto escolar</i> ?	Locally defined perception of the importance of the <i>huerto escolar</i> .	What was the rationale behind the implementation of the <i>huerto escolar</i> ?	"... the kids go home and even teach their parents about conservation agriculture. This system has rippling effects throughout the community."
2. Participant's perception of traditional and small-scale agriculture in addressing anemia	What are the benefits of small-scale agriculture like school gardening could have on nutrition outcomes in Ica?	Nutrition benefits for families and households	Organic farming and school gardening yields positive nutrition impacts on households.	"I think so, the kids go home and even teach their parents about conservation agriculture. This system has rippling effects throughout the community"
3. Participant's perception on native crops to mitigate anemia	Please identify native plant species or any others that would be essential in reducing malnutrition, anemia in Ica	Crops used to mitigate the prevalence of anemia	Lack of public engagement by the municipalities, different priorities and lack of awareness are some of the	"Spinach, beetroot, and tomatoes grow well here and are rich in minerals and vitamins. In terms of natives, the huarango comes to mind, many healthy products could be derived from it."

			barriers impeding community- based agriculture.	
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Table 5: Table showing categorization of interview data using pre-determined frames from the systematic scoping review