Final Report to the Ohio State University

Global Water Initiative

Forest Garden Component of the Sustainable Village Water Systems Program

Singida Villages Project

Villages of Mughanga and Ghalunyangu

Singida Region, Tanzania

Submitted: July 21, 2021

SUMMARY

Ohio State University (OSU), through their Global Water Institute (GWI) began the Sustainable Village Water Systems Project (SVWSP) in Tanzania in late 2017. GWI works to improve sustainable water access and develop a workforce that can turn water and energy into economic prosperity. Through the SVWSP, GWI awarded Trees for the Future (TREES) a generous grant of $49,999 to implement Forest Garden demonstration sites and develop Forest Gardens with 60 farmers from the villages of Mughanga and Ghalunyangu. While other GWI partners established and organized water access points, TREES mobilized 60 farmers near water points to form 2 farmer groups. The establishment of Forest Gardens included providing training and extension services, seeds, planting materials and equipment for up to 30 Forest Gardens in each village and operating demonstration farms at lead farmer sites for other farmers to visit and learn about the Forest Garden methodology. OSUs funding helped support 60 farming families – comprising 498 people – to improve their lives through planting trees and vegetables in sustainable farming systems. As of April, 2021, the farmer participants have completed three years of the project and graduated from the program. In total they planted 212,155 trees on 60 acres of land. The project was so successful that in 2019, TREES secured additional outside funding and registered and began working with 200 additional farmers in the villages.

PROJECT CONTEXT AND OBJECTIVES

The aim of this project was three fold: (1) create a sustainable farming model that can be used to increase incomes to pay for new potable water access, (2) plant trees to ensure sustainable food systems and rechargeable groundwater tables near water access points and (3) develop training and demonstration sites that encourage further training and adoption of the Forest Garden methodology.

Singida is known as the sunflower region of Tanzania. Thousands of trees have been cut down across the region over the last decades to make charcoal for cooking and to make room for moncropping of sunflowers and corn. The villages of Mughanga and Ghalunyangu, where OSU GWI's projects are located, are only 60 miles from the Maswa Game Reserve which borders the famous Serengeti National Park. This sustainable agroforestry project is particularly important in this region because it begins to restore a buffer between conservation areas and agriculture production. In addition, farmers are growing everything they need, preventing further deforestation and mining of forest resources.

The impacts that agroforestry systems achieve are as follows:

- Creates ecosystem synergies allowing the intercropping system to produce higher yields
- Protects the fragile semi-arid ecosystem where soil conditions cannot support typical monoculture crops
- Ensures large quantities of biomass for mulching and moisture retention
- Increases farmer incomes and food security
- Prepares farmers for adaptation to climate change and resilience to rainfall variability, including drought and flooding by reducing the effects of climate-induced hydro meteorological events and transforming dryland into a sponge that can absorb and channel rainwater into the ground during heavy rain events and release green water during months of drought
- Creates CO_2 sequestration-intensive farmland
- Improves soil fertility through intensive pruning, mulching, use of manure and the introduction of nitrogen-fixing (leguminous) cover crops
- Assist farmers in adopting organic practices, ensuring no use of pesticides or chemical fertilizers

PROJECT BENEFICIARIES

In May, 2018, following a three month mobilization and registration period, farmers in the OSU Project began training in Forest Garden Design and Nursery Development. This month, they completed their third year of the program. The figures below provide information on the number and demographic breakdown of Total project beneficiaries supported through this partnership.

Farmers Metrics	Project Total
Number of Farmers **Female 40%** **Male 69%**	60
Families Beneficiaries	498

TREE PLANTING ACTIVITIES

TREES projects are planned and implemented following a seasonal calendar (See Season Planting and Harvesting Work Plan). In Tanzania the rainy season occurs between late November to January. Often there is a dry month in February and the rain continues into March and April. However, this second rain is highly variable. This year, the rains have continued and allowed for excellent continued tree growth.

Development of Two Demonstration gardens: Demonstration Sites were developed with the following Lead Farmers from each village

- Ally Rajabu Mahayu, Mughanga
- Sifaeli Nalopa Nsali, Ghalunyangu

Collaboration with BM Farm Africa

- Collaboration in training of some modules like Permagarderning since BM Farm Africa staff are very experienced in vegetables and fruits production.
- Collaborative meetings with farmers in Mughanga and Ghalunyangu during water project sensitization with farmer community and continued care, diversification and advanced gardening techniques.

Trainings: In preparation for a successful outplanting season, technicians spend months training farmers in groups on the following modules:

Year One trainings and activities done from May 2018 to April 2019

- Forest Garden Design
- Growing Agroforestry Seedlings
- Outplanting Agroforestry Seedlings
- Permagardening for the family

Year two Trainings from May 2019 to April 2020

- Review of the Forest Garden Design
- Growing Fruit Tree Seedlings
- Planting Fruit Tree Seedlings
- Permagardening for the market
- Fruit tree grafting

Year three Trainings from May 2020 to April 2021

- Optimizing the Forest Garden Design
- Growing Timber Tree Seedlings
- Permagardening for the Future
- Pruning and harvesting

Project Metrics	Project Total
Number of Trees Planted	212,155
Number of Training Conducted	44
Number of Acres Planted	60
Metric Tons of CO2 Sequestered over 20 years	8,678

See the table below highlighting the tree species and vegetables out-planted by 60 farmers over the last 3 years. The accompanying Seasonal Planting and Harvest Work plan provides visual details on the function of each tree species with the system.

Tree Species	Vegetable Crops
Agroforestry trees	Okra Carrot Onion Tomatoes Pumpkin Cassava Beans Chinese Cabbage Swiss Chard
Acacia polyacantha	
Gliricidia sepium	
Leucaena leucocephala	
Leucaena diversifolia	
Moringa oleifera	
Fruit trees	
Papaya	
Passion	
Guava	
Avocado	
Mango	
Timber trees	
Acrocarpus Fraxinifolius	
Grivellia robusta	

AGROFORESTRY SYSTEM DESIGN AND COMPONENTS

TREES Forest Garden Approach is an adaptable methodology. Although we have recommended species and approaches that farmers learn during training, ultimately the farmer designs their own

Forest Garden. During Forest Garden Design training, TREES technicians utilise a participatory process to engage with farmers to further adapt the design to align with farmer's recommendations. This results in a design, crop selection, and placement that all farmers are committed to implementing because they have ownership over the design process. The basic building blocks of all Forest Gardens are outlined below.

Living Fence/Green Wall

Green Walls consist of three rows of agroforestry trees that surround the entire perimeter of the field. The purpose of the green wall is to protect the field from animals, wind and water erosion, stabilize soils, fix nitrogen in soils, provide organic matter for composting, and provide additional food crops and animal fodder. The two outer rows consist of a mixture of agroforestry trees, outlined in the Planting and Harvesting Plan. Additional seedlings are grown in later years for transplanting to fill in missing spaces of those trees that may not survive. The inner third layer of the green wall consists of a row of timber trees that support the structure of the outer layers and provide a long term investment and may be sustainably harvested in 30 plus years.

Alley Cropping

Alley cropping segments the field by planting nitrogen fixing and food crop trees. Alley cropping improves the soils, provides organic material for composting and mulching, captures and infiltrates rainfall, and also provides animal fodder and food.

Fruit Trees

Fast growing, quick producing fruit trees including *Papaya* and *Passion Fruit* were planted throughout the field. These trees will provide a valuable food source and income within the first three years. In addition, slower growing fruit trees including *Avocado* and *Mango* were planted in the field and will produce after the third year.

Staple Crops

In the alleys between trees, farmers have the choice of growing staple crops or expanding vegetable permaculture. Either way, these alleys provide a secure food source and income. Farmers plant a variety of crops in these alleys including: *Beans, Cassava, Maize, Sweet Potato,* and *more.* Some alleys may be split with various staple crops.

Market Garden

The market garden provides a space for continuous horticulture production, including after all trees are fully grown. Crops grown in this area are for home consumption and/or sale including: *Okra, Carrots, Onion, Chard, Okra, Tomato, and Pumpkin.* Market gardens produce during

different seasons: including wet and dry season crops. Some of these crops will also be grown in the staples alleys during the first 3 years of production and some staple crops could be grown in this area post 5 years.

Composting and Mulching: Farmers develop one open pit compost pile within the first year and a second pile later in the project. The compost includes a mixture of available organic matter, manure (if available) and is continuously turned and kept at optimal moisture to ensure aerobic decomposition. Farmers are trained on compost development and can additionally harvest leaves, from trees in the green wall and alleys, to mix into the compost to add organic matter. In addition these leaves make excellent mulching material for fruit trees.

Aggregation and Processing: With increased production of fruits and vegetables, there is an opportunity to aggregate the production of these smallholder farmers for processing or sale to a higher market.

Value added products: High protein animal feed can be made from species in the green wall. In addition, flowering trees will provide an ideal environment for beekeeping. These food and income generating activities can be introduced later in the project.

Biodegradable seedling sacs: With the expansion of agroforestry systems and the desire to have all elements of the value chain sustainable, TREES made the commitment to using biodegradable tree seedlings sacs were used in all our projects in 2019. However, in Tanzania they were unavailable and importing across the border from Kenya proved to be infeasible. In 2020 we found a supplier in Tanzania and are now using 100% biodegradable tree sacs.

Farmers with their completed Farmers Workbooks

Farmers being trained on composting

MONITORING AND EVALUATION

Monthly farmer visits conducted by technicians to observe progress and provide one-on-one mentoring and technical support. Technicians also record the number of trainings conducted and trees planted and report this information through an online Monthly Reporting Form integrated with SalesForce. Randomly selected samples of this data and the data collected below are backchecked by the Regional Coordinator, Country Director and Programs Director annually.

To track the impact of our projects, TREES has a robust GIS based mobile Monitoring and Evaluation system, TaroWorks, integrated with Salesforce. Through this system we register farmers at the beginning of the program and conduct two annual surveys:

Registration: This records the farmers name, GPS point of the field, photo of farmer and land, land

size, baseline tree count and crops species. It also records gender and family demographics.

Annual Technical Data Form TDF: This annual survey is conducted for every Forest Garden and tracks the physicalities and production (size, marketable products, # of trees onsite, and household data. The chart below shows a summary of the baseline and final data from the annual surveys

TDF	2018	2021
Food Crops	3	7
Marketable Products	3	7
Average FG Size (acres)	1	1
Trees per Hectare	0	1,575

Annual Sample Survey: For the annual sample survey we use ArcGIS to determine a selection size that will result in a 95% confidence level and randomly select farmers in each country to do a more in-depth survey which includes 75 questions in four areas:

- General demographics: family size, age, education levels, gender
- Food and security access: USAID Household Access to Food Survey
- Household dietary diversity (FAO survey): questions regarding different types of foods eaten in the last 24 hours, including by specific food groups
- Household resilience: measuring changes in income

The timing of these surveys is critical. They are taken during periods of highest stress in the year (before harvest) and measure important aspects of the realities of our participants' day-to-day lives. For the communities in Tabora this is between January and February. We currently have baseline data on food security and dietary diversity for this project as well as 2 additional years of data. Data from 2021. This data was taken prior to their first vegetable harvest. As you can see in the chart below, the food insecurity is quite high and dietary diversity very low. The numbers for food insecurity and dietary diversity in the chart are 'index scores'. For more details on the process see info below.

Household Food Insecurity Access Score: In TREES' journey to build more prosperous and resilient farming communities, one of the major impacts we aim for is increased food security for our participating farmers and their households. By improving people's access to food, our work is eliminating hunger for thousands of families. The way in which we measure this impact is via the Sample Survey's Household Food Insecurity Access Scale (HFIAS). This tool was developed by the United States Agency for International Development (USAID) and is a global standard for measurement of household food insecurity.

Each of the questions in the survey is asked with a recall period of four weeks (30 days). The respondent is first asked an occurrence question – that is, whether the condition in the question happened at all in the past four weeks. These are very difficult questions to ask and to hear the results for. A sample of some of the questions are listed below.

- Did you or any household member have to eat a limited variety of foods due to a lack of resources?
- Did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
- Did you or any household member have to eat fewer meals in a day because there was not enough food?
- Was there ever no food to eat of any kind in your household because of a lack of resources to get food?
- Did you or any household member go a whole day and night without eating anything because there was not enough food?

Results of the Project's baseline and final HFIAS can be seen below.

Singida OSU Project HFIAS Results

Household Food Insecurity Access Score	2019	2021	Target
Average (out of 27)	12.53	6.05	6.26

Household Food Insecurity Access Category	2019	2021
Food Secure	1.72%	9.30%
Moderately Food Insecure	41.24%	38.37%
Severely Food Insecure	52.23%	25.58%

Household Dietary Diversity Score (HDDS): A second metric used to measure the food security of households is dietary diversity which also relates to the nutritional qualities of meals consumed. Dietary diversity is defined as the number of different foods or food groups eaten over a reference time period. Based on research conducted by the Food and Agriculture Organization (FAO), when combined with access, the diversity of a diet can provide an adequate measure of food security.

The TREES Household Dietary Diversity Score survey is adapted from FAO's Household Dietary Diversity Score. Many of TREES' sampling and analysis procedures were kept from the FAO survey, but TREES adapted the questions to include local foods commonly eaten in the areas where programs are implemented.

To better reflect a quality diet, the number of different food groups consumed is calculated, rather than the number of different foods consumed. This is a more meaningful indicator than knowing that households consume four different foods, which might all be cereals. The following set of 12 food

groups is used to calculate the HDDS:

a. Cereals
b. Root and tubers
c. Vegetables
d. Fruits
e. Meat, poultry, offal (organs)
f. Eggs
g. Fish and seafood
h. Pulses/legumes/nuts
i. Milk and milk products
j. Oil/fats
k. Sugar/honey
l. Miscellaneous

Data for the HDDS indicator is collected by asking the respondent a series of yes or no questions regarding the food they have consumed using the previous 24 hours as a reference period (24- hour recall). Longer reference periods result in less accurate information due to imperfect recall. Results of the projects baseline and final HDDS survey can be seen below. See page 19 of our 30th Anniversary Impact Report to see increase in access to different food groups across all of our projects.

Singida OSU - HDDS Results

Household Dietary Diversity Score	2019	2021	Target
Average (out of 12)	4.66	5.66	8.33

Household Dietary Diversity Category	2019	2021
High Dietary Diversity	4.12%	10.47%
Moderate Dietary Diversity	46.74%	59.88%
Low Dietary Diversity	49.14%	29.65%

CHALLENGES

Water: The primary challenge in the Singida Region is water access. Drought and very limited water resources, often far from farmers' homes and Forest Gardens, caused many trees to die in the first year and made it difficult to produce vegetables. When the project started, OSU indicated that Forest Garden farmers would create gardens near the water access points and be granted special permission to utilize the newly developed water sources. However, it was soon discovered that even potable groundwater is scarce and proved difficult to tap. Once the wells were established, it was determined that the water recharge would only be sufficient for potable use and the Village Water Committee did not allow farmers special permission to use it for agriculture production. Therefore, farmers' success was restricted due to water access. Despite this challenge, data shows increased tree cover,

diverse crop production, and increased food security and dietary diversity. To ensure sustainable irrigation water all future projects should include training and materials for developing rain water harvesting systems with farmers. However, despite this challenge farmers are seeing increased food security, dietary diversity and incomes, which allow households to pay for household potable water.

Drone imaging: Gathering drone imagery and infrared photos on a portion of the farmers land, was originally a component of this project. This imagery can assist us in the calculating Above Ground Biomass and Leaf Area Index. In September, 2018 Baseline data was taken. However, when we returned in September, 2019 to collect year 1 data, the drone was confiscated at the airport due to a new policy requiring a special permit. We were able to recover the drone upon departure. However, travel restrictions during COVID-19 made it impossible to collect data for 2020. In early 2021 TREES Tanzania M&E coordinator received training and is now licensed to fly the drone for monitoring purposes. TREES aims to gather this data by Q4 of 2021. Follow up drone footage and the accompanying calculations will be provided to OSU as soon as it is obtained.

FARMER STORY

Name: Mwajabu Omary Mughuna
Farmer Group: Mapinduzi group
Village; Mughanga
Age: 45
Family Members Supported:
2 Children and 3 grandchildren

Mwajabu Omary first planted a live fence to protect her field. Within the protection of this living fence she plants vegetables and fruit trees. She said “Before I grew my live fence, during the dry season, animals were destroying my crops, but now with the living fence there is no disturbance in my Forest garden which leads to better growing of crops”.

Now Mwajabu has access to diverse food crops in her forest garden, she plants and harvest vegetables throughout the year. “We now have food to eat and my grandchildren are happy when they come back from school, they get food, now we have a different kids of vegetables like chinese cabbage, spinach, onions, okra, tomato and sweet potatoes.”

Despite getting vegetables to eat from their permagarden, she also gets income by selling the surplus from her permagarden. Mwajabu said,“I sell chinese cabbage, okra, and tomatoes to neighbors which

help me to get a little money for acquiring some basic needs and other education materials for my grandchildren".

Mwajabu's Forest garden has been fertilized, through training on making compost and alley plantation. Mwajabu said "Now my crops grow well due to availability of compost which is not not have chemicals and is affordable. I can produce my own Compost and plant alley crops thanks to our technicians that taught us well."

ADDITIONAL DOCUMENTS AND COMMUNICATION MATERIALS

Stories From the Field - Tanzania
2019 Impact Report
2020 Impact Report
COVID-19 Response
TREES Documentary
ONE SHOT: Trees as our Last Chance for Survival, by TREES Executive Director, John Leary

MAP OF SINGIDA REGIONAL PROJECTS