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PROJECT MANAGEMENT

IMPROVING COMMUNITY'S STANDARDS OF LIVING THROUGH THE PROVISION OF CLEAN, SAFE, ADEQUATE, RELIABLE AND ACCESSIBLE WATER THROUGH EXCAVATION OF WATER RESERVOIRS, CONSTRUCTION OF RAIN HARVESTING AND WATER CONVEYANCE TECHNOLOGIES IN YATTA CONSTITUENCY

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ABSTRACT

The project goal was to improve community's standards of living through the provision of clean, safe, adequate, reliable and accessible water through excavation of water reservoirs, construction of rain harvesting and water conveyance technologies in Yatta Constituency by 2013. The problems of food insecurity in the drought stricken areas cannot be over emphasized. Common effects of drought include insufficient water and shortage of food. This may lead to malnutrition and water related diseases which could contribute to increase in medical expenditure, reduced productivity and increased death rate. Malnutrition is a major problem in parts of the world where most of its population is undernourished due to famine, poverty and limited crop production. In Kenya water resources are highly vulnerable to climate variability which includes droughts. Water scarcity is a major challenge to achieving the Millennium Development Goal of reducing the number of people without access to water and sanitation by the year 2015. Rain water harvesting, food preservation and conservation and increased food production are some of

the mitigation measures expected to play a key role in addressing this gap. This project aimed at contributing to improved health and income generation by mitigating the shortage of water through a low cost roofed water reservoir for harvesting rain water and storing it for use during the dry spells. Boosting food security to keep starvation at bay and generate income in future was addressed by introducing green houses for growing vegetables and solar food dryer technologies for drying surplus food.

The project was implemented in phases mainly: - Site selection at Ikombe and Kinyaata locations was done in liaison with local administration, community and school representatives. The total population in the study locations was 6,116 households. From these a sample of 612 households representing 10% of the total households was selected during field visits using simple random and stratified sampling techniques. The communities were mobilized, sensitized and trained on water harvesting, green house and food preservation technologies as well as entrepreneurial skills, good water hygiene and balanced diet. Environmental impact assessment was conducted and prevalence of human diseases related to water and food shortage before and after implementation of the project was documented. Installation of the technologies**-** Green houses, food dryers and rain water harvesting reservoirs was done and communities were trained and encouraged to initiate and manage their own food dryers, rain water harvesters and greenhouses for improved health and income generation.

Information of the project was collected using checklists, subjected to simple analysis of each data set and interpreted. The key results included training a total of 160 community members and demonstrations conducted at various stages of the project on the whole package comprising of greenhouse technology, water harvesting and storage, crop production, pest and disease management, entrepreneurial skills, food preservation skills and sensitization on causes and prevention of water borne diseases and those related to food deficiency. Screening of the environment on positive and negative impacts of the technologies predicted the negative impact to be minimal after which possible mitigation measures were determined and implemented. Two water reservoirs were excavated, roofed and utilization of the water (irrigation and drinking) initiated at Kimuuni and Mbembani primary schools. A food dryer and a greenhouse were each installed at Ngangani and Mbembani. After sensitization, communities formed groups and have since written proposals soliciting for funding from various organizations and institutions to enable them to replicate the projects.

Regarding common diseases related to water and food deficiency at the study sites, examination of water samples revealed contamination including high levels of bacteria, and high prevalence of malaria, water borne diseases and diseases associated with food deficiency which contributed to more than one third of the disease burden in the dispensaries in the area. Assessment of the dried foods indicated they all had essential nutrients and an array of health protective bioactive ingredients making them valuable tools to both increase diet quality and help reduce the risk of chronic disease and /or malnutrition and deficiency diseases. Sales of tomatoes, kale, spinach and onions from the green houses enabled students to do extra-curricular activities at Mbembani and assisted in school renovations at Ngangani.

From the findings, it is concluded that the interventions and results of these technologies indicate viability and worthy efforts in alleviating hunger, poverty and disease, and make potential contribution to the attainment of the Millennium Development Goals and Kenya Vision 2030. It is recommended that further assessment of the project be carried out after a period of time to determine sustainability of the use of the technologies and find out how much of the technology

was adopted and adapted by the larger community; and possible scale up of the project be implemented.

Key Words: *Community, Living standard, Clean, Safe, Adequate, Reliable Accessible Water*

1.1 BACKGROUND OF THE RESEARCH

The problems of food insecurity in the drought stricken areas cannot be over emphasized. Common effects of drought include insufficient water and shortage of food. This may lead to malnutrition and increase in water related diseases. Over one billion people struggle to feed themselves worldwide, half of them (0.5 billion) being in Africa (Mosota, Standard 31st January 2011) including 17.5m people from Kenya, Ethiopia and Somalia (Gatonye, 2011 Nation newspaper). This calls for 70% increase in agricultural production by 2050 worldwide in order to feed the projected 9 billion people.

Kenya is prone to cyclic droughts with the major ones occurring every decade and minor ones being experienced every three to four years, threatening over five million Kenyans with starvation. In addition, localized severe droughts occur frequently in the country especially in the arid and semi-arid lands (ASALS), which occupy about 83% of Kenya (Republic of Kenya, 2003).The adverse effect of drought in Kenya has forced redirection of funds (Kshs.77 million), meant for setting up 96 modern workshops to create jobs for the youth, to emergencies caused by drought such as buying food and water to supply to the affected areas. In total over Kshs.500million has been used to mitigate famine in most parts of the country (Wanyama, star 31st January, 2011). In some parts of Kenya such as Turkana, competition for the scarce water and pasture resources has led to fights and conflicts among herders (Obare, Standard, and 31st January, 2011). Further, the biting hunger has forced more than 500 pupils from public schools in Elgeyo Marakwet County to abandon school in search of food and water. The government remains committed to the use of appropriate technology that Communities fully understand as well as the use of traditional technologies commonly referred to as indigenous Technical knowledge (ITK) with modifications. The Ministry for Irrigation and Water Resources is using the water levies and fees to ensure a healthy state of the Nation's water including support for research into technologies suited to our water needs (Ochieng, Wesonga, 2012).

The proposed study intends to mitigate the shortage of water through a simple water harvesting technology. This technology can be used to harvest rain water and store it for use during the dry spells. The study also hopes to boost food security in Yatta District and keep starvation at bay in future by introducing green houses and solar food dryer technologies to farmers. The green houses will be used to grow vegetables to ensure food self - sufficiency and income generation. This initiative is hoped to help alleviate poverty by improving the economic status of the community. This mitigation measure is already being implemented in the coastal region especially Kaloleni and Ganze where Coast Development Authority (CODA) in collaboration with the United Nations Population Fund (UNFPA) has procured 4 green houses for farmers' groups at a cost of KSh.150, 000 each as part of the launch of the programme (Mosota, Standard 31st January, 2011)

The study targeted 173,943 rural poor populations in Yatta District, Kenya. The study was intended to mitigate the shortage of water due to drought through a simple water harvesting technology. This technology can be used to harvest rain water and store it for use during the dry spells. The study also aimed at boosting food security in Yatta District and keeping starvation at bay by introducing green houses and solar food dryer technologies to farmers. The green houses will be used to grow vegetables to ensure food self - sufficiency and income generation. The food drying technology was introduced to ensure supply of vegetables all year round, reduced post-harvest losses and income generation for the farmers. This initiative is hoped to help alleviate poverty by improving the economic status of the community. This mitigation measure is already being implemented in the coastal region especially in Kaloleni and Ganze where Coast Development Authority in collaboration with the United Nations Population Fund (UNFPA) has procured 4 green houses for farmers' groups in the areas (Mosota, The Standard Newspaper, and 31st January, 2011).

1.2 RATIONALE

According to the International Rescue Committee (IRC) 2003report, malnutrition is prevalent in parts of the world where famine, poverty and limited crop production are high due to drought. High levels of malnutrition then lead to increased medical expenditure reduced productivity and increased death rate in the country. Human and environmental health is therefore crucial for sustainable development. In Kenya, water resources are highly vulnerable to climate variability which includes droughts (Republic of Kenya, 2002). Water scarcity poses the challenge of achieving promotion of both equitable access and adequate supplies of water in order to reduce the number of people without access to water and sanitation by the year 2015 as part of efforts to achieve Millennium Development Goal (MDG)7: "To ensure environmental Sustainability" (http://www.undp.org), as well as to attain of Vision 2030 (Republic of Kenya, 2007). Rain water harvesting, food preservation, conservation and increased food production are some of the mitigation measures expected to play a key role in addressing this gap (Andreas, 2008). In Yatta, there are frequent droughts, poverty, lack of communities capacity to man their water supplies and encroachment of water catchments (Republic of Kenya, 2008).The distance to the nearest water source is between 5 to 10 kms when the rivers are not dry (Republic of Kenya, 2008). This is way above the recommended water coverage in rural areas which is defined as a minimum of 20 liters of clean water from improved drinking water sources with a maximum collection distance of 2 kms and available at an affordable price (Republic of Kenya, 2010). Currently information on technologies to mitigate occurrences of diseases related to drought and contaminated water is scanty. The purpose of this project was to introduce technologies that would address food insecurity and water scarcity to alleviate malnutrition, water borne diseases and poverty among the Communities.

1.3 OBJECTIVES OF THE STUDY

i. To improve community's standards of living through the provision of clean, safe, adequate, reliable and accessible water through excavation of water reservoirs, construction of rain harvesting and water conveyance technologies.

ii. To empower/sensitize/train the communities to initiate and manage their own food dryers, rain harvesters and greenhouses for improved health and income generation.

iii. To document the prevalence of human diseases related to water and food shortage.

1.4 EXPECTED OUTPUTS/ OUTCOMES

The following outputs were expected upon completion of the project:

From the Greenhouse project: It was expected that there would be;

- Improved food production in both quality and quantity
- Economic empowerment of the community
- Replication of the Greenhouses to other communities
- Lower incidences of malnutrition

From the solar dryer: It was expected that there would be;

- Reduced post- harvest losses
- Some entrepreneurs to come up and sell the dryers and the dried foods
- Replication of dryers

From the rain water harvesting reservoir: It was expected that there would be;

- Reduced incidence of water borne diseases
- Replication of the reservoirs to other members of the community
- Improved water quality for domestic use

2.0 UP-TO-DATE SCHOLARLY KNOWLEDGE

Greenhouse Techniques

Kenya's arid and semi- arid lands (ASALS) are now home to 30% of the country's population. Many years of underdevelopment together with recurrent droughts have put pressure on arid areas where poverty is higher than the rest of Kenya. Yatta is one of the areas in Kenya where there are frequent droughts and poverty (Republic of Kenya, 2008). Green house farming in ASALs will contribute significantly to Kenya's economy through diversification if they have to reduce vulnerability in extreme climate conditions. Thus, farmers will be forced to switch to more resourceful farming like irrigation and green houses. As Kenya endeavors to reduce rural poverty, green house farming will play a crucial role in development. It will be a step towards transformation of subsistence farming into a commercial enterprise which ensures food security and economic empowerment for the rural poor. This is because Green- house farming employs less labour and its crop water requirements are minimal. The plastic cover provides a barrier to moisture loss and reduces excess transpiration by 60 - 85% compared to outside farming (Fernandes et al., 2003).Crop water requirements of drip irrigated tomatoes grown in greenhouses in the tropical environment has been investigated in the past. The results show that Greenhouse farming performed better than open farming systems in terms of crop yield, irrigation water productivity and fruit quality. Greenhouse farming can save 25% of water compared to open drip irrigated systems (Harmato *et al.*, 2004).

The benefits of greenhouse are increased yields; minimal chemical requirement and minimal water usage though drip irrigation. It is practiced on a small area and saves time when working. The green house roof can be used for rainwater harvesting and coupled with other sources of water will transform lifestyles. CODA views greenhouse farming as an approach which will boost food security in the region and leave starvation at bay (Mosota, Standard 31st January, 2011). UNPFA has purchased green houses for farmer groups in Ganze at a cost of Kshs. 150,000 each. They are used to grow vegetables to ensure food sufficiency and income generation for the rural poor. Every greenhouse is expected to raise Kshs. 0.5 million after every three months. Ngolanya community Aid programme has organized farmers groups to harvest water from rock catchments in Mwingi District (Omondi, 2001).

The Horticultural crops Development Authority (HCDA) is supporting greenhouse farming in different parts of the country where the trial crops are tomatoes and capsicums. Growing crops under greenhouses has several advantages. They take a shorter period (2 months) to mature whereas outdoor farming is 3 months. Tomatoes are susceptible to diseases requiring regular application of pesticides, but not with greenhouse farming where most pests are kept at bay with basic hygiene techniques. Amiran Kenya and other companies provide Green House technologies at different costs. In addition, Amiran Kenya, Osho Chemicals and other companies are providing free chemicals to farmers in initial stages of planting (Nation media.com, 2007). The fact that Green- house farming coupled with drip irrigation doesn't need a lot of water makes it ideal for water scarce areas like Yatta. This technology, for which there is evidence of effectiveness in some parts of Kenya, can be replicated in Yatta. Green house farming will enable communities to grow crops all year round. It will also provide employment for the community. Women and community based organizations can collaborate and find employment and gain essential skills.

Water Harvesting and Storage Techniques

According to Todaro & Smith (2004), water pollution and water scarcity have caused more than 2 million deaths and billions of illnesses a year attributable to pollution, poor household hygiene and added health risks caused by water scarcity. This leads to rural household time costs of safe water provision, aquifer depletion leading to irreversible compaction and constraints on economic activity because of water shortages. Kenya is a water scarce country (Republic of Kenya, 2030). Most rural households do not have access to portable water supply throughout the year. The reasons for this are varied across seasons and climatological regions (UNEP, 2005). Rural households generally obtain their water from surface water, ground water and rain water (Republic of Kenya, 2010). The country therefore aims to conserve water sources and start new ways of harvesting and using rain and underground water. The vision 2030 for water and sanitation is to ensure that improved water and sanitation is available and accessible to all. The goal for 2012 is to increase both access to safe water and sanitation in both rural and urban areas beyond present levels (Republic of Kenya, 2030). The challenges associated with the above sources of water in Kenya are that rain water provides naturally purified water but requires to be harvested and adequate storage provided to have enough water to last the household through the year. Surface water sources are either seasonal or prone to pollution and contamination which renders the water unsafe for drinking. Ground water from springs provides portable water but the shallow wells may be subject to pollution or contamination. In most communities there is rainfall sometimes in the year. However, harnessing this water and safe storage has usually been done by those who can afford iron sheet roofs and G.I. or plastic water storage tanks.

Water pans used are open to major sources of pollution and most have dried up. This problem is exacerbated by the frequent drought situation in Kenya. For example, in Panganuo village in North Eastern Kenya where open water pans are used most of them have dried up due to persistent drought. The water harnessed from iron roofs and stored in fero-cement water storage tanks have also dried up. Besides, this storage facility is too expensive for most households. The bore holes have also dried up due to the drop in the water table as a result of the prolonged drought leaving dry pits. Sources including wells and pans have also dried up. The uncovered sources of water such as wells and pans had been contaminated due to sharing of the water with cattle and baboons and were at risk of contracting water borne diseases (Kigondu, Star, 16thFebruary, 2011). In Wajir County, the open water wells in Arbajan were also prone to pollution and the plastic containers could not hold enough water. Here a cup of water is shared between two or three people, way below the recommended 20 litres per person per day by the Ministry of Water and Irrigation (MoWI, 2010). Women have to wade through mud to fetch little water from mud which they often filter with cloth (Abjata, Star, 16thFebruary, 2011).

In Yatta, there are frequent droughts and poverty, lack of community's capacity to man their water supplies and encroachment of water catchments (Republic of Kenya, 2008).Access to water distance is between 5 to 10 kms when the rivers are not dry (Republic of Kenya, 2008). This is way above the recommended water coverage in rural areas which is defined as a minimum of 20 liters of clean water from improved drinking water sources with a maximum collection distance of 2kms and available at an affordable price (Republic of Kenya, 2010). According to Republic of Kenya (2010), clean water is water conforming to the Kenyan water quality standard. Basically the water according to this standard should be free from impurities outlined below:

i). Free from pathogenic organisms

ii) Fairly clear with low turbidity

iii) Not saline

iv) Not causing corrosion or staining clothes.

v) Contains no compounds that cause an offensive smell.

In Yatta District, springs are the major source of water especially for those who do not have big water storage tanks. However, these springs also dry up during the dry season. This increases the distance for water collection to between 5-10kms (Yatta District Development Plan, 2008). The management of Yatta Canal Water Sources is still poor and does not benefit the wider community as expected. In this regard, initiatives need to be put in place to ensure that the entire district is properly catered for (Yatta District Development Plan, 2008). Rain water harvesting has been shown to be an appropriate technology to provide sustainable water for individual households and institutions (KWAHO, 2008). A low cost community rain water harvesting reservoir was seen to be of necessity in Yatta to serve the population and provide Yatta residents with the recommended 20 litres of water per day, including the 4 months of dry spells.

Solar Food Driers

In Kenya and elsewhere, millions of shillings worth of national food produce are lost through spoilage. The reasons include ignorance about preservation of produce and low prices the rural farmers receive during the harvest season among other reasons. Drying of crops can change this trend and the savings could help strengthen the economic situation of the communities. Unfortunately many of the areas that could benefit from food drying technologies lack adequate information related to how to employ the technology and which technology to use under specific conditions. Solar drying is a process for producing material of the required quality. Drying is an excellent way to preserve food and solar food driers are an appropriate food preservation technology for a sustainable world. With the increasing interest in healthy eating, sustainable local food supplies, self-reliance and the increasing local drought incidences there is need to discover the benefit of solar food driers. Solar dryers are specialized devices that control the drying process and protect agricultural produce from damage by insects, dusts and rain. In comparison to drying product in the open, solar dryers generate higher temperatures and lower relative humidity and increase flow of air across the produce, resulting in shorter drying period lower product moisture content and reduced spoilage during the drying process. Solar dryers come in various forms and sophistication. The basic principle is that air is heated n a collector by the green- house effect. The hot air then dries the produce in a drying chamber. Depending on the construction both collector and drying chamber may be combined or separated.

In many countries of the world, the use of solar thermal systems in the agricultural areas to conserve vegetable, fruits, coffee and other crops has shown to be practical and economical and a responsible approach environmentally. The food driers among many other benefits improve the quality of the product while reducing wasted produce and traditional fuel - thus improving the quality of life. The food driers could be made to operate as individual, medium and large scale processing systems and are easily accumulated in most cultures. In many places, use of solar drying devices is becoming an established part of the agricultural or food processing business, especially where the product can be sold at a higher price or transported more easily when dried. Products that are commonly dried include fruits, tea, coffee, lumber, pyrethrum, maize, fish, meat and other. Tobacco curing is also possible. A number of commercially successful solar drying initiatives have been carried out in East Africa. Fruits of the Nile in Uganda are working with hundreds of women to dry pineapples, mangos, chilies and banana for export.

In Kenya, GTZ played a key role in introducing the technology. Most of the work was with simple direct, lowest cost type solar dryers. Such ‘simple’ designs use frames made of wood, inside which screen trays are laid. ATIV resistant plastic film is used as a cover. In Kenya a successful food drying project has been done by a group called SCODE (Sustainable Community development Services). This group has employed a solar drier since 2002 for the drying of harvesting produce. Through this the farmers have been able to raise productivity by about 50%. In this project 30 solar driers have been installed, 920 farmers trained on their use and 30 craftsmen have been trained in the construction and installation of the driers. The projects have contributed to an overall improvement of living conditions, family nutrition, environmental protection and income generation in Rift Valley.

The Kenya Industrial Research & Development Institute (KIRDI) is also actively working with institutions and women's groups in developing improved dryers for processing of fruits, vegetables and cereals on a commercial basis. It was felt that the Solar Drying technology was of great necessity in Yatta to preserve food in order to mitigate the untoward effects of drought and improve the health and socio-economic development of the community.

3.0 RESEARCH METHODOLOGY

This was a descriptive study in which baseline data was collected on the drought related diseases. Community views were also solicited after which intervention technologies were implemented in 3sites randomly selected. In addition, community mobilization, sensitization and training on the Technological interventions: water harvesting, greenhouse and food preservation technologies as well as entrepreneurial skills were carried out. The project was undertaken in Ikombe and Kinyaata locations within Yatta Constituency in Machakos County. This Constituency is predominantly water scarce. It is about 90km from Nairobi City centre along Thika-Garissa road off Matuutown. The climatic conditions are semi-arid, with mean annual temperature varying from 15ºC to 25ºC and a total annual rainfall ranging between 400 mm and 800 mm (NRI, 1990).

The study was carried out in Ikombe and Kinyaata locations. The area experiences frequent droughts, poverty, and shortage of water which is way below the recommended 20 liters per person per day (Republic of Kenya, 2010). The criteria for selecting the specific study sites included accessibility of the surrounding community members to participate in the project, site security to avoid vandalism, and security of land tenure to avoid possible conflicts. Having adequately consulted with the community and other stakeholders, the following three sites were selected the implementation of the project; Ngangani, Mbembani and Kimuuni Primary Schools.

Water harvesting was done at Mbembani and Kimuuni primary schools while greenhouse and the food drying technologies were implemented at Ngangani and Mbembani. The study population comprised of residents of Ikombe and Kinyaata locations in Yatta constituency. Yatta constituency has a population of 152,985, with 18,062 and 18,635 being in Ikombe and Kinyaata locations respectively (IEBC, 2012). Out of these, 612 households were involved in the study. Site selection was done during field visits in liaison with local administration, community and school representatives using stratified and simple random sampling. Selection of 612 households, which is 10% 0f 6116 total households in Ikombe and Kinyaata locations, was done. According to Saunders and Saunders (2007), a sample size of a descriptive research design is calculated as 10% of the total population.

Identification of three sites namely Ngangani in Kinyaata location, and Kimuuni and Mbembani in Ikombe location were done using the following criteria:

1. Easy accessibility to community members
2. Security of interventions at all times from animal and human interference
3. Availability of water for the green houses
4. Land with legal documents of ownership

Water harvesting was done at Mbembani and Kimuuni primary schools while greenhouse and food dryers were implemented at Ngangani and Mbembani.

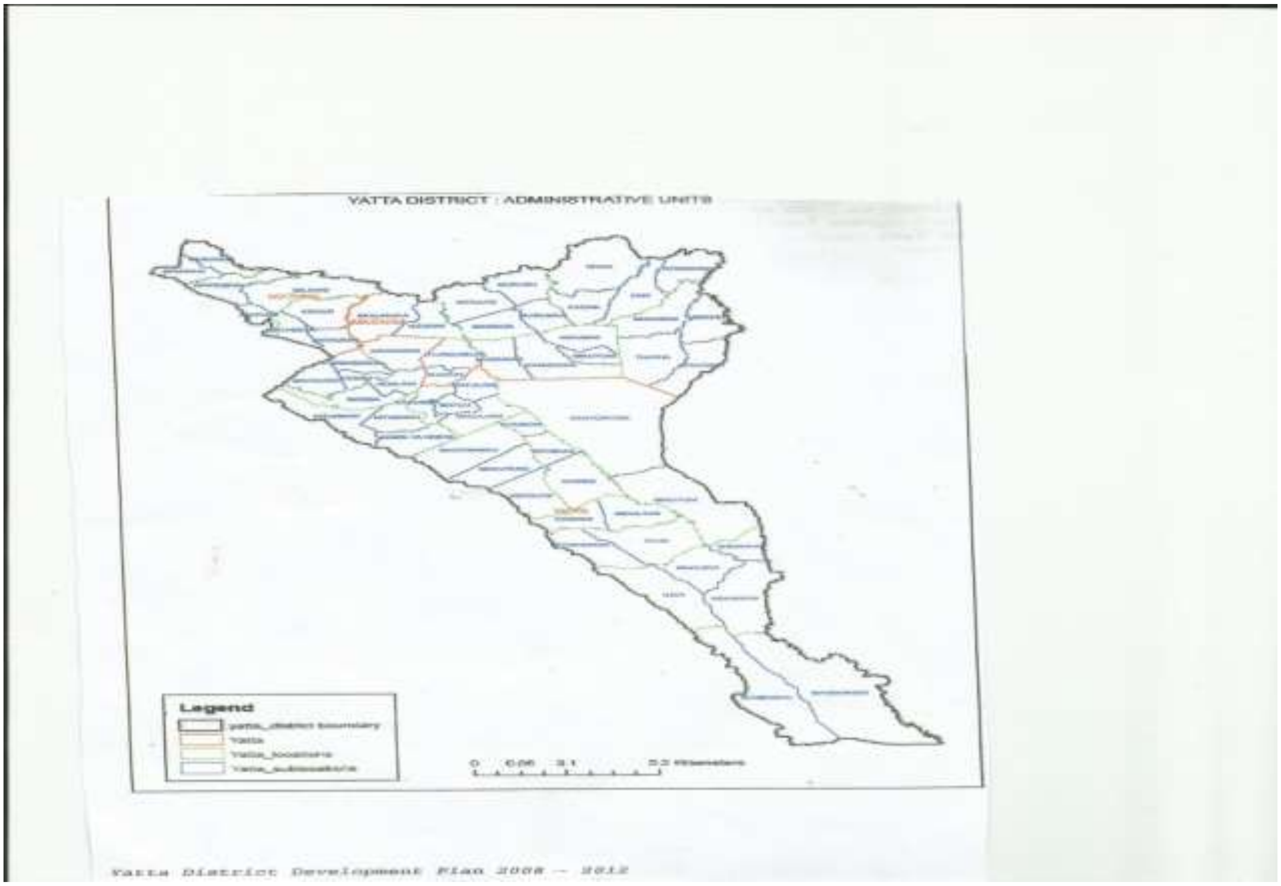

Figure 1: Administrative Boundaries of Yatta District

3.1 PROJECT IMPLEMENTATION

Objective 1: To improve community's standards of living through the provision of clean, safe, adequate, reliable and accessible water through excavation and construction of water reservoirs, rain harvesting and water conveyance technologies.

The Water and Irrigation Engineer in the team constructed the water reservoirs and water conveyor systems with the help of the local artisans and the community. A group of technicians were trained on details of how to construct water reservoirs such as measurements of water pans, covering the reservoirs, and treating the water.

Objective 2: To encourage the communities to initiate and manage their own food dryers, rain harvesters and greenhouses for improved health and income generation.

Communities were encouraged to form groups to request for assistance on dam liners, green houses and food dryers. The requests were made to the Ministry of water and Irrigation, Agriculture, Livestock and fisheries, women enterprise fund, youth development fund, Equity Bank and any micro-finance institution.

Objective 3: To document the prevalence of human diseases related to water and food shortage. Baseline assessment was conducted.

i. The community was sensitized on the common diseases associated with malnutrition and drinking dirty contaminated water.

ii. Water samples were collected at water pans (Silanga) and boreholes from various points within the study areaand analysed for presence of pathogens, purity/clarity and hardness.

Testing procedures and parameters may be grouped into physical, chemical, bacteriological and microscopic categories.

Physical tests

Through the use of the human senses, the Colour, turbidity, total solids, dissolved solids, suspended solids, odour and taste were recorded.

Chemical tests

pH, hardness, presence of a selected group of chemical parameters, biocides, highly toxic chemicals, and B.O.D were estimated using Standard Operating Procedures (SOPS) for water analysis.

Biological Oxygen Demand (B.O.D)

Biological Oxygen Demand was measured using the B.O.D Kit.

Bacteriological tests

i. Water samples were cultured in the laboratory on Agar media and the bacterial colonies were observed under the microscope to identify the different micro-organisms present.
ii. Investigation of dietary components of various foods was carried out to compare fresh and dried foods. Test for carbohydrates and starch in both fresh and dried foods were carried out as shown below:

Test for reducing sugars

A solution of the substances to be tested was placed in a boiling tube and Benedict's solution added and color change was observed. The solution was heated gently for about two minutes in a water bath. Colour change from blue to green and finally yellow or orange indicated the presence of simple sugars like glucose fructose in the test food stuff.

Test for starch - iodine test

In testing solid foods, three drops of iodine solution, which is brown in colour, was added directly to the test substance in a plastic dish. For liquids starch is insoluble in water, therefore five drops of Iodine solution was added to the liquid test substance in a test tube then observed. A colour change from brown to blue black indicates a positive test for starch.

Test for proteins

Test for proteins in food stuff was done by Biurret test. Sodium hydroxide and copper Sulphate were added to the test substance. A colour change from blue to a purple like colour shows the presence of a protein.

Test for lipids (fats and oils)

Ethanol was added to a very small amount of the test substance; the mixture was shaken and heated gently in a water bath (DO NOT HEAT OVER A BUNNER). The solution was then filtered to obtain a fairly clear liquid which is the solution of fats in ethanol. The ethanol solution was poured into a test- tube containing tap water. A white emulsion milky appearance indicates the presence of fats or oils in the food items. Data collection on water borne/related and food deficiency diseases

i. Visits were made to Ikombe, Kinyaata and Kikesa clinics between 28th June 2011 and 3rd August 2012 to gather information on common diseases related to water and malnutrition
ii. To assess the common ailments that afflict the community, data was collected by reviewing clinical records from the three dispensaries. Emphasis was on malaria, water borne diseases and diseases associated with food deficiency as these are the diseases upon which the results of this intervention would have a direct impact.

4.0 FINDINGS AND DISCUSSIONS

4.1 Improving Community's Standards of Living through the Provision of Clean, Adequate, Reliable and Accessible Water

Two water reservoirs were excavated, roofed and utilization initiated at Kimuuni and Mbembani primary schools. The water was used for irrigation of the food crops in the green houses. The water was treated before use for drinking to minimize possibilities of taking contaminated water. The communities in Kimuuni and Mbembani appreciated the provision of water considering that Yatta is a predominantly dry district falling under Arid and Semi-Arid Lands (ASAL). In addition, the rains are low and erratic and vary greatly both in space and time. Rainfall events are generally intense and can produce considerable runoff and soil erosion. People walk for more than 20km daily in search of water hence the need for water harvesting.

Plate 1: Consultations at the Mbembani Reservoir

Mbembani Primary school

The following are the findings and the design document which focused on three aspects mainly;

1. Roof catchment water harvesting,
2. Water conveyance
3. Water delivery for utilization

One excavated and lined water reservoir of 280M^{3}capacity at Mbembani Primary school was done by the community members over a period of two weeks. The reservoir was covered with a Ultra Violet treated polyethylene plastic sheet to avoid water loss through evaporation, since this area falls under ASALs and has high temperatures that lead to high evaporation and evapotranspiration rates. Special synthetic straps with enough tensile strength were incorporated to hold the covering material in place and to prevent any large animal from falling inside the pan. A 50mm mesh insect net was used to cover the pan sides. This will prevent snakes, insects and other small organisms from entering the water pan.

Plate 2: Complete Mbembani pan

Kimuuni Primary School

Initially, the site selected for the second water pan was at Kinyaata; however excavation of the site encountered rocks that could not be removed by hand so after excavation for about two meters deep, the site was abandoned and an alternative site proposed at Kimuuni primary school. At this site the reservoir was fully covered with corrugated iron sheets. A method of harvesting the rain water for crop production was vital and it was agreed that schools with their vast roof area would be the best option to harness rain water from.

Plate 3: Complete Kimuuni Pan

4.2 Encourage the Communities Initiate and Manage Food and Rain Harvesting Technologies

The communities were sensitized on the use of dryers, water harvesting technologies and green houses. This was done during the training sessions. The community showed willingness to adopt the technologies. However, the community was faced with the challenge of obtaining seed capital to implement the technologies. They were therefore, encouraged to form groups and solicit for funding from various organizations and institutions such as banks, donors, GOK (women and youth enterprise fund etc). Various groups were formed and have since written proposals to various institutions to solicit for funds.

4.3 Documenting Prevalence Human Diseases Related To Water and Food Shortage

Baseline assessment to gather information on common diseases related to water and malnutrition at clinics around Mbembani and Ngangani areas was carried out.

4.3.1 Water Sample Analysis

The community was sensitized on the common diseases associated with malnutrition and drinking dirty contaminated water. Water was collected from nearby water pans that were used for both domestic and livestock use and analysis carried out to determine their levels of contamination.

Plate 4: Water pan at Ikombe, Yatta District

The results and full report from the laboratory is shown in Table 5-1. In this table, the first column indicates the test parameter and the last column indicates the method used to determine the test result (sometimes, more than one method may be used to determine residuals). The WHO Standards shown in Appendix 10 were used to compare with our results as discussed below. The sample analysis results are given in the table below. The second column indicates how the parameters are measured; the third column gives the actual test result which may then be compared to the values in the fourth column. The values in the fourth column are national standards or limits set by Governments and may differ from country to country. The values in the third column should not exceed those in the fourth column.

Table 1: Water Analysis Results

Parameter		Unit	Test Remarks	Requirement	Methods
Physical & Chemical *):					
	□Colour	Pt. Co scale	3	15	Colorimetric
	□Odour	Pt. Co scale	negative	Odourless	Organoleptic
	□ pH	Pt. Co scale	6.50	6.5-8.5	Electrometric
	□ Taste	Pt. Co scale	normal	tasteless	Organoleptic
	□Turbity	FTU	1	5	Turbidity
	□ Aluminum	mg/l	below 0.20	0.2	AAS
	□ Copper	mg/l	below 0.03	1.0	AAS
	□ Iron Total	mg/l	below 0.04	0.3	AAS
	□ Manganese	mg/l	0.06	0.1	AAS
	□ Sodium	mg/l	96.93	200	AAS
	□ Zinc	mg/l	0.047	5	AAS
	□ Chloride	mg/l	140.41	250	Argentometric
	□Flouride	mg/l	0.09	1.5	Colorimetric
	□ Nitrate	mg/l	below 0.11	10	Colorimetric
	□ Nitrite	mg/l	0.96	1	Colorimetric
	□Sulphate	mg/l	below 0.94	400	Turbidimetric
	□ Arsenic	mg/l	below 0.001	0.05	AAS
	□ Barium	mg/l	below 0.10	1	AAS
	□ Cadmium	mg/l	below 0.005	0.005	AAS
	□ Cyanide	mg/l	below 0.01	0.1	Colorimetric
	□Chrom Hexavalent	mg/l	below 0.006	0.05	Colorimetric
	□ Lead	mg/l	below 0.01	0.05	AAS
	□ Mercury	mg/l	below 0.001	0.001	AAS
	□ Selenium	mg/l	below 0.007	0.01	AAS
	□ Organic Matter by KMnO4	mg/l	3.06	10	Permanganantometric
	□ Dissolved Solid	mg/l	431	1000	Gravimetric
	□ Hydrogen Sulphide as H2S	mg/l	below 0.01	0.05	Colorimetric
	□ Total Hardness	mg	95.49	500	AAS

Parameter		**Unit**	**Test Remarks**	**Requirement**	**Methods**
Physical & Chemical *):					
	□Colour	Pt. Co scale	3	15	Colorimetric
	□Odour	Pt. Co scale	negative	Odourless	Organoleptic
	□ pH	Pt. Co scale	6.50	6.5-8.5	Electrometric
	□ Taste	Pt. Co scale	normal	tasteless	Organoleptic
	□Turbity	FTU	1	5	Turbidity
	□ Aluminum	mg/l	below 0.20	0.2	AAS
	□ Copper	mg/l	below 0.03	1.0	AAS
	□ Iron Total	mg/l	below 0.04	0.3	AAS
	□ Manganese	mg/l	0.06	0.1	AAS
	□ Sodium	mg/l	96.93	200	AAS
	□ Zinc	mg/l	0.047	5	AAS
	□ Chloride	mg/l	140.41	250	Argentometric
	□Flouride	mg/l	0.09	1.5	Colorimetric
	□ Nitrate	mg/l	below 0.11	10	Colorimetric
		CaCO3			
Bacteriological:					
	□ Total Bacteria	per ml	6.9 x 102	1.0 x 102	Pour Plate
	□ Coliform	per 100 ml	nil	nil	Filtration
	□ E. Coli	per 100 ml	nil	nil	Filtration
	Salmonella sp	per 100 ml	negative	negative	Filtration

4.4 Discussion

Examination of the water pans (Silanga) water samples revealed that whereas the iron and manganese levels were over the limit, indicating vegetable matter in the pool, the sodium and chloride levels were low, indicating that the pump was not overdrawing. Both the nitrate and nitrite levels were low indicating that sewage intrusion into the borehole casing was not a problem. The total bacterial count, however, was very high, indicating that the water has to be chlorinated to lower the count. The high level of contamination is probable due to fact that the (Silangas) are large water pans in which the rainwater runoffs collect. The rain water sweeps every matter in the environment including fecal matter from animals like humans, livestock and wild life.

Table 2: Ikombe Water Pan Analysis Results

Analytical Laboratory Report		
Analysis	**Results**	**Units**
Total Coliform Bacteria	50	#/100ml
Nitrate-Nitrogen	4.55	mg/L
pH	7.5	
Iron	0.55	mg/L
Hardness as CaCo3	280	mg/L
Sulfate Sulfur	32	mg/L
Chloride	25.4	mg/L
Specific Conductance	344	umhos/cc

4.4.1 Discussion on Water Analysis

On the basis of the above test result(s), this water sample DOES NOT MEET EPA Drinking Water Standards. The Total Coli form Bacteria exceeded the maximum level of 1 colony/100ml while the Iron level exceeded the limit of 0.3 mg/L. Examination of the piped bore- hole water sample test report (comparing them to the Silanga water) indicates that the bacterial count is slightly lower but not enough to be considered sanitary and fit for drinking. The turbidity also dropped dramatically between Silanga and borehole. The nitrate level also drops as the nitrates are further converted to nitrites indicating bacteriological activity inside the overhead tank as well.

4.4.2 Assessment on Common Water Borne Diseases

The results obtained from the assessment of common water borne diseases are as summarized in the tables below.

Table 3: Disease distribution by age-group at Kinyaata Dispensary

Disease	Year and months					
	2011 (Jan-Dec)			2012 (Jan-Jun)		
	<5yrs	>5yrs	Total	<5yrs	>5yrs	Total
Typhoid fever	0	18	18	2	9	10
Diarrhea	143	39	182	75	13	88
Dysentry	3	9	12	1	0	1
Malnutrition	4	0	4	33	0	33
Anaemia	1	2	3	1	0	1
Malaria	756	1810	2566	471	1408	1879
Intestinal worms	34	0	34	0	0	0
Total	**941**	**1878**	**2835**	**583**	**1430**	**2012**

At Kinyaata, malaria was the most common ailment among the population and diarrhea is common among those under 5 years of age (Table 3).

Table 4: Disease burden each six months (July 2011 – June 2012) at Kinyaata Dispensary

Disease	Year and months 2011 (July-December)	2012 (January-June)	Freq	%
Typhoid fever	12	10	22	0.5
Diarrhoea	77	88	165	3.6
Dysentry	1	1	2	0.04
Malnutrition	3	33	36	0.8
Anaemia	2	1	3	0.006
Malaria	756	1879	2635	57.7
Intestinal worms	6	0	6	0.1
Sub-total	**857**	**2012**	**2869**	**62.8**
All other ailments	1180	516	1696	37.2
Total disease burden	**2037**	**2528**	**4565**	**100**

The combined totals of malaria, water borne diseases and diseases associated with food deficiency contributed highly to the disease burden at Kinyaata before the implementation of the technologies, with rates of 62.8%, while the most common disease was malaria which contributed 57.7% to the disease burden (Table 4).

Table 5: Disease burden each six months (July 2011 – June 2012) at Kikesa Dispensary

Disease	Year and months		Total
	2011 (July-December)	**2012 (January-June)**	**No. (%)**
Typhoid fever	139	90	229 (4.2%)
Diarrhoea	109	78	187 (3.4%)
Dysentry	-	-	-
Malnutrition	1	0	1 (0.02%)
Malaria	1029	658	1687 (30.6)
Intestinal worms	116	202	318 (5.8%)
Sub-total	**1394**	**1028**	**2422(43.9%)**
All other ailments	1161	1936	3097 (56.1%)

Malaria combined with water borne diseases and diseases associated with food deficiency contributed 44.9% of the disease burden at Kikesa before implementation of the technologies. Regarding specific diseases, malaria was the most common with rates of 30.6% (Table 5).

Table 6: Disease burden each six months (July 2011 – June 2012) at Ikombe Dispensary

Disease	Year & age group					
	2011			**2012**		
	<5yrs	**>5yrs**	**Total**	**<5yrs**	**>5yrs**	**Total**
Typhoid fever	_	_	152	_	_	85
Amoebiasis	106	96	202	7	65	72
Diarrhea	127	91	218	85	106	191
Cholera	0	0	0	0	0	0
Bacillary dysentry	0	0	0	0	0	0

Available data at Ikombe dispensary before implementation of the technologies was not complete and could not be used to make any logical conclusions. However it is clear that typhoid fever, amoebiasis and diarrhea were common ailments (Table 6).

Table 7: Disease distribution by age-group at Kinyaata Dispensary

	Year & age group					
	2012 (July-December)			**2013 (Jan-June)**		
Disease	**<5yrs**	**>5yrs**	**Total**	**<5yrs**	**>5yrs**	**Total**
Typhoid fever	0	7	7	4	17	21
Diarrhoea	53	18	71	50	19	69
Dysentry	0	0	0	3	2	5
Malnutrition	14	0	14	3	0	3
Anaemia	0	8	8	1	1	2
Malaria	167	726	893	17	77	94
Intestinal worms	53	0	53	19	61	80
Sub-total	**287**	**759**	**1046**	**97**	**177**	**274**
All other ailments	12	74	86	137	462	599
Total disease burden	**299**	**833**	**1132**	**234**	**639**	**873**

The most common ailments at Kinyaata in the period after implementation of the technologies were malaria, diarrhea and intestinal worms (Table 7).

Table 8: Disease burden each six months (July 2012–June 2013) at Kinyaata Dispensary

	Year and months		
	2012	**2013**	
Disease	**(July-Dec)**	**(Jan-Jun)**	**Total (%)**
Typhoid fever	7	21	28 (1.4%)
Diarrhoea	71	69	140 (7%)
Dysentry	0	5	5 (0.3%)
Malnutrition	14	3	17 (0.9%)
Anaemia	8	2	10 (0.5%)
Malaria	893	94	987 (49.2%)
Intestinal worms	53	80	133 (6.6%)
Sub-total	1046	274	1320 (65.8%)
All other ailments	86	599	685 (34.2%)
Total disease burden	1132	873	2005 (100%)

Malaria alone contributed 49.2% of the disease burden at Kinyaata dispensary after implementation of the technologies, while the contribution was much higher (62.8%) when malaria was combined with water borne diseases and diseases associated with food deficiency (Table 8).

Table 9: Disease distribution by age-group at Kikesa Dispensary

	Year & age group					
	2012 (July-December)			2013 (Jan-June)		
Disease	**<5yrs**	**>5yrs**	**Total**	**<5yrs**	**>5yrs**	**Total**
Typhoid fever	0	39	39	0	8	8
Diarrhea	48	21	69	73	21	94
Dysentry	0	0	0	0	0	0
Malnutrition	440	41	481	191	12	203
Anaemia	0	0	0	0	0	0
Malaria	165	391	556	3	10	13
Intestinal worms	32	104	136	77	417	494
Sub-total	**685**	**595**	**1281**	**344**	**468**	**812**
All other ailments	123	216	339	111	306	417
Total disease burden	**808**	**811**	**1619**	**455**	**774**	**1229**

In the period after implementation of the technologies, the most common ailments at Kikesa were malaria, diarrhea and intestinal worms (Table 9).

Table 10: Disease burden each six months (July 2012 – June 2013) at Kikesa Dispensary

Disease	**Year**		**Total**
	2012 (July-December)	**2013 (January-June)**	**No. (%)**
Typhoid fever	39	8	47 (1.7%)
Diarrhoea	69	94	163 (5.7%)
Dysentry	0	0	0
Malnutrition	481	203	684 (24%)
Anaemia	0	0	0
Malaria	556	13	569 (20%)
Intestinal worms	136	494	630 (22.1%)
Sub-total	**1281**	**812**	**2093 (73.5%)**
All other ailments	339	417	756 (26.5%)
Total disease burden	**1620**	**1229**	**2849 (100%)**

The combined malaria, water borne diseases and diseases associated with food deficiency contributed highly (73.5%) to the disease burden at Kikesa while malnutrition, malaria and intestinal worms each contributed >20% of the disease burden (Table 10).

Table 11: Disease Distribution by Age-Group at Ikombe Dispensary

	Year & Age Group					
	2012 (July-December)			2013 (Jan-June)		
Disease	**<5yrs**	**>5yrs**	**Total**	**<5yrs**	**>5yrs**	**Total**
Typhoid fever	0	61	61	0	74	74
Diarrhoea	39	33	72	32	27	59
Dysentry	0	1	1	0	0	0
Malnutrition	15	1	19	21	2	23
Anaemia	0	3	3	0	4	4
Malaria	5	7	12	1	3	4
Intestinal worms	3	9	12	2	10	12
Sub-total	**65**	**115**	**180**	**56**	**120**	**176**
	491	1586	2077	771	1904	2675
All other ailments						
Total disease burden	**556**	**1701**	**2257**	**827**	**1024**	**2851**

At Ikombe, after implementation of the technologies, the most common diseases were other ailments apart from malaria, diarrhea and intestinal worms for which low numbers of patients were treated (Table 11).

Table 12: Disease burden each six months (July 2012 – June 2013) at Ikombe Dispensary

	Year		
	2012	2013	
Disease	**(July-Dec)**	**(Jan-Jun)**	**Total (%)**
Typhoid fever	61	74	135 (2.6%)
Diarrhoea	72	59	131 (2.6%)
Dysentry	1	0	1 (0.02%)
Malnutrition	19	23	42 (0.8%)
Anaemia	3	4	7 (0.1%)
Malaria	12	4	16 (0.3%)
Intestinal worms	12	12	24 (0.5%)
Sub-total	180	176	356 (7%)
All other ailments	2077	2675	4752 (93%)
Total disease burden	2257	2851	5108 (100%)

The contribution of malaria, water borne diseases and diseases associated with food deficiency to the burden of disease was very low at Ikombe (7%) where other ailments were predominant with a rate of 93% (Table 12).

4.5 Assessment of Common Diseases Related To Water and Food Shortage

To assess the prevalence of human diseases related to water and food shortage before and after implementation of the technological interventions in this project, baseline information on the health status of the population regarding water-related and food deficiency diseases was documented. The information was obtained from health facility records in the three dispensaries at Kinyaata, Kikesa and Ikombe in the study sites. This formed the basis for assessment of changes resulting from the interventions and was then compared with information gathered after implementation of the interventions. The findings are summarized in the tables below.

4.6 Discussion

The baseline information on common diseases related to water and food deficiency and malaria that was obtained from health facility records in the three dispensaries of Kinyaata, Kikesa and Ikombe was incomplete to some extent. However during the project, the records improved and the data collected after implementation of the technologies was more complete, perhaps as a consequence of discussions between the study team and the health facility staff during the initial visits to the facilities on the importance of complete data. The incompleteness of the baseline data was more pronounced for Ikombe dispensary which made comparison of baseline data and data collected after implementation of the technologies difficult. For the other diseases, there does not appear to have been much change with an exception of the intestinal worms and malnutrition for which the prevalence in Kikesa increased after implementation of the technologies.

The data from health facilities in the study sites indicates that the total number of patients who were treated decreased by almost half after implementation of the technologies, from 4565 (July 2011-June 2012) to 2005 (July 2012-June 2013) in Kinyaata dispensary and from 5519 to 2849 in Kikesa dispensary during the same period. This is an indication of marked decrease in disease burden at the study sites, a possible indication of improved health among the communities served by these health facilities. With regard to diseases, malaria, water borne diseases and diseases associated with food deficiency contributed highly to the disease burden at Kinyaata and Kikesa both before and after the implementation of the technologies, with rates of 62.8% and 65.8% for Kinyaata during the period July 2011-June 2012 and July 2012-June 2013 respectively, and 43.9% and 73.5% for Kikesa during the same period. It is interesting to note that at Ikombe dispensary, although there is no available baseline data for comparison, these diseases contributed only 7% of the disease burden in July 2012-June 2013.

The prevalence of malaria decreased with time at Kinyaata and Kikesa dispensaries after implementation of the technologies. In the period July 2011-June 2012 and July 2012-June 2013, the decrease in malaria prevalence was 57.7% to 49.2% and 30.6% to 20% at Kinyaata and Kikesa dispensaries respectively. At Ikombe, the contribution of malaria to the disease burden was low (0.3%) in the period July 2012-June 2013. However the records at the health facilities indicated that most of the time, diagnosis of malaria is by use of clinical findings by the health practitioner without any laboratory confirmation. Other common ailments include diarrhea, dysentery and malnutrition all of which showed persistently high rates in Kinyaata and Kikesa even after implementation of the technology. These diseases are related to water, food deficiency and poor hygiene. The results also agree quite well with the results of water analysis from water pans around the study area which indicated that the water did not meet EPA drinking water standards, and thus there was direct correlation between the water analysis results and prevalence of water borne diseases. Thus although the supply of water increased at the study sites due to implementation of the three technologies, the need for continued health education of the communities as well as on good hygiene and appropriate food and water handling cannot be overemphasized.

4.6.1 Results and discussion on food analysis

The dried food samples collected from dryer stationed at Ngangani primary school which is one of the project sites were: mangoes, cowpeas leaves pigeon peas, maize grains and grated dried carrots. Maize grains were crushed into powder using a pestle and mortar then a drop of iodine solution poured on test substance in a welled tile showed blue black color indicating presence of starch. Cowpeas leaves were cooked in a source pan and fresh ones too cooked. The two vegetables were served in different plates and given to a sample of people to eat.

There was no significant difference between dried and fresh vegetables in terms of color and taste upon cooking. In fact the people eating did not notice any difference between the dried and fresh cowpeas. Pigeon peas (nzuu) in kikamba' was dried in the food dryer and tested for presence of proteins. Burette test showed positive meaning that the peas had retained their nutritional value of high proteins. Dried slices of mangoes were said to be sweater than the fresh slices and the results when a sample was ground dissolved in water and tested for presence of ascorbic acid using DCIP Reagent. There was no significant difference the amount of ascorbic acid in fresh and dried mango fruit meaning that drying in the food dryer does not destroy nutrients in fruits. The dried foods have a higher concentration of nutrients say sugars than fresh ones that has lots of water hence dilute. In short all dried foods provide essential nutrients and an array of health protective bioactive ingredients making them valuable tools to both increase diet quality and help reduce the risk of chronic disease and /or malnutrition and deficiency diseases.

5.0 CONCLUSION

The findings, of this project at Yatta, are encouraging as they indicate viability & worthy efforts in alleviating hunger and poverty, and potential contribution to the attainment of the MDGs and Kenya Vision 2030. Impact assessment of the project needs to be carried out to find out how much of the technology was adopted and adapted. As such, every effort should be made to sustain the strengths & close or minimize the gaps as we move forward to finalize the project while addressing the issue of sustainability.

6.0 RECOMMENDATIONS

Based on the findings, the study recommended that, the project should go into another phase to offer an opportunity for further sensitization of the community on rain water harvesting at household level. The study in addition recommended that the community should be encouraged to practice proper sanitation and waste disposal methods and other environmental conservation measures in order to reduce water borne diseases.

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