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CLIMATE-SMART FAMILY FARMING FOR FOOD SECURITY IN SMALL ISLANDS

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ABSTRACT

Traditional island communities of Yap and its 14 atoll islets in the western Pacific are among the most economically disadvantaged and environmentally vulnerable groups in the Federated States of Micronesia. Climate change amplified by regional ENSO phenomena presents many of the atoll islets within the region with unique challenges including decreased rainfall, rising temperatures, sea-level rise, contamination of freshwater resources with saltwater, coastal erosion, an increase in extreme weather events, coral reef bleaching, and ocean acidification. The effects of these extreme weather events are manifested in the "life-support systems" of atoll communities by the loss of land due to erosion and inundation (land security), by the loss of food production as a result of reduced quality and quantity of freshwater (food security) and declining habitat security. Low adaptive capacity induces atoll communities to abandon their homelands and relocate to highlands on Yap Proper. Atoll migrants to Yap Proper are confronted by lack of jobs, little governmental support, and remain destitute in a degraded environmental setting. This paper presents the results of a case study to show how a comprehensive sustainable agricultural intervention combining traditional farming and insights from climate smart agriculture brought fresh promise to the displaced atoll population by transforming a carbon-neutral terrain into carbon-rich biodiverse and sustainable food production system. A greener, biodiverse agriculture system brought decent livelihoods, a smaller ecological footprint, increased resilience to climate change and enhanced food security. The potential transformative strength of climate-smart family farming in providing food security for similar climate change-forced and climate change-induced migrants is discussed. Though proven on a limited area, by scaling up with right incentives, these displaced atoll population can be at the forefront of a sustainable revolution in island agriculture.

Key words: Climate-smart agriculture, Climate change adaptation, Yap Island

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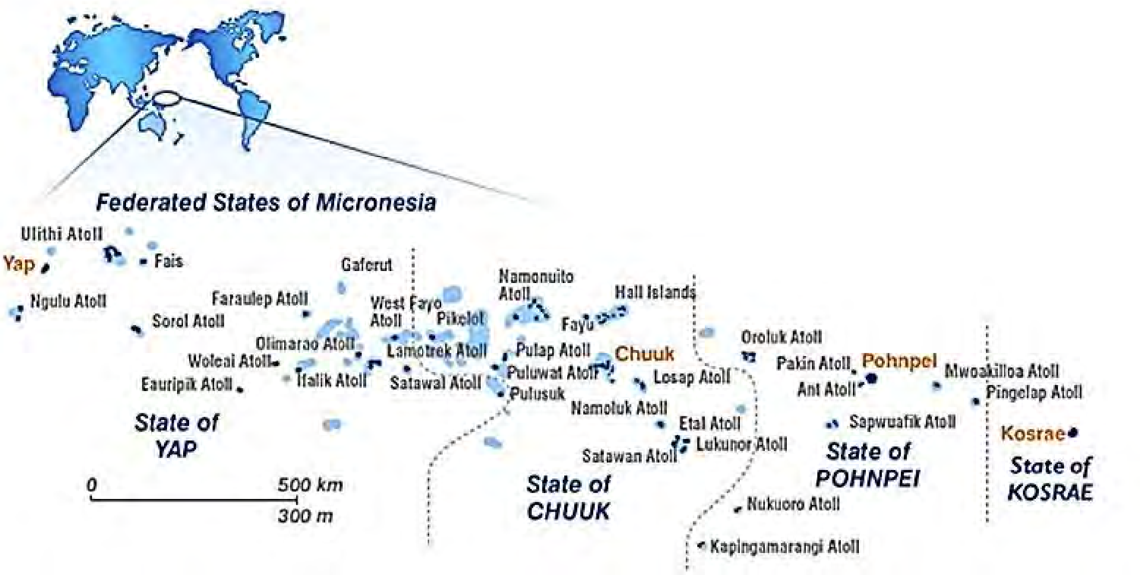
INTRODUCTION

The Federated States of Micronesia (FSM) occupies a major part of the group of Micronesian Islands called the *Carolines*, a chain stretching over 1,500 miles in an east-west direction roughly parallel to the equator. There are four states in the FSM, which from east to west are Kosrae, Pohnpei, Chuuk and Yap (Figure 1). Although the total land surface of the FSM's 607 islands (65 of which are inhabited with a population of about 102,600) is only about 271 sq. mi. the Exclusive Economic Zone (EEZ) covers a vast area of almost 1.9 million sq. mi. The islands and surrounding ocean are home to some of the most pristine habitat in the world and possess tremendous biodiversity. They are thus of immeasurable value to all people.

The situation has changed over the last few decades as environmental degradation began engulfing the atolls and island states within the region. Environmental problems associated with altered weather patterns and problems related to energy converge to place the Micronesian Islands, especially the atoll islets and other coastal settings, at the forefront of climate change (Fletcher and Richmond 2010). Changing climate patterns and associated ill-effects are inherently severe today and pose persistent challenge as the nation seeks to nourish its people and to achieve Millennium Development Goals. With an Environmental Vulnerability Index score of 392, the FSM is currently one of the highly vulnerable Small Island Developing States (SIDS) in the Pacific.

Figure 1: Map of the Federated States of Micronesia



CLIMATE STRESSORS FOR THE FEDERATED STATES OF MICRONESIA

The FSM's climate varies considerably from year to year due to the regional ENSO. Recent research shows that the frequency of extreme El Niños is expected to double due to climate change, with the average frequency increasing from once every 20 years to once per decade (Cai *et al*. 2014). All climate models indicate that El Niño and La Niña events will continue to occur and have a significant impact on inter-annual variability in the region. Some of the impacts of ENSO on rainfall (e.g. floods) may intensify in a warmer climate due to increased atmospheric moisture (Seager *et al*. 2012). Global warming is also expected to enhance average rainfall along the equator, and new research suggests it will also enhance El Niño-driven drying in the western tropical Pacific and El Niño-driven increases in rainfall over the central and eastern tropical Pacific (Power *et al*. 2013).

Climate projections based on the analysis of about 26 new GCMs in the CMIP5 database, show that for all emissions scenarios temperatures will continue to rise in the FSM, as will sea level and ocean acidification (Australia Bureau of Meteorology and CSIRO, 2014, IPCC, 2014). On top of an existing, naturally variable climate, these longer term changes have a profound impact directly on the livelihoods of communities on atolls

- Coastal effects of sea-level rise, including erosion and inundation
- Reduced quality and quantity of water resources
- Coral reef degradation

- Reduced agricultural productivity
- Impacts on human health such as water-borne illnesses, heat-related diseases

Climate stressors of this magnitude threaten the life-support systems of atoll communities essentially in three ways: impact of land security – the very physical presence of land on which to live and sustain livelihoods, ii) threat of livelihood security (food security) where productivity of subsistence reduced or lost, and iii) declining habitat security as atoll environment becomes less inhabitable. Failure of these life-supports systems resulting from climate shocks and disasters propel vulnerable atoll communities into poverty traps and eventually force them to migrate to highlands on Yap Proper in search of better living opportunities.

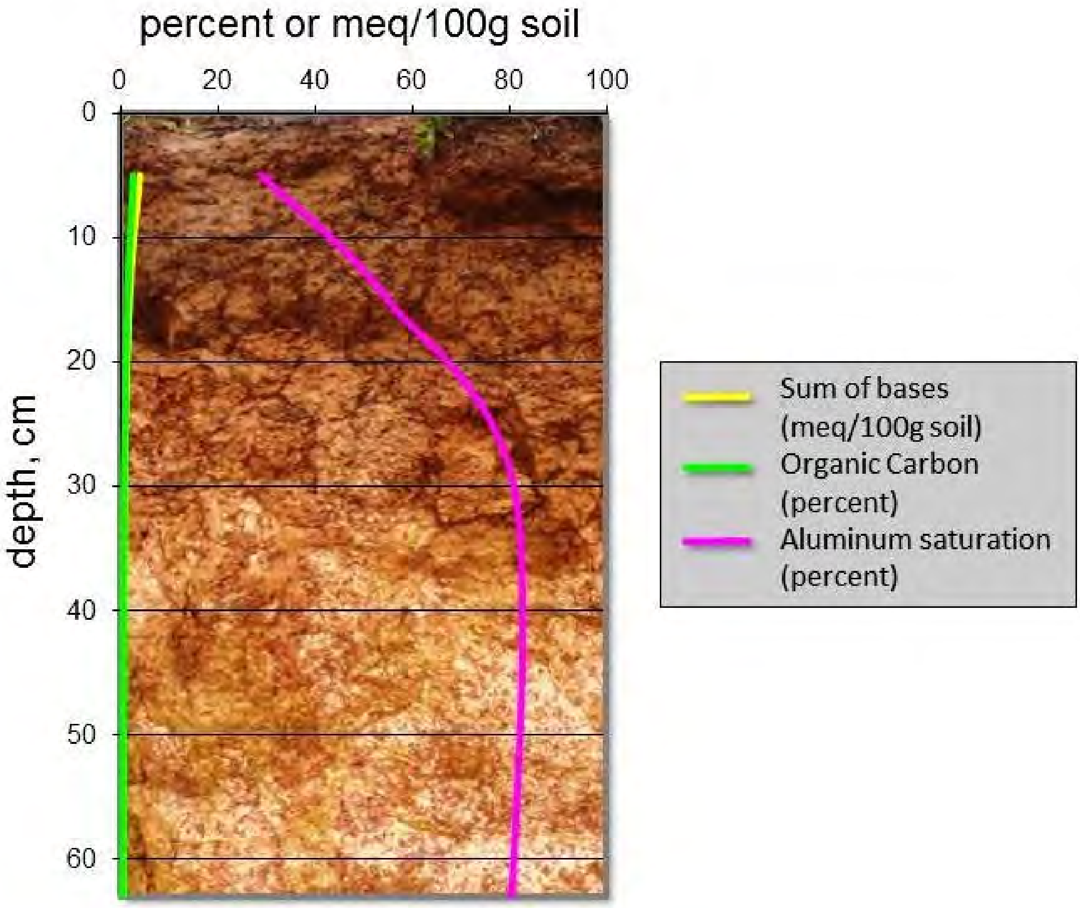
ADAPTATION OF CLIMATE CHANGE MIGRANTS IN A CHALLENGING ENVIRONMENTAL SETTING

The climate change-forced and climate change-induced atoll communities comprise about 20 percent of current population on Yap Proper. They principally reside on four settlements on a volcanic plateau north of Yap Proper. The soils at these localities are mostly degraded, dominated either by ferns or grasses (open savannah) (Figure 2). While the origins of these savannahs are still debated (Falanruw, 1993, Hunter-Anderson, 1991), a more intensive form of agriculture was practiced there mainly in the more fertile areas. The amount of nutrients and the ability to hold on to nutrients are very low in these soils (Figure 3). Ferns are the main vegetation on these soils because they can tolerate the low soil fertility and high amount of soluble aluminum.

Figure 2. Degraded soil under ferns with no top soil

Coping chronically poor yields of food crops is critical for the survival of vulnerable populations in marginal environments where agro-climatic conditions are challenging. Managing risk exposure is an important preoccupation of vulnerable populations living in such environments and the use of inventive self-reliance, locally available resources and the climate-smart, low input food production systems provided an insurance mechanism for the displaced communities. The power of a comprehensive agriculture intervention program combining scientific insights and traditional farming brought fresh promise to these climate immigrants.

Figure 3. Key soil quality parameters



Climate-smart agriculture is a science-based approach to increasing smallholder productivity under challenging environmental conditions. Climate-smart agriculture seeks to increase sustainable productivity, strengthen farmers' resilience, reduce agriculture's greenhouse gas emissions and increase carbon sequestration (FAO 2010). Climate-smart agriculture focuses on meeting the needs of people for food through science-based actions, contributing to economic development, poverty reduction and food security. In subsistence agriculture-based smallholder systems this innovative approach is not only important for food security but also for poverty reduction, as well as for aggregate growth and structural change. Production is enhanced through a number of crop systems which range from smallholder mixed cropping and livestock systems to intensive family farming practices. However, there is no blueprint for climate-smart agriculture and it is often specific to particular locations and productions systems. Its precise nature varies from place to place, influenced by a whole host of local factors, including the climate, the soil, the crops grown, available technologies and the knowledge and skills of individual farmers. For displaced atoll population at Gargey settlement, adoption of specific climate smart strategies brought fresh promise to cope with unfavorable conditions.

The most important strategy to manage degraded volcanic red soils and to bring back the soil biota was through topsoil build up using organic amendment such as composted chicken manure, plant-derived compost and mulch. Addition of lime improved soil pH and reduced aluminum toxicity while providing needed calcium for the plants. This process helped establishing vegetable crops that were more sensitive to soluble aluminum. However, lack of nitrogen and other essential nutrients in the volcanic red soil is impediment to field-based subsistence vegetable production. This is resolved by the use of more environment-friendly low-cost alternative crop production models. Some of the strategies successfully tested include small plot (SPIN) intensive farming, micro-gardens, raised beds, container home gardening, agroforestry and integrated farming with livestock. In all the strategies implemented, the focus was to i) promote sustainable agriculture methods, ii) assist communities in adapting to challenging soil conditions, iii) food security, and iv) access to local markets.

After several crop cycles, the science-based knowledge along with human ingenuity brought much sustainability and success to the crop systems at Gargey settlement. The adoption of Sustainable Agricultural Land Management practices by blending alternative crop production practices along with rainwater harvesting and water conservation techniques brought much resilience to the smallholder systems at Gargey. Despite limited resource settings and challenging soil conditions, the agricultural intervention boosted the adaptive capacity of the communities and successfully establishes biodiverse home gardens and directly participates in building their future. Today, these home gardens stand as sustainable food production systems displaying a mixture of traditional root crops, fruit and nut trees and vegetables.

BARREN LAND TO BIODIVERSE HOME GARDENS

An assessment of crops at Gargey settlement after 9 years of human habitation revealed significant development of agrobiodiversity (Table 1). The transformation of barren land to a biodiverse landscape was remarkable. Today the settlement has become a multiethnic center of cultural diversity endowed with unique cultures coupled with rich diversity of crops. Over 90 percent of the crops currently established in the settlement have its origin from atolls or Yap Proper, brought with them, exchanged, bought or shared otherwise. The predominant subsistence orientation of garden cultivation and the consequent greater flexibility in farming practices encourages the introduction and maintenance of indigenous crops and traditional varieties. Cultural and socioeconomic factors have also profound influence on the diversity of crops. In general, the communities' experimentation of crop varieties and cultivars in challenging soil and environmental conditions led to an exceptionally strong connection between diversity of crops, ethnic population, their cultures and the landscape they presently live in. Families engage in food production for sustenance at the same time, these smallholder systems are important social and cultural spaces where knowledge related to agricultural practices is transmitted and through which households improve their livelihoods. A return to agroforestry and home gardens modelled on traditional systems holds promise for the displaced population who are seeking the multifaceted benefits that traditional agro systems have provided for millennia.

DISCUSSION

Climate change projections for small islands are inherently severe (Australia Bureau of Meteorology and CSIRO, 2014, Grose *et al*. 2014, IPCC, 2014). This brings difficulties to people living in atoll islets for whom achieving food security is already problematic, and is perhaps the FSM's the most pressing challenge as the nation seek to nourish its people and to achieve Millennium Development Goals (United Nations, 2014). This uncertainty is compounded by the paucity of arable land to increase the agricultural production. Thus, production impacts are often severe in small island states. For the atoll population who rely on traditional subsistence agriculture, food security is strongly dependent on local food availability. The environmental constraints therefore directly impact the food production systems that eventually spur a whole gamut of social, ecological and environmental issues (Erickson 2009; Liverman and Kapadia 2010). Traditional agriculture is one of the high priority sectors in the small islands where the impacts of climate change exceed tolerance limits with implications for the livelihoods of impoverished people occupying marginal environments. Migration within islands is complex, having both positive and negative impacts on adaptation and household resilience. Climate shocks and disasters propel people living under vulnerable conditions into poverty traps (Campbell, 2014, Wrathall, 2012). This results in forced migration of atoll population to high lands in search of better living opportunities. Lack of arable land adds to the agony of the displaced population and threatens food security at household levels.

Soils are the major natural resources of small Islands (Morrison, 1999). Given the fragile island environment, it is imperative that good soil management be practiced if communities were to sustain traditional food systems. Years of 'slash and burn' and shifting cultivation practiced by the early settlers in the fragile tropical humid island environment left much of Yap's volcanic soils degraded and depleted of nutrients. Such blunders of environmental management are extremely difficult to rectify. Therefore, sound and sustained soil management practices are central to recover or establish crops in the degraded red soils of Yap. This calls for adoption of alternative methods to bypass unfavorable soil conditions. The restoration of degraded soils and adoption of improved crop production practices improve soil quality and soil health. Such management practices can at the same time improves food security as well as soil-related environmental services.

Impacts of extreme weather events on traditional agriculture are not uniform in small islands due to obvious differences in the expected effects among islands, island topography and geographic location and production systems (FAO, 2008). Therefore, the uniqueness of each island must be at the fore of adaptive strategies implemented to safeguard food security of the affected population. For displaced populations, the nature of assistive strategies depends on their ability to accept improved production practices or diversifying into income generating activities. In this study, effective extension intervention and outreach strategies manifested with greater understanding of farmers beliefs about climate change and their readiness to respond to climate change through various adaptive strategies.

The term climate-smart agriculture has developed to represent a set of strategies that can help to meet these challenges by increasing resilience to weather extremes, adapting to climate change and decreasing agriculture's greenhouse gas (GHG) emissions that contribute to global warming (Steenwerth *et al*. 2014). Climate-smart agriculture also aims to support sustainable and equitable transitions for agricultural systems and livelihoods across scales, ranging from smallholders to transnational coalitions. Forming a core part of the broader green development agenda for agriculture (World Bank, 2011, 2013, FAO, 2013), climate-smart agriculture focuses on meeting the needs of people for food, fuel, timber and fiber through science-based actions; contributing to economic development, poverty reduction and food security; maintaining and enhancing the productivity and resilience of both natural and agricultural ecosystem functions, thus building natural capital; and reducing the trade-offs involved in meeting these goals.

Food security is the central focus of vulnerable island populations. Since climate-smart alternate crop production systems target the short term needs of the displaced population, the approach is well accepted by the community. Improving traditional food systems is critical to reaching poverty reduction and food security objectives of a nation (FAO, 2009, 2010). On degraded lands where agricultural productivity is challenging and the means of coping with extreme events are limited, enhancing food production requires agricultural systems to change in the direction of higher productivity. In the present study, the sustainable intensification of production through climate-smart alternate strategies ensured food security and livelihoods for it targeted short term needs of the displaced population. The displaced communities are able to directly participate in rebuilding their future on a carbon neutral land by maintaining a sustainable food system.

CONCLUSION

The climate-poverty puzzle is one of the intractable problems limiting the development of island communities and the uptake of agricultural innovations. Impacts of climate change add to the problem and hinder the efforts to successfully achieve the Millennium Development Goals. With the backdrop of the 2014 International Year of Family Farming, the focus is now to raise the profile of family farming and smallholder agricultural production systems. Climate-smart agriculture in this study had a different meaning focused on the scale at which it was implemented. It was more to be seen as an adaptive strategy for the displaced population in a degraded environmental setting rather than providing ecosystem services *per se*. It identified barriers of adoption and provided appropriate solutions focused on strengthening the livelihoods of climate change migrants by improving access to services, knowledge, resources and markets. In terms of moving quickly, establishing and effectively adapting, the low-resource, smallholder systems have had larger gains. Most of these practices are not necessarily new but are used in the context of climatic changes, which were unfamiliar to the displaced communities. This study demonstrates the transformative powers of climate-smart agriculture on a carbon-neutral land. The climate-smart approach enabled the needed changes of crop production on a degraded land given its necessity to address food security and climate change. Most of the strategies are 'multiple-benefit' type because it provides food security and income with much sustainability. Locally grown food decreases island communities' reliance on fossil fuels for transport of food from outside market that reduces society's carbon footprint.

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Table 1

Plant name		**No. of cultivars**	**Seed source**
Common name	**Scientific name**		Local
Cococnut	*Cocos nucifera*	4	Local
Betelnut	*Areca catechu*	2	Local
Banana	*Musa* sp.	7	Local
Papaya	*Carica papaya*	2	Local
Soursop	*Annona muricata*	1	Local
Mountain apple	*Syzygium malaccense*	1	Local
Chestnut	*Castanea* sp.	1	Local
Guava	Psidium guava	2	Local
Breadfruit	*Artocarpus altilis*	4	Local
Orange	*Citrus* sp.	1	Local
Mango	*Mangifera indica*	3	Local
Noni	*Morinda citrifolia*	3	Local
Swamp taro	*Cyrtosperma merkusii*	8	Local
Honolulu taro	*Xanthosoma sagittifolium*	2	Local
Sweet taro	*Colocasia esculenta*	4	Local
Sweet potato	*Ipomoea batatus*	6	Local
Cassava	*Manihot esculenta*	3	Local
Yam	*Dioscorea* sp.	7	Local
Pineapple	*Ananas comosus*	1	Local
Sugarcane	*Saccharum officinarum*	2	Local
Chinese cabbage	*Brassica pekinensis*	1	Imported
Green onion	*Allium fistulosum*	1	Imported
Okra	*Allium fistulosum*	2	Imported
Eggplant	*Solanum melongena*	3	Imported
Kangkong	*Ipomoea aquatica*	2	Local
Chili pepper	*Capsicum* sp.	4	Local
Pumpkin	*Cucurbita pepo*	3	Imported
Squash	*Cucurbita* sp.	2	Imported
Cucumber	*Cucumis sativus*	2	Imported
Tomato	*Solanum lycopersicum*	3	Imported
Sweet pepper	*Capsicum annum*	2	Imported
Kalamansi	× *Citrofortunella microcarpa*	1	Local
Watermelon	*Citrullus lanatus*	4	Imported

Long bean	*Vigna unguiculata*	3	Imported
Winged bean	*Psophocarpus tetragonolobus*	1	Local
Ash Gourd	*Benincasa hispida*	2	Local
Passion fruit	*Passiflora edulis*	1	Local
Bird's nest fern	*Asplenium nidus*	1	Local
Screw pine	*Pandanus tectorius*	1	Local