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Environmental Impact Assessment (EIA) Before Implementing the Technological Interventions to Reduce Incidences of Drought Related Human Diseases in Yatta District in Kenya, 2013

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Abstract

The project goal was to contribute to improved health and income generation through increased food production, preservation, improved water quantity, quality and availability 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.

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Key Words: *Environmental, Assessment, Technological Interventions, Drought related, Diseases*

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

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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 Objective of the Study

To carry out Environmental impact assessment (EIA) before implementing the technological interventions to reduce incidences of drought related human diseases in Yatta district in Kenya

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).

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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 and 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

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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

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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.

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Figure 1: Administrative Boundaries of Yatta District

3.1 Project implementation

To carry out Environmental impact assessment (EIA) before implementing the technological interventions

i. Screening of environment was conducted to study any positive and negative impacts of the technologies on water harvesting and storage (the water reservoir) and the green

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houses.

ii. Review and verification of compliance with regard to Environmental Management and Coordination Act (EMCA,1999) was carried out in relation to the following: Health and safety, Solid waste disposal, Water pollution, Air pollution, Noise pollution, Dust pollution and Aesthetic view
iii. Identification and assessment of prevailing environmental issues was carried out.
iv. Assessment of implementation and monitoring procedures during the operation of the project.
v. Identification and assessment of social issues related to the project.
vi. Assessment of public opinion of proposed project siting/location and initiation.

Methods used when compiling the information:

i. Direct Observation within and around the Site.

Observation within the site and its environs provided first-hand information about the site and its neighborhood. Through this, it was possible to assess the potential ecological damage.

ii. Personal Interviews
Through personal interviews it was possible to assess the stakeholders and the community's feeling on the location of the project. This gave the experts a chance to evaluate the level of the project's acceptance.

iii. Public meetings
During the study period public meetings were held with The Researchers, the Community and the Local leaders. This was to inform them of the policy requirements for the project as far as the environment was concerned and to develop terms of reference for the EIA assessment.

iv. Official Documents
Documents kept by Schools' Management team were retrieved and made use of as an added source of information and these included the allotment letters and certificate of registration of the schools (Appendix 2).

v. Field Measurements
Measurement in the field is one approach used when collecting data. Distances measurements were done while in the field and this assisted in the eventual evaluation of the environmental impacts. The possible mitigation measures for negative impacts were determined and the community sensitized.

4.0 Findings and Discussions

Screening of environment was conducted to study any positive and negative impacts of the technologies on water harvesting and storage, the water pan, and the green houses (Appendix 8 shows NEMA Letter of approval of EIA baseline study report). The possible mitigation measures for negative impacts were determined and the community sensitized on these. Making recommendations regarding negative and positive impacts was identified and results are discussed below.

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4.0.1 Potential Environmental Impacts of the Project and their Mitigation Measures

The predicted environmental impact of the project was minimal during construction, operation or even decommissioning phases of the project.

4.0.2 Pertinent National Environment Policy and Regulatory Framework

Selection of the project site and the proposed mode of project implementation were done with the pertinent National Environmental Policy and Regulation in mind. In all aspects of the project development, the researchers sought to comply with the National legal and regulatory provision .Some of the legal provisions relevant to the project are discussed below.

4.0.3 Environmental Management and Co-ordination Act (EMCA) 1999

Environmental Management and Co-ordination Act .No 8 of 1999 spells out that every person has a right to clean and healthy environment and has a duty to safeguard and enhance the environment. Any person violating the environmental right or causing significant environmental pollution shall be guilty of an offence. It is the duty of every person to prevent discharge or emission of any pollutant into the environment and to ensure sustainability of environmental goods. The Act utilizes the following fundamental principles:

i. Integration of Environmental consideration into development policies, plans, programmes, and projects,
ii. Ensuring sustainability of environment and natural resources,
iii. Offering precautionary measures to mitigate adverse environmental impact, and
iv. Encouragement of consultation and public participation especially with regard to development policies, plans, and /processes for management of the environment. Further to the above principles, respect for cultural, social and traditional norms and values consistent with laws for environmental quality is upheld.

4.0.4 Environmental Management and Coordination Act (Water Quality Regulations) 2006

The regulations are meant to protect sources of domestic water from pollution through discharge of domestic and industrial effluents. Sitting of the green houses and water reservoirs was such that there would be no pollution of water from use of chemicals in the green house.

4.0.5 Environmental Management and Co-ordination Act (Waste Management Regulations) 2006

These regulations define responsibilities of waste generation and define the duties and requirements for transportation and disposal of waste. These provide for mitigation of pollution and handling of hazardous and toxic wastes. The regulation requires a waste generator to dispose waste only to a designated waste receptacle. The project would generate no hazardous waste and only a little organic waste from the green house will be used as compost.

4.0.6 The Water Act

The Water Act contains provisions which require conservation and rational use of water resources. Water resources include; surface water, underground water, estuarine, marine and all water bodies. Section 160(2) of the Act puts emphasis on water pollution. It has guidelines and

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rules on effluent discharge standards to water bodies. The standards are categorically put in three sets as:

- Generalized effluent discharge standards
- Effluent discharge standards into the aquatic environment.
- Effluent discharge standard into municipal sewers.
- The project was found to generate no waste water.

4.0.7 Public Health Act

The Public Health Act is concerned with domestic water supply and sources of water used for human consumption. It gives specifications on waste water or noxious matter being discharged to waterways. It describes environmental pollution as a "nuisance" to human health. The project was found to generate no waste water.

4.0.8 Factories and Other Places of Works Act Cap 514

The Act contains a set of exposure thresholds technically referred to as "Threshold Limit Values" (TLV) applicable for the health and safety of workers. It seeks to minimize exposure to harmful gases, liquids, noise, dust/particulate matter, light, radiations, and general physical harm. It is concerned with ambient environment in work places. TLV have been specified for a wide range airborne substances and energies to which a worker may be exposed. The Act contains the Noise Pollution Standards set out as part of the safe ambient noise levels a worker can be exposed without long-term health effects. The project generated no noise and technicians in the green houses were given protective gear such as masks, overall, gloves and gum boots for use.

4.0.9 The land and Planning Act

The land and Planning Act covers the overall development and use of land for any given activity or purpose. Any Project location is subject to approval by Interim Planning Authority (IPA) who assesses the project Physical Plan against the regulations governing establishment, change of use, or disposal of waste in any given environment. The project did not generate any waste and its scope did not warrant the intervention of the IPA.

4.0.10 Environmental Impact Assessment and Audit Regulations (2003)

This regulation gives information on the need for Environmental Impact Assessment and Audits when undertaking development projects. It indicates which development projects require full or partial environmental impact assessment and which one are exempted. It also gives procedures to follow when undertaking project Assessment or Audit. The regulation further gives procedures followed when evaluating an Environmental Impact Assessment or Audit Study. The above legislation were instrumental when deciding on project site and when developing processes and contingency plans for effective implementation of the project. The predicted environmental impact of the project is categorized into the following:-

- Social impact
- Physical impact
- Occupational hazard

- Workplace accident and risk.

4.1 Types of Environmental Impact

4.1.1 Social Impact

The project is not expected to affect the legal, economic and cultural issues of the local communities. The project will not lead to conflict related to legal ownership of land; it may infringe on cultural rights and may even create variance in economic interest on the situation of the project. Positively, it is expected to create jobs and improve the health of the community.

4.1.2 Physical Impact

Excavating for leveling or foundation preparation in the project would not cause damage on the physical appearance of the site and its environs.

4.1.3 Biological impact

Destruction of vegetation in the project site could cause decimation of certain plants casting a negative effect on "normal" biological processes expected in a natural ecosystem. This would not be a major problem for the project, because already the site is devoid of vegetation.

4.1.4 Chemical impact

There was no chemical impact.

4.1.5 Occupational hazard

There was no occupational hazard as the workers were given protective gear.

4.1.6 Workplace Accidents and Risks

Workers will be exposed to increased accidents while fetching the water and the school children could also be exposed to accidents in the dam. Occurrence of such accidents will nevertheless be dependent on the level and provision of appropriate mitigating measures. Covering and fencing around the water reservoir is expected to mitigate this.

4.1.7 Impacts without the Proposed Project

Considering the absence of the proposed project as the alternative option, the following impacts would be realized.

- There would be no more gainful employment impacting on economic recovery and wealth creation strategy for the country,
- There would be reduced revenue and taxes for the central government,
- There would be increased waterborne diseases.
- There will be reduced gainful business for people around the project site.

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4.2 Predicted Environmental Impacts and their Mitigation Measures

The predicted negative and positive impact, both temporary and permanent, likely to be associated with the project are shown in Tables1, 2 and 3. Of paramount importance are the mitigation measures of the foreseen negative impacts.

Table 1: Economic Impacts

Type of Impact	Permanent Impact associated with construction	Temporary Impacts	Proposed Mitigation Measures
Employment and poverty reduction	• Increased food supply • Reduced waterborne diseases • Risen income • Improved livelihood	• Jobs created during and after construction	None required
Accessibility to nutritious food stuff	• Reduced famine • Improved food security • Reduced deficiency diseases	• Availability of food	None required
Revenue generation and government liability for the project	• Revenue generated for the community and government • Local county council benefit through taxes		
Infrastructure development and stimulus to local business	• Attraction of other investors • Development of amenities • Increase of food production		

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Table 2: Social Impacts and their Mitigation Measures

Type of Impact	Permanent Impact	Temporary Impact	Proposed Mitigation Measures
Community	Employment of local community	Employment of local community	None needed

Table 3: Physicochemical Impacts

Type of impact	Permanent Impact	Temporary Impact	Proposed Mitigation
Dust particles in the air		Pollution of the surrounding atmosphere	Select energy efficient equipment Adopt cleaner production

4.3 Findings from Environmental Impact Assessment Study

Data collected using various methods were analyzed and used when evaluating the intensity and nature of the identified impacts. As already noted the environmental impacts identified broadly fell into the following categories:-

a) Socio-economic
b) Physical
c) Chemical and
d) Biological

4.4 Findings of the Study with Project

Field visits and measurements together with questionnaire and interview administration yielded data that enabled the Lead Expert to decide on the intensity of the impact. Evaluation of the level of significance of the impact was based on the scales earlier described. With these scales decisions were made on Socio Economic, Physical, Ecologic, and Chemical impacts.

4.5 Socio –Economic Impact

4.5.1 Legal Ownership of project site

From the baseline study on the project site, it was found out that the predicted impact of potential ownership dispute was non-existent because an allotment letter herewith attached was availed and no boundary dispute was cited by the neighbors when offered an opportunity to do so.

4.5.2 Community and Stakeholders Perception of the Project

In order to obtain perception of the community and that of the stakeholders on the above, project interview schedules were used. The intention was to assess people's feelings on the

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establishment of the project (whether they support or oppose) and reasons why they took the stand they took. Analysis of the views received indicated that;-

- All (100%) stakeholders of the project site supported initiation of the project with majority citing employment and increased food production as the major reasons why this is supported.
- All (100%) of stakeholders of the project supported the start of the project and cited the same reasons given above as the major ones for supporting it. Others included enhancement of business and stimulation of new trade.

Plate 1: Community in Agreement to Support Project

4.5.3 Dust and Noise during the Construction Phase

Emission of excessive dust and noise may disturb the surrounding community during construction phase of the project. Considering the type of tools and the magnitude of the project, these were rated of ‘‘low significance’’ especially when adequate mitigating measures as earlier proposed are taken. The constructor will be advised to intermittently sprinkle water on site to reduce dust, and to reduce noise emitting machinery during the day. These impacts in our assessment are short term. The contractor shall be advised in this case to be sensitive to the surrounding community on when the specific activity is to take place in a bid to reduce conflict that would occur. The study showed that no complaints have been received so far even when construction have gone on.

4.5.4 Physical Impact

Evaluation of the extent of predicted physical damage to the environment was done with respect to the spatial extent of the project site. In our view the impact will be “short term’’ and of “low significance’’. This is because arrangements have been put in place by the proponent to;-

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- Landscape the excavated area within the project site.
- Build proper storm drainage channels and water storage.
- Properly fence around the reservoir to avoid accidents

4.5.5 Biological Impact

Site visit indicated that no plant species categorized as "endangered or threatened'' were identified on the project site. Considering the spatial extent of the site and its environs the site was not "biologically sensitive'' nor did it show any evidence of existing sensitive biological process such as breeding ground. In our view therefore using the scale earlier cited the biological impact predicted for the site would be of "low significance" both because of vegetation absence and low spatial extent. The dominant plant observed in the study site is Acacia as is shown in Plate 2.

Plate 2: Vegetation type around the Study Site - Mbembani

4.5.6 Chemical Impact

Considering the lifespan of the project and its spatial influence of chemical waste, this impact has been rated of "low significance'' and temporary.

4.5.7 Generated Solid Waste Impact

In our view the impact of the soil from the excavation activities will be of low significance because it will be recycled to plant grass around the dam.

4.5.8 Occupational Health Hazards and Work Place Accidents

These impacts are particularly expected during the construction phase of the project. Provisions of the needed facilities have been indicated by the proponent. Helmets, breathing masks and ear protective items should be used in order to reduce the intensity of the impacts. In view of the availability of these items, the impact in our view will be of "low significance'' and of "short term''. Full time workers however may experience long-term exposure to risk by virtue of the nature of work they do. Continuous surveillance of the health condition of such workers should

be undertaken in line with the project management plan herewith attached. This is where construction plans and provisions should strictly be followed to avoid any workplace accidents.

5.0 Conclusions

The project, which was conceived out of the need to enhance food security and community health in Yatta district, is perceived by the project team as being beneficial both to the community and other stakeholders. Business within and around the proposed project once operational will in no doubt alleviate poverty among the people of Yatta and its environs. Having widely consulted the proponent realizes that the project might trigger off minor effects on the environment. Consequently, appropriate mitigation measures for the potential minor environmental impact have been put in place.

Further to this, appropriate Environmental Management Plan (EMP) has been developed for all phases of the project cycle. This is expected to improve and maintain the quality of the environment around the project site. While deciding to undertake the project, the proponent is convinced that adherence to the relevant legislations is of paramount importance if the environmental quality is to be maintained or enhanced.

6.0 Recommendations

Based on the findings and conclusions 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 also 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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