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Strengthening sustainable approaches and technologies, including generation of biomass charcoal briquettes, rainwater harvesting and small scale vegetable gardens.

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Abstract: Across the societies, the impacts of climate change affect women and men differently. Women are often responsible for gathering and producing food, collecting water and sourcing fuel for heating and cooking. With climate change, these tasks are becoming more difficult. Extreme weather events such as droughts and floods have a greater impact on the poor and most vulnerable. As climate change turns what were already unfavorable conditions into unlivable ones, Kenya that is made up of 80% arid land, still relies heavily on rain fed agriculture. Severe water constraints and prolonged droughts have exacerbated drought occurrence due to high anomalies in precipitation resulting from climate change. Despite women being disproportionately affected by climate change, they play a crucial role in climate change adaptation and mitigation. Women have knowledge and understanding of what is needed to adapt to changing environmental conditions and to come up with practical solutions. But they are still largely untapped resource. Restricted land rights, lack of access to financial resources, training and technology and limited access to political making spheres often prevent them from playing a full role in tackling climate change and other environmental challenges. This project aims at strengthening climate action and gender equality through sustainable approaches and technologies, including generation of biomass charcoal briquettes, rainwater harvesting and small scale vegetable gardens. Rainwater harvesting primarily consists of the collection, storage and subsequent use of captured rainwater as either the principal or as a supplementary source of water. Examples exist of systems that provide water for domestic, commercial, institutional and industrial purposes as well as agriculture, livestock, groundwater recharge, flood control, process water and as an emergency supply for fire-fighting. Production of renewable biomass charcoal briquettes on small scale by households using cow manure, kitchen waste, leaves, maize stalks, rice and coffee husks using suitable digesters that are considered as an alternative renewable source of fuel. To build greenhouses on a glass modular unit containing growing medium in the form of an engineered soil layer that is closed off entirely to the natural elements. To enhance knowledge management and information sharing on drought

resilience and fully engage women who we intend to be fully responsible for the management of these projects.

Keywords: biomass charcoal briquettes, rainwater harvesting, small scale vegetable gardens.

1. Introduction

The impact of climate change is already causing widespread socioeconomic and environmental loss, and human suffering around the globe. Climate change erodes human freedoms and limits choice. However, the impacts of climate change are not felt equally, with women often bearing the brunt of climate impacts. Without measures to address the injustice of climate change, those with the fewest resources, countries and individuals alike, will be most susceptible to its negative effects. Achieving sustainable development and food and nutrition security in a changing climate requires addressing the fundamental issue of gender inequality whilst building the adaptive capacity of both men and women. While it is believed women produce 60–80% of the food in developing countries, worldwide they only own 10–20% of agricultural land. Rural women are particularly vulnerable to the impacts of climate change due to limited access and control over resources fundamental to adaptation and limited participation in decision-making processes. Similarly, they lack equal access to productive resources needed for agricultural livelihoods, and are often the last to eat when food is scarce. However, women should not be viewed only as victims; they have valuable skills and knowledge that contribute to successful adaptation and play a key role in ensuring the food and nutrition security of their households and communities. The project therefore will provide experiential learning and training on sustainable agriculture practices, market engagement, gender and equity, nutrition, and group empowerment. Through community adaptation action plans, it will allow women and communities to prioritize risk and make collective decisions on new or improved actions they can take to build household or community resilience to the impacts of climate change.

About 80% of the Kenyan population lives in rural parts of the country. This population is totally dependent on the use of biomass consisting of firewood and charcoal to meet its energy demands for cooking and other domestic demands. The use of firewood and charcoal as fuel has serious ill effects such as degradation of environment due to deforestation. The traditional cooking lacks any provision for smoke exhaust and this particularly exposes women and children to smoke containing harmful products. Prolonged exposure to smoke is responsible for coughing, wheezing and acute respiratory infection. This project will ensure what is referred to as solid waste is made useful. Women are charged with the responsibility to secure water, food and fuel for cooking and heating face the greatest challenges. Secondly, when coupled with unequal access to resources and to decision-making processes, limited mobility places women in rural areas in a position where they are disproportionately affected by climate change. It is thus important to identify gender-sensitive strategies to respond to the environmental and humanitarian crises caused by climate change.

Fresh water is expected to become increasingly scarce as temperature and sea levels rise due to Global Climate Change. As climate change turns what were already unfavorable conditions into unlivable ones, Kenya that is made up of 80% arid land, still relies heavily on rain fed agriculture. Severe water constraints and prolonged droughts have exacerbated drought occurrence due to high anomalies in precipitation resulting from climate change. Women comprise of the most vulnerable groups of societies in drought heat areas. Rainwater Harvesting is a widely used term covering all

those techniques whereby rain is intercepted and used 'close' to where it first reaches the earth. The term has been applied to arrangements to cause rainfall to percolate the ground rather than run off its surface, to forms of flood control, to the construction of small reservoirs to capture run-off water so that it can be used for cattle or micro-irrigation and to the collection of run-off from roofs and other impermeable surfaces. Thus, roof water harvesting is a subset of rainwater harvesting, albeit an important one. Rainwater harvesting primarily consists of the collection, storage and subsequent use of captured rainwater as either the principal or as a supplementary source of water. Examples exist of systems that provide water for domestic, commercial, institutional and industrial purposes as well as agriculture, livestock, groundwater recharge, flood control, process water and as an emergency supply for fire-fighting. The concept of rain water harvesting is both simple and ancient and systems can vary from small and basic, such as the attachment of a water butt to a rainwater downspout, to large and complex, such as those that collect water from many hectares and serve large numbers of people.

Detrimental effects of climate change can be felt in the short-term through natural hazards, such as landslides, floods and hurricanes; and in the long-term, through more gradual degradation of the environment. The adverse effects of these events are already felt in many areas, including in relation to, inter alia, agriculture and food security; biodiversity and ecosystems; water resources; human health; human settlements and migration patterns; and energy, transport and industry. In many of these contexts, women are more vulnerable to the effects of climate change than men—primarily as they constitute the majority of the world's poor and are more dependent for their livelihood on natural resources that are threatened by climate change. Furthermore, they face social, economic and political barriers that limit their coping capacity.

Climate change has significant impacts on fresh water sources, affecting the availability of water used for domestic and productive tasks. The consequences of the increased frequency in floods and droughts are far reaching, particularly for vulnerable groups, including women who are responsible for water management at the household level. All over the developing world, women and girls bear the burden of fetching water for their families and spend significant amounts of time daily hauling water from distant sources. The water from distant sources is rarely enough to meet the needs of the household and is often contaminated, such that women and girls also pay the heaviest price for poor sanitation. Given the changing climate, inadequate access to water and poor water quality does not only affect women, their responsibilities as primary givers, and the health of their families', it also impacts agricultural production and the care of livestock; and increases the overall amount of labor that is expended to collect, store, protect and distribute water.

In terms of health, some potential climate change scenarios include: increased morbidity and mortality due to heat waves, floods, storms, fires and droughts. What's more, the risk of contracting serious illnesses is aggravated by environmental hazards caused by climate change. In addition to the reference provided above of climate impacting women's health through water scarcity and water contamination, an abundance of evidence links the evolution and distribution of infectious diseases to climate and weather. This entails a greater incidence of infectious diseases such as cholera, malaria, and dengue fever, due to the extension of risk seasons and wider geographic distribution of disease vectors. Whilst climate defines the geographical distribution of infectious diseases, weather influences the timing and severity of epidemics. Diseases transmitted by mosquitoes, for example, are particularly sensitive to variations in climate. Warmth accelerates the biting rate of mosquitoes and speeds up the maturation process of the parasites they carry. Sub-Saharan Africa is already home to the most efficient mosquito species and to the most severe forms of malaria. Rising temperatures are likely to accelerate the lifecycle of the malaria parasite and to

spread malaria to new areas. Furthermore, floods—increasing consistently with climate change—may also increase the prevalence of water-related diseases, especially water and vector-borne diseases, which affect millions of poor people each year. In addition, an increase in prevalence of diseases will likely aggravate women's care-giving of family and community members who are ill. These diseases include malaria, schistosomiasis and diarrheoa. Women are usually at higher risk of being placed in unsafe, overcrowded shelters, due to lack of assets, such as savings, property or land. In the context of cyclones, floods, and other disasters that require mobility, cultural constraints on women's movements may hinder their timely escape, access to shelter or access to health care. Exacerbating this effect, women often avoid using shelters out of fear of domestic and sexual violence, and become even less mobile as primary family care-givers. Poor women and those in countries of higher gender inequality appear to be at the highest risk: a direct correlation has been observed between women's status in society and their likelihood of receiving adequate health care in times of disaster and environmental stress.

Gender equality and the empowerment of women is a global sustainable development goal, also subject to many influences depending on context and national circumstances. While there is no doubt that climate and gender equality are intersectional issues, both are stand-alone goals under the Sustainable Development Goals (SDGs) and jostle for position with other social and economic development priorities. Social attitudes and behavior change are a hugely important part of this, along with the global shift to a low-carbon society and economy. Steps towards gender equality can be realized through a Just Transition but retraining or giving access to resources is not the same as realizing value from resources. Addressing the difference between core societal values and pervading gender-based behavior, is as critical as integrating gender

Water supply is considered the most pressing issue in the 21st century across the globe. Evidently, water related stress and scarcity are now the greatest hazard to the environment, human health, universal food supply and economic and social advancements (IDRC, 2000). Of the entire social and natural crisis that individuals face, water catastrophe are crucial to the survival of the planet and human beings (UNESCO, 2003). Water is a renewable natural source whose use is a major element in the growth of livelihoods and as such, the equitable distribution of basic water needs is crucial (Hardin, 1965). The world is facing intensifying demands for moral quality water as present use from both ground and surface outdo supply. The nation's water towers do not attain a fair distribution in the nation with climate change taking a noteworthy toll on the water accessible. Rainwater harvesting can be a solution for times when the steady supply has been affected. Additionally, natural circumstances such as droughts increase the need to protect, conserve and supplement the water sources. Rainwater harvesting has conventionally been utilized in varying parts of the globe since the commencement of the history of human beings, without posing any challenges. Lately, people have begun to deliberate on this overlooked insight as the primary choice to solve the globe water problem. Rainwater collection is a profitable supplementary hotspot for household water prompting developing enthusiasm for the utilization of rainwater catchment framework. It is an invention used for the purpose of harvesting and keeping rainwater for use from housetops, pavement surfaces using forthright strategies and built procedures.

Problem statement

Rural development is entirely dependent on the use of biomass consisting of firewood, charcoal, and crop residues as a source of fuel. This is responsible for serious environmental degradation

due to deforestation. Therefore, there is urgent need to provide economical and sustainable alternate source of energy to minimize deforestation. Renewable biomass charcoal briquettes are considered as one such alternative renewable source of fuel. They can be produced on small scale by households using cow manure, kitchen waste, leaves, maize stalks, rice and coffee husks using suitable digesters. Severe water constraints and prolonged droughts have exacerbated drought occurrence due to high anomalies in precipitation resulting from climate change. Conflicts resulting from the displacement of communities seeking and pastures is also common. This paper proposes engineering and design as well as installation of hydroponic garden system, an artificial closed ecosystem that creates viable crop growing conditions requiring minimum amount of water. The communities collect the excess rainwater from house roof tops in a pond lined with the UV-resistant plastic liner. The overflow water is collected here and it can be used in the future mainly for the irrigation purposes and kitchen gardening.

General objective

To adopt a range of environmentally sustainable approaches and technologies that increase the resilience and adaptive capabilities to climate change of women and girls, including generation of renewable charcoal briquettes using low cost and innovative solutions, rainwater harvesting and building a sustainable food system in the growing food security through hydroponic farming techniques that creates viable crop growing conditions requiring minimum amount of water.

Justification

The greenhouse concept promotes year round growth rather than waiting for the right season to grow particular plants. Rain fed agriculture has for a long time been affected by season fluctuations and caused great losses to farmers.

Target Groups

1) Women who are the final end users of the briquettes
2) Communities who are trained on briquette and clean energy stove production
3) Women groups who turn production of briquettes into profitable business.

Group discussions are organized to create awareness about alternative cooking fuels, particularly biomass briquettes, learn of any previous experiences they have had with biomass briquettes, understand their opinions on the use of briquettes and specific cooking preferences.

Social benefits

According to world health organization, household air pollution is the most essential environmental health risk worldwide, women are at risk from exposure. Women and girls bear the largest health burden from domestic pollution sources, ranging from collection to usage posing health risks which lead to their high mortality rate globally as a result of indoor greenhouse gas emissions.

Environmental benefits

Briquettes are a renewable source of fuel and energy. The raw materials are abundant. Nature itself produces millions of tons of biodegradable waste which can be converted to briquettes. This can be agricultural or forestry waste. Wood and charcoal are the principal cooking and heating fuels gotten by felling trees which has negative impacts to the environment and climate leading to

deforestation, desert encroachment and soil erosion. Owing to the health and environmental concerns, methods of disposal and use of agricultural residues have shifted towards the global waste to resource. Therefore, using biomass briquette contributes immensely to sustainable forest management, neutralize carbon dioxide emissions and other gaseous emissions. Jobs are created in the production of the briquettes and the production of clean energy stoves. There is solid waste management as a result of using wastes as raw materials for the production of briquettes.

1. Literature review

Biomass densification/briquetting technologies

Biomass energy is undergoing a revival of interest and new technological advances are showing that it is capable of becoming more efficient and competitive. In this context, biomass appears to be an attractive energy resource because it is a domestic and environmentally sound renewable fuel. The use of biomass residues and wastes as an energy source can meet the requirement of fostering sustainable development, due to their numerous positive environmental and social impacts, including improvement of degraded lands, creation of employment opportunities and raised living standards for poor communities in developing countries. Generally, biomass can be defined as renewable organic materials that contain energy in a chemical form that can be converted to fuel. It includes the residues from agricultural operations, food processing, forest residues, municipal solid wastes and energy plantations. The use of biomass residues and wastes (for chemical and energy production) was first seriously investigated during the oil embargo of the 1970s. When oil prices dropped after the embargo, biomass residue lost its competitiveness with fossil fuel. In recent years the use of biomass as a source of energy became of great interest world-wide because of its environmental advantages. The use of biomass for energy production (biofuels) has been increasingly proposed as a substitute for fossil fuels. Biomass can also offer an immediate solution for the reduction of the CO_2 content in the atmosphere. It has three other main advantages: firstly its availability can be nearly unlimited; secondly it is locally produced; and thirdly the fact that it can be used essentially without damage to the environment. In addition to its positive global effect by comparison with other sources of energy, it presents no risk of major accidents, as nuclear and oil energy do.

The production of a compacted solid out of loose granular material on an industrial scale is a nineteenth century technique first used to make a solid fuel out of peat. It has since become a widespread technology in many fields, for example animal feedstuffs, fertilizers and iron-making. Fuel briquetting of peat and, particularly, brown coal is still practiced on a large scale. The application of briquetting to biomass residues from agriculture or forestry is of later origin, being used on a widespread scale in USA during the depression, 1930s, and in central. European countries suffering from fuel shortages during the Second World War. The briquetting of wood wastes using screw presses was pioneered in the late 1940s in Japan as a wood substitute. In the era of cheap oil in the 1950s and 1960s, biomass fuel briquetting was little used but it revived again after 1974 when there was a general search for alternative fuels for oil.

The history of biomass briquetting in Africa is largely one of single projects in various countries which have usually not been successful. Unlike India, Brazil and Thailand, no African country has developed anything resembling a briquetting industry with several plants based upon the same technology. The raw materials most commonly briquetted in Africa are coffee husks and

groundnut shells; sawdust and cotton stalks are also used to a limited extent. Small scale biomass briquetting projects are implemented by NGOs with the participation of local communities, mainly in Eastern Africa. The communities are trained to produce briquettes using manual presses with the primary objective of satisfying their fuel needs and possibly generating some income. However, the impact of such small projects is rather localized. Several biomass briquetting projects were implemented in Kenya. The main raw material was coffee husk and both direct briquetting and carbonization/briquetting were tried on a commercial basis. Due to the high cost of biomass briquettes compared with cheap firewood, none of the plants was able to continue production. In recent years Charcoal dust established a carbonization/briquetting plant based on bagasse. It seems Charcoal dust is successful in marketing its charcoal briquettes. However, the main market is within the services sector and not households.

Historically, biomass briquetting technology has been developed in two distinct directions. Europe and the United States have pursued and perfected the reciprocating ram/piston press while Japan has independently invented and developed the screw press technology. Although both technologies have their merits and demerits, it is universally accepted that the screw pressed briquettes are far superior to the ram pressed solid briquettes in terms of their storability and combustibility.

Binders can be added to this process to improve mechanical strength and also allow dry materials to be briquetted. Binders such as molasses and vegetable starch (from maize, cassava etc.) add to the calorific value of the briquette. Materials such as clay, ash and cement can be used as a binder but they inhibit combustion, producing more ash and smoke. Many different materials can be used for briquette making, for example agricultural residues like ground nut shells, straw, tree leaves, grass, rice and maize husks and banana leaves. It is also possible to use already processed materials such as paper, saw dust and charcoal fines.

3. Materials and procedures

Charcoal briquette production

Charcoal briquette is compressed charcoal dust and is used as a fuel in jikos, stoves and boilers. The ingredients of charcoal briquettes will usually fall under the following: heat fuel, burning speed, white Ash Color, Binder, press release (in case of machine pressing) and filler. The heat fuel in this study is charcoal dust and the binder and burning speed is waste paper or cow dung. As charcoal is drawn from sacks or stores, a lot of charcoal dust is formed, which is considered as a waste. Many charcoal stores have bags of charcoal dust and the store owners do not know what to do with the dust apart from throwing it away in dumping sites. Offices, schools, government offices and other institutions have a lot of waste paper that is just collected and dumped together with other wastes in dumping sites. The dumping of the charcoal dust and waste paper as waste together with other wastes requires big dump sites, which are not necessary if charcoal briquettes are made using the charcoal dust and waste paper. There is also the problem of putting all the waste in one dustbin because there is no demand for waste paper.

Burning of wood to make charcoal has several negative effects such as deforestation, burning of vegetation soil, which is used for farming and environmental pollution due to the gas emitted in the process. The gases emitted contribute to ozone depletion, which is leading to global warming. Charcoal production requires trees but charcoal dust can be produced from small sticks and leaves. Also, the quality of charcoal produced depends of the type of tree used. Some trees produce charcoal of big volume but less density thus burns very fast that the user has less value for the

money spent to purchase the charcoal. It is therefore difficult for the users of charcoal to differentiate between good charcoals with high density that will burn for a longer time. Charcoal briquettes made using waste paper have high uniform density and they take longer to burn with higher heat capacity. It is more economical to use charcoal briquette that using the normal charcoal.

Charcoal briquettes made from charcoal dust and waste paper or cow dung

Charcoal burning produces carbon monoxide, which leads to death in an enclosed room. Some people use charcoal to cook food overnight when they are sleeping so they endanger their life by using charcoal in an enclosed room. Charcoal briquettes just use little charcoal in form of dust thus less emission of carbon monoxide.

Pyrolysis chambers made of Bricks and clay walls with a metallic cover

Solar drier

This section will be used to dry the charcoal briquettes, vegetables or cereals using the sun.

Solar drier drying charcoal briquettes

The greenhouse

A hydroponic system is a system in which plants are grown in growth media rather than natural soil. All nutrients are dissolved in the irrigation water and are supplied at regular basis to plants. This is done in a greenhouse. A greenhouse creates an environment that is more favourable to plant growth than the natural environment. The power used is from renewable energy. The greenhouse is designed to absorb as much natural heat from the sun and the ground as possible. It is also designed to capture rainwater that falls on it using the fitted gutters. The rainwater recirculates and is used in the irrigation of the plants. This enables growth and distribution of sorted crops using half the energy required by traditional growers. Apart from the rain water, during the dry season, portable water is used. The water is taken down to the basement run through a filter and their nutrient content accessed. More nutrients are added to the mixture and recirculated back into the hydroponic system and then into the plants. The nutrient solutions supply the plants with all the necessary elements and ions needed for growth and development – calcium, nitrate, potassium, phosphate, magnesium, sulphur, iron, manganese, zinc, copper, boron and molybdenum.

Components of roof water harvesting

Plastic Pond

The proposed concept is to collect the excess rainwater in a pond lined with the UV-resistant plastic liner. For this, people dig a pond of different sizes and capacity. The overflow water is collected here and it can be used in the future mainly for the irrigation purposes and kitchen gardening. Catchment is the surface area that is used to collect the rainwater. The catchments in use are roof type and ground type. In roof type catchments, roof of a building is used to collect the rainwater whereas in ground type catchments, a paved or suitable platform is used to collect the rainwater. Roof type catchments is appropriate and popularly being used for rural rainwater harvesting systems in Kenya. Roofing materials used are Corrugated Galvanized Iron sheets but it may be cement concrete or roofing tiles or slate roofs for safe catchments.

The proposed plastic lined pond

The proposed catchment area and gutter system for collection of rain water from traditional house`s roof

Impact and expected outcomes

a. Waste management by converting it to renewable energy.

b. By utilizing cut leaves, grass and sticks to make charcoal dust, the trees are spared to mature for them to be utilized to produce timber for affordable housing and manufacturing.
c. Hydroponics if incorporated in the community farming have the potential to optimize food production on an exponential scale.
d. Enhancement of support community based agriculture initiatives, households and small community groups to become more food secure in an environmentally conscious manner.

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