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Keyhole Gardens as the Key to Environmental Sustainability and Access to Fresh Produce in Samoa: A Case Study of an Organic Keyhole Farm

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Keyhole Gardens as the Key to Environmental Sustainability and Access to Fresh Produce in Samoa

A Case Study of an Organic Keyhole Farm



Madeline Allen

Academic Director: Roland Pritchett

Academic Advisor: Mikaele Maiava

S.I.T. Samoa, Spring 2018

Abstract

Keyhole gardens represent one of the many ingenious adaptations that are currently being used in Samoa to combat climate change, promote environmental sustainability, and improve diet. Through their design, these gardens are built to withstand greater fluctuations in climate; utilize alternative water resources and conserve fresh water; and contribute towards a solution to the waste management problem in Samoa. Additionally, keyhole gardens increase access to fresh produce, and can be used as tools to educate the community about healthy eating. This is of great national importance due to the myriad of health concerns that accompany the current diet in Samoa, which contains copious amounts of imported foods with low nutritional value and high fat and sodium content. This report includes a case study of Mikaele Maiava's keyhole gardens, as well as pertinent information from multiple interviews and several secondary sources.

Keyhole gardens; environmental sustainability; access to fresh produce

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Dedication:

To my mom – without her, I would never have made it where I am today.

To my father – who taught me to see farming as an honorable and fascinating endeavor.

To Mouna Farm in Waianae, Oahu – for truly introducing me to the beautiful and spiritual adventure that is organic farming.

To Mika's farm – for allowing me to continue this adventure and for making me feel at home in Samoa.

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I have been so blessed this semester with so many wonderful mentors.

- Thank you, A.D. Roland Pritchett, for answering my many questions over the semester and constantly reassuring me that the outcome would be wonderful.
- Thank you Lise Higgs for being a constant calming presence and for watching out for us all semester.
- Beyond grateful for my family in Fasito'o for providing a home away from home, you all have brought me so much joy and love and I can not imagine these past few months without you.
- Huge thanks to the Maiavas and for all the others working on the farm and in the kitchen, thank you for your kindness and generosity. I will never forget the days we spent gardening, talking, dancing, and laughing. And Mika - thank you SO much for teaching me about organic farming; you share everything you have with others and I have learned so much from you about how I want to live my life. I remember one day while we were in the garden, a couple you had never met pulled into the driveway to ask for directions and left with the directions, two cabbages, a huge handful of beans, and instructions on how to plant two sprigs of basil to regrow at their house. Your generosity and compassion amaze and inspire me. Thank you so much for everything.

Table of Contents:

Title Page	1
Abstract	2
List of Contacts	3
Dedication	4
Acknowledgements	5
Table of Contents	6
Methodology	7
Introduction	
Background on Keyhole Gardens	8
Case Study Focus: Mikaele Maiava’s Organic Gardens 11.....	10
Logistics of Keyhole Gardens	
Construction.....	12
Maintenance	14
Environmental Sustainability Benefits	
Climate Change – Relevance & Adaptations	15
Other Environmental Problems	17
Waste Management	18
Water Conservation	21
Community Outreach & Increased Access to Fresh Produce	
Current state of the Samoan Diet	22
Major National Health Concerns Related to Diet	25
Role of Home Gardens in Combating Health Concerns	26
Specific Community Outreach Programs	29
Conclusion	32
Recommendations for Further Study	34
Bibliography	35

Methodology

The goal of this research project was to collect detailed information about organic farming and the use of keyhole gardens in Samoa. This project was structured as a case study of a specific farm – Mikaele Maiava’s organic gardens in Moamoa, Samoa – in order to collect the most in depth information as possible, and to write about the experience of constructing and maintaining an organic keyhole garden from a personal perspective. Participant observation was a vital component to this study, and observations were recorded during several days spent on Maiava’s farm over the course of April and May 2018. Through this, a unique understanding of the difficulties and triumphs of organic farming and utilizing keyhole gardens in Samoa was gained.

Mikaele Maiava was interviewed several times, and his wife – Isabel Maiava, who runs a healthy food truck in Apia, Samoa – was also interviewed. To augment the information collected through this case study, an additional interview was conducted with Dr. Siaka Diarra, an Associate Professor of Animal Science at the University of the South Pacific, Alafua, who has extensive knowledge on the problems associated with waste management in Samoa. His input was extremely relevant to understanding the importance of the compost component of keyhole gardens.

The remainder of the paper is comprised of information obtained through reviewing secondary sources, as well as notes taken over the course of the semester during guest lectures – mainly the lecture on food security given by Professor Taema Imo-Seuoti, Associate Professor of Environmental Science at the National University of Samoa.

Introduction

Background on Keyhole Gardens

Keyhole gardens are raised garden beds with a composting area at the center, that are usually circular with a path cut out to the central compost unit - giving them their characteristic keyhole shape. Keyhole gardens are built in a unique way that provides ideal gardening conditions. They are comprised of multiple layers including a drainage layer, a moisture-retaining layer, and layers of green clippings, compost, dry leaves, and soil. The central composting unit has many benefits - it provides a place to put compostable material, it serves as a central watering area that supplies water to all layers, and it allows for the dispersal of nutrients from the compost to the soil (Maiava, Personal Communication, April 2018). As stated in *How to Grow a School Garden* - "Compost is the magical secret ingredient that makes all garden soil hum with life and vigor," and keyhole gardens utilize this "secret" to its fullest abilities (Bucklin-Sporer, Pringle, 2010, p. 106).

Several research papers have identified ways in which these gardens have benefitted people around the world in various climates. In "Keyhole Garden a la Tica: Organic and Sustainable," Arias et al. describe the use of keyhole gardens in Monteverde, Costa Rica. The research group utilized the method of keyhole gardening, which "was originally implemented in an arid region of sub-Saharan Africa," and made necessary adaptations based on the difference in climate (p. 3). Specific decisions about what materials to use for different layers and what crops to plant were made based on surveys and discussions with the community. The issue of food insecurity in the region

due to the growing tourism industry was the initial motivating factor behind this research (Arias, et al., 2013).

Michael Raleigh details the use of keyhole gardens in urban settings in “Urban Farming in Buffalo: Economic Development and Climate Change Strategy.” Raleigh highlights the way in which keyhole beds “use space and labor more efficiently” and their success in reaching their initial goal - “to provide more low cost, naturally grown, healthy produce to the immediate area” (p. 5). The need for gardens in this urban setting is connected to the increase in diseases that are related to poor diets, such as diabetes and heart disease, which is also occurring in Samoa (Raleigh, 2010).

The paper “Homestead vegetable gardening using graywater: meeting the need of year-round vegetable requirement of landless and marginal farmers,” focuses on the water-conserving features of keyhole gardens, and their ability to fulfil a dire need for fresh produce in areas of rural India. The conditions in the regions discussed are extreme – during the 8-month dry period of the year, almost no vegetables are consumed by the farmers because water is so scarce; and most farmers, such as those in the Gadakwadi village, are below the poverty line. Keyhole gardens provided a viable option for growing produce year-round, due to: the low monetary cost in building them because of the use of “locally available materials,” the easy construction and maintenance, and the use of captured rainwater and grey water. The specific construction of the gardens accounted for times of low rainfall as well as monsoon season, demonstrating that keyhole gardens can be used in areas with high variability of precipitation (Pachpute et al., 2017).

The literature on keyhole gardens all point to similar findings – that these gardens can make farming more productive in a variety of climates, and that utilizing these gardens can provide families and communities with essential fresh produce.

Case Study Focus: Mikaele Maiava's Organic Gardens

This research paper will incorporate a case study of the organic farm and keyhole gardens grown by Mikaele Maiava. Maiava's household and farm are in Moamoa, on the island Upolu of Western Samoa. Maiava is originally from Nukunonu, an atoll of Tokelau, and he is still extremely involved with the Tokelauan population in Samoa. The household is maintained by Maiava and his family, and functions as a meeting place and accommodations for visitors from Tokelau. The family is paid 50,000 New Zealand Dollars per year to assist with the upkeep of the property. The costs of the gardens are mainly covered through the Small Grants Program, a part of the United Nations Development Programme Global Environment Finance (UNDP-GEF). Maiava is active in several different local networks and organizations: he is the president of the Keyhole Gardeners Group Incorporated (KGGI) which is comprised of 15 other farmers; he is a member of the Informal Gardeners Group (IGG); and he is the interim secretary of Samoa Federated Farmers Incorporated (SFFI) which is comprised of 250 farmers. Additionally, he is a part of several different community outreach programs: a youth outreach program funded by the Food and Agriculture Organization of the United Nations (FAO) that gets youth involved in gardening; a project located on his own farm that targets unemployed youth and teaches them about farming as well as cooking with

the organic produce they grow, which is funded by the Small Grants Program; and a project called “Nobesity” which targets children suffering from obesity and is funded by Business Systems Limited (BSL), (Maiava, Personal Communication, April 2018). These projects are described in more detail in the community outreach section of this paper.

Maiava’s farm is certified organic through The National Association for Sustainable Agriculture, Australia (NASAA) – a process assisted by Women in Business Development Incorporated (WIBDI). A wide variety of produce is grown on the farm including: cabbage, basil, ginger, parsley, spinach, lettuce, sweet potatoes, green beans, and others. This produce goes to a variety of sources, including orders organized by WIBDI, the family’s food truck, meals for the family and for visiting Tokelauans, and the majority is shipped back to Maiava’s home atoll in Tokelau – Nukunonu – and distributed throughout the community. Some of the produce is also sold to various restaurants around Samoa such as Scalini’s – one of Samoa’s most highly acclaimed restaurants. As explained by Maiava, “they buy it because they know I grow it well.” Buyers frequently visit the farm before placing an order, allowing Maiava to show them the high-quality conditions in which the produce is grown. Maiava attributes his knowledge of farming practices to his late uncle, Seumanutafa Dr. Malcolm Hazelman, who was also extremely active in community outreach programs and helping others (Maiava, Personal Communication, April 2018).

Logistics of Keyhole Gardens

Construction

Keyhole gardens can be built in many ways using a variety of different materials. This section details the specific construction methods utilized by Maiava. The main raised perimeter of the garden located on his farm is constructed from wooden boards that were previously a part of pallets carrying supplies used by Samoa Stationary and Books (SSAB), in downtown Apia. Maiava bought five to six pallets at 5 tala each (roughly 2 US dollars each) and used this recycled wood in construction. It is important to note however, that this perimeter can be constructed of other recycled or natural materials - in the keyhole gardens used in the FAO project Maiava is involved with, one of the perimeters is composed entirely of volcanic rocks which can be collected by any family on the island. Also, the keyhole garden built for the Nobesity project was constructed using old wooden planks and large branches from the nearby forest (Maiava, Personal Communication, April 2018).

One of the aspects of keyhole gardens that make them so unique is the central composting area. This is very simply constructed using chicken wire (or some other type of metal mesh) secured to a couple posts or sticks in the center, in a rounded shape. This is where all compost can be continuously fed to the garden after its construction (Maiava, Personal Communication, April 2018).

Another unique feature of the garden is the system of layers detailed below. All the layers described in this section are approximately 4 inches in height, except for the final soil layer which is thicker (Maiava, Personal Communication, April 2018).

Bottom Layer	The bottom layer is comprised of branches of assorted sizes, some decently large (2-3 centimeters maximum diameter). This is the primary drainage layer. It is important to make sure the layer is compacted so there are not too many airholes.
Second Layer	The second layer is comprised of coconut husks, with the inner part of the husk facing upwards. This layer can also include recycled cardboard either in addition to the coconut husks or instead of them. The main function of this layer is to retain moisture in the garden, assisting with water conservation efforts and overall productivity of the garden. This layer is soaked thoroughly in water before the addition of the next layer.
Third Layer	The third layer is the “green layer” – green plants and clippings. Ideally this includes clippings from legume trees or plants, bolstering the nitrogen content of the garden.
Forth Layer	The fourth layer is four inches of compost that includes chicken manure. Maiava buys the chicken manure from the USP Alafua farm for 10 tala a bag and uses a lot of his own compost. For his large keyhole garden, he only needed to purchase one bag of compost. The purchase of additional compost is not necessary, though it is helpful to incorporate composted animal manure if possible to increase the nutrient content of the garden. * The third and fourth layer are then compacted and soaked in water.

Fifth Layer	The fifth layer is the “brown layer” composed of dry leaves that can be collected from the yard.
Top Layer	Finally, a layer of soil is added to the top that is thicker than the rest of the layers, approximately 10 inches in height.

Overall, the construction of the keyhole garden can be somewhat effort-intensive, but it is not cost-intensive. The only costs associated with the keyhole garden built on Maiava’s property were the cost of the wooden pallets, the composted manure, and the chicken wire. However, the wooden pallets could have been replaced with either scrap pieces of wood that a family already owned, or volcanic rocks collected from the area. Additionally, the composted manure does not need to be purchased – a family or community could either use manure from their own livestock farm, or they could use green compost from yard clippings and green food scraps (though this compost is not as high in nutrients, and thus compost that contains animal manure is preferable). The only remaining cost is that of the small amount of chicken wire for the central composting unit, which would likely not be cost prohibitive.

Maintenance

After the keyhole garden is built it is not a tremendous amount of work, which is why it is so ideal for school gardens and community outreach programs. The maintenance includes planting seeds, harvesting, and general weeding – as with any garden, which is not extremely time consuming or difficult if the gardener stays on top

of it. Additionally, the bed is raised and constructed in a way that makes it easy to do all the tasks above without having to be down on the ground (Maiava, Personal Communication, April 2018).

One other aspect of maintenance is the watering of the plants. This task is made easier by the unique set up of the keyhole garden for a couple reasons. One of the main attractions of this garden is that the watering can be done mainly through the center composting section – the compost from yard clippings or vegetable scraps from the kitchen are placed in the central hole separated by wire mesh, and the water for the garden is fed directly in to this area. This makes the process of watering easier; allows one to use greywater as described in a later section; and acts as a built-in fertilizer for the garden as the water gains nutrients from the compost before spreading to the rest of the garden bed (Maiava, Personal Communication, April 2018).

Environmental Sustainability Benefits

Climate Change – Relevance & Adaptations

Climate change is relevant worldwide and Samoa is already experiencing some of the effects. Climate change is a result of human activity, mainly the release of enormous quantities of carbon dioxide into the atmosphere through the burning of fossil fuels. Climate change has wide-reaching effects, and several changes will – or already have – directly and indirectly affect agriculture and food production in Samoa. John Morton explores this issue in his paper “The impact of climate change on

smallholder and subsistence agriculture.” Morton summarizes the importance of the topic of study when he states:

Some of the most important impacts of global climate change will be felt among the populations, predominantly in developing countries, referred to as “subsistence” or “smallholder” farmers. Their vulnerability to climate change comes both from being predominantly located in the tropics, and from various socioeconomic, demographic, and policy trends limiting their capacity to adapt to change. (p. 1)

When covering the effects of climate change on smallholder agriculture, Morton highlights the relevance of complexity and location specificity to these farms and their stressors, and the challenges this poses to large scale research endeavors and adaptation measures. However, Morton also includes information on the ways in which these farmers have increased resilience due to: “efficiencies associated with the use of family labor, livelihood diversity allowing spreading of risks, and indigenous knowledge allowing exploitation of risky environmental niches and coping with crises” (p. 2).

The book *Climate Change and Small Island States: Power, Knowledge, and the South Pacific* by Jon Barnett and John Campbell expands upon this topic and includes multiple areas of study including the increased vulnerability of many South Pacific islands due to colonization; climate science research and international panels; initiatives occurring within the Pacific; and policies related to climate change. Within this, they include several important points concerning effects of climate change on agriculture. They summarize: “Agricultural production in the Pacific Islands is likely to be adversely

affected by climate change through loss of coastal lands, increased contamination of groundwater and estuaries by saltwater incursion, and losses due to cyclones and storm surges, heat stress and drought” (Barnett, Campbell, 2010, p. 13). All of these are of interest to this study, particularly the reduction of freshwater resources and the damaging effects of drought, both of which are covered in the section on water conservation. Both sources cited above cover the tremendous difficulties imposed upon southern Pacific communities by climate change and other environmental issues, but both also vehemently conclude that these communities’ ability to adapt “should not be underestimated” (Morton, 2007, p. 5). Keyhole gardens are a useful and environmentally sustainable adaptation currently being used in the South Pacific to combat climate change.

Other Environmental Problems

There are also several environmental issues that exist in Samoa that are not directly linked to climate change. Barnett and Campbell’s book cited above examines some of these topics. One key problem included was insufficient waste management systems mainly due to “inadequate disposal facilities” and “increasing use of agricultural chemicals,” (Barnett, Campbell, 2010, p. 43). This results in the pollution of land, fresh water and coastal areas. They also touched upon the issue of land degradation due to deforestation and expansion of agriculture, which results in increased erosion and poor soil fertility. One other problem they mentioned was freshwater degradation, which is problematic due to climate change but is also

exacerbated by improper waste management and over use of fresh water resources (Barnett, Campbell, 2010, p. 43). The following sections are used to address the issues of waste management and the scarcity of fresh water. This paper does not focus on the issues of deforestation, however it is important to note that by utilizing agricultural areas to their fullest productive capacities – as is done with keyhole gardens – agricultural expansion is reduced, and the need for deforestation is decreased.

Waste Management

A key feature of keyhole gardens is their use of waste: composted animal manure within the layers, and green compost in the central composting area. This productive use of waste plays a role in the national issue of waste management, which is a growing concern in Samoa. An interview with Dr. Siaka Diarra, Associate Professor of Animal Science at the University of the South Pacific, Alafua, was extremely helpful in gaining a better understanding of the severity of this problem. Diarra is a major advocate of developing sustainable manure management systems, and he has extensive knowledge in livestock farming, particularly with poultry (Diarra, Personal Communication, April 20, 2018).

Currently, much of the waste at the USP farm and most other farms in Samoa is simply flushed directly into bodies of water which creates a multitude of environmental hazards. The improper disposal of waste creates air quality issues, including increases in NH₃, dust, and odor. It also contaminates the water and leads to unhealthy levels of organic matter, nitrogen, phosphorous, salts, arsenic, and other contaminants in

freshwater sources. Improper waste management also runs the risk of reducing soil quality through the introduction of excess levels of nitrogen into the soil and through the conversion of NH₃ to NO₃⁻ which increases acidity and affects soil fertility (Diarra, Lecture: Manure Management for Sustainable Poultry Farming, 2016).

The ideal way to eliminate the waste that is generated from livestock is to use it productively. The farm at USP Alafua has tried a couple of these options. At one point the manure was used to produce biogas, but this use was discontinued for an unknown reason. One idea that Diarra described for future use, is to create a fish farm that utilizes the waste as feed which in turn produces fish at low cost and reduces the amount of manure that needs to be disposed of. One current use of the manure that is of particular interest in this study, is composting it and selling it to neighboring farms. This is currently being done at a small scale, but according to Diarra, there are high hopes for a future in which the farm produces the compost at commercial levels. Composting manure is accomplished by mixing the manure with grass and dry leaves and is an ideal way to reintroduce nutrients into the soil. Compost can be particularly helpful for organic farming because the use of other chemical fertilizers is prohibited, and compost is a natural substitute (Diarra, Personal Communication, April 20, 2018). As mentioned in the logistics section, Maiava utilizes the composted poultry manure from USP Alafua in his keyhole gardens and has attested to its ability to revitalize the soil and invigorate plant growth (Maiava, Personal Communication, April 2018). When asked to explain the benefits of using compost, Diarra summarized concisely – “crop yield will be

increased, at a cheaper cost, in an environmentally friendly manner” (Diarra, Personal Communication, April 20, 2018).

The issue of waste removal exists at a variety of scales in Samoa – some family farms are small enough that the waste can be disposed of fairly easily and naturally. However, some poultry production on the island is becoming extremely hazardous. For example, Alhiki Farms currently has close to 90,000 chickens laying eggs. A portion of the manure is converted into compost and utilized in the produce portion of Alhiki Farms, but unfortunately around 70% of the manure still ends up being dumped into the environment (Diarra, Personal Communication, April 20, 2018). Encouraging the use of composted animal manure both aids in creating a sustainable way to manage waste in Samoa and promotes healthier forms of fertilizing soil for agricultural purposes.

Additionally, Maiava stresses the issue of people burning their rubbish – including green food scraps and yard clippings that could be used in composting. The burning of these materials pollutes the air with smoke and affects the health of the environment and people in the area. Keyhole gardens combat this issue through the inclusion of the central composting unit. This effectively provides a space for families to put a large amount of the rubbish they would normally burn (Maiava, Personal Communication, April 2018).

Water Conservation

Keyhole gardens are also extremely environmentally beneficial due to their water-conserving adaptations. As discussed in the introduction, this form of gardening has been used in a variety of climates – from the hot and arid regions of sub-Saharan Africa, to the cooler and rainier Monteverde, Costa Rica, to areas with dry seasons and monsoons such as rural parts of India. This is important given Samoa’s tropical climate, that consists of a dry season and a wet season. As such, for a garden to be successful year-round, it must be able to handle large variations in rainfall. Keyhole gardens contain a drainage layer, which facilitates the flow of water through the garden bed so that the roots do not remain soaked in water which would cause the roots to rot or would stunt their growth. This accommodates for the periods of heavy rain experienced in Samoa. Additionally, the fact that the garden is raised significantly above ground, issues of flooding which are common in Samoa are less likely to affect the produce production. These gardens also include a water-retaining layer – which in Maiava’s garden is comprised of coconut husks or cardboard – that keeps the layers moist during dry spells (Maiava, Personal Communication, April 2018). As mentioned in the section on climate change, it is possible that these periods of rainfall and drought may increase in severity, in which case the adaptations of the keyhole garden will be even more beneficial.

Another unique feature that plays a role in conserving water is the central composting area. This area is the main part of the garden that receives intentional watering, because the water can then seep into all the layers carrying nutrients from the

compost material. Since the water is not going directly onto the produce, it can be captured rainwater or grey water – as long as no harmful chemicals were used before collection. As mentioned previously, fresh water is a scarce resource in Samoa. As ocean levels rise, salt water intrusion increases, and fresh water sources become scarcer. As Maiava explained, the ability to utilize grey water or collected rainwater is already an incredibly important adaptation in the South Pacific, particularly in places like Nukunonu - low-lying atolls with even more severely limited water resources (Maiava, Personal Communication, April 2018).

Community Outreach & Increased Access to Fresh Produce

Current state of the Samoan Diet

The data compiled by Adams and Sio, “Research on Existing Situation of Malnutrition in Samoa,” contains a wealth of information on the traditional Samoan diet that fed the people relatively healthily for centuries, and the major changes that have occurred recently. As described in the report:

The traditional Samoan diet was based on staple food... a variety of root crops like taro, giant taro, yams, and the starchy fruit crops, green bananas and breadfruit... This was accompanied by... fish, shell fish, other sea foods, chicken and pork, the main sources of protein. The main traditional vegetable eaten in the islands was *palusami*, a vegetable parcel made from taro leaves and coconut cream, the main source of fat in the diet over generations. (p. 43)

Unfortunately, the Samoan diet has declined severely in healthiness, particularly over the past half century. This report attributes the many changes in diet to “increased urbanization, more imported foods, and effects of natural disasters” (p. 43). The main concern stems from the enormous reliance on imported foods. This has been flagged as a significant problem since the early 1980s and continues to grow in severity today. According to the report, “the main imported foods are white rice, white flour, sugar, tinned fish, tinned corned beef, mutton flaps, turkey tails, liquid milk, packaged instant noodles and a variety of packaged snack food items” (p. 43). It goes on to explain that “most of these foods are high in fat, salt or sugar, and have few vitamins, minerals and little dietary fiber” (p. 43).

Samoans are increasingly relying on these unhealthy imports as key elements to their diet; “imports account for 48% of the total dietary energy requirements and 60% of protein requirements” (Adams, Sio, 1997, p. 43). This dietary change is often linked to the urbanization of Samoa and the rapid growth of Apia, as well as the spread of infrastructure such as small shops to rural areas. Now unhealthy imported foods can be accessed throughout the island and are creating significant and widespread health problems. It is also interesting to note that these dietary changes do not necessarily stem from discontent with traditional food sources. As mentioned in the report, the study by Furnin in 1992 titled “Attitudes of Mothers and children Concerning Food and Nutrition in Samoa,” showed that among the young Samoan population (ages 5 to 10), 97% like to eat breadfruit and 90% reported liking banana, bread, taro and yam (Adams, Sio, 1997, p. 44). Additionally, an unpublished ISP focusing on the impact of

urbanization on nutrition, notes that, “Especially in the urban areas, there is this false idea circulating that imported foods are more nutritious than traditional foods.

Purchased foods like rice and canned meat are often associated with a higher socioeconomic status than locally produced foods. They imply success in a wavering cash economy even though they are of a very low nutritional value” (Welborn, J. (1999).

The Consequences of Urbanisation on the State of Food and Nutrition in Samoa. SIT Samoa. Unpublished ISP. p. 10).

One main concern is the dramatic change in the types and amounts of fats consumed. In the traditional Samoan diet, fats mainly came from coconut cream as well as meat or fish – though it is important to note that the types of meat consumed were generally the parts of the animal that were lower in fat. Food was cooked using the *umu* - heating food with the use of hot stones. Today however, different methods of cooking have been introduced. The introduction of pots and pans led to the inclusion of fats and oils to fry food and allowed for the cooking of stews and gravies. Additionally, the types of meats consumed has changed drastically – many of the imported goods like turkey tails and mutton flaps are the fattiest parts of the animal and are drastically different health-wise compared to the traditional meat options (Adams, Sio, 1997, p. 44).

Another aspect of Samoan diet that is of particular interest to this study is the consumption of fruit and vegetables. As the report on malnutrition plainly states, “Samoans are not known for their fruit and vegetable consumption” (Adams, Sio, 1997, p. 45). A survey conducted in 1991 revealed that only half of the population regularly consumed vegetables, and only 34.4% regularly consumed fruit (Adams, Sio, 1997, p. 6).

More recent numbers from the *Samoa Demographic and Health Survey 2009* are similarly alarming. The Ministry of Health recommends five servings of fruits and vegetables per day (a serving being a half cup of fruits or cooked veggies or a cup of uncooked greens), which is 35 servings per week. The survey conducted provided three ranges for the number of servings of fruits and vegetables a week: 0-9, 10-19, and 20+. Only 4% of women and 9% of men reported having over 20 servings per week. The largest percentage of people ages 15 to 49 reported consuming between zero and nine servings per week: 70% of women and 66% of men (Ministry of Health, 2010, p. 151-152). Additionally, personal observations of what food was available in several SIT students' homestays in Fasito'outa, as well as the food available in the canteen (cafeteria) on the USP Alafua campus, also attest to the lack of availability of vegetables and produce in general.

Major National Health Concerns Related to Diet

The changes to the traditional Samoan diet described above have had incredibly negative impacts on the health of Samoans. The lack of fresh produce is a significant problem because fruits and vegetables are a vital component of any diet, since the nutrients they provide "are needed for protection against infectious diseases, nutritional deficiency diseases, like iron deficiency anemia, skin problems, heart diseases, cancer and many other ailments" (Adams, Sio, 1997, p. 45). One key health concern linked to poor diets and more sedentary lifestyles is non-communicable diseases. *The National Food & Nutrition Policy 2013-2018* summarizes: "In Samoa, non-communicable diseases

(NCDs) including obesity, diabetes, heart disease, high blood pressure, stroke and cancer are increasing and have been identified as a top health priority” (p. 7). Survey results included in this national document report that roughly 30% of men and 50% of women are obese, 23.1% of the population has diabetes, and 21.4% have hypertension ((Ministry of Health, 2013, p. 7).

Obesity in particular is an extremely significant problem in Samoa: the 2010 Global School Health Survey reported that in children 13 to 15 years old, 43.4% of boys and 59.1% of girls are overweight, and 15.7% and 22.3% respectively are considered obese. These NCDs are a result of dietary changes and increased sedentary lifestyles. Overall, NCDs are an alarmingly significant problem in Samoa and already account for 70% of all deaths in Samoa (Ministry of Health, 2013). Of these, cardiovascular disease is the leading cause of death. At current rates, it is estimated that “1 in 3 adults aged 25-64 years [are] predicted to develop an NCD in the future” (Ministry of Health, 2013, p. 7). Additionally, anemia is a major issue, particularly in youth, as demonstrated by the statistic that 60% of children in hospitals suffer from anemia (Adams, Sio, 1997, p. 6). This is a major problem not only for health, but also for overall productivity of the population because anemia diminishes a person’s ability to learn effectively.

Role of Home Gardens in Combating Health Concerns

The “Research on Existing Situation of Malnutrition in Samoa” also highlights the importance of home gardens. The report includes the fact that The Ministry of Agriculture, Forestry and Fisheries (MAFF) supports the development of home gardens

but promotes the cultivation of imported vegetables that can be sold for cash, rather than vegetables to be consumed by the family. To combat this, the report suggests an emphasis on “food first” initiatives, so that the presence of a home garden translates to healthier diets of family members (Adams, Sio, 1997, p. 49).

Additional studies have been conducted on using home gardens to directly address various health concerns in the South Pacific region. Research conducted by Amar Sharan, a USP student, examines key health concerns in Fiji and calculates to what extent a carefully planned home garden can address the main concerns. There are a variety of nutritional problems in Fiji similar to those in Samoa - malnutrition, infant mortality and morbidity, anemia and underweight babies, obesity, cardiovascular disease, and diabetes. “Nutritional evaluation using the food balance sheet data showed that the diet was deficient in Vitamin A, Calcium, and riboflavin” (Sharan, 1988, p. 29). The description of Fijian diet was similar to the Samoan diet, in that it contained mainly staple carbohydrates and a source of protein but lacked vegetables and fruits that contain necessary nutrients. A detailed explanation of the crops included in the garden was included in the paper, and Sharan ultimately concluded that “From this study, it was estimated that a 25 m² home garden can supply the Recommended Daily Allowance (RDA) for a family of five with 107.5% vitamin A, 344.4% of vitamin C, 62.9% of iron, 26.9% of calcium and 16.4% of protein and that home gardens can play a vital role in the nutrition improvement of the Fijian population” (Sharan, 1988, p. 43).

These home gardens contribute towards efforts to ensure food security in Samoa. In a guest lecture given by Taema Imo-Seuoti, an Associate Professor of Environmental

Science at the National University of Samoa (NUS), food security was defined as physical and economic access to adequate amounts of nutritious, safe, and culturally appropriate foods for all people at all times, while also producing that food in an environmentally sustainable way. She shared with us that in the past, food security has not been a major problem in the South Pacific because there are many sources of food including subsistence farming, trading and selling products, fishing, and hunting. However, the increasing dependency on imported goods that have low nutrient content is directly reflected in the declining health of the Pacific islander population (Imo-Seuoti, Lecture: Food Security, March 29, 2018). *The National Food & Nutrition Policy 2013-2018* identifies other factors leading to food insecurity in Samoa including: “climate change, trade agreements, the community’s response to globalisation, urbanisation and related stress on infrastructure, gaps in transportation, increasing waste, pollution and deforestation” (Ministry of Health, 2013, p. 5). There are a growing number of health concerns, including diabetes, heart disease, stroke, and cancer. As a result, action is needed to ensure that affordable, nutritious food is available for the entire population of Samoa, and that the environment is protected in the process (Imo-Seuoti, Lecture: Food Security, March 29, 2018). Keyhole gardens in communities are a legitimate step towards achieving this goal, as they increase the availability and affordability of fresh produce.

Specific Community Outreach Programs

There are numerous community outreach programs in Samoa utilizing gardening to employ and educate members of the society, particularly youth. As noted earlier, Maiava plays a key role in several of these programs. One of these programs takes place on Maiava's farm, and targets unemployed youth. Recently, a "training fale" (a Samoan style house/building) was constructed next to the gardens to serve as a location for training sessions on organic farming and cooking with vegetables grown in the gardens. So far, this program has already been able to reach between 100 and 150 youth. According to Maiava, individuals come as often as they find necessary – some come once a month, others come once a year (Maiava, Personal Communication, April 2018).

Another program Maiava is involved with is funded through the FAO, which also targets youth in various communities. Maiava assisted in the construction and the continued maintenance of keyhole gardens that grow King's Cross (round cabbage), tomatoes, and lettuce. This program encourages youth to get involved with farming and to eat the produce they grow (Maiava, Personal Communication, April 2018).

Maiava is also involved in a program called Nobesity, which targets youth and helps teach them about the importance of healthy eating from an early age. The program has several unique features, including keyhole gardens that Maiava assisted in building at the Endemann residence in Ululoloa, Samoa. These gardens serve as a mode through which youth are educated about healthy diets and the importance of fresh produce. The project coordinator, Visceta Meredith, explained, "The idea is to get

parents to create very simple vegetable garden in their backyards and to make sure there's readily available vegetables for their meals for the whole family" (Nataro, 2018).

Maiava's family also interacts with the community through their organic food truck. The truck is parked outside Samoa Stationary and Books (SSAB) and serves fresh burgers, soup, chicken, and fish to locals every day. It was beautifully painted by a local artist, and brings fresh, healthy lunch options to those working in Apia. It was dreamed up and is now operated by Maiava's wife, Isabel Maiava, who employs two people to help with the cooking and operation of the food truck. Her enthusiasm for cooking and her excitement at being able to share high-quality food with others is inspiring. She never received formal training in cooking but has always loved food and experimenting with creating new recipes (Maiava, I., Personal Communication, April 26, 2018).

The beginning of her career as a chef was during the Teuila Festival - a festival held every September in Samoa, and one of the main annual tourist attractions. At last year's festival (2017), she opened a food booth, and was able to make roughly six thousand tala over the course of the week. From that point on, people were constantly contacting her and inviting her to come to different festivals and celebrations to sell her food, and some started asking if she could open something more permanent, so they could have her food all the time. She then decided to open a food truck, so that she could provide food daily while also being able to relocate to different festivals. The food truck is completely operated electrically through the solar panel on the roof - the coffee machines, the sandwich grill, and even the cash register are solar powered. It has been two months since it first opened, and she has already profited half of the initial startup

costs, and at this rate will have completely recovered the costs within 4 to 6 months.

This reception to healthy, high-quality food further demonstrates the need for it in the community (Maiava, I., Personal Communication, April 26, 2018).

Conclusion

The case study of Maiava's keyhole gardens demonstrates that these gardens can be created by families and communities at a low cost using local materials. It also concludes that these gardens have an overall very beneficial impact on both environmental and health issues in Samoa.

Due to climate change and other human disturbances, there are a variety of environmental issues that pose a serious threat to Samoa. These include but are not limited to changes in rainfall, temperature, and storm severity as a result of climate change; the depletion of clean freshwater sources through overuse, pollution, and saltwater intrusion; the contamination of the environment, air, and water due to improper waste management; and deforestation through expansion of agriculture and development. Keyhole gardens address most of these issues either directly or indirectly. They are built to withstand a variety of different rainfall amounts and even flooding conditions, creating a garden that is more resilient to changes in climate. The gardens can also utilize alternative water sources such as captured rainwater and greywater, contributing to the conservation of the limited fresh water on the island. Keyhole gardens utilize different forms of waste, including animal manure that would otherwise be dumped into and contaminate the environment; as well as vegetable food scraps and yard clippings which can be continuously fed into the central composting unit instead of being burned – simultaneously adding nutrients to the garden and reducing air pollution.

Samoa is also experiencing a major transition in diet, from the traditional Samoan diet high in carbohydrates, protein, and some nutrients, to a much less healthy diet that is reliant on nutrient-low imported goods. This shift has been accompanied by increasing rates of diseases related to poor diet, including but not limited to obesity, heart disease, and diabetes. Keyhole gardens combat this increasingly unhealthy diet by providing greater access to fresh produce. Outreach programs educate the public – particularly the youth – on the importance of a balanced diet, and through the inclusion of gardens in these projects, directly provide a way to obtain healthier food.

Recommendations for Further Study

Researching keyhole gardens in Samoa has been an incredibly rewarding and fascinating experience. There are several aspects of integrating keyhole gardens into Samoan communities that are not comprehensively covered in this paper. Further research is needed on the communities' perception of organic farming and their desire to have their own gardens. Ideally, more communities and families in the future will have access to fresh produce through local gardens, and there is a multitude of different options on how this could be made possible – through funding from a wide variety of foreign aid (some of which were already discussed in relation to Maiava's work in community outreach); through the government or individual communities prioritizing the cultivation of school gardens; through involving different women's committees in this effort; and many more. Research is needed on the best ways to not only educate people on the importance of including fresh produce in their diet, but also on how to best implement plans to make this goal possible.

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