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Food for thought: Increasing nutritional diversity by adapting to droughts in Timor-Leste's permaculture/agroecology garden schools.



A research project presented in partial fulfilment of the requirements for the degree of Master of International Development, Massey University, Palmerston North, New Zealand

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ABSTRACT

The main aim of the research was to explore community resilience, and specifically whether and how garden schools that use permaculture/agroecology principles may be usefully contributing to adaptation to climate change and nutritional diversity in Timor-Leste. The research also aimed to investigate the challenge of implementing garden schools in Timor-Leste. Specifically, targets of the Sustainable Development Goals relating to water conservation, resilience and food security were utilized to measure the progress of garden schools. The above is embedded in a conceptual agroecology framework that assesses the resilience of food growing systems in relation to climate change as the schools utilize permaculture/agroecology principles, with permaculture being a form of agroecology.

Timor-Leste is now faced with extreme climate patterns as a result of climate change that can lead to more prolonged droughts. This study used a qualitative methodology, which included interviews of teachers with school gardens, to help understand how teachers and their students are adapting to these droughts. The study also examines nutritional diversity in schools and the benefits and challenges of implementing school gardens. Furthermore, the study explores the transfer of nutritional and gardening knowledge from schools to the community to increase community resilience.

The research revealed that garden schools internationally improve students' scientific understanding and agricultural knowledge and their taste for locally grown fruit and vegetables. The school gardens in Timor-Leste have multiple benefits with regard to improving educational outcomes and community resilience as a school garden transforms a schoolyard into a green laboratory for students to learn about nutrition, mathematics and linguistics.

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Chapter 1

1.1 Introduction

Like many other developing nations, Timor-Leste is now faced with extreme climate patterns as a result of climate change that can lead to more prolonged droughts (Chandra et al., 2016, p. 477). Therefore rural communities are having to adapt to these new weather patterns and become more resilient by conserving water to face longer droughts or other extreme weather (Intergovernmental Panel on Climate Change, 2007). Together with a rapidly increasing population (Molyneux et al., p. 823), these droughts can impact on the food supply because Timor-Leste has a seasonal rainfed agricultural system.

Timor-Leste already has high rates of malnutrition (Marino, 2014) and evidence suggests that hunger also impacts on education as malnutrition continues among children over five (World Food Programme, 2018). Therefore climate change is a major challenge for small farmers and their children as parents' income reduces because of droughts and other climatic events and that in turn affects parents' ability to put food on the table and give their children an education (Hanna & Oliva, 2016).

International development organizations such as UNICEF and the Food and Agriculture Organization of the United Nations (FAO) believe that school gardens can play multiple roles in addressing the above challenges (Iltus, 2012). There has also been an international drive to promote the role school gardens can play in attaining food security with support from the World Bank and the FAO as well as many NGOs (Lander, 2013). At the same time, UNICEF emphasizes the opportunity to include ecological sustainability and involve the community in the school curriculum (Iltus, 2012). While the FAO states that it is time to educate both poor and rich children about health, agriculture and the environment and their relationship to livelihoods utilizing school gardens to teach children how to grow healthy nutritious food. Therefore school gardens are attracting growing interest in government and international development circles (FAO, 2010).

Timor-Leste garden schools are part of the government's new National Food and Nutrition Security Policy that focuses on risk reduction and resilience (Republica Democratica de Timor-Leste, 2014). The NGO Permaculture Timor Leste (Permatil) has formed a partnership with the Ministry of Education to implement gardens in over 1400 schools based on permaculture/agroecology

principles as part of the school curriculum (Lemos, 2014). Gliessman (2007, p. 345) argues that agroecology and permaculture are highly complimentary and their fusion is based on sharing the principle that well-designed human and cultivated systems should emulate healthy natural systems in order to create more sustainable solutions. Permatil's programme was set up for the purpose of not only providing nutritious food to children in schools but also imparting knowledge and skills in relationship to gardening which could be transferred to the home environment and the wider community. According to the director of Permatil, this programme could potentially end hunger in Timor-Leste (Lemos, 2014).

1.2 Significance of the research

There are presently gaps in the available data that my research will address as it aims to explore the benefits of school gardens and the role they can play in improving nutritional diversity and community resilience to climate change. For example, even though garden schools are part of the Timorese government's policy and many permaculture manuals were distributed - only a few permaculture school gardens have been implemented (Lemos, personal correspondence, 2017). Gostelow et al., (2016) argue that it is important to look at the interrelationship between climate change, resilience and nutrition because doing so may lead to a better understanding of the causes and solutions to undernutrition.

Regarding school gardens and community gardens in Timor-Leste, Noij (2011, p. 18) emphasizes that it is important to explore the links between the support of gardening and improving nutritional practices. Chandra et al. (2016) emphasize that there needs to be more research into community climate change adaptation in Timor-Leste as this could benefit other regions faced with adaptation to extreme weather patterns such as droughts. Furthermore Mancebo and de la Fuente de Val (2016) argue that more work needs to be done in measuring sustainability and resilience in communities who have adopted permaculture. This is relevant because the Permatil school garden programme is based on permaculture/agroecology principles (Lemos, 2014) with Hathaway (2016, p. 239) stating that permaculture is a form of agroecology.

The research design and framework are both partly based on the agroecology framework by Altieri et al. (2015) that is used to assess the resilience of a food growing system and adaptation to climate change. Furthermore Henfrey and Penha-Lopes (2015, p. 34) advocate that permaculture can play an important role in implementing the Sustainable Development Goals (SDGs) as permaculture is based on ethical design principles including equity and social and ecological regeneration and

transformation. Thus climate change adaptation and nutritional diversity were explored in relationship to various targets and indicators of the SDGs at the schools that participated in this research in Timor-Leste.

1.3 Research Aims and Questions

The main aim of the research was to explore community resilience, and specifically whether and how permaculture garden schools may be usefully contributing to adaptation to climate change and nutritional diversity in Timor-Leste. The research also aimed to investigate the challenge of implementing garden schools in Timor-Leste. My aims led me to develop my research questions that are introduced below.

1. How can garden schools in Timor-Leste lead to improved community resilience through climate change adaptation?
2. Will garden schools lead to improved community resilience and increased nutritional diversity in Timor-Leste?
3. What are the benefits and challenges of implementing school gardens based on permaculture/agroecology principles?

1.4 Motivation for the research

I was motivated to undertake this research as I had visited Timor-Leste multiple times between 2001, 2005 and 2006 while making two broadcast documentaries ‘Emails from East Timor’ and ‘Children of a Nation’. After gaining permission from the Ministry of Education I visited many schools in 2005 and during the crisis of 2006 and observed that many of these schools were under-resourced and that many families were living in dire poverty. I also met Ego Lemos, director of Permatil, who was developing a book with many detailed illustrations on how to create community and school gardens. Just before I departed I heard of the first permaculture schools in Timor-Leste and always wanted to find out if they could help solve the multiple problems the country is facing.

1.5 Conceptual Framework

The themes of my research report were derived from the social-ecological features of the agroecology framework by Altieri et al. (2015) and Nicholls et al. (2013) and these themes were used to analyze the resilience of the food growing systems of two permaculture/agroecology schools in Timor-Leste. These social and ecological factors are relevant to the focus of my research questions, namely community resilience, climate change adaptation, and nutritional diversity.

The agroecology conceptual framework of Altieri et al. (2015) also applies to permaculture as both permaculture and agroecology have merged together in the context of garden schools in Timor-Leste. The FAO (2016, p. 1) refers to Permatil and the Ministry of Education's school garden programme for grades 1-6 and recently up to grade 9 as '*Permaculture/Agroecology system in Timor-Leste's National School Curriculum for Basic Education.*' Furthermore Hathaway (2016, p. 239) states that permaculture is a form of agroecology that provides an ethical and design framework for diverse ecological and cultural settings. Salas (2016, p. 1) reasons it will require a global transformation to an agroecological alternative in contrast to the present dominant industrial agricultural system for the Sustainable Development Goals to be fully achieved. While Fletcher strongly advocates that the key to achieving the 17 Sustainable Development Goals is through permaculture/agroecology lessons in school gardens (Fletcher, 2017, p. 1). Please refer to 1.6 regarding the SDGs.

Thus the agroecology conceptual framework by Altieri et al. (2015) and Nicholls and Altieri (2017) was used to analyze the resilience of the food growing systems at two permaculture/agroecology garden schools in Timor-Leste. Resilience is determined by the interrelationship between various social-ecological factors (Altieri et al., 2015) such as vulnerability and reactive capacity in relation to climatic events as well as social capital. In this context vulnerability refers to the inability of a food growing system to adapt or cope with adverse climatic effects such as droughts (Altieri et al., 2015). Whereby reactive capacity is the ability of communities to react and recover from climatic events based on sustainable agroecological practices (Nicholls & Altieri, 2017) such as crop diversity and water conservation (Altieri et al., 2015) as well as levels of collective action such as social networking and organizational strategies (Nicholls & Altieri, 2017). Adaptive capacity is determined by a combination of both agroecological and social conditions *that influence the ability of individuals or groups, and their farms, to respond to climate change in a resilient manner* (Nicholls & Altieri, 2017, p. 3). Together the above factors determined the overall resilience of the

food growing system in two schools in Timor-Leste (Nicholls & Altieri, 2017).

Because not all groups respond to vulnerability in a sustainable way the agroecology conceptual framework uses up-scaling of more vulnerable groups by sharing knowledge from more sustainable communities (Altieri et al., 2015). For example, the garden school programme in Timor-Leste aims to make communities more resilient by transferring permaculture/agroecology knowledge back into the communities through the students (Lemos, 2014). This transfer of knowledge was also explored in the research report. Please refer to the diagram below as presented by Altieri et al. (2015) who sourced the original from Nicholls et al. (2013).

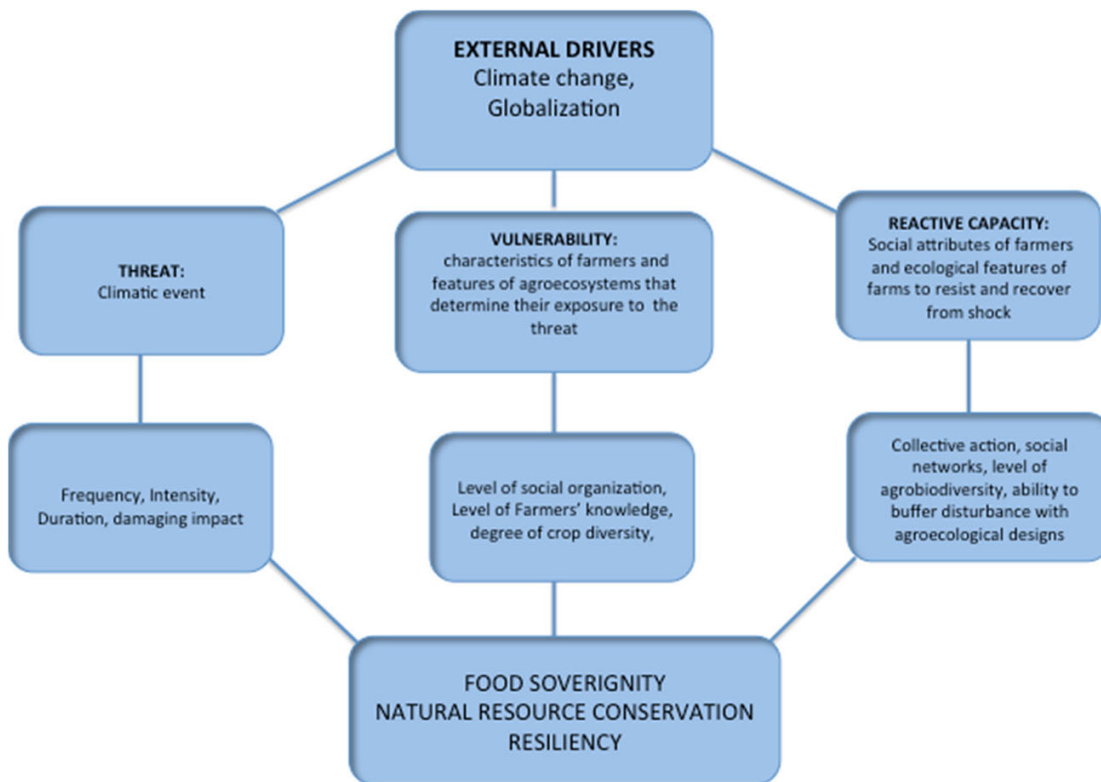


Fig. 2: Socio-ecological features that determine the vulnerability and reactive capacity of farmers to enhance the resiliency of their systems and communities Nicholls et al. (2013) as cited in Altieri et al., 2015, p. 883).

1.6 Methodology

The methodology for this research is predominantly descriptive and qualitative. O’Leary (2014, p. 130) argues that qualitative research embraces the search for holistic meaning and takes the voice of those being researched into account. It allows for emergent methodology design and for a small sample size using non-randomized techniques with the strategic goal of gaining an insight through rich engagement with people in various settings that can include immersion into the reality of those being researched. Traditionally qualitative research is based on three paradigms of research that can include survey research and secondary analysis as well as participatory or non-participatory field observation (Wienclaw, 2013, p.1).

For this research existing records were used for qualitative analysis. Relevant government records, reports in the mass media and evaluation reports from NGOs and international development organisations were examined via document analysis: Documents were first examined for bias by comparing them with other sources for evidence of subjectivity, being mindful of the intended purpose and audience, then the documents were ‘interviewed’ in order to extract the necessary data to answer the research questions (O’Leary, 2014, pp. 250-251). Document analysis was undertaken relating to international and Timorese documents on permaculture, agroecology and school gardens, as well as Timor-Leste’s government policy on food and nutrition security that specifically mentions garden schools based on agroecology (Republica Democratica de Timor Leste, 2014).

But because archival information can be limiting (Wienclaw, 2013, p. 1) interviews were conducted in order to add the insights of the four participants in Timor-Leste to ensure their lived experiences were heard. In qualitative research, where field observation is utilized, reality is subjective and is determined by the participants own perception and experiences (Smith, 2013, p. 1). How schools were adapting to extreme climatic events such as droughts was revealed in interviews with a school principal and two teachers. Besides interviews, participatory food and garden photography (Subar et al, 2012) gave insights into the participants’ world (Hallberg as cited in Howson, 2013, p. 1).

Furthermore a SWOT analysis (Strengths, Weakness, Opportunities, Threats) was utilized in order to help answer research question 3 regarding the benefits and challenges of implementing school gardens based on permaculture/agroecology principles, as SWOT analyses are being utilized internationally to research the outcomes of NGO environmental programmes (Maqbool et al., 2014, p.11).

For this research report, some of the United Nations (UN) seventeen Sustainable Development Goals (SDGs) were explored in relationship to permaculture/agroecology garden schools through a document analysis and interviews with two school teachers and a school principal. The government of Timor-Leste wants to achieve SDG 2 (promoting sustainable agriculture to achieve food security to end hunger and reduce malnutrition) by 2030 (UN, 2018). Therefore the interviews revealed how much food was being produced in the school gardens and consumed by the students. Furthermore crop diversity and the nutritional awareness of students and their families were examined to measure progress towards achieving SDG 2 and strengthening community resilience. The latter are socio-ecological features of the agroecology conceptual framework that measures the resilience of a food growing system (Nicholls & Altieri, 2017, p. 3),

Thus SDG 2 and some of the other SDGs relate to the research themes of sustainable agriculture, food security and community resilience. For example, the data was analyzed in relation to SDG Target 6.4: *Reducing the number of people suffering from water scarcity by 2030* (Sustainable Development Solutions Network, 2017) by exploring how two garden schools in Timor-Leste were managing their water resources in a drought. This also relates to SDG 13 about taking urgent action on climate change and its impacts (Henfrey and Penha-Lopes, 2015, p. 34). The gardening practices of the two schools in Timor-Leste were also explored to see if they coincided with SDG Target 2.4: *Implement resilient agricultural practices that strengthen capacity for adaptation to climate change ...* (SDSN, 2017). Finally the research findings with regard to the SDGs were utilized to answer the first two research questions about climate change adaptation and nutritional diversity.

1.7 Methods

A document analysis was used to mine data and analyze content. Mining data involves sourcing academically peer-reviewed journals, books, reports and publications from NGOs and governments and utilizing document analysis to assess if the documents include information that is relevant to the research (O'Leary, 2014, pp. 250-251). The focus was firstly on garden schools internationally before it turned to Timor-Leste in a subsequent chapter.

The research also focused on utilizing qualitative semi-structured interviews of key informants with first-hand knowledge of the programme to be researched, who were willing to share their insights (Bamberger et al, 2004). As O'Leary (2014, p. 191) states, these are “*people in the know.*” My research assistant, Miguel de Araujo, conducted the interviews with a school principal and two teachers from two different garden schools and one of Permatil's programme

managers. These interviews were conducted at different times to work around the busy schedules of the principal and the teachers.

Even though the research was predominantly desktop-based, semi-structured interviews were utilized as they allow for open-ended answers to interview questions that can be framed in themes relating to the research questions (O'Leary, 2014, p. 217). However semi-structured interviews can also allow for the emergence of other questions from the dialogue (Whiting, 2008). They can, therefore, provide some scope for interviewers to follow new arising themes that may not have been anticipated (O'Leary, 2014) as interviews have the advantage of being more personal (Valenzuela & Shrivastava, n.d.).

Interviews can be defined as a method of data collection whereby one person asks questions of a respondent (or the interviewee) (Polit & Beck, 2006, as cited in Whiting, 2008). Interviews can also be described as a complex process of both asking and listening that allows the respondent to develop trust and rapport with the interviewer (O'Leary, 2014, p. 217). Respondents are part of the qualitative research process in search of descriptive meaning and central themes sourced from the interviewee's life experience or perspective (Kvale, 1996 as cited in Valenzuela & Shrivastava, n.d.). The interview of a school principal and two teachers from two different schools near the capital Dili as well a Permatil programme manager in Timor- Leste provided the researcher with deep, rich qualitative data (O'Leary, 2014).

To examine dietary diversity, the Food Photography 24-h Recall method (FP 24-hR), an adaptation of the 24-hour dietary recall survey, was utilized. Respondents take digital photos of what is on their plate (and out of their gardens) before and after meals within 24 hours. Instead of the participants writing down what they have eaten in the last 24 hours, as they do in the 24-hour dietary recall survey, they instead make a visual record of the food they have eaten. The data (photos) that is collected indicates what types of food are being consumed, ie how much food from the garden is making its way onto the plate. The Food Photography 24-h Recall method (FP 24-hR) was adapted, with photos of the participants' garden contrasted with one school with a permaculture garden to establish a baseline regarding the transfer of knowledge from the programme and thus showing an increase in community resilience. The advantage of this method is that it is confidential as pictures are only taken of the food and not of the people and unlike the conventional 24-hour dietary recall survey which is written in the native language the photos do not need to be translated and allow semi-literate people to participate (Subar et al, 2012).

1.8 Ethics

I met with my supervisor and another staff member of the Development Studies Programme at Massey University, on 28th June 2017, and discussed the ethical issues. We specifically discussed ethics involved in employing a research assistant on my behalf. Subsequently I submitted an application to the Massey University Human Ethics Committee (MUHEC) and MUHEC assessed this research project as low-risk because the nature of the harm was minimal and no more than normally encountered in daily life. All research was conducted in accordance with Massey University's research requirements as detailed in the MUHEC Code of Ethics.

1.9 Limitations and challenges

This project was mainly based on a document analysis with the addition of some field work involving interviews and food and garden photography. Thus a limitation of this project is that the sample size of four interviews (one school principal, two teachers, and one programme manager) is very small and may not be considered representative of the population or broad enough to produce reliable evidence (O'Leary, 2014, p.185). However, the sample size was determined by a small budget to hire a research assistant and a limited timeframe to do so. The participants had been recommended by a Permatil advisor to the Ministry of Education Timor-Leste to ensure representation of one zone (O'Leary, 2014) outside of Dili with participants all coming from schools with organic or permaculture gardens.

All transcribed data had to be translated from Tetum to English which poses a risk that important findings may sometimes be lost or confused in translation (McLennen, Storey, & Lesley, 2014, p. 154). But I endeavoured to clarify the transcriptions with Miguel, my research assistant, when appropriate, as well as ensuring the research questions were culturally appropriate in liaison with him.

1.10 Chapter outline

Chapter 1 has introduced the significance of the research including research aims and research questions. The conceptual framework and themes of the research as well as the methodology and methods, including document analysis, semi-structured interviews and food photography, were explained and discussed.

Chapter 2 contains a theoretical discussion concerning the need for school gardens based on permaculture/agroecology principles (including permaculture's relationship to the Sustainable Development Goals) in order to face the multiple challenges of adapting to climate change and increasing community resilience, nutrition, and food sovereignty.

Chapter 3 explores the benefits and challenges of implementing school gardens internationally. Permaculture in Development is then explored including why NGOs and local organizations are adopting permaculture strategies. Then the historical background of NGO Permaculture Timor-Leste (Permatil) is discussed.

In **Chapter 4** hunger, malnutrition and challenges to education in Timor-Leste are examined. Then the National Food and Nutrition Security Policy of Timor-Leste's government is explained. Environmental issues facing Timor-Leste are also examined, with Permatil garden school approaches possibly offering solutions to some of these issues. Then some of the challenges to implementing the programme are addressed.

Chapter 5 introduces the key findings from four sources including semi-structured interviews, a SWOT analysis, document analysis and a food and garden photography analysis. The participants and their respective schools are introduced, followed by the analysis and discussion of the data utilizing the agroecology framework.

Chapter 6 compares and contrasts the findings from the literature review with the interviews, document analysis and the food and garden photography. Specific targets of the Sustainable Development Goals are examined to see if Permatil's programme is helping to achieve various SDGs, followed by recommendations and a conclusion.

Chapter 2 Theoretical discussion concerning the need for school gardens

2.1 Introduction

Many communities around the world are faced with multiple challenges including climate change, complex environmental issues and a need to improve community resilience and nutrition. This chapter explores how school gardens are playing a growing role in addressing some of these challenges. The relationship between indigenous and traditional agriculture and permaculture/agroecology is briefly discussed. Next the theory behind permaculture and agroecology is explored and how both these approaches can be used for social and ecological regeneration. Then the impact of climate change, especially on children, and the need for climate change adaptation at the community level utilizing permaculture and agroecology approaches are explored. Then the relationship between permaculture and the Sustainable Development Goals is discussed. Lastly, community resilience is defined and its relationship to nutrition is explored.

2.2 The need for school gardens to address the multiple challenges of improving nutrition and adapting to climate change

UNICEF highlights the role school gardens can play in adapting to climate change because most schoolyards have wasted space that can be utilized for growing food and this is ideal in developing countries where many students only have one meal per day. The food from a school garden can help supplement their existing diet to improve their nutrition, while students learn gardening skills that can potentially strengthen food security (Iltus, 2012). Food security was defined at the World Food Summit in 1996 as

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. (FAO, 2006, June).

Therefore school gardens can also be an effective buffer to reducing child poverty by giving children greater access to nutritious fruit and vegetables (Utter et al, 2016, p. 831).

Internationally there has been an increased focus on how school gardens can teach children to grow healthy nutritious food, as well as teaching them about agriculture and the environment and their

relationship to livelihoods (FAO, 2010). Therefore school gardens can also be effective in increasing community resilience by transferring nutritional and environmental knowledge back into the community (Hockin-Grant & Yasué, 2017). However the wider community can also be involved in passing gardening knowledge on to the next generation in the school garden (Iltus, 2012).

In the last decade, school garden programs based on permaculture principles have emerged in developing countries (Hockin-Grant & Yasué, 2017), including in Timor-Leste, aiming to increase community resilience and nutritional diversity (Lemos, 2014). Wade (2017) argues that there is a need for an alternative to conventional education that has been based on industrialism and modernist concepts separating man from nature. A holistic educational approach based on permaculture, that includes a focus on social and ecological regeneration, prepares the students for the multiple challenges of today's world such as climate change. Increasingly NGOs involved with both social regeneration and the design of resilient food systems in developing countries are using permaculture for community education and climate change adaptation (Hockin-Grant & Yasué, 2017).

2.3 Indigenous and traditional agriculture and their relationship to agroecology and permaculture

For indigenous peoples, resilience is based on both traditional knowledge and an in-depth understanding of the land that enables them to be resilient and adapt to environmental changes (Galloway McLean, 2012). Traditional and indigenous agricultural systems were based on preserving agrobiodiversity in order to be resilient to future shocks (Sardos et al, 2016). These practices include local knowledge and cultural interaction with animals, plants, genetic resources, the land and water resources so that the system is both resilient and adaptive to stress and can support food production and food security (PAR Platform For Agrobiodiversity Research, 2010).

For example, in Vanuatu, different crops are traditionally planted at the same time so that there is always another crop to eat if one crop fails due to an extreme climatic event such as a cyclone or drought. These crops can then be supplemented by bush foods from the forest adjacent to the gardens (Sardos et al, 2016, p. 721). This symbiotic and holistic approach to agriculture has influenced both permaculture and agroecology design principles and concepts of sustainability (Henkel, 2015).

Agroecology is defined as a scientific discipline with emphasis on ecological systems management of land and water with human and animal inputs in sustainable agroecosystems (Silici, 2014). It includes the right to water, the protection of biodiversity and climate justice (Varghese, 2012). As well as a holistic approach to cultural, socio-economic and ecological sustainability in order to facilitate the resilience of farming systems (Silici, 2014).

The term 'Permaculture' actually means 'Permanent Culture and Permanent Agriculture' and was coined by Bill Mollison and David Holmgren who began writing books about the subject in Australia in the 1970s (Mollison & Holmgren, 1978). It is an evolving concept based on land use, community building and the ethical design of food production systems and incorporates a practical and integrated approach to assist people and communities to design a system for sustainable and productive living (King, 2008). As Mollison and Holmgren explain, the early aim of permaculture was

consciously designed landscapes which mimic the patterns and relationships found in nature while yielding an abundance of food, fibre, and energy for provision of local needs
(Mollison & Holmgren (1978) as cited in King, 2008, p.118).

As the concepts of permaculture and agroecology are similar some NGOs are using the term permaculture/agroecology to describe their focus on sustainable regenerative systems to improve community resilience (Lemos, 2014) and this is recognised by the FAO (2016). Both proponents of permaculture and agroecology emphasize the importance of utilizing local free resources such as biomass (rotting plant matter) to make compost for soil regeneration as well as companion planting to make use of space to increase food production outputs (Ferguson & Lovell, 2014). Gliessman (2007, p. 345) argues that both agroecology and permaculture are highly complimentary and that their fusion is based on sharing the principle that well-designed human and cultivated systems should emulate healthy natural systems in order to create more sustainable solutions. Wade (2017, p. 98) states

Permaculture designers begin by studying the site itself: the soil, water, wind, human, animal, and plant communities that comprise the place, their patterns, habits, and needs, following the principle observe and interact.

At the same time Hathaway (2016) argues that if agroecology and permaculture were used on a larger scale they could provide nutritious healthy food while rejuvenating degraded soil and at the same time reducing wastage of fresh water. Large amounts of biomass could be transformed to create biodiverse agriculture while reducing pesticide and energy usage. In contrast, the dominant

paradigm of industrial agriculture produces nearly half of the world's greenhouse emissions based on high energy consumption. Industrial agriculture also uses pesticides that come with a high ecological cost and it accounts for nearly 85 percent of fresh water usage (Hathaway, 2016, p. 239).

The strengths of both agroecology and permaculture are in recognizing existing traditional or indigenous agroecosystems as well as designing agroecosystems that relate to the local culture and microclimate (Henfrey & Penha-Lopes, 2015, p. 49). Thus a greater variety of food is provided for local people and there is increased nutritional diversification through genetic diversity which reduces the risk of shocks such as droughts and climate change (Putnam et al, 2014). However there was very little mention of permaculture in the scientific literature until recently (Ferguson & Lovell, 2014).

2.4 Climate change and how it affects small farmers and children

Globally, the burning of fossil fuels, the farming of livestock and the destruction of rainforests by humans are impacting on the earth's temperature by increasing greenhouse gas emissions such as carbon dioxide (CO₂), methane nitrous oxide and fluorinated gases. Over and above natural emissions, human beings are accelerating the greenhouse effect that leads to global warming, resulting in climate change that affects the weather patterns. Climate scientists agree that compared to pre-industrial Earth which was 0.85 degrees Celsius cooler than now, an increase of 2 degrees Celsius increases the risk of catastrophic environmental climate change globally (European Commission, 2017, p. 1).

Most of the greenhouse gases are produced by people in rich developed countries such as the USA, or countries with accelerated growth such as China and India. Thus climate change is an issue of justice and security for many small developing countries (The Green Belt Movement, 2009).

Vulnerable communities, especially in developing countries, are at risk from extreme weather patterns such as droughts and flooding and rising sea levels. Subsistence farmers are the people who are most vulnerable to climate change because they lose their purchasing power at markets or are unable to reinvest in farming when crops fail due to extreme weather patterns such as droughts (Hanna & Oliva, 2016). Currently, 370 million of the world's poorest farmers are at risk through climate change. A recent UN report states that an additional 122 million people could be forced into extreme poverty by climate change (if it is not reversed) because it would make it virtually impossible to grow food in large areas around the world (Provost, The Guardian, 2016, October 17).

This is backed up by Altieri et al (2015, p. 870) who state

The implications for food security could be very profound, especially for subsistence farmers living in remote and fragile environments that are expected to produce very low yields. These farmers depend on crops that could be dramatically affected, such as maize, beans, potatoes and rice.

Children are particularly vulnerable, as most developing countries have no safety net. This means that there is no money for school fees and less food on the table and thus an increased risk of malnutrition and hunger (Intergovernmental Panel on Climate Change, 2007). Children are also in danger of climate change related violence over dwindling resources, migration and decreasing air and water quality (Hanna & Oliva, 2016).

2.5 Climate change adaptation strategies

Rural communities are increasingly being faced with the challenge to adapt to the new weather patterns caused by climate change. They also need to become more resilient by conserving water to face longer droughts or other extreme weather patterns as well as reconnecting with sustainable indigenous systems that allowed communities to adapt in a crisis for centuries before colonization (Intergovernmental Panel on Climate Change, 2007).

Some indigenous cultures are now utilizing permaculture strategies in an effort to regain and preserve traditional knowledge and also to revitalize management systems in order to adapt to changing weather patterns (Henfrey & Penha-Lopes, 2015, p. 18). This can lead to a site-specific design that takes environmental and social issues into account (Mancebo & de la Fuente de Val, 2016). Such strategies include water management and mulching to retain moisture in the soil as well as complimentary food producing crops and nitrogen producing shrubs and trees to regenerate and preserve the soil. Furthermore, an abundance of leaves can be combined with animal dung to make compost to increase soil fertility for further food production (Henfrey & Penha-Lopes, 2015).

Alternatively communities can adapt locally by observing other communities who have developed good strategies to become more resilient to changes in similar climatic conditions (Henfrey & Penha-Lopes, 2015, p. 18). From an agroecology perspective, the first step is to identify those communities whose agriculture and food systems have withstood a drought, for example, and have thus shown resilience to climate change (Altieri et al, 2015). These communities can then share

their sustainable agricultural practices and local knowledge with others food growers. (Kremen, Iles, & Bacon, 2012).

2.6 Permaculture/agroecology's contribution to climate change adaptation and the SDGs

An agroecology conceptual framework has recently emerged which looks at multiple relationships to assess the resilience of a food growing system, including its vulnerability and the threats posed by climatic events (see 1.5) (Altieri et al., 2015, p. 883). This framework can be utilized to assess both agroecology and permaculture systems impacted by climate change events such as a drought (Putnam et al., 2014).

Mancebo and de la Fuente de Val (2016) explain that more work needs to be done to measure sustainability and resilience in communities who have adopted permaculture principles. They argue that the 17 SDGs address some of the root causes of poverty, environmental degradation, inequality and climate change. Each Goal has its own targets whereby there are a total of 169 targets set by the UN. The SDGs evolved from a mostly transparent consultation process, the largest in UN history, and were ratified in 2015. Furthermore Henfrey and Penha-Lopes (2015, p. 34) advocate that permaculture can play an important role in implementing the SDGs as permaculture is based on ethical design principles including equity, social and ecological regeneration and transformation. This applies especially to SDG 2 that promotes sustainable agriculture to achieve food security to end hunger and reduce malnutrition and SDG 13 that is about taking urgent action on climate change including its impacts (Henfrey & Penha-Lopes, 2015, p. 34).

Andeyo (2016) also argues that permaculture initiatives should first focus on SDG 13 Climate action as developing countries are frequently affected by climatic events such as droughts and floods, hampering the nations' ability to achieve all the other SDGs. Permaculture can mitigate climate change and can assist farms to *become resilient to extreme weather patterns and events* (Andeyo, 2016, p. 2). Permaculture's organic practices also promote the health of the soil as well as producing healthy food to achieve SDG 15 Life on the Land (Sustainable Development Knowledge Platform, 2017).

Hanna and Oliva (2016) argue that children must be considered in framing any policy on climate change, as they are the most vulnerable and this could be seen as an investment in the future. While Fletcher advocates that the key to achieving the 17 Sustainable Development Goals is through

permaculture/agroecology school gardens that take lessons outside the outdated academic theoretical model to outdoor participatory classrooms. There children not only learn about a healthy organic diet but learn about the climate and how to manage water and pests sustainably. The lessons learned in the school garden prepare them to be able to help solve the world's multiple problems including combating hunger and increasing food security (Fletcher, 2017, p.1)

2.7 Community resilience and nutrition

Increasingly policymakers in developing countries such as Timor-Leste (Republica Democratica de Timor Leste, 2014), international development organisations such as the FAO and communities are showing an awareness of the importance of being prepared for future shocks and having increased community resilience (Hockin-Grant & Yasué, 2017). The FAO has worked with multiple partners and stakeholders to develop a multi-sectoral policy framework, sharing evidence-based information on food security knowledge to assist systems in decision making. They have also taken into account the balance between people, ecology, and food production when considering resilience by promoting diversified nutritious food based on agroecosystems, so communities and households have the resilience “*to anticipate, absorb and recover from the negative impacts of human-made and natural shocks*” (Food and Agriculture Organization of the United Nations, 2014, p. 1).

Communities are defined by MacQueen et al. (2001) as a group of people who are connected by social relationships. They participate in a collaborative activity in a common setting or in a specific geographical or territorial location. This is distinct from networks with no specific location such as the internet community (Theodori, 2005). Communities around the world are facing multiple challenges such as climate change, hunger, a rapidly growing population, degraded soil and displacement of people (Braun & Birner, 2016). Therefore they need community development designs that are site-specific so that they can make use of local resources to prepare for future crises while taking care of every member of the community (Chacon et al., 2015).

While Carbel and Oelofse (2012, p. 1) state:

Resilience is defined as the ability of a social or ecological system to absorb disturbances while retaining its organizational structure and productivity, the capacity for self-organization, and the ability to adapt to stress and change following a perturbation.

There is also research that indicates that focusing on both resilience and nutrition will lead to a better understanding of the causes of undernutrition and therefore better health. As the FAO mentions, both nutrition and resilience are interrelated and interconnected stating “*nutrition is both an input to and an outcome of strengthened resilience*” (Food and Agriculture Organization of the United Nations, 2014). By focusing on both community resilience and nutrition, more holistic approaches can be facilitated, integrating health, sustainability (including climate change adaptation) and equality (Gostelow et al., 2016).

2.8 Food Security and Food Sovereignty

One of the arguments for transforming underutilised land in schools into school gardens is that it can potentially increase food security (Lander, 2013). While proponents of school gardens based on permaculture and agroecology principles argue that if these are implemented properly they will increase food sovereignty (Lemos, 2014). Food sovereignty is distinct from food security. Food sovereignty is defined as the right of people and countries to nutritious, healthy food which is culturally appropriate and based on sustainable agroecological methods while maintaining the right of farmers to determine their own system of agriculture (Declaration of Nyéléni, 2007, as cited in Belarmino, 2015).

Thiemann (2015) argues that investing in agroecology can be seen as a key to food sovereignty in order to achieve better food security as investing in agroecology shifts the focus from an investment in capital to an investment in both work and knowledge that can benefit those who are capital poor.

2.9 Conclusion

This chapter has explored how school gardens can help address some of the global challenges, including the impact of climate change, and lead to increasing food security and nutritional knowledge. By utilizing permaculture and agroecology approaches school gardens can support the need for climate change adaptation at the community level, especially for children. Permaculture is in alignment with the SDGs with their intention to transform and regenerate both social and ecological systems in order to adapt to climate change (Henfrey & Penha-Lopes, 2015, p. 34).

In contrast to industrial agriculture, permaculture/agroecology can provide nutritious healthy food while rejuvenating degraded soil and at the same time reducing wastage of fresh water based on site-specific design. Food security and food sovereignty were also defined and it was explained that one needs food sovereignty in order to have food security which can be achieved by promoting agroecology so that people have access to locally grown food.

Chapter 3 An international perspective on school gardens and permaculture and the emergence of NGO Permatil in Timor-Leste

3.1 Introduction

This chapter investigates the benefits of implementing school gardens internationally and will also show examples of school garden projects that did not succeed for a variety of reasons. Then UNICEF recommendations are introduced on how to achieve success with school garden programs with limited resources. Permaculture's emergence in Development is then explored including why NGOs and local organizations are adopting permaculture strategies. Examples follow that discuss different locations and different reasons for implementing permaculture projects and the impact that they have had. Then the historical background of NGO Permaculture Timor Leste (Permatil) is discussed including its relationship to Timorese culture, small farmers and education which will be the backdrop for the next chapter.

3.2 The benefits and challenges of implementing school gardens internationally

There has been an international drive to promote school gardens as a solution to food security with support from the World Bank and the United Nation's World Food Programme as well as many NGOs globally (Lander, 2013). But school gardens also provide an outdoor classroom for environmental education relating to climate change adaptation (Iltus, 2012). Some of these garden school programs have been successful while others have not (Lander, 2013).

Research indicates that professionals such as nutrition educators and school administrators should implement school gardens if they are serious about influencing dietary preferences at an early age (Parmer et al, 2009). Internationally school gardens have been found to increase children's taste for fresh fruit and vegetables while improving academic achievement by fostering an active learning environment (Baildon, 2016, p. 1).

A school garden can serve as a multidisciplinary 'living laboratory' that actively engages children in nutrition education and horticulture.

In Uganda, the students in garden schools are seen as the farmers of the future who will lift the nation out of poverty with increased nutritional awareness (Snodgrass, 2012). Another advantage of school gardens is that they increase children's scientific understanding compared to non-garden school students (Klemmer et al, 2005).

However, an investigation by Lander (2013) in Manenberg, in South Africa, found that an NGO had planted a small vegetable garden with school volunteers and an administrator. Students would have the advantage of learning about nutrition and growing food in an outdoor classroom. In an area with great poverty and high unemployment the community thought that the school garden was a great opportunity for their children. But the NGO withdrew its support three years later and the school garden ceased to exist because the school did not have anyone who was responsible for the garden and there were no gardening tools available. Lander (2013) found that this was not a one-off situation.

There were also various other reasons for the failure of school gardens throughout South Africa: Such as the NGOs had underestimated the cost of vegetable gardens, making the mistake of buying in compost instead of making it themselves. Some teachers said that they did not have the time to create lesson plans for the gardens, while other teachers were confused about the purpose of the school garden - whether it was for nutrition or for environmental education (Lander, 2013). In Nepal Schreinemachers et al. (2017, p. 343) found that more work was needed on the individual and community level regarding the transfer of nutritional knowledge from the students to the households as there was no increase in nutritional status or vegetable and fruit consumption at home although the students had increased knowledge of sustainable agriculture.

Other reasons for failed school gardens in poor areas of South Africa included lack of funding, inexperienced staff, vandalism from not being able to afford a caretaker and lack of community support (Lander, 2013). Sometimes this related to parents expectations or perceptions of school gardens. For example in a permaculture school garden project in Kenya Hockin-Grant and Yasué (2017, p. 438) found that

Another teacher noted that 'false hopes' were causing initially supportive community members to withdraw support from the project: There was an issue of creating false promises. False hopes, rather, that these gardens would create money.[...] Some parents feel that their children have been enslaved. They work without pay.

On the one hand some parents, and even a school governor, expected the school gardens to generate

an income but on the other hand some parents thought that the teachers were exploiting the students by encouraging the children to participate in the garden (Hockin-Grant & Yasué, 2017, p. 438).

Funding can also be a big challenge for school garden programs: Research in South Africa indicates that NGOs would be wise to promote the benefits of school gardens for learners. For example, school garden programs could network with external organizations to publish the benefits and this could be influential in gaining funding support (Laurie et al., 2017).

Regarding the lack of resources, UNICEF recommends the child-centred friendly schools approach for environmental education. This has the advantage that when a school has very limited teaching resources the garden itself can be used to create lesson plans that are based on interactive teaching approaches and methodologies. The teacher becomes a facilitator by encouraging children to participate and work together based on learning while doing an activity in the garden (Iltus, 2012).

3.3 The emergence of permaculture in Development

When faced with multiple challenges caused by environmental degradation, local communities and NGOs around the world are creating innovative interventions that respect local cultural values and sense of identity while incorporating permaculture and agroecology principles to increase dietary diversity and thus increase community health, wellbeing and resilience (Chacon et al., 2015). There are also educational projects that utilize permaculture and agroecology principles so that small farmers can become resilient and achieve sustainable development outcomes (Gómez et al., 2013). Permaculture is also increasingly being used in developing countries for climate change adaptation and resilience (Oxfam Issue Briefing, 2014).

The award-winning NGO Pura Vida from Guatemala is such an example. The NGO established garden schools around Lake Atitlan via community networks, including women's groups. These garden schools were based on Mayan cosmology in order to build self-esteem (Heisse, 2014) as well as permaculture and agroecology principles (Henfrey & Penha-Lopes, 2015) to promote nutrition and environmental awareness (Heisse, 2014). Pura Vida had noticed that there was a direct link between the amount of plastic waste being dumped into Lake Atitlan and the amount of processed food being promoted on television and then consumed. So they started nutritional education campaigns that included permaculture in schools and started to transform waste plastic into superblocks (plastic bottles filled with waste plastic) to build school infrastructure, including

water tanks (Heisse, 2014). In contrast, plastic waste is often disposed of by burning which is a toxic health hazard or by dumping in non-sustainable ways in the absence of government funded waste management in many developing countries (Neubauer, 2017).

Research into an educational aid project in a school in Butula, Kenya, that was supported by Canadian NGO Seven Ravens Permaculture Academy (SRPA), revealed various benefits of implementation and the long-term sustainability of the project in the community (Nickels, 2013). SRPA had developed demonstration gardens in schools as well as training teachers in permaculture. Students were taught how to transfer the techniques they had learned, including soil conservation, pond making, nurturing native tree seedlings, multiple crop cultivation, in order to regenerate their parents home gardens. They also planted income-earning fruit trees that could potentially produce crops that would fetch a good price. Students liked the fact that permaculture was in harmony with traditional values and that they could grow a surplus, regenerate the soil and increase livelihoods with the methods they learned from studying permaculture (Hockin-Grant & Yasué, 2017). A student of the program cited by Hockin-Grant and Yasué (2017, p.438) stated

Within the small acreage that you have, you are able to produce enough to eat and also to sell. [...] Permaculture will work with our people. It will work because it's something we identify with.

Thus permaculture was helping to increase livelihoods as well as relating to their sense of identity.

3.4 A short history of permaculture in Timor-Leste and the founding of NGO Permatil

In 2000, a few months after the tumultuous vote for independence from Indonesia in 1999 (Fernandes, 2011), Steve Gran and other Australian permaculturalists met Ego Eugenio Lemos in East Timor (McKenzie, 2015). Ego Lemos had been active in the independence movement but had also been promoting organic agriculture (Wigglesworth, 2013). At the time East Timor was a UN mandate and was trying to recover from the violence of the retreating militias (Fernandes, 2011). At first, the Australian permaculturalists taught standard permaculture design courses as they were also taught in Australia. But they soon realized that they had to adjust the teaching to include the social realities of people living in extreme poverty as well as integrating the Timorese indigenous culture into the permaculture framework (Hara, 2016).

Permaculture Timor Leste (Permatil) was formed by a group of Timorese who had attended the first permaculture courses, beginning their first garden school in 2002 (Hill, 2016). Permaculture was thus accepted by the Timorese because they used good design and practical techniques to help improve people's livelihoods and develop sustainable agriculture. They also shared the same relationship to nature that related to the Timorese identity and culture (McKenzie, 2015) as Timorese people's identity is based on spiritual and ancestral connection with the land (Batterbury et al., 2015).

But officers from the East and the West of Timor-Leste fought each other in 2006 (Marra, 2007, in collaboration with Centro Audio Visual Max Stahl Archive) and Permatil had to suspend operations while Ego Lemos promoted peacebuilding with other musicians (Correspondence with Council for International Development, 2006).

Permatil realized that it needed to work with other organizations and government departments if it was going to help transform society. Ego Lemos and Permatil began writing a tropical permaculture guidebook 'Kuidadu Ba Rai, Kuidadu Ba Malu, Ho Futuru Timor Leste' which was first published in 2006. The book, A permaculture guidebook from East Timor / created by Permatil, is fully illustrated and covers every aspect of indigenous sustainable agriculture including climate change adaptation and resilience planning to deal with food shortages and droughts and avoid landslides and erosion (McKenzie & Lemos, 2008).

3.5 Conclusion

This chapter revealed that the success of school gardens depends on the NGOs' strategies to gain funding and the support of the community. Whether an NGO is wanting to increase nutritional agricultural knowledge and educational quality so students can become the farmers of tomorrow or whether school gardens become living laboratories through increased nutritional and scientific knowledge of the students. In Guatemala the NGO Pura Vida combined permaculture and transforming trash into school infrastructure as part of its nutritional program. While a Canadian NGO in Kenya had success in establishing an educational program to pass on permaculture knowledge back into the community.

In Timor-Leste, NGO Permatil adapted permaculture from its Australian origins to take into account the reality of mass poverty and Timorese concepts of identity and ecology. Permatil realized that it had to collaborate with many different NGOs and government departments in order to successfully implement permaculture projects in Timor-Leste. It developed an illustrated guidebook for teaching permaculture not only to farmers but also in schools.

Chapter 4 Permaculture garden schools in policy and practice and the nutritional and environmental challenges facing Timor-Leste

4.1 Introduction

Timor-Leste is a tropical half-island state with a size of 15410 square kilometres in total, located north of Australia. It borders West Timor which is in the Indonesian province of East Nusa Tenggara (East Timor Government, 2012). Since independence Timor-Leste has gone from being the fourth poorest nation in the world to now being ranked as a lower middle-income country, ranked number 133 in the Human Development Index (HDI) out of 188 listed countries (United Nations Development Programme, 2012, p. 1). However Timor-Leste faces multiple challenges regarding nutrition, education and the environment including climate change adaptation (Lemos, 2014). The Permatil school garden programme, supported by government policy, may be part of the solution to overcoming some of these multiple challenges.

In this chapter hunger, malnutrition and challenges to education in Timor-Leste are examined and contrasted with garden school perspectives, seeking solutions to the above through student and community participation and active learning. Then the National Food and Nutrition Security Policy of Timor-Leste's government is explained, including the role of garden schools in meeting some of the policy objectives. Complex environmental issues facing Timor-Leste are also examined, with garden school approaches possibly offering solutions to some of these issues. These approaches include training children to be climate change adapters and transferring gardening and nutritional knowledge back into the community. Then some of the challenges to implementing the program are addressed.

4.2 Hunger, malnutrition, challenges to education and garden school perspectives

The population of Timor-Leste is expected to rise from 1.2 million in 2013 up to 3 million by 2050, putting pressure on available resources and food consumption (Molyneux et al., 2013, p. 823). In Timor-Leste, 49.9 percent of the population is presently below the national poverty rate with the average per capita income being \$5446 per year (Asian Development Bank, 2017, p. 1). Eighty percent of the population are engaged in agriculture (Correia et al., 2009, p. 1) with Timor-Leste's farmers plagued by a hunger season from October to March each year (Marino, 2014). This occurs

because farmers have sold or eaten their previous crops and are waiting for their new crops to grow to be harvested in March or April (Levy, 2016). Due to this hunger season, Timor-Leste is ranked fourth worst in the world in the Global Hunger Index (Campbell, 2013). The hunger season is classified as transitory food insecurity when there is a temporary decline in access to food which can often impact on nutritional status (Republica de Timor-Leste, 2014).

Forty-five out of every 1000 babies die in Timor Leste before their first birthday which is the highest infant mortality rate in the greater Pacific region (Asian Development Bank, 2017, p.1). Twenty-seven percent of women aged between 15 and 49 are malnourished which puts them at greater risk of experiencing illness, obstructed labor and dying from bleeding after childbirth (UN Women, 2014, xiv). Fifty percent of children under five are stunted in Timor-Leste, one of the highest rates in Asia (World Food Programme, 2011) indicated by a child being too short for their age. This is a key indicator of malnutrition (Rudert, 2014). And eleven percent of children are underweight compared to their height which is a key indicator of wasting (World Food Programme, 2011).

Evidence suggests that hunger also impacts on education as malnutrition continues among children over five with many children arriving at school hungry and thus not able to concentrate (World Food Programme, 2011). Permaculture/agroecology garden schools may be able to help solve the multiple challenges of hunger, climate change adaptation and student engagement as they are now part of the Ministry of Education's programme for grades 1 to 6 and then to Grade 9.

4.3 Permatil's school garden programme

School gardens based on permaculture and agroecology principles are being introduced into 1415 government schools in Timor-Leste as part of formal education (Lemos, 2014). This has come about because of a change of focus in the national curriculum that allows for activities outside the classroom instead of a focus on passive learning inside the classroom (Hill, 2016, p. 1). The first priority is teaching teachers and students how to grow a variety of seasonal crops to assist with the school feeding program (Lemos, 2014). Photos from the World Food Programme (2011) indicate that students' meals at school usually consist of rice and beans if the school does not have a school garden for growing food.

The second goal of this programme is to transfer gardening knowledge from the students back into

the community to improve nutrition (Lemos, 2014). An interview with a teacher and parents in a Permatil garden school highlighted the benefits to the community from growing fresh vegetables beside the family home instead of only growing flowers like before. The older students are also more eager to help out in the family garden where both parents and their children exchange gardening knowledge (McKenzie & Lemos, 2017).

However an evaluation funded by UNICEF's MDG Achievement Fund, that included household gardening and garden schools in Timor-Leste, raised some interesting issues: Noij (2011, p. 18) found that rural communities close to markets are also more likely to sell their vegetables to obtain cash to either buy food or pay for their social obligations while perhaps eating part of the crop they have grown. Instead of the family, including reproductive women with children under 5, consuming the nutritious food from their garden themselves. Noij therefore found that an accompanying education campaign regarding nutrition is necessary. As he states

Nevertheless, there is a need to make a clear and explicit linkage between support for gardening on the one hand and promotion of enhancing nutritional practices on the other hand. The school gardens are a good example of the approach as these are meant for educational purposes of both gardening and food consumption.

Based on the reformed curriculum in Timor-Leste, Permatil has been working with the Center for the Study of Science and Mathematics (SESIM), which is linked to Timor-Leste's Ministry of Education, to include science, maths and other subjects in the school garden programme. One of the members of SESIM, Curt Gabrielson (2016, p. 1), states that the school garden can be an ideal opportunity to teach multiple subjects that relate to the new education curriculum.

Mathematics and science lessons can be based on the garden. Health lessons can analyze the nutritional results and possibilities of the garden. Social science lessons can look at the history and current reality of food production in Timor-Leste. And even literacy can use the garden and local agriculture as a subject for writing or reading

However when researching education in Timor-Leste in comparison to other new developing countries, Burns (2017) found that innovative school programmes that try to relate schooling to work or practical-orientated education historically faced challenges to preparation, supervision and funding. Even though garden schools are part of the Timorese government's policy and many permaculture manuals were distributed - only a few permaculture school gardens have been implemented (Lemos, personal correspondence, 2017). NZAid, for example, funded the distribution

of permaculture manuals to 1415 government schools in Timor Leste but did not contribute to the implementation of the permaculture/agroecology system in these schools (Correspondence with Ego Lemos, 2017). Besides investigating the benefits of the garden school programme it was thus essential to find out what some of the challenges are to implementation (Lemos, 2017). Ego Lemos (2014, p. 2), the director of Permatil, argues

If this program is implemented well, in five years Timor-Leste will have strong food sovereignty, better nutrition for the children and community, there will be no more hunger, and the local economy of the people in rural areas will improve.

4.4 Timor-Leste's government policy on food sovereignty and food and nutrition security

In October 2010 key Timorese Ministries signed the Comoro Declaration in consultation with international partners and NGOs which led to the Strategic Development Plan (SDP) 2011-2030. The Ministers also established the National Food and Nutrition Security Policy in 2014 which emphasized the fundamental right of their citizens to be free from malnutrition and hunger (Republica Democratica de Timor-Leste, 2014). It is important to note that the Comoro Declaration (2014) was signed before the Sustainable Development Goals that were adopted by 193 governments at the United Nations in September 2015 (UN Sustainable Development Knowledge Platform, 2015).

While the previous national policy had focused on crisis management, the new National Food and Nutrition Security Policy focuses on risk reduction and resilience building by addressing the issues of food sovereignty and food and nutrition security to improve maternal health while recognizing women's role in feeding and food production in Timor- Leste. Furthermore, the new policy promotes new guidelines to improve the school feeding programme (Republica Democratica de Timor-Leste, 2014).

The aim of the National Food and Nutrition Security Policy is to achieve self-sufficiency in staple food production by 2020 and to be free from hunger by 2030 while respecting traditional and cultural values and protecting the environment and biodiversity, increasing food security and recognizing equal rights for women, children and vulnerable people such as subsistence farmers. How wealth is measured is paramount in the Comoro Declaration "*the true wealth of a nation lies in the strength of its people*" (Republica Democratica de Timor-Leste, 2014, p. 4).

Garden schools are part of the government's National Food and Nutrition Security Policy (Republica Democratica de Timor-Leste, 2014). Food diversity may be increased by garden schools through transfer of knowledge from the school to the home as one of the key targets and indicators of the National Food and Nutrition Security Policy is *Household dietary diversity score: ≥ 5 number of food groups consumed by $\geq 50\%$ of the population* (Republica Democratica de Timor-Leste, 2014,p.5). If garden schools can lead to more than 5 food groups being eaten by at least 50 percent of the population then this is an indication of an increase in Household Dietary Diversity Score.

The government of Timor-Leste (Republica Democratica de Timor-Leste, 2014) also sees the role of garden schools as a hub of knowledge integrating both nutrition and health activities, not just in the classroom but spreading awareness of hygiene and sanitation to the wider community as well as dietary diversity through garden knowledge, water safety and resilience planning. This will help Timor-Leste's government reach the main goal of the National Food and Nutrition Security Policy:

By 2030 Timor-Leste will be free from hunger and malnutrition and Timorese people will enjoy healthy and productive lives. People in Timor-Leste will be well-fed principally from increased variety of locally produced safe and nutritious food for healthy and productive lives while witnessing carefully-managed agroecosystems (Republica Democratica de Timor-Leste, 2014, p. 21).

The government of Timor-Leste is thus aiming to achieve SDG 2: End Hunger, *Achieve Food Security And Improved Nutrition And Promote Sustainable Agriculture* (Sustainable Development Knowledge Platform, 2015).

4.5 Historical environmental issues facing Timor-Leste and garden school solutions

Timor-Leste inherited some of its environmental problems from the Indonesian occupation such as the impact of the use of chemical fertilizers in agriculture, while increased usage of high input chemical farming methods led to water and soil pollution (Trueman, citing Lemos, 2007). This resulted in increasing livestock and crop losses and increasing pest resistance forcing farmers to be more dependent on external inputs such as imported fertilizers while competing in the free market economy which resulted in less available income for farmers' families (McKenzie & Lemos, 2008).

Illegal logging in rural areas is another major problem in the wet season as it can lead to landslides,

as well as slash and burn agriculture in rainforest areas which creates erosion problems. In contrast to this Permatil's garden schools teach children how to manage nurseries for tree planting that can produce fruit and nuts and also forage for animals while reducing the risk of erosion (McKenzie & Lemos 2008, 2017).

Another environmental problem facing Timor-Leste is the lack of solid waste management with the World Health Organization being concerned with the lack of institutional support in Dili. The largest dumping site, Tibar, is namely home to families with children who burn plastic while searching for items they can resell like cans. This results in serious health issues from the toxic smoke. At the same time various NGOs have failed to make an impact to benefit residents or improve the waste management system (Neubauer, 2017).

4.6 Climate change adaptation in Timor-Leste

Natural hazards and risks faced by Timor-Leste include earthquakes, tsunamis, landslides, climate change, droughts and flooding (Norton & Waterman, 2008, as cited in Mercer et al., 2014, p. 702). The country also faces the threat of extreme weather variations caused by climate change that can lead to a disruption of agricultural production (International Panel on Climate Change, 2007). Therefore climate change adaptation is urgently needed as Timor-Leste has a rainfed agricultural system and the annual temperature is expected to rise by 2.5 ° Celsius by 2070 which could have disastrous economic consequences for agriculture if community climate change adaptation strategies are not implemented (Chandra et al., 2016, May). In 2016-2017 Timor-Leste was hit by El Niño droughts leading to crop failures followed by La Niña extreme rainfall leading to landslides (Levy, 2016). This happened just when the long-term Seeds for Life government programme was starting to show positive results as it had been set up to support small farmers with a wide variety of organic seed varieties and due to the programme's success women farmers were able to pay for school fees (Locke, 2016).

A recent Ted Talk (Ted, 2017) by Ego Lemos, Permatil's director, highlighted that garden schools can be part of the solution to some of the environmental problems facing Timor-Leste. There children learn environmental problem solving and how to adapt to climate change through active learning outside the classroom. In the climate action orientated lessons students participate in the permaculture design of the school and the wider community. They learn how to manage pests in a sustainable way and conserve water by mulching as well as how to make compost for soil fertility

and seed save for future replanting. Thus the programme aims to help students spread climate change adaptation knowledge to their communities so that they can achieve the Sustainable Development Goals (McKenzie & Lemos, 2017). The government of Timor-Leste, Permatil's partner, is now part of the United Nation's High-Level Support Group for SDG Implementation across all sectors of society (Lemos, 2014). Timor Leste is the only nation from the Asia-Pacific region to join the group (Hill, 2016, p. 1).

As Hill states

Timor-Leste played a role in shaping the new global agenda, particularly in advocating for the inclusion of [SDG] Goal 16 to promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build, effective, accountable and inclusive institutions at all levels.

Students are learning how to tackle Timor-Leste's major problems including nutrition, water, food security and climate change adaptation (Hill, 2016, p. 1) which also relates to SDG 13 *Take urgent action to combat climate change and its impacts* (Sustainable Development Knowledge Platform, 2015)

However, Chandra et al. (2016, p. 477) argue that there needs to be more research on community climate change adaptation in Timor-Leste as this could benefit other regions faced with adaptation to extreme weather patterns such as droughts, stating that

Climate change adaptation is an emerging field for development and international aid efforts in Timor-Leste, largely due to the country's reliance on favourable weather to drive agricultural productivity but also limited adaptive capacity.

Thus more research is needed to find out how people, including garden schools, are adapting to extreme weather patterns and finding ways to grow food when there is no rain.

4.7 Conclusion

The literature indicates the importance of having government policy that supports small farmers, women, and children, valuing them as ‘the true wealth of a nation’, with garden schools being part of a multifaceted approach to improve community health, nutrition and resilience. Collaborations are also important with NGOs such as Permatil who has developed the garden school programme based on its experience working in rural communities. If the policy is properly implemented it can help Timor-Leste achieve the Sustainable Development Goals, including SDGs 2, 4, 6 and 13.

Evidence also indicates that the students in Permatil’s garden school programme are being trained to become climate change adapters who can help their communities reach the Sustainable Development Goals (TED, 2018, January). Chandra et al. (2016, May) argue that there needs to be more research into community climate change adaptation in Timor-Leste as this could benefit other regions faced with adaptation to extreme weather patterns such as droughts.

Chapter 5 Garden schools in Timor-Leste: Key findings

5.1 Introduction

This chapter will introduce the key findings from four sources (semi-structured interviews, a SWOT analysis, document analysis and a food and garden photography survey carried out by my research assistant in Timor-Leste). First the participants will be introduced - Principal 1 and Teacher 1 at School A with an organic school garden near Dili in Timor-Leste contrasted with Teacher 2 at School B with a Permatil-based school garden in the same area. Then the agroecology framework is explained as it can measure the resilience of a food growing system and social networks in response to climate change related droughts. This leads to the first key findings that are based on the interviews with the above participants in order to help answer research questions 1 and 2 about the role of garden schools in improving community resilience through climate change adaptation and nutritional diversity. Then a SWOT analysis is introduced that is based on the responses of Principal 1, Teachers 1 and 2 and a Permatil programme manager in order to answer research question 3 relating to the benefits and challenges of implementing a school garden. Lastly the findings of a food and garden photography survey will be introduced.

5.2 The participants

Two schools participated in this research: School A with Principal 1 and Teacher 1 as well as School B with Teacher 2. Teacher 2 (at School B) followed Permatil's recommendations while Principal 1 (at School A) had developed his own organic gardening system rejecting Permatil and the Ministry of Education's guidelines because he thought the size they recommended for the school garden was too small. More significantly his approach to transferring knowledge from the community to the school was the exact opposite of Permatil's recommendation that the gardening knowledge that students learn at school could then be transferred to households. As he encouraged the local farmers to first establish the school garden and then learn from best practices in the community. It is important to clarify that Principal 1's school garden design was similar to illustrations in Permatil's book 'Kuidadu Ba Rai, Kuidadu Ba Malu, Ho Futuru Timor Leste' that included a water tank, fish farm and organic composting. A Permatil programme manager was also interviewed in order to answer research question 3 about the benefits and challenges of implementing a school garden.

5.3 Thematic analysis of interviews

Thematic analysis was utilized to analyze the answers of the participants in order to be able to answer the research questions. There were a total of 12 semi-structured interview questions whereby nine were designed to answer the first two research questions: Research question 1 How can garden schools in Timor-Leste lead to improved community resilience through climate change adaptation? as well as research question 2 Will garden schools lead to improved community resilience and increased nutritional diversity in Timor-Leste?

A respondent's answers to the first nine questions were broken down into themes relating to the agroecology conceptual framework of Altieri et al. (2015). This framework was utilized as the schools food growing system is referred to by the FAO as the 'Permaculture/Agroecology system in Timor-Leste National School Curriculum for Basic Education (FAO, 2016, p. 1). The interview questions focused on the process of permaculture design (Who was involved and what did they do?); the engagement/teaching of children in the school garden; the management of water in the school garden; adapting to droughts in the school garden; what fertilizers were used and who helps; the types of vegetables and fruit grown; what produce from the school garden was being used for school lunches; how were gardening skills and nutritional knowledge being transferred from the school back into the community; children's health and school attendance.

Each sentence and the key words from the respondents were coded and placed with the relevant themes from the agroecology framework, such as 'Vulnerability to climate change', 'Reactive Capacity/Adaptation', 'Crop Diversity', 'Collective action, social networks, agroecological design to buffer shocks', 'Natural resource conservation versus unsustainable practices' and 'Resilience'. Then the data was analyzed according to the above themes from the agroecology framework. For more detail on the significance of these themes please refer to Chapter 1.5.

5.4 Key findings and themes from semi-structured interview questions analysed using the agroecology framework

5.4.1 Vulnerability

Participants felt that they were vulnerable to a number of different factors. For example both

Teachers 1 and 2 and Principal 1 all mentioned that they felt vulnerable because of a lack of water. Teacher 2 at School B mentioned that there was no water for the school garden or for sanitation during dry periods while Principal 1 at School A mentioned that their water pumps were constantly breaking down and they were running out of ways to fund their repair. Teachers were also vulnerable because of a lack of parent engagement in the school garden program. For example, Teacher 1 at School A faced problems with monitoring and evaluating whether garden knowledge was being transferred back into the community as this was an important part of the programme (Lemos, 2014). On the other hand Teacher 2 was confronted with the fact that some parents thought that having the children work in the school garden was exploitative.

Even their participation was criticized by the community and their parents because they thought that we use them (exploitatively) for work.

Besides being vulnerable due to lack of water School B faced outside threats of social misconceptions from the parents about the program and there was a lack of socialization between teachers and parents for program clarification.

5.4.2 Reactive capacity/Adaptation

Participants described their reactive capacity or their adaptation to vulnerability based on a lack of water. Lack of water and water management in general is becoming more common as rural communities are having to adapt to new weather patterns and become more resilient by conserving water to face longer droughts or other extreme weather (Intergovernmental Panel on Climate Change, n.d.). The two schools adopted different strategies to cope with a lack of water: School B had no water tank and asked students to bring a bottle of water a day to water the garden. School A obtained water tanks with the help of the Thai embassy and they also had water pumps. Principal 1 of School A had also developed a low-cost innovative management plan for water conservation based on a drip feed irrigation system utilizing hanging plastic water bottles. He called his concept ‘*inventing the rain*’

I’ve tried by arranging a bottle of water, make a tiny hole at the bottom and fill it full with water and hang it in a stick on the top of plants and it will drip slowly down to the plants which could last for a month.

Teacher 1 and the other teachers at School A found solutions to the problem of communicating with

parents about the potential benefits of the school gardens and the lack of a monitoring program to find out whether gardening knowledge was being transferred back into the community. They established a parent-teacher association and resolved the problems by organizing meetings with the parents to socialize and explain the benefits of garden activities by emphasizing that one of the main aims was to teach children how to plant and grow food on their own for the benefit of the community.

Faced with the challenge of lack of water and parents misconceptions about the program, School A showed a great level of Reactive Capacity that included social organization to be able to deal with threats (Altieri et al., 2015). They did this by networking with the Thai embassy and establishing a parent-teacher association to be able to monitor the program. This is similar to the concept of adaptation where communities have to pool their resources when they are threatened by droughts or other threats (Intergovernmental Panel on Climate Change, 2007). However by asking students to bring a bottle of water a day School B ended up with a lot of plastic waste that later became a threat.

5.4.3 Crop diversity and nutritional awareness

Crop diversity refers to the amount of food growing in the food growing system and helps define the resilience of this system, including sustainable practices. As research has indicated monoculture food growing systems are less resilient than communities that have increased food diversity (Altieri et al., 2015).

Fieldwork revealed that both schools showed an increase in dietary diversity with school meals providing at least three vegetables from the school gardens that were producing up to nine types of fruit and vegetables. Teacher 2 from School B said that children also liked the taste of the freshly grown organic produce they had grown themselves compared to non-organic produce. School B has only had a school garden since 2016 and has had two to three harvests since being established. By speaking to a program manager at School B my research assistant found out that the school feeding program was not always consistent on the days that it operated (Messenger conversation with Miguel, 2017). Thus Teacher 2 had to come up with innovative ways to make the most of their food resources and community networks. For example, by asking the students to bring cooked rice from home. Thus when they were getting their vegetable garden and the school lunches established Teacher 2 said

Due to the amount of each veggie that we harvested wasn't that much, so we cooked all of

them together in a mixed dish called “Raba-Raba’ (in Tetum).”

School B’s garden was a lot less established than School A’s so they had to make the most of their smaller harvests. Teacher 2’s comments indicated that the school meal program was not operating and students were asked to bring rice from home.

In contrast Principal 1 and Teacher 1 at School A, which had been established for 2 to 3 years, said that the suppliers of the school lunches bought the vegetables from the garden and cooked them in the kitchen and served them to the students and that they thus did not have to buy vegetables from outside suppliers. Principal 1 had extended the school gardens to be larger in size than the garden size, shape and location recommended by Permatil and the Ministry of Education. Unexpectedly Principal 1 of School A also established a student cooperative to generate income from the sale of vegetables even though the principal had had no time to follow up on the student cooperative’s earnings and they had not yet touched the money to buy seeds. However, Teacher 2, whose school garden had only been going for one year, did not appear to be making an income from selling produce but was encouraging students to save the seeds from the produce that they had grown. Seed saving is part of the permaculture concept (Lemos, 2014). Principal 1 said regarding the sale of produce *“This also brings an income to the students cooperative group that we established here at the school.”*

So School A’s garden had been established longer than School B’s garden and was very productive producing a surplus that could be sold to the school lunch suppliers and generate an income that was managed by the school students. The principal was intending to invest the income earned back into the school including buying more seeds. Whereas School B’s vegetable garden was only one year old and the teacher and students were seed saving which is an important concept in permaculture because growers do not have to spend money buying more seeds. Thus both schools were making the most of their gardens’ produce and student participation.

5.4.4 Collective action, social networks, agroecological design to buffer shocks

The permaculture and agroecology design and use of local networks at both school gardens involved the participation of teachers and students at one school and parents, teachers and students at the other school. Teacher 2 at School B said everyone (teachers and 5th and 6th grade students) had

worked together right from the start establishing the school garden - from building the fence, digging the soil, making the garden, to planting and watering. They had recently extended the school gardens to the rear of the school so Grade 1 to Grade 5 students could participate. This approach is also recommended in Permatil's guidebook and is based on passing knowledge from teachers to students and then back to the community. Whereby the students share what they have learned about vegetable gardening with their families. Unexpectedly Teacher 2 from School B had obtained information from the Thai embassy on how to manage a school garden and had even gone to Thailand to obtain additional training.

Whereas School A tried to take advantage of local knowledge by getting the parents who are farmers involved from the start as they made the first garden while the students and teachers observed. This raises an interesting issue as a Permatil programme manager informed my research assistant that a lot of the older generation of farmers are retiring and there will be a shortfall of farmers in the future. Principal 1 from School A appears to be undertaking an adaptation strategy of upscaling knowledge by observing which types of gardening practice are working better than others in the community. As Principal 1 states "*We don't just apply our idea, but also considering theirs.*"

To summarize: Upscaling takes place when one adapts locally by observing other communities who have developed good strategies to become more resilient to changes in climatic conditions (Henfrey & Penha-Lopes, 2015, p. 18). Or one identifies those communities whose agriculture and food systems have been resilient to climate change by withstanding a drought, for example, and then upscaling or improving on their strategies (Altieri et al., 2015). Both schools were making the most of their networking opportunities in order to develop their school gardens. The Thai embassy's involvement was unexpected as they gave training to Teacher B and a water tank and water pumps to School A.

5.4.5 Natural resource conservation versus unsustainable practices

Both schools had learned to transform free resources such as biomass (rotting leaves, cut grass, and dung) into dry and liquid compost to fertilize the gardens whereby both teachers and students participated in the compost making. Principal 1 of School A had banned all chemical fertilizers from being used in his school and had focused on organic methods of making fertilizers. His school had a fishpond that was generating waste that could be used as fertilizer as well a potentially producing another food source.

However, both schools had serious issues with managing plastic waste. Principal 1 and Teacher 1 from School A buried plastic waste although some garden photos reveal that some of the plastic bottles were transformed into seeding containers. However, School B, the school that had no water tanks and which had asked its students to bring a bottle of water to school each day, had the most unsustainable practices: As teacher 2 states

About the sanitation, there is no water in the school and to control the rubbish we dig two big holes. One hole is to put the plastic rubbish until it's full and then we burnt it.

Even though the Timor-Leste government has implemented the policy on school gardens (Republica de Democratica Timor Leste, 2014) it has not implemented the policy on waste management yet.

5.4.6 Resilience and key findings, analysis and summary

Both schools had adapted to a shortage of water during droughts. In particular, Principal 1 had developed a low-cost innovative management plan for water conservation based on a drip feed irrigation system utilizing hanging plastic water bottles. Principal 1 said all students are instructed to take care of nature in the garden and not to use chemical fertilizers. The community is also benefiting because of the transfer of garden school knowledge through Grade 6 children because they are able to create gardens at home by making compost and conserving water in droughts.

Both schools showed an increase in dietary diversity with school meals providing at least three vegetables from the school gardens that were producing up to nine types of fruit and vegetables. Teachers confirmed the improved health of students because they were more active in the garden and eating and enjoying the organic food they had helped to produce. The variety of vegetable crops grown in the schools showed increased food sovereignty because the vegetables were locally grown and not imported as previously for the school lunch program (Lemos, 2014).

The adaptation strategies and networks that the garden schools are generating indicate that they have the potential to cope with stress (Carbel and Oelofse, 2012) This is indicated by School A's garden producing a surplus and the students selling this surplus to the school lunch suppliers and then setting up a cooperative in order to reinvest the money they have earned in the school garden. However if the issue of burning plastic is not resolved it will prevent the programme from

becoming fully resilient as burnt plastic waste is a health hazard (Neubauer, 2017). However, this issue could be resolved by Permatil networking with other groups who have found creative solutions to managing plastic waste (Heisse, 2014).

5.5 SWOT

The SWOT analysis below was based on the experiences of one of the Permatil programme manager's who was familiar with the monitoring of the programme contrasted with the experiences of Principal 1, Teacher 1 and Teacher 2. Participants were all asked 3 semi-structured interview questions while the Permatil programme manager was asked a fourth interview question spontaneously, relating to the challenges Permatil is facing with the implementation of school gardens in Timor-Leste.

5.5.1 Strengths

According to this Permatil programme manager, one of the biggest strengths of the programme is a partnership that has been formed between the Ministry of Education and Permatil. This cooperation enables Permatil to legally implement permaculture school gardens in all of Timor-Leste. Permatil's estimated timeframe to implement permaculture gardens in all primary schools across Timor-Leste is 5 to 10 years. Based on the evidence so far the Permatil programme manager is confident that the school garden programme will benefit the school lunch programme economically *“by reducing the amount of money spent buying the food from outside (suppliers)”*.

The Permatil manager also explained that the Permatil programme transforms a schoolyard into a green laboratory for students to learn about nutrition and mathematics as well as linguistics, including utilizing the Portuguese language in the garden. Turning the outdoor learning environment into a practical workshop is also confirmed by Principal 1. He commented that his school is specifically developing a mathematics study system based on his alternative approach to the school garden through student observation and participation. Students will learn how to calculate on their own while undertaking a price comparison when they sell produce from the school garden. Teacher 1 said that a major benefit of having implemented a vegetable garden at his school will be that his students will have practical skills to survive in Timor-Leste as not all students

will be able to find office work. The Permatil manager also confirmed that the hands-on approach to education is showing that the sustainable knowledge that the students learn in the school gardens is being transferred back into the community which confirms that garden schools increase community resilience.

We observe that students really show their interest to the program because it's very hands-on learning for them and when they go back home they share it with their parents as well."

Teacher 1 also confirmed an added bonus of the school garden program is that his students will have the potential to transfer skills that they have learned to motivate parents to plant vegetables instead of flowers next to their houses. Likewise, Teacher 2 said that implementation enriches children's knowledge of gardening and plants. Principal 1 was hoping that the students will make use of their families' available land, mentioning how the school garden program can help with adapting to climate change related extreme weather patterns in Timor-Leste stating that

Parents can benefit from students knowledge that it's possible to plant when it's not the rainy season and adapt to droughts by conserving water.

One of the success stories of the programme has been confirmation of transfer of knowledge from the schools back into the community as parents were previously planting flowers instead of vegetables by their houses. Knowing how to conserve water and being able to plant when it is not the rainy season is also a major step in a traditional rain fed agricultural system on which 80 percent of the population rely.

The major weakness of the school garden programme, which is led by Permatil in partnership with the Ministry of Education, is that there is no funding for the programme which was confirmed by two teachers. This includes no money to build fences to protect against threats even though schools build their own fences out of whatever materials they can find but these are not always effective against large animals such as buffalos.

5.5.2 Weaknesses

The major weakness of the school garden programme, which is led by Permatil in partnership with the Ministry of Education, is that there is no funding for the programme which was confirmed by the two teachers. One of Permatil's programme managers mentioned that even though Permatil is

in a partnership with the Ministry of Education to implement permaculture school gardens in all state-run primary schools in Timor-Leste, it is a small organization with a very small budget. Thus its capacity is limited when implementing the curriculum of school gardens.

5.5.3 Opportunities

The Permatil manager had heard that a lot of older farmers are going to retire as they now receive a pension from the government. Thus there will be a shortfall of farmers in the future. So the Permaculture garden school programme is an opportunity to reinforce how important agriculture is for Timor-Leste to potential donors as it provides an opportunity for students to learn a way to generate an income from gardening and agriculture in a sustainable way.

Also, Principal 1 revealed that they had overcome the scepticism and suspicion of parents that they were exploiting their children by forming a teacher-parents association and establishing a better relationship with the community. This could potentially be replicated when establishing school gardens in future to ensure more parent participation and sharing of knowledge to meet the programme objectives. Specifically this could also be an opportunity for Permatil and the Ministry of Education, as well as teachers and parents to find a sustainable way to manage their plastic waste.

5.5.4 Threats

The lack of funding for the garden school programme (confirmed by all four interviewees) slows down implementation. Thus there is no money for emergencies when a water pump breaks down or no money for building larger animal-proof fences. Principal 1 confirmed that the school had managed to build wooden fences themselves but these were not large enough to keep out buffalo who can destroy the school gardens. The school principal also said that they had no control over the mentality in the community as someone had stolen their crop of eggplants.

School B had the less established garden and Teacher 2 thought that the biggest challenge was water as they had no water tank. However Teacher 2 was trying to adapt to having no water by asking students to bring a bottle of water each a day to water the garden. This resulted in piles of plastic

bottles and so they dug a hole and filled it with plastic waste and burnt it which is a toxic hazard. The Permatil programme manager and the teachers said that parents had a lack of understanding about the role school gardens play. Parents were concerned that teachers might be exploiting the students and taking away their time in the classroom. The programme manager said this could partly be based on experiences in the Indonesian period when there was a program where children worked in gardens. He explained

The parents think that we will just make the children work (in the garden), but the parents don't know that the school garden is a school subject for students to learn. Therefore, communicating how school gardens are beneficial to their children is such a challenge.

This a threat because innovative education programs need the buy-in of parents in order to succeed long-term because positive feedback from parents has the potential to lead to more funding.

5.6 Food photography and garden photography participants

Photos of school gardens were taken by my research assistant, Miguel de Araujo, and provided by Permatil in relationship to water management and water conservation to help answer research question 1 How can garden schools in Timor Leste lead to improved community resilience through climate change adaptation? Secondly, photos of school gardens were also taken by my research assistant, Miguel, and provided by Permatil to show the variety of food grown to help answer research question 2 Will garden schools lead to improved community resilience and increased nutritional diversity in Timor-Leste? Even though no photos of meals served at schools with gardens were provided, a baseline was established through World Food Programme (2011, February 15) photos that indicate that rice and beans are served to students in the school feeding programme (where there is no school garden to grow food).

As one of the objectives of the Permatil school garden programme is the transfer of gardening and nutritional knowledge to households (Lemos, 2014) I explained to my research assistant that the objective of facilitating a 24 hour food garden survey was to find out how much nutritional knowledge was being transferred from a school with a permaculture or agroecology garden program to the community. However, my research assistant could only find one household that wanted to

participate, but he took photos of the adjoining school garden(s) thus helping to establish a baseline of varieties and quantity of food grown to compare with household consumption in a 24 hour period.

This information was measured against Noij's (2011, p. 18) evaluation indicator of school gardens transferring nutritional knowledge in Timor-Leste: That if a school garden program is successful then surrounding households will benefit from the nutritional knowledge and consume the vegetables grown. His evaluation report was commissioned by UNICEF and titled '*Promoting sustainable food and nutrition security in Timor-Leste: Mid-term evaluation report.*' Much of this evaluation focuses on the goal of improving the nutritional status of women of reproductive age and children under five. However it also touches on school gardens and transferring nutritional knowledge back into the community (Noij, 2011, pp. 14-18).

The group of photos below are divided into two sections: (A) Firstly, photos reveal a comparison of two school gardens including photos of produce, resources and in some cases lack of resources that are explained in the context of this report. (B) Secondly, the Food Photography 24-h Recall method (FP 24-hR) was utilized where participants (in this case a family member who lives over 1 km from School B) take their own photos of the food they are preparing and the food they eat over a 24 hour period as well a photo of their vegetable garden. This survey was done in the context of transferring knowledge. Then all photos and supporting data were analyzed before leading to a final conclusion of Chapter 5.

Section (A) Photos of school gardens and resources



Figure 3 Part of School B's garden. **Source** Helio Miguel de Araujo.

Above is a photo of part of School B's garden where Teacher 2 asked her students to bring a bottle of water to school each day to water the gardens, as there was no other water available for the school garden in a drought. However, this leads to an accumulation of plastic waste. More money needs to be invested to ensure every school garden in Timor Leste has access to water via water tanks.



Figure 4 School with a water tank. **Source** Permatil

School A's garden has a water tank (similar to the one seen in Figure 4) and is more established than School B's garden. It produces a surplus that can be sold back to the school lunch suppliers and the money can be reinvested back into the school. However, they have problems with water pumps breaking down and sourcing funding for their repair.



Figure 5 Produce Source Helio Miguel de Araujo

Some of the school gardens are extensive, producing a wide range of both vegetables and fruit. This is only a small section of this garden, further proof that the permaculture/agroecology approach in Timor-Leste's schools (FAO, 2016, p.1) is increasing food sovereignty by growing a diverse amount of food locally to increase food security (Lemos, 2014). This indicates more food diversity in contrast to the baseline photo by the World Food Programme (2011), that indicates that a meal for students in the school feeding programme is usually rice and beans and no vegetables in a school without a vegetable garden.



Figure 6 Fishpond Source Helio Miguel de Araujo

Figure 6 shows the fishpond at School A that produces extra nutrients for the school gardens besides compost made from buffalo dung and leaves. It can also potentially provide a source of protein with the fish.

Section (B) below. Food Photography 24-h Recall method (FP 24-hR) with a household 1 km from School B.



Fig 7 Household garden **Source** Helio Miguel de Araujo.

In the Food Photography 24-h Recall method (FP 24-hR), participants (in this case a family member who lives over 1 km from School B) take their own photos of the food they are preparing and the food they eat over a 24 hour period. Figure 7, above, shows part of a family garden. Interviews with teachers and other interview sources revealed that households were growing flowers next to their houses but not vegetables prior to the establishment of the garden schools.



Figure 8 Household vegetable preparation **Source** Helio Miguel de Araujo. Above are the ingredients from participants before being transformed into meals. Note there is also a packet of rice that is not seen in the photograph. Food diversity may be increased through the transfer of knowledge from the school to the home (Lemos, 2014).



Figure 9 Prepared household meal 1. **Source** Helio Miguel de Araujo. Teachers confirmed before the school garden program began households were growing flowers instead of vegetables. Surrounding households will benefit from the nutritional knowledge and consume the vegetables grown if a school garden programme is successful (Noij, 2011, p. 18).



Figure 10 shows prepared household meal 2. **Source** Helio Miguel de Araujo. Note there are 3 vegetables on this plate including onions, ie a total of 7 vegetables consumed with rice in 24 hours. The Timor-Leste government wants to achieve the Household Dietary Diversity Score by 2030. *Household dietary diversity score: ≥ 5 number of food groups consumed by $\geq 50\%$ of the population* (Republica Democratica de Timor-Leste, 2014, p. 5).

5.6.1 Analysis of the food and garden photography survey

A comparison between a school with a water tank and a school with little access to water showed that the school with a water tank had a more abundant garden. This indicates that managing water resources diligently through appropriate water management practices and gaining access to water are the key for schools and communities to adapt to climate change.

Photos of the school gardens indicate more food diversity (more than 5 vegetables grown). This is in contrast to the baseline established by the World Food Programme (2011), because their photos indicate that a meal for students in the school feeding programme is usually rice and beans and no vegetables in a standard school without a vegetable garden. Because only one household participated in the 24 hour food photography survey the transfer of gardening and nutritional knowledge to a household cannot be measured against the Timor-Leste National Food and Nutrition Security Policy as it lacks validity. However when interviews with a school principal and two teachers are taken into account the transfer of gardening and nutritional knowledge from schools to households is confirmed. This indicates that surrounding households will benefit from the nutritional knowledge and consume the vegetables grown if a school garden programme is successful (Noij, 2011, p. 18). In conclusion, the food and garden photography confirmed that a wide variety of vegetables is grown in school gardens and a home garden in Timor- Leste.

5.7 Conclusion

Both schools had adapted to a shortage of water during a drought. The community is also benefiting because of the transfer of garden school knowledge through Grade 6 children as they are able to create gardens at home by making compost and conserving water. One family close to a garden school photos indicated they had a home garden and were eating a wide range of vegetables within a 24 hour period. Both schools showed an increase in dietary diversity that was also confirmed by garden photography with a wide variety of crops grown. The health hazard of burning plastic needs to be resolved for the programme to become fully resilient. Regarding problems with lack of funding and lack of buy-in by parents this is an opportunity for Permatil to promote the benefits of school gardens to both parents and potential funding partners.

Chapter Six Discussion and Conclusion

6.1 Introduction

This chapter discusses community resilience, specifically whether and how permaculture/agroecology garden schools may be usefully contributing to adaptation to climate change and nutritional diversity in Timor-Leste. The benefits and challenges of implementing garden schools in Timor-Leste are also investigated. Then a comparison is made between the information gathered from the analysis of official documents and interviews and the literature. The documents include the 2014 Timor-Leste National Food and Nutrition Security Policy and documents relating to the Sustainable Development Goals and to permaculture/agroecology garden schools. The aim was to explore three research questions.

1. How can garden schools in Timor-Leste lead to improved community resilience through climate change adaptation?
2. Will garden schools lead to improved community resilience and increased nutritional diversity in Timor-Leste?
3. What are the benefits and challenges of implementing school gardens based on permaculture/agroecology principles?

By using the agroecology conceptual framework by Altieri et al. (2015) and Nicholls and Altieri (2017) this enabled the voice and experiences of the participants, ie the principal, the two teachers and the Permatil programme manager, to be central to answering my research questions. This framework is relevant as it presents a summary of the social and ecological factors that determine the degree of resilience to climatic, and other, shocks (Nicholls & Altieri, 2017). It is also relevant as permaculture is a form of agroecology (Hathaway, 2015, p. 1) and the garden schools are referred to as the „Permaculture/Agroecology system in Timor-Leste’s National School Curriculum“ by the FAO (2016).

The conceptual framework revealed that community resilience is determined by the interrelationship between specific social-ecological features (Altieri et al., 2015). On the one hand there is the vulnerability of the food growing system (Sardos et al., 2016, p. 721) when faced with the stress of a climatic event such as a drought (Nicholls & Altieri, 2017). On the other hand there is the reactive capacity of the farmer, in this case teachers and their students in garden schools, to react

and respond to a climatic event (Altieri et al, 2015). By using innovative solutions they are not only adapting to the climate (Smit & Wandel, 2006, p. 283-284) but also potentially enhancing the resilience of their food growing system through crop diversity (Nicholls & Altieri, 2017). This leads to better nutritional diversity and also to food sovereignty to increase food security (Thiemann, 2015). However, the agroecology framework also considers external, social and ecological threats and it was adapted in this case by adding sustainable/unsustainable practices.

6.2 Discussion in Response to Research Question One

How can garden schools in Timor-Leste lead to improved community resilience through climate change adaptation?

The key issue in response to this question is that climate change adaptation is urgently needed as Timor-Leste has a rainfed agricultural system and the annual temperature is expected to rise by 2.5 ° Celsius by 2070. This could have disastrous economic consequences for agriculture if community climate change adaptation strategies are not implemented (Chandra et al., 2016). In 2016-2017 Timor-Leste was hit by El Niño droughts leading to crop failures followed by La Niña extreme rainfall leading to landslides (Levy, 2016).

In Timor-Leste both school gardens were based on permaculture/agroecology design principles and were impacted by extreme climatic events such as droughts. Being vulnerable to a lack of water for their gardens, climate change adaptation strategies included ‘*inventing the rain*’ water conservation based on a drip feed irrigation system utilizing plastic water bottles. Thus people faced with the challenge to adapt to the new weather patterns caused by climate change need to become more resilient by conserving water to face longer droughts or other extreme weather patterns (Intergovernmental Panel on Climate Change, 2007).

The ‘*inventing the rain*’ concept could be regarded as an example of climate change adaptation where people recover from climatic events based on sustainable agroecological practices (Nicholls & Altieri, 2017). In permaculture/agroecology garden schools in Timor-Leste there were other examples of water management including harvesting water in water tanks, the use of a fish farm and making attempts to conserve water including the mulching of the soil to retain moisture (Lemos, 2014).

The research found that some schools are finding innovative ways to deal with water shortages that relate to sound water management practices and coincide with SDG Target 6.4: *By 2030 reduce the number of people suffering from water scarcity* (Sustainable Development Solutions Network, 2015). As demonstrated in the garden photography a school with a water tank is less vulnerable than a school without a water tank (Lemos, 2014). However, by encouraging students to bring a bottle of water to school every day School B started the toxic practice of burning accumulated plastic (Neubauer, 2017). Ideally every school in Timor-Leste should have access to water including a means of water harvesting and storage such as water tanks to encourage sustainable water management.

Both participating schools in Timor-Leste demonstrated that they were striving to reach SDG Target 2.4 by making an effort to adapt to a climatic extreme such as drought through resilient agricultural practices such as improving soil and land quality (FAO, 2015). This was demonstrated by the participation of both teachers and students in making compost by transforming free resources such as biomass (rotting leaves, cut grass, and dung) into dry and liquid compost to fertilize the gardens as recommended by Henfrey and Penha-Lopes (2015, p. 43) to increase soil fertility for further food production. Both schools also banned the use of chemical fertilizers and School A made use of a fish pond to generate nutrient waste for liquid fertilizer for the school garden to be able to grow food sustainably. Increasing community resilience was confirmed as Grade 6 children transferred their garden school knowledge to their homes where the family had previously grown flowers, as they were able to create organic gardens by making compost and conserving water in droughts. Thus the key to achieving SDG Target 2.4, such as implementing resilient agriculture practices in order to have the capacity to adapt to climate change (SDSN, 2017), is a site-specific design that takes environmental and social issues into consideration (Mancebo & de la Fuente de Val, 2016).

Timor-Leste's government has shown its commitment to take climate action in order to achieve SDG 13 *Take urgent action to combat climate change and its impacts* (Sustainable Development Knowledge Platform, 2015) by incorporating the teaching of permaculture/agroecology in school gardens as part of the new education curriculum (Lemos, 2014). Fletcher (2017, p. 1) argues that the key to achieving the Sustainable Development Goals is through permaculture/agroecology school gardens that take lessons outside the outdated traditional model of indoor classrooms into participatory outdoor classrooms, integrating earth science into lesson plans thus taking action on climate change (ibid.).

However the research found even though the government of Timor-Leste has a policy relating to teaching permaculture/agroecology in the school system (Repulica de Timor-Leste, 2014) it has a

lack of policy for implementing accessible waste management systems demonstrated by Neubauer's report (2017) on Dili's largest rubbish dump where children and adults were burning plastic. Field research also revealed the issue of burning plastic waste in one school. If this is prevalent in more schools and the issue is not resolved it will prevent the permaculture/agroecology school garden programme from becoming fully resilient as burnt plastic waste is a health hazard for all, including children (Neubauer, 2017).

6.3 Discussion in response to Research Question Two

Will garden schools lead to improved community resilience and increased nutritional diversity in Timor-Leste?

Due to the hunger season, Timor-Leste is ranked fourth-worst in the world in the Global Hunger Index (Campbell, 2013). The hunger season is classified as transitory food insecurity when there is a temporary decline in access to food which can often impact on nutritional status (Republica de Timor-Leste, 2014). As explained in chapter one hunger also impacts on education as malnutrition continues among children over five with many children arriving at school hungry and thus not able to concentrate (World Food Programme, 2011).

However permaculture/agroecology schools in Timor-Leste showed an increase in dietary diversity with school meals providing at least three vegetables from the school gardens that were producing up to nine types of fruit and vegetables. As explained in chapter 5 food and garden photography showed an abundance of different food crops grown. This is significant as photos from the World Food Programme (2011) indicate that students' meals at school usually consist of rice and beans if the school does not have a school garden. Thus garden school students were eating 3 vegetables or more equalling 5 or more in total on top of rice and beans. The aim of the Timor-Leste government is that at least 5 food groups are being consumed by 50 percent of the population. If more garden schools were implemented they could help reach *Household dietary diversity score: ≥ 5 number of food groups consumed by $\geq 50\%$ of the population* (Republica Democratica de Timor-Leste, 2014, p. 5) through the transfer of gardening and nutritional knowledge.

Teachers confirmed the improved health of students because they were more active in the garden

and eating and enjoying the organic food they had helped to produce. Thus the interviews revealed that the garden school programme is helping to achieve one of the goals of the government of Timor-Leste which is to end hunger and malnutrition by 2030 with the population eating locally grown food based on *carefully-managed agroecosystems* (Republica Democratica de Timor-Leste, 2014). This is similar to SDG 2 that is to end hunger and increase food security through sustainable agriculture (UN, 2018). Furthermore the Timor-Leste government sees the role of garden schools as a hub of knowledge integrating both nutrition and health activities, not just in the classroom but spreading awareness of hygiene and sanitation to the wider community as well as dietary diversity through garden knowledge, water safety and resilience planning (Republica Democratica de Timor-Leste, 2014). This is backed up by the literature review that reveals that school gardens have been found to increase children's taste for fresh fruit and vegetables while improving academic achievement by fostering an active learning environment (Baildon, 2016, p. 1).

Another research finding relates to NGO Permatil's objective of transferring nutritional and gardening knowledge from garden schools back into the community. This transfer of knowledge benefits the community as fresh vegetables are now grown beside the family home instead of only growing flowers like before. The older students are also more eager to help out in the family garden where both parents and their children exchange gardening knowledge (McKenzie & Lemos, 2017). Food and garden photography also confirmed that a wide variety of vegetables is growing in school gardens and a home garden close to a permaculture/agroecology garden school in Timor-Leste. The above is also confirmed by Noij's observation in Timor-Leste that a successful school garden programme will coincide with support for gardening while promoting and enhancing nutritional knowledge (2011, p. 18). This is important because if more households are cultivating vegetables instead of flowers because of the Permatil garden school programme on a wider scale it could have an impact as twenty-seven percent of women aged between 15 and 49 years old are malnourished and that puts them at greater risk of experiencing illness, obstructed labor and dying from bleeding after childbirth (UN Women, 2014, xiv).

6.4 Discussion in Response to Research Question Three

What are the benefits and challenges of implementing school gardens based on permaculture/agroecology principles?

Benefits

In collaboration with Timor-Leste's Ministry of Education Timor-Leste, Permatil's permaculture/agroecology garden school programme is part of the hands-on approach to education of the new curriculum as revealed in Chapter 4. Klemmer et al. (2005) highlight the advantage of school gardens as they increase children's scientific knowledge compared to non-garden school students. The Permatil programme is showing that the sustainable knowledge that the students learn in the school garden is being transferred back into the community which confirms that garden schools increase community resilience. While Fletcher (2017, p. 1) advocates the advantages of „agroecology/ permaculture” school gardens as children have an education that prepares them to be able to help solve the world's multiple problems including combating hunger and food insecurity. The school gardens can also help achieve the SDGs because school gardens transform a schoolyard into a living laboratory where children gain an education in applied science relating to sustainable agriculture and nutrition (Baildon, 2016, p. 1). Chapter 5 also revealed that the outdoor learning environment is turned into a practical workshop that transforms a schoolyard into a green laboratory for students to learn about nutrition and mathematics as well as linguistics in Timor-Leste. There is also evidence of economic benefits as the garden school programme can reduce the amount of money spent on food from outside suppliers. School A even generated an income that was managed by the students and could be invested back in the school.

Challenges

Inadequate funding is the biggest challenge to implementing the permaculture/agroecology garden school programme led by Permatil in partnership with the Ministry of Education in Timor-Leste (FAO, 2016). This includes no money to build fences to protect against large animals such as buffalos or no emergency funding to repair water pumps or install more water tanks for harvesting water for garden irrigation. Furthermore, Permatil is a small organization with limited staff and budget capacity and is therefore limited when implementing the school garden curriculum. The lack of funding is an issue for school garden programs in developing countries confirmed by Lander

(2013). Burns (2017), who researched education in Timor-Leste in contrast to other young developing countries, said that innovative school programmes that try to relate schooling to work or practical orientated education historically faced challenges to preparation, supervision and funding.

Another challenge to implementation is parents' lack of buy-in to the concept of school gardens. Some parents also did not perceive the school garden as being part of the school curriculum and so they thought that the garden was taking their children away from normal school lessons. It has been shown internationally that lack of community support can hinder school garden implementation (Lander, 2013). In one case internationally Hockin-Grant and Yasué (2017) revealed that parents had false hopes regarding the income generated by the school garden and they thought that the teachers were enslaving the children to work hard in the garden. In an interview with a programme manager in Timor-Leste, it was revealed that some parents had bad memories of working in school gardens under Indonesian occupation which is documented as having been very oppressive (Fernandes, 2011). However, one school teacher resolved this issue by setting up a parent-teacher association so there was more communication between parents and the teacher and there was an opportunity to monitor the transfer of knowledge from the programme to the home (Teacher 1, School A, 2017).

One hurdle to long-term sustainable implementation is that teachers are using unsustainable practices by burying or even burning plastic. The World Health Organization is concerned with the lack of institutional support for solid waste management in Dili. This results in serious health issues from toxic smoke. At the same time, various NGOs in the past have failed to make an impact to benefit residents or improve the waste management system in Dili (Neubauer, 2017).

6.5 Final Discussion and Recommendations

This study has explored community resilience, and specifically whether and how permaculture/agroecology garden schools may be usefully contributing to adaptation to climate change and nutritional diversity in Timor-Leste. The research also examined the challenge of implementing garden schools in Timor-Leste. By utilizing permaculture and agroecology approaches school gardens can support the need for climate change adaptation at the community level, especially for children. The success of school gardens depends on the NGOs strategies to include community members, teachers and children. This study revealed the importance of having government policy in Timor-Leste that supports small farmers, women and children, valuing them as ‘the true wealth of a nation’(Republica Democratica de Timor Leste, 2014), with garden schools being part of a multifaceted approach to improve community health, nutrition and resilience. Evidence also indicates that the students in Permatil’s garden school programme are being trained to become climate change adapters who can help their communities reach the Sustainable Development Goals.

Besides the improved health of children, coinciding with an increase in the dietary diversity of school meals, this study revealed that the community is also benefiting because of the transfer of gardening and nutritional knowledge from school to home. Improving dietary diversity and health is significant because Timor-Leste has a rain-fed agricultural system and when rural families are waiting for crops to grow they can suffer from a hunger season. The research further revealed that households that used to grow flowers around their houses are now growing vegetables because of this transfer of knowledge. Thus the research shows that the permaculture/agroecology garden school programme can contribute to the government's goal for Timor-Leste to be free from hunger and malnutrition by 2030 with people eating an increased variety of safe and locally-grown food from sustainably managed agroecosystems. That coincides with SDG 2: *End hunger, achieve food security and improved nutrition and promote sustainable agriculture* (Sustainable Development Knowledge Platform, 2015).

Permatil’s programme offers multiple benefits including that the school garden programme transforms a schoolyard into a green laboratory for students to learn about nutrition and mathematics as well as linguistics. The research also revealed that the implementation of the permaculture/agroecology garden schools is helping Timor-Leste’s government achieve multiple SDGs: Besides SDG 2 that is about increasing food security through sustainable agriculture, it

includes SDG 13: *Take urgent action on climate change and its impacts*. As this research found garden schools in Timor- Leste are adapting and responding to climatic events (droughts) mostly in a resilient manner.

However, significantly this research revealed that there were also some unsustainable practices such as burning plastic waste. But this could be seen as an opportunity for Permatil to network with other organizations to find solutions in the absence of government funded recycling programmes (Neubauer, 2017). For example, the Center for the Study of Science and Mathematics (SESIM) is linked to the Ministry of Education and already facilitates science and maths and other subjects in the school garden programme (Gabrielson, 2016). SESIM could adapt Pura Vida's (Guatemala) Superblock concept as a curriculum subject in Timor-Leste. Waste is thereby transformed into school infrastructure including water tanks that garden schools need (Heisse, 2014).

Even though multiple benefits of the programme were identified this study found that the implementation of the permaculture/agroecology garden schools is underfunded and under-resourced. If the Timor-Leste government wants to achieve SDG 2 it must find a way to allocate more funding towards Permatil's programme. To have long-term success these school gardens need to be implemented in all the targeted schools instead of just a few. Also, even though MFAT/NZAid funded the distribution of the permaculture manuals to 1415 schools in Timor-Leste it did not fund the implementation of the programme.

Thus urgent action by potential funders is needed to support the full implementation of the Permatil garden school programme in all 1415 targeted schools as this research has significantly revealed that there is going to be a shortfall of farmers in the future due to older farmers retiring while the population is going to increase dramatically. This may be an opportunity for Permatil to involve more families and community members at the beginning of the program to share their knowledge as well as having the parents participate in parent-teacher associations (PTAs) to build community participation and awareness of the benefits of the programme.

In order to ensure that the implementation of Permatil's garden school programme is successful, this research report revealed that more funding is needed to establish large animal-proof fencing to protect school garden produce and to both install more water tanks and to set up a maintenance program for water pumps. The former (more water tanks) will ensure that the sustainable water management of school gardens is achieved and that SDG Target 6.4: *By 2030 reduce the number of people suffering from water scarcity* is met. Reducing the impacts of water scarcity will also help

Timor-Leste achieve SDG 2 relating to increased food security and ending malnutrition.

With increased funding more students in Timor-Leste will be able to enjoy the benefits of Permatil's garden school programme that transforms a schoolyard into a green laboratory for students to learn about earth science, nutrition, mathematics, literacy and linguistics while taking action on climate change.



Figure 11 Ego Lemos, founder of Permatil and advisor to the Ministry of Education Timor-Leste harvesting greens with teachers and students. **Source** Permatil archive. Hill (2016, p. 1) argues that garden schools help Timor-Leste achieve SDG 4 – a quality, equitable and inclusive education and lifelong learning opportunities for all.

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Apenddices Information sheet

Formally called

Permaculture garden schools in Timor-Leste: Building resilience and adapting to climate change: Food for thought!

Peter Marra

Please note all research documents had the Massey Letter head inserted at the time of correspondence .

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Ego Lemos <ego.lemos72@gmail.com> 1/4/17

to me

Dear Peter,

Happy New Year to you and family.
Sorry I just return to work after long holiday.

I have read you proposal it sound good.
NZAid did funded the printing 4600 copies of the Permaculture Kids book but not funded the implementation of the actual school garden.

The school garden program just start implementing in few school but good to video interview with the teachers.

So I have consulted with Permatil and really like you to come do research here in Timor-Leste.

Good luck with you proposal and hope to see you back in Timor-Leste soon.

Best Regards,
Ego

To A.Lindsay, Peter.Marra.1, M.Borovnik,
M.E.Thomas

HoU Review Group

Ethics Notification Number: 4000018080

Title: Permaculture garden schools in Timor-Leste: Building resilience and adapting to climate change: Food for thought!

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our system which is reported in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please log on to <http://rims.massey.ac.nz> and register the changes in order that they be assessed as safe to proceed.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Dr Brian Finch, Director (Research Ethics), email humanethics@massey.ac.nz. "

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish require evidence of committee approval (with an approval number), you will have to complete the application form again answering yes to the publication question to provide more information to go before one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

You are reminded that staff researchers and supervisors are fully responsible for ensuring that the information in the low risk notification has met the requirements and guidelines for submission of a low risk notification.

If you wish to print an official copy of this letter, please login to the RIMS system, and under the Reporting section, View Reports you will find a link to run the LR Report.

Yours sincerely Dr Brian Finch Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

Information sheet

Permaculture garden schools in Timor-Leste: Building resilience and adapting to climate change: Food for thought!

Bon dia,

My name is Peter Marra. I am currently a Master student of International Development at Massey University, New Zealand. My research aims to explore the role permaculture garden schools can have in increasing nutritional diversity .As well as adapting to climate change including droughts in Timor-Leste. This research also aims to investigate the challenge of implementing garden schools in Timor-Leste.

This research is linked with PERMATIL, and results, including interview tapes or videos and photos, will be owned and be archived by this organisation.

PERMATIL's director Ego Lemos invited me to explore at least one school that has implemented Permaculture gardens. The adviser to the Ministry of Education Timor Leste has suggested that Ego Lemos and PERMATIL select such a school. I am aiming at asking the school principal "of one school" and two or three teachers to participate in this study, and would like to invite you to participate in this study.

If you are comfortable with the conditions that PERMATIL will have access to the the taped or filmed interview material afterwards, then I would like to invite you, to participate in the research. Participation in this study will involve an interview of approximately 40 minutes. The interview will be conducted by a research assistant, , . I would much appreciate if you would allow him/ or her on my behalf to film or tape record this interview. If you agree, then I would also be grateful if you would allow me to include images of your school garden and your school meals to be included in the research.

Please see the list of proposed interview questions that are designed to answer the research questions attached. All interviews will be "conducted in Tetum" and then translated from Tetum into English for the purpose of my research report.

If you prefer not to be video taped during the interviewe, please inform my research assistant. and If you prefer you can be sound recorded during the interviewed instead. My research assistant may take notes in case that neither filming nor sound recording is your preference. You are under no obligation to participate in this research and have the right to ask for the camera /recorder to be turned off or ask for note taking to stop at any time during the interview.

The ownership of the video will belong to PERMATIL and yourself, after your interview has been transcribed and translated. The transcriptions and the images of your school garden and the school meals will be shared with Massey University, myself, and. PERMATIL, and your school will be given access to a summary of the project findings when it is concluded.

PERMATIL and your school will be given access to a summary of the project findings once the research is concluded. Feel free to share your interview tape, film or photos with other teachers who would like to implement gardens in their schools.

If you give permission, then your video or taped interviews can will be stored in a safe place that you all agree to. You can decide at any time, even after completion of this research, if you want to continue to have your interview materials stored or whether you want to have them removed from the archives and destroyed. Please contact me or my supervisor if you have any concerns about this. You can find my contact details and those of my supervisor below.

Yours Sincerely

Peter Marra

Email petermarra58@gmail.com

Supervisor Dr Maria Borovnik Massey University m.borovnik@massey.ac.nz

PARTICIPANT CONSENT FORM - INDIVIDUAL

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time. Please indicate whether you agree or do not agree to the statements below:

I agree/do not agree to the interview being sound recorded. *(if applicable include this statement)*

I agree/do not agree to the interview being image recorded. *(if applicable include this statement)*

I wish/do not wish to have my recordings returned to me. *(if applicable include this statement)*

I wish/do not wish to have data placed in an official archive. *(if applicable include this statement)*

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature:

Date:

.....

Full Name - printed

.....

[Print on Massey University departmental letterhead]
[Logo, name and address of Department/School/Institute/Section]



MASSEY UNIVERSITY
COLLEGE OF HUMANITIES
AND SOCIAL SCIENCES
TE KURA PŪKENGĀ TANGATA

Semi Structured interview questions

for research assistant.

Peter Marra Master of International Development student Massey University email petermarra58@gmail.com

Research question	1(a) Will garden schools lead to improved community resilience and nutritional diversity in Timor-Leste? And if so how will they achieve the above?

- (1) How did you design the school garden? Who was involved and what did they do?
- (2) How do you teach the children in the school garden about climate change?
- (3) How are gardening skills and nutritional knowledge being transferred from the school back into the community?
- (4) How are you adapting to droughts in the school garden?
- (5) How do you manage water in the school garden and sanitation in the school?
- (6) What types of vegetables, fruit and herbs are grown in the school garden? And where do the seeds come from?
- (7) What types of food grown in the school garden are being used for school lunches?
- (8) How do you fertilize the school vegetable garden? Who helps?

Research question	b) What are the benefits and
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	challenges of implementing school gardens based on permaculture principles?
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(9) How has children's health and attendance improved since the school garden started?

(10) How have you implemented your Permaculture school garden?

(11) What have been the benefits of implementing a permaculture garden in your school and community?

(12) What have been the biggest challenges to implementing a permaculture school garden?

Contract Agreement between Researcher, Peter Marra, and Research Assistant

Peter Marra, Master student (International Development), Massey University New Zealand agrees to hire a Research Assistant under the following terms and conditions.

The research project is about exploring the role that permaculture garden schools can have in increasing nutritional diversity and adapting to climate change (droughts) in Timor-Leste. This research also aims to investigate the challenge of implementing garden schools in Timor-Leste.

Participant Rights, Privacy and Confidentiality

The research assistant agrees that the privacy and confidentiality of any participants who are to be interviewed for this research must be respected and kept. All data collected in the field must be safeguarded and shared with the chief researcher, Peter Marra. When arranging interviews the research assistant agrees that participants will be informed about the purpose and particularities of this research, and their rights: that there is no pressure to participate in the research and that participants have the right to withdraw from the research at any time.

Financial Agreements

The research assistant will be paid in US dollars to translate and transcribe interviews from English to Tetum for the following documents:.(1)

1. An information sheet for people being interviewed,
2. An informed consent sheet for the participant to sign (without pressure).
3. A list of interview questions for people to be interviewed (ideally sent to them before they are interviewed).

At the rate of \$15 US per page but no more than a total of \$200 US including translated interviews.

The total amount to be paid is \$360 US in total including travel, USB stick, interviewing and translating. See below.

The research assistant agrees to interview the following people:

- (1) Ego Lemos, the Director of PERMATIL, who can be interviewed in English.
- (2) A school principal and two teachers connected with the school garden at a school with a permaculture garden to be interviewed in Tetum.
- (3) The research assistant agrees to facilitate a food photography survey of the school garden and what ends up on the table from the garden in a school lunch.

Listen to Ego Lemos advice which Permaculture garden school would be the closest to Dili to undertake interviews. Then arrange a time to meet with the principal of the school with a permaculture school garden. Ideally sending a list of interview questions before you arrive.

Terms of payment are an agreement to undertake the above task the research assistant will receive the first payment on translating the informed consent, information sheet and interview questions from English into Tetum. As well as money to purchase a USB stick and cover transport costs and for undertaking interviews. Which will be the sum of \$150US.

Please include **account name** and number, country code, swift code, and bank address.

The second payment will be made when you send me the translation of the interviews and the photos of school permaculture garden and food on the table of participants are received by me, Peter Marra. The amount for the above is \$210. It is essential that all receipts and invoices during this process are sent to me. The total amount paid after all tasks are done will be \$360 US (the equivalent of \$500 New Zealand dollars).

A bonus of \$50US will be given if all interviews and food photography is completed by early August.

Interview procedures

- The first interview at the Permaculture garden school should be held with the school principal.
- **At the start of the meeting with interview participants, please present the information sheet and explain the purpose and focus of this study.**
- Ask the school principal and each teacher whether they are ok with being video interviewed. If they prefer not to be interviewed via video please give them the option if they prefer to be interviewed by sound recorder or for you to take notes.
- Remind them that *they are* under no obligation to participate in this research and have the right to ask for the camera /recorder to be turned off or ask for note taking to stop at any time during the interview.
- During the interviews please take notes in English of the main points.
- After the interviews please ask the school principal and the teacher/s to sign the participant consent forms.
- If they ask you to playback the interviews before signing please do so.
- Also please ask the teacher/s if they can take photos of the school garden as well as the school lunches.
- and if possible photos of household meals and garden next to the permaculture garden school within a 24 hour period.
- The images of the school lunches are anonymous meaning no pictures of children or people are made but focus on the food on the table and in the garden.

- The photos are shot from directly above the food. As well as the photos of the school garden.
- If adjoining households want to participate who may have benefited from the Permaculture school programme show them how to frame the photos of their meals and gardens.
- Provide my email petermarra58@gmail.com contact to send the photos day and date to as well as explaining they are under no obligation to participate. Providing them with an informed consent form.
- After the interviews the main points of the interviews are translated into English and emailed to petermarra58@gmail.com
- As well as images of gardens and food on the table the ownership of the videos will belong to PERMATIL and the principal and teachers interviewed after being transcribed and translated.
- The translation of interviews and the images of the school garden and the school meals will be shared with Massey University, PERMATIL and myself.
- A safe place of storage will be arranged for all video interviews and Images that is agreed between PERMATIL and Myself.
- If teachers want their recordings destroyed after the interviews have been translated into English then you should do so.
- It is important to be in regular contact with me besides my email petermarra58@gmail.com my Skype address is Peter.marra1

Thank you very much for taking on the role of Research Assistant.

Yours sincerely

Peter Marra signed.

Research assistant

Date

Ba Informasaun

Jardim escola permacultural iha Timor-Leste: Hari Resiliencia no Adaptasaun ba

Mudansa Klimatika: Hahan ba ita nia kakutak!

Dader diak,

Hau nia naran Peter Marra. Hau estudante mastrado iha area Desenvolvimentu International iha Uiversidade Massey, Nova Zelandia. Objectivo husi hau nia pesquisa ida ne mak atu explora oinsa papel husi jardim eskola permacultural bele aumenta tan diversidade nutrisional no mos oinsa bele halo adaptasaun ba mudansa klimatika inklui mos tempu bai-loron iha Timor-Leste. Pesquisa ida ne mos ho objective atu investiga dezavius husi implementasaun jardim escola nian iha Timor-Leste.

Pesquisa ida ne halo ligasaun ho PERMATIL, no resultado hotu, inklui gravasaun ou videos ba entrevistas ho fotografias sei intrega hotu no halo ba arkivo ba organizasaun ida ne. Diretor PERMATIL Sr. Ego Lemos mak konvida hau atu explora eskola ida nebe maka implementa ona jardim permacultural. Assesor ba Ministerio Edukasaun Timor-Leste nian ne, Sr. Ego Lemos no PERMATIL sujere ona sujere ona mai hau atu hili eskola ida ne. Hau ho intesaun hakarak halo entrevista ba direktor eskola nian no mos professores nain-rua ka nain-tolu atu participa iha estudo ida ne'e, no hau hakarak konvida ita-bot atu participa mos.

Se karik ita bot senti seguro katak PERMATIL sei bele asesu ba material gravasaun no filmagem intrevista nian iha tempu oin mai, entaun hau hakarak atu konvida ita bot atu partisipa iha pesquisa ne. Partisipasaun iha estudo ida sei inklui entrevista ida ho nia durasaun kuaze minute 40. Entrevista ne sei halao husi assistente pesquisa nian, Sr. Helio Miguel. Hau sei aprecia tebes karik ita bot bele fo lisenca ba nia atu representa hau atu halo gravasaun ba audio visual ba entrevista ida ne.

Se karik ita bot konkorda, entaun hau mos sei agradese tebes karik ita bot bele fo lisenca ba hau atu inklui mos hasai fotografias husi ita bot nia jardim eskola nian no hahan merenda eskolar nian ba pesquisa ne.

Favor ida hare lista perguntas entrevista nian nebe mak hau proposta ba nebe mak dezenho atu hatan ba perguntas perquisa nian neba mak inklui mos tiha ona iha neba. Entrevistas hotu sei "halao iha Tetum" no depois sei tradus husi Tetum ba Ingles ho intensaun atu halo relatorio ba hau nia pesquisa.

Se karik ita bot prefere lakoi atu halo video durante entrevista, favor ida hato'o ba hau nia assistente no karik ita bot prefere liu atu halo gravasaun audio durante entrevista. Hau nia assitente mos bele halo nota deit se karik ita bot la prefere atu halo gravasaun audio visual. Ita bot laiha obrigasaun atu participa iha pesquisa ida ne no iha direito atu hapara gravasaun no mos bele hapara halo nota durante tempu entrevista.

Video hirak nebe mak grava sei sai propriedade ba PERMATIL nian no ba ita bot rasik depois de data entrevista nian copia no tradus tiha ona. Transkrisaun no fotografias jardim eskola no ai-han husi ita bot sira nia eskola sei distribui ba Universidade Massey, ba hau rasik no ba PERMATIL. PERMATIL no ita bot sira nia eskola sei hetan asesu ba

informasaun nebe si hakerek iha sumariu ida kona ba saida det mak konsege identifika iha projeitu ne depois de halo tia konklusaun ona.

Ita bot sira iha liberdade atu pasa no distribui gravasaun audio visual husi ita bot nia entrevista no mos fotografias hirak ne ba professores sira seluk nebe hakarak mos implementa halo jardim iha sira nia eskola.

Se karik ita bot fo licensa, entaun gravasaun no video husi entrevista nian ami sei halot iha fatin seguro ida. Ita bot sira sei iha direaitu atu decidi iha tempu saida deit mesmo depois de pesquisa ida ne, karik ita bot sei hakarak fo nafatin licensa ba mi atu kontinua rai nafatin ita bot sira nia dadus, ou karik ita bot hakarak atu hasai tia dadus hirak ne husi arkivus no hakarak ami hamos tiha. Favor ida kontaktu hau ou hau nia diretor karik ita bot iha prekupasaun ruma kona ba asuntu ida ne. Detailadu kontaktu ba hau nian no hau nia direitora nian mak lista iha kraik ne'e.

Comprimentus

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Semi Structured interview questions for research assistant. For Interviewing programme manager.

Peter Marra Master of International Development student Massey University email petermarra58@gmail.com

Research question	b) What are the benefits and challenges of implementing school gardens based on permaculture principles?
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1) What have been the biggest challenges to implementing a permaculture school garden programme in Timor Leste?

(2) How have you or organisation implemented the Permaculture school garden programme in Timor Leste?

(3) What have been the benefits of implementing permaculture gardens in schools and surrounding community?

(4) How has children's health and attendance improved since the school garden program started?

Permaculture garden schools in Timor-Leste: Building resilience and adapting to climate change: Food for thought!

Bon dia, my name is Peter Marra. I am currently a Master student of International Development at Massey University, New Zealand. My research aims to explore the role permaculture garden schools can have in increasing nutritional diversity. As well as adapting to climate change including droughts in Timor-Leste. Including weather gardening and nutritional knowledge is being transferred from Permaculture garden schools into households in the surrounding community.

To help facilitate this research I have employed a research assistant Miguel to conduct a Food and garden photography survey. That includes house holds, living next to a permaculture garden school whose children attend the permaculture garden school

In the first step, digital photographs are taken by you the householder, of the foods you consume over a 24 hour period including food from your vegetable garden; These photos are taken vertically above the meals (whats on your plate) and in your vegetable garden. These photos are totally anonymous as no images of people are recorded, but only images of food and gardens.

You are under no obligation to participate in this research and have the right to ask for the camera/recorder to be turned off or ask for note taking to stop at any time.

If you would like to participate or know of other people in your community who live near to the Permaculture garden school who would like to participate please inform Miguel

Once you have completed taking photos of your vegetable garden and the food you have prepared – that ends your plate to be eaten please send these to Miguel email by August (Miguel suggest a date in early August)...Or arrange a time for Miguel to collect the images.

Your school and the people who participated in this research will be given access to a summary of the project findings once the research is concluded.

Yours Sincerely Peter Marra Email petermarra58@gmail.com

Supervisor Dr Maria Borovnik Massey University m.borovnik@massey.ac.nz

Food for thought : increasing nutritional
diversity by adapting to droughts in
Timor-Leste's permaculture/agroecology
garden schools : a research project
presented in partial fulfilment of the
requirements for the degree of Master of
International Development, Massey
University, Palmerston North, New Zealand

Marra, Peter

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