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COST BENEFIT ANALYSIS OF THE COMMUNITY LIVELIHOODS IMPROVEMENT INITIATIVES IN TANZANIA.

Lessons for Enhancing Integration of Poverty – Environment Linkage Objectives into National and Sub-National Development Planning and Budgeting Frameworks

2017

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Acronyms

CA	Conservation Agriculture
CBA	Cost Benefit Analysis
CEA	Cost effeciency Analysis
CH_4	Methane
CO_2	Carbon Dioxide
DB	Discounted Benefits
DCs	District Commissioners
DEDs	District Executive Directors
DTC	Discounted Total Cost
ENR	Environment and Natural Resources
ESRF	Economic and Social Research Foundation
FGD	Focus Group Discussions
FFYDP	First Five Years Development Plan
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GoT	Government of Tanzania
HBS	Household Budget Surveys
JKT	Jeshi la Kujenga Taifa (National Service)
l	litres
IRA	Institute of Resource Assessment
INDCs	Intended Nationally Determined Contributions
IMF	International Monetary Fund
LED	Local Economic Development
LPG	Liquefied Petroleum Gas
m2	Square meters
m3	Cubic meters
MDA	Ministries, Departments and Agencies
MDGs	Millennium Development Goals
MKUKUTA	Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Tanzania
M&E	Monitoring and Evaluation
MoFEA	Ministry of Finance and Eonomic Affairs
MOU	Memorandum of Understanding
NAMAs	Nationally Appropriate Mitigation Actions
NDP	National Development Planning
NDR	Nominal Discount Rate
NEAP	National Environment Action Plan
NEP	National Environmental Policy
NGO	Non-government Organisation
NPV	Net Present Value

Spanis

NSGRP	National Strategy for Growth and Reduction of Poverty
p-e	poverty and environment
PEI	Poverty Environment Initiative
PPEG	Pro-poor Economic Growth
REDD	Reduced Emission from Deforestation and Degradation
RDR	Real Discount rate
SEZ	Special Economic Zones
TC	Total Cost
Tsh	Tanzania Shillings
UNDP	United Nations Development Programme
UN ENVIRONMENT	United Nations Environment Programme
VPO	Vice President's Office
WAVES	Wealth Accounting and Valuation of Ecosystems Services
WB	World Bank
WSP	Water Supply Project

Executive summary

The report presents findings of the economic analysis for the Pro-poor Economic Growth and Environmentally Sustainable Development Project, which is a joint venture between the Government of the United Republic of Tanzania and United Nations Development Programme (UNDP) and United Nations Environment Programme (UN Environment). Furthermore, business proposals for the up-scaling of the poverty-environment projects, institutional arrangement and capacity development strategy have been developed. The Pro-poor Economic Growth and Environmentally Sustainable Development project is undertaken with the overarching objective of mainstreaming environmental sustainability, poverty reduction and gender into development planning and budgeting processes. Ultimately, it is envisaged that robust and efficient mainstreaming would result in improved livelihoods of women and men through the more sustainable use of natural resources and improved climate resilience. The programme focuses on contributing to "Tanzania Development Vision 2025" which aims at eradicating extreme poverty by 2025. In the endeavour to demonstrate the strong linkage between sustainable management of environmental resources, poverty reduction and livelihood improvement, pilot projects that are pro-poor, gender-responsive, and environmentally sustainable were undertaken in six (6) districts of Bunda in Mara Region, Ileje in Mbeya Region, Ikungi in Singida Region, Sengerema in Mwanza Region, Nyasa in Ruvuma Region and Bukoba Rural in Kagera Region.

In order to effectively replicate and scale-up the best practices and lessons learnt from the pilot project interventions (aquaculture, apiculture and biogas production), there is a need to undertake a thorough economic analysis to assess the projects' viability. It is thus against this background that the Cost Benefit Analysis (CBA) of the interventions was undertaken. The generated evidence will be used to advocate enhanced allocation of resources to sustainable and gender-responsive poverty reduction interventions.

The results from the CBA display a strong positive Net Present Value (NPV) for all the piloted projects based on timeline of 15 years, nominal discount rate of 8.5% and 6% inflation rate. NPV for aquaculture was estimated at Tsh. 7 billion, apiculture Tsh. 1.3 billion and biogas at Tsh. 60 million. Biogas production had the lowest NPV due to the fact that it covered a small number of beneficiaries (10) relative to the other projects. Positive NPV implies that the pilot projects total benefits exceed total costs and therefore are able to self-finance their operations without external financial assistance. For instance, over 15 years, aquaculture total benefits exceed total costs by Tsh. 7 billion. The 15-year period was used to project the costs and benefits as these projects have long term objective of poverty reduction and environmental sustainable. Therefore, it was deemed that they should be categorised as long-term projects. It is important to note that the findings of the economic analysis of the study is in line with the Five Year Development Plan II (FYDP II) whose objectives are to accelerate broad-based and inclusive economic growth that reduces poverty substantially and allows shared benefits among the majority of the community.

The estimated NPV for all the projects covered quantified costs and benefits and thus excluded qualitative costs and benefits. An analysis of the socio-economic impact of the projects revealed that the projects have diverse and critical positive impacts to community livelihoods and the environment. Some of the impacts that were identified during interactions with the communities and beneficiaries are:

- Reduced illegal fishing activities in Lake Victoria, which involved highly ecological destructive methods. The environmental impacts associated with reduced illegal fishing included increased ecological productivity of the lake. This was evident from discussion with community members who revealed that fish population and the fish size caught have increased. This has resulted in reduced fishing time which can be viewed as both a positive social and economic benefit.

- Reduced deforestation was another positive environmental impact that was highlighted emanating from biogas production. Households with biogas plants indicated that demand for fuelwood has declined. The environmental benefits of reduced deforestation is reduced soil erosion, maintenance of soil fertility and increase in agricultural yield.

- Linked to the reduced deforestation is reduced GHGs emissions from deforestation and degradation (REDD) which can be included in the REDD+ programme and hence carbon trading and revenue generation.

- Improved social cohesion was another impact that was linked to all the projects. Members noted that the projects have reduced time associated with fishing

and fuelwood collection considerably. For fuelwood, women revealed that the biogas project has reduced number of trips from 4 to 2 per week while the trip duration has remained about 5 hours. For fishing, aquaculture has reduced the fishing time from 10 hours to 3. This has allowed household members (men and women) to spend more time with their families, which they noted has contributed to enhance family cohesion.

- With regard to biogas production, the project has resulted in improved well-being and hygiene particularly for women, as they have more time for other household activities, including personal hygiene. The other benefit of use of biogas is reduced incidence of respiratory diseases that are linked with emissions from cooking using fuelwood.

- Another important benefit from biogas production was increased time for school children to focus on school work and hence the potential for improved school performance. This impact is fundamentally important for closing the gender gap between boys and girls in education in future.

- Women's enhanced inclusion in economic activities was another important benefit that was highlighted by the beneficiaries. Consistently, members noted that the projects have brought opportunities for women to get involved in economic activities, which they previously could not participate in. These economic activities included fish farming and beekeeping. It was thus argued that the projects are highly critical for female-headed households as they are now able to provide for their households.

Based on the diverse socio-economic and environmental impacts of the projects and the positive Net Present Values, which implies that the projects have potential to generate significant income, the following recommendations were made:

- *Based on the economic analysis which displayed a strong positive NPV, it is strongly recommended that the poverty-environment (p-e) project should be scaled-up.*

- *Development of operational guidelines for poverty environment projects*: The operational guidelines should be used to minimise the unintended social and environmental costs. Consequently, the guidelines should have safeguards to minimise issues of conflicts, and attaining limits of acceptable changes, amongst others. At the same time, the operational guidelines should be used to optimise the benefits from the projects.

- *Mainstreaming poverty-environment projects into district and national planning systems*: Currently, the poverty-environment and gender nexus is not fully integrated and supported in the district planning system as per discussion with district officials. Lack of mainstreaming and integration results in inadequate support for the operations of the p-e projects. Thus, it is pertinent that these projects are mainstreamed in decision making to ensure adequate provision of financial and human resources for planning, infrastructure and marketing the associated products of the projects.

- *Establishing policy framework and instruments*: in order to create a conducive environment for optimal operations of the p-e projects, it is highly recommended that policy and instruments that would support the p-e projects are established and strengthened. Some of the relevant policies are environmental protection policy and that of value chain mechanism.

- *Creating synergies with other economic activities*: currently, most of the initiatives have by-products that could support other initiatives such as production of Azolla and bio-slurry from aquaculture and biogas production respectively. It is therefore important that a platform is created to ensure strong synergies between these initiatives and other economic activities such as conservation agriculture, production of bio-slurry and apiculture for cross-pollination.

- *Promoting Climate Change Adaptation*: in order for biogas production to be a success, it is important that at the national level it is included under the National Adaptation and Mitigation Actions (NAMAs), the Intended Nationally Determined Contributions (INDCs) and the National Adaptation Plans (NAP). This will create a platform for domestic and international funding through climate change funds and REDD+ schemes.

- *Institutional Arrangements*: Institutional arrangements need to be made more efficient so as to strengthen integration of the interventions in the district development plans as well as increasing the uptake by local communities. Therefore, p-e mainstreaming need to be integrated into the existing district development institutional structures

- *Monitoring and Evaluation (M&E)*: this is an important instrument for project evaluation and improved

performance. Therefore, through improved institutional arrangement, it is important that timely M&E is undertaken to optimise the operations of the implemented projects. Through M&E system factors that inhibit optimal operations of the projects will be identified and eliminated.

- *Capacity building:* it is also important that there is continuous on-site hands-on mentoring and coaching of the beneficiaries to ensure improved operations of the projects. At the same, there is also a need for government officials (from both the local and national levels) to be capacitated on evaluation of the p-e projects including monitoring.

- *Set-up a loan facility for household implementation:* in order to enhance uptake of the p-e project, it is critical that a loan facility is established in the rural areas to finance households willing to invest in the projects. It is recommended that the loans given should be interest free.

- *Mobilisation of government and donor funds should strongly be encouraged to support the scaling up of the p-e project:* One way through which government and donor funding can be mobilised is through the results from CBA.

1.

Economic analysis of the poverty-environment pilot projects

1.1. Introduction

The Pro-Poor Economic Growth and Environmentally Sustainable Development project is a joint initiative of the Government of Tanzania (hereinafter GoT) and United Nations Development Programme (hereinafter UNDP)/United Nations Environment Programme (hereinafter UN ENVIRONMENT). It aims at contributing to mainstreaming poverty reduction and environmental sustainability into development planning, monitoring and budgeting frameworks. The programme focuses on contributing to "Tanzania Development Vision 2025" which aims at attaining a middle-income country status characterised with competitiveness and quality livelihood by 2025. The p-e projects are in line with the FYDP II whose objectives are to accelerate broad-based and inclusive economic growth that reduces poverty substantially and allows shared benefits among the majority of the community. This is to be achieved through increased productive capacities and job creation especially for the youth and disadvantaged groups.

The Pro-Poor Growth and Environmentally Sustainable Development project aims at influencing policy and planning processes at both Macro and Micro-levels through technical assistance, support to development of relevant tools and mechanisms and generation of evidence. This is to support the effective inclusion of poverty-environmental-gender objectives into development planning, which will ensure that economic and social benefits generated by Environment and Natural Resources (ENR) are maintained. Emphasis is put on sustainable environmental utilisation as unsustainable use of ENR reduces flow of ecosystems services, which support rural livelihood. Some of the previous initiatives of p-e Initiatives include support to mainstreaming of poverty-environment and gender indicators into the MKUKUTA I (2005-2010) and MKUKUTA II M&E plan 11/2010-15/2015 as well as the First Five Years Development Plan (hereinafter FFYDP I). While notable progress has been achieved in integrating poverty-environment and gender objectives into national planning and monitoring frameworks, challenges persist. This is in terms of ensuring that national, sector and sub-national policies are designed and implemented to reach and sustainably transform the lives of the poorest women and men at the community levels through the more sustainable use of natural resources and improved climate resilience. This, thus, calls for translation of national policy objective framework into practical tangible actions on the ground. The project has recently supported government in the development of the new FYDP II 2016/17-2020/21 that includes the approach of Local Economic Development (LED) that enables the implementation of the policy, plan and budget at sub-national and local levels. LED is a process through which the public, business and NGOs partners work collectively to attain economic growth and employment creation. Its main focus is to enhance competitiveness and increasing sustainable growth that is inclusive. Consequently, this is in line with the p-e initiatives, which aim at enhancing economic growth that is inclusive and environmentally sustainable.

The p-e programme has been piloting p-e projects in the selected communities of Tanzania to demonstrate their potential contribution to poverty reduction and environmental sustainability. The pilot p-e projects have been implemented in six (6) districts namely Bunda in Mara Region, IIeje in Mbeya Region, Ikungi in Singida Region, Sengerema in Mwanza Region, Nyasa in Ruvuma Region and Bukoba Rural in Kagera Region. The major goal of the pilot scheme was to generate evidence on the potential benefits of the initiatives, which will be used to advocate for a full scale up. It is thus against this background that Cost Benefit Analysis of the interventions is undertaken.

1.2 Objectives of the study

The main objective of the study is to determine the economic viability of the Nature-based Community Livelihood interventions (hereinafter NBCL) and make recommendations for the full scale-up strategy. Other objectives include development of the business proposal for p-e project scale up, development of the capacity development strategy for government official to undertaken CBA. The economic viability of the interventions was assessed from the economic, social and environmental impacts perspective.

1.3 Methodological approaches

A multi methodological approach was adopted to adequately cover the objectives of the study. CBA was the main method that was used to achieve the main objective of the study. CBA is an appraisal technique that is used to assess the viability of a proposed or implemented project from an economic perspective. The following steps were employed in determining the economic viability of the interventions:

1. Description of the interventions: this stage will involve a detailed description of the interventions, in terms of scale of operations, number of women and men affected by the intervention, the level of impact amongst different households based on male/female headed, ecosystems in the vicinity of the interventions and how they have been impacted.

2. Identification of the interventions impacts: this is the second step of CBA and it involves identification of the economic, social and environmental impacts both positive and negative. Achieving this task involves the following methods:
   - *Consultation with the stakeholders:* all stakeholders, mainly project proponents, communities, men and women beneficiaries, district extension officers, district councillors, district executive directors, implementing NGOs and others were interviewed. Therefore, questionnaires were developed and thorough consultation undertaken to identify the economic, social and environmental impacts (positive and negative) of the interventions on women and men respectively. All beneficiaries of the p-e projects were interviewed. The questionnaires were structured to capture all costs and benefits of the interventions, including issues of time poverty and the cost of unpaid care work. Additionally, consultation was undertaken with government officials to identify impact at the national level. It is also important to note that through the consultation distribution of benefits were identified and later assessed.

   - *System thinking:* this is a holistic method that is used to understand system behaviour and connection between systems (environment systems and socio-economic systems). Therefore, based on feedback from consultations, causal loops were developed to identify subtle impacts, which could have escaped identification from consultations. Based on system thinking approach, the interventions were linked with the social-economic activities and other aspects such as health, to gain an in-depth understanding of the current and potential impacts of the interventions.

   - *Documentation review:* in addition to consultation and application of system thinking, intensive documentation review of relevant documents such as PIF, reports (monthly, quarterly) and evaluation reports was undertaken to identify the project impacts.

3. Quantification of the identified project costs and benefits. This is the most technical aspect of CBA and it involves attaching numeric values to the identified costs and benefits over the project lifespan. In order to quantify the costs and benefit of the interventions, various techniques were employed such as:
   - Consultation with the stakeholders mainly women and men community members and relevant government officials.

4. Valuation of the quantified costs and benefits: this is the four step of CBA and it involves attaching monetary or dollar value to quantify costs and benefits. For the marketed costs and benefits, market prices and shadow prices will be used. For non-marketed costs and benefits particularly those that are related to environmental costs and benefits, various valuation techniques were employed as follows:
   a. Market price of substitutes
   b. Travel cost method

5. Discounting the future costs and benefits: costs and benefits of an intervention occur at different time frames. It is therefore important that they are discounted to allow for comparison. Based on the national discount rate of 8.25% as used by the Bank of Tanzania (BoT), the present value of future costs and benefits will be derived.

6. Estimating Net Present Value: NPV is summed discounted benefits less summed discounted costs. Social NPV was estimated to determine the economic viability of the intervention. Based on the derived NPV, the interventions were categorised as either economically viable or non-viable using the following criteria:
   - NPV > 0 the interventions are economically viable
   - NPV< 0 the interventions are economically non-viable

7. Sensitivity analysis: this is the last step in CBA and it involves changing the values of the variables to determine the sensitivity of calculated NPV to changes in values of the parameters.

In order to collate the information from key informants mainly NGOs, Economic and Social Research Foundation (hereinafter ESRF), beneficiaries (community groups and individual households), and Government officials, for input in CBA and development of the institutional arrangement for p-e project scale up, questionnaires were developed. Prior to application of the questionnaires, an in-depth consultation was undertaken with the Ministry of Finance and Planning (MoFP) and the Poverty Environment Initiative (PEI) project team on the developed questions for finalisation. The questionnaires were developed to capture both quantitative and qualitative data associated with the livelihood improvement interventions.

Based on the questionnaires, individual, group interviews and focus groups discussions (FGDs) with all stakeholders and key informants were conducted to collate data for economic analysis of the p-e projects. Additionally, interviews were conducted with the project non-beneficiaries to gauge the household demands for the interventions.

Analysis of the captured data involved use of Excel software to quantify the benefits and costs of the pilot projects. Quantification was based on scale of production (honey production, cow dung and methane amount, carrying capacity of cages) and valuation was based on market prices. In addition, qualitative data was coded and analysed to identify the qualitative impacts (positive and negative) of the Interventions. Livelihood and gender aspects were also critically considered and analysed.

1.4 Economic analysis of the p-e projects

Economic analysis was undertaken on apiculture, aquaculture and biogas production, as these are the currently piloted projects. This section describes the piloted projects in terms of size/scale of operations, location and products of the projects. This is followed by the description of the costs and benefits; quantification of the identified costs and benefits; valuation and discounting and lastly estimating the NPV and sensitivity analysis. Essentially, this section follows typical CBA steps in appraising a project.

The economic analysis was based on Net Present Value. Mathematically, Net Present Value is summed discounted benefit less summed discounted costs. It is a measure that is used to determine viability of the project. A positive NPV implies that the discounted benefits exceed the discounted costs. A project with positive NPV is deemed as economically viable. NPV for the interventions was estimated based on 15 years period. 15 years period was selected, as the objective of the programme is long term based on their linkages with poverty reduction. Real discount rates of 2.3% based on equation below, 5% and 10% Nominal discount rate and inflation of 8.5% and 6% were adapted as the official rate used by the Central Bank. Estimating the future costs and benefits was based on the concept of real cash flows discounted at real discount rates of 2.3%. Real discount rate was computed using equation below.

$$RDR = (1 + NDR) \div (1 + IR) - 1$$

Where:
RDR is the real discount rate
NDR is the nominal discount rate
IR is the inflation rate
Discounted costs and benefits were estimated based on equation below.

$$DTC = \sum_{t} \frac{C_t}{(1+r)^t}$$

Where:
DTC is discounted total cost
C_t is the cost occurring in year t
t is the time
r is the real discount rate
The formula for estimating the NPV for the intervention is as follows:

$$NPV = \sum \frac{b_t - c_t}{(1+r)^t}$$

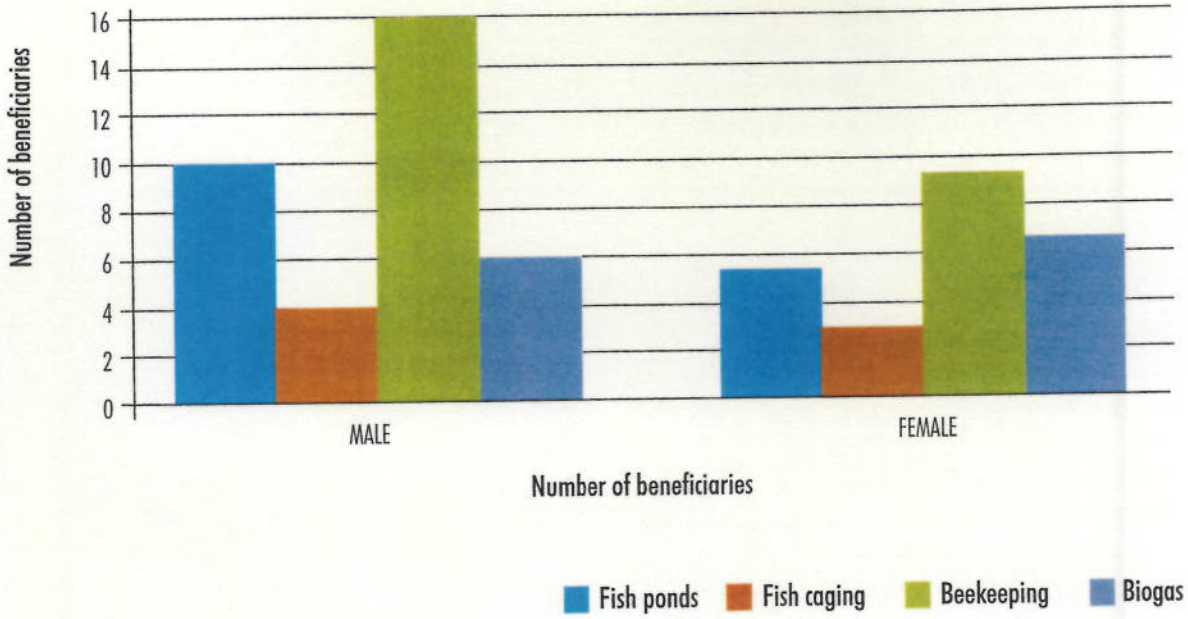
NPV is the Net Present Value
b_t is the benefit occurring in time t
t is the time
c_t is the cost occurring in time t
r is the real discount rate

1.5 Poverty-environment Projects

The p-e projects piloted include apiculture, aquaculture and biogas production. Figure 1 depicts number of beneficiaries by gender. It is on the basis of the beneficiaries that NPV is estimated.

Figure 1:

Number of respondents by gender involved in PEI livelihood interventions



1.5.1. Aquaculture

Aquaculture commonly known as fish farming is one of the projects that have been piloted. The two types of fish farming methods that are supported by p-e initiative are fish caging and fishponds farming. Fish cage farming is undertaken exclusively in Lake Victoria. Currently, it is implemented by Jeshi la Kujenga Taifa (the National Service, hereinafter JKT) in association with fish farming groups around Bunda District, Mara Region and Bukoba Rural District in Kagera Region.

Currently, there are 53 cages with varying size from 50 m^3 to 20 m^3. The fish species currently reared within the cages is predominantly Nile *Tilapia (Oreochromis niloticus)*. The fishponds are constructed and operated outside the lake and are predominantly within the Bunda District. Majority of the ponds are operated by the JKT. During the field visits, a total of 10 fishponds were identified with a total size of 6,000 m^2. Nine of the ponds reared catfish and one reared Nile Tilapia (*Oreochromis niloticus*). The rearing periods, which define the weigh at which the fish is ready for market to maximise profits for Tilapia and catfish, are approximately 8 and 12 months respectively. The estimate weight at maturity for Tilapia and Catfish is approximately 750 grams and 2.5 kilograms. The carrying capacity of Tilapia and Catfish was estimated at 6.5 and 5 fingerling per m^3.

1.5.2. Apiculture

Apiculture commonly known as Bee keeping, is another PEI supported project predominantly in the Central (Ikungi District) and Southern highlands (Nyasa and Ileje Districts) zones of Tanzania. According to existing data from UNDP, 500 beehives of 20 litres capacity have been distributed to the households in the pilot areas. The by-products from apiculture are honey and wax. The country is generally characterised by two (2) harvesting seasons, that is, February and July. Apiculture projects benefited a total of 22 groups. The total number of females and males beneficiaries is 145 and 165 respectively.

1.5.3. Biogas production

Biogas production is the third intervention that has been piloted primarily in Sengerema District in Mwanza Region. Anaerobic digestion of livestock dung and human waste produces Methane (CH_4), Carbon dioxide (CO_2) and water vapour and a nutrient-rich substrate generally referred to as bio-slurry (Gerlach, *et al.*, 2013). Methane is a natural gas that is highly combustible and used as cooking gas (Gerlach *et al.*, 2013). The primary objective of this intervention was to ensure rural communities' easy access to renewable energy sources and reduce dependence on fuelwood. Observation is that

only 2% of the rural Tanzania population have access to electricity and biomass accounts for 80% of energy sources (Msyani, 2013; Uisso, undated). Consequently, the initiative targets at reducing deforestation in the Sengerema area by providing an alternative renewable energy source.

The project involved construction of a biogas plant, installation of biogas pipes to transmit produced methane, supply of biogas single-plated stoves and lighting system. The beneficiaries contributed 15% of the total investment costs. The operation of the plant involves feeding the cow dung into the fermentation chamber and mixing it with water to enhance fermentation and an outlet for bio-slurry. Methane produced is collected from a collection chamber through pipes, which feed the biogas stove. The number of households that have benefitted from this initiative is ten (10) among which seven biogas plants were still operating while three were non-operational. The primary reason for non-operational of the biogas plant given by the beneficiaries is lack of cow dung, a key ingredient in methane production.

1.6. Costs and benefits of the piloted p-e projects

This section of the report identifies and describes the impact of the interventions. Since the interventions are in the second year of implementation and have not fully realised the impacts, this exercise relied on assumptions and similar studies to identify the impacts. Therefore, some of the impacts identified are anticipated rather than actual. The impacts are divided into positive (benefits) and negative (costs). These impacts are identified and described under each intervention.

1.6.1. Aquaculture

The primary objective of fish farming is to rear or breed fish at a large scale for commercial purposes. Therefore, the benefit associated with the intervention is income generation for the project proponent/owners. The other positive impact that was identified during consultation with the stakeholders is readily availability of fish in areas, which originally had fish scarcity. Therefore, fish farming has positively impacted the community through reducing the distance travelled to the market and hence a benefit of avoided cost of travel to the market. Therefore, reduced distance travelled approximately 20 km has allowed for reallocation of labour to other household income generating activities, which are mainly farming and livestock rearing. According to fish farming project beneficiaries in the settlements, apart from the monetary and time, the initiative improved diet for the household particularly increased access to protein.

Environmentally, fish farming has benefits as was testified by the consulted beneficiaries. Members testified that since the operation of the fish cages in Lake Victoria was established, illegal fishing has been significantly curtailed. This is mainly due to the presence of guards who monitor the cages. Incidentally, illegal fishing methods such as poisoning and use of explosive have been controlled. The environmental benefit associated with controlled illegal fishing is increase in lake fish productivity and population for various fish species.

Another possible impact, which was not reported by the beneficiaries but highly likely, is improved water quality of the lake due to reduced use of poisonous chemicals. Consequently, reduced illegal fishing and accompanying methods would result in restoration of the lake biodiversity, which would restore the lake's ecosystem in the long run. Increased diversity of the lake use is evident from the increase in fish catch with less effort and the size of the fish.

The socio-economic benefits of increased fish productivity and population in the lake as a result of cage fishing as noted by the beneficiaries include reduced time for fishing. Fish farmers revealed that they now spend less time fishing than before the establishment of fish caging in the lake. Prior to the establishment of fish cages, the average fishing period was 10 hours per day and the catch would be 5-7 pieces weighing approximately 400 grams each. However, since the inception of fish caging the fishing hours have been reduced from 10 to 3 hours a day. Additionally, the catchability index per fish farmers has also improved from an average of 6 to 30 pieces with an average size of 750g. Therefore, household income has improved due to the increase in catch, size of the fish, which collectively affect fish farmers' revenue.

Throughout all the settlements, the beneficiaries indicated that the positive social impact of the aquaculture is increased social cohesion within the households. Household members noted that now they are able to spend more quality time with their families. Other beneficiaries (both male and female) in Kemondo and Bunda noted that prior to fish farming, women would not engage in fishing activities, as it was perceived as strictly a male domain. However, this has changed and women are also actively participating in running both fishponds and caging in the areas. It was indicated that women are now actively involved in all stages on farm farming, from feeding the fingerlings, monitoring and probably they would also be involved in processing and selling. This can be viewed as an important benefit particularly for female-headed households who had to rely on purchasing fish to feed their dependents. Thus, through active participation, female-headed households would benefit from income generation from sale of fish and also have easy access to fish for home consumption. Another noted benefit is increased security in the community due to the presence of the army (JKT). Their presence and patrol has resulted in improved security in the lake area mainly around the Bunda and Sengerema districts. Incidents of harassment and robbery of the fish catch were reported by the fishermen prior to the establishment of the fish cage initiative. But these incidents were observed to have stopped as reported by both JKT and community members.

Similarly, aquaculture has various negative impacts. These impacts can be categorised into economic, social and environmental. The economic costs of aquaculture are generally the fixed and operational/variables costs. These include the cost of construction of the cages, ponds, floating houses and motorised boats. The variable costs include maintenance of motorised boats, petrol, labour, fingerlings, feeding and transportation of the harvest to the market. These variable and fixed costs are an integral part of the project.

The social cost of the intervention includes the risk of drowning and death. This impact is anticipated to be significant in the fish cage relative to the ponds, as project proponents have to travel considerable distances from the shores to the cages. In some instances, the climatic conditions mainly wind compound to these potential costs. So far, however, no incident of drowning has been reported.

Increase in conflicts amongst community members is one of the potential impacts of this intervention. The lake is an open access resource, which is used by various community members. Therefore, placement of the fish cage in certain parts of the lake creates a sense of exclusive property rights to section of the lake. Similar incidents have been reported in Uganda where fish cage farming has created some conflicts amongst fishermen and community members who view the lake as a community resource and should not have exclusive use (Kifuko, 2015; Tudela, 2002; Cameron, 2002). Additional potential future conflicts may result from restricted movements that would inhibit fishing in certain sections of the lake as caused by placements of the fish cages.

Environmentally, the intervention has some associated costs. The immediate environmental cost that is likely to arise from the project is loss of lake aesthetics and appeal. Constructing and placing of multiple cages in the lake could become an eye soar and thus degrade the environmental aesthetic value of the lake (Cameron 2002; Staniford, 2002). The immediate impact of loss of aesthetic value of the lake would be decline in tourism potential and loss in tourism revenue.

For instance, Tudela quoted in Staniford (2002) noted that "Intensive industrial scale aquaculture has become synonymous with pollution and destruction of the marine environment, conflicts with other resource users, and high levels of toxins in the fish produced. The spread of aquaculture, a cause of increasing concern and growing alarm, has been described as a cancer at the heart of the coastal environment".

Another potential environmental cost of this intervention is loss of lake species mainly birds, otters and reptiles due to tangling in the cage nets while trying to get into the cage. Thus, the fish cage has the potential to trap and suffocate lake wildlife resulting in species mortality.

Table 1 below summarises impacts of the aquaculture intervention.

Table 1:

Impacts of Aquaculture

	Economic	Social	Environmental
Benefits	Revenue generation	Reduced time of fishing	Improved lake productivity
	Increased household income	Increased family cohesion	Increased fish species
	Increased agricultural productivity	Improved security	Improved water quality
	Avoided cost of fish purchase	Improved household nutrition	Increased lake diversity
	Economic	**Social**	**Environmental**
Costs	Investment and operation cost	Risk of drowning and death	Decrease in wildlife species from cage mortality
	Decline in tourism activities on the lake due to decline in lake aesthetics	Increase in conflicts from exclusive use of lake	Decline in aesthetic value of the lake due to cages as an eye sore
	Decline in tourism revenue	Loss of business to fish farmers driven out of business due to lack of access in the lake	

1.6.2 Apiculture

The foremost positive impact of apiculture is income/ revenue generation from sale of honey and wax. Wax has various purposes such as:

- Manufacture of cosmetics;
- Wax tablets for writing purposes;
- Bow making;
- Strengthening and preservation of sewing thread, cordage, shoe laces;
- Manufacturing of sealing wax; and,
- As a sealant and lubricant for bullets in cap and ball firearms, to stabilize military explosives.

Other by-products of wax include royal jelly, pollen, *propolis*, bee colonies, and bee venom. Therefore, the global demand for wax is significantly high.

At the household level, the households would benefit through consumption of a portion of honey produced and hence an economic benefits of avoided costs of honey purchase.

The other benefit of bee keeping is increase in agricultural productivity due to cross-pollination. Studies have indicated that bees contribute significantly to agricultural production due to pollination of crops (Mazorodze, 2015; Bardbear, 2009; Lalika, 2009). Some of the crops that are known to be highly dependent on bee for pollination include pumpkins, oranges, grapefruit, onions, cucumbers, avocados, cherries and Apples (Bradbear, 2009). Maize has also been observed to respond significantly to bees' presence. For instance, in Kenya a farmer indicated that prior to apiculture yield per acre was approximately 10 bags but has increased to 30 bags per (Smart Farmer Magazine, 2016).

The additional benefit of apiculture is employment for the local communities with emphasis on women employment opportunities. Employment of the local community will result in improved socio-economic status of the employed and hence contribution to poverty alleviation. At the large scale the benefits are generally employment through multiplier effects and value addition chain. This can result in establishment of complementary industries, production of wax, medicine and polish industries.

Consultation with the beneficiaries showed that this intervention has attracted about 145 women, which was contrary to previous beliefs that beekeeping was totally a male domain. The most plausible reason for the more women being involved in apiculture is that it is less labour intensive. Thus, the project has significant positive impacts on the social gender dimensions. For instance, female-headed households would be able to improve

their economic status and also reduce their poverty levels.

In addition, bee keeping and its associated benefits is likely going to change household perception on the environment resulting in conservation of flowering plants (Lalika, 2009). Studies have shown that one of the benefits of apiculture is mind-set change towards environmental conservation (Lalika, 2009). For instance in Zimbabwe, it has been recognised that protecting and conserving forests can be achieved through beekeeping, Environment Africa initiated and implemented a number of beekeeping projects across districts throughout the country (Environment Africa, 2011).

Similarly to any other economic activity, apiculture has economic, social and environmental costs. The economic costs of apiculture include: fixed costs and these are beehives costs. The operational costs are those that are associated with harvesting, processing, and maintenance of beehives and marketing of the produce. These economic costs are an integral part of the operations of the project. It is important that they are listed and described as it is the standard practise in CBA.

The social costs of the apiculture are bee attacks resulting in human and livestock mortality. The honeybees are known to be highly aggressive and will attack any living creature that comes near the hives. Table 2 depicts a summary of the costs and benefits of apiculture.

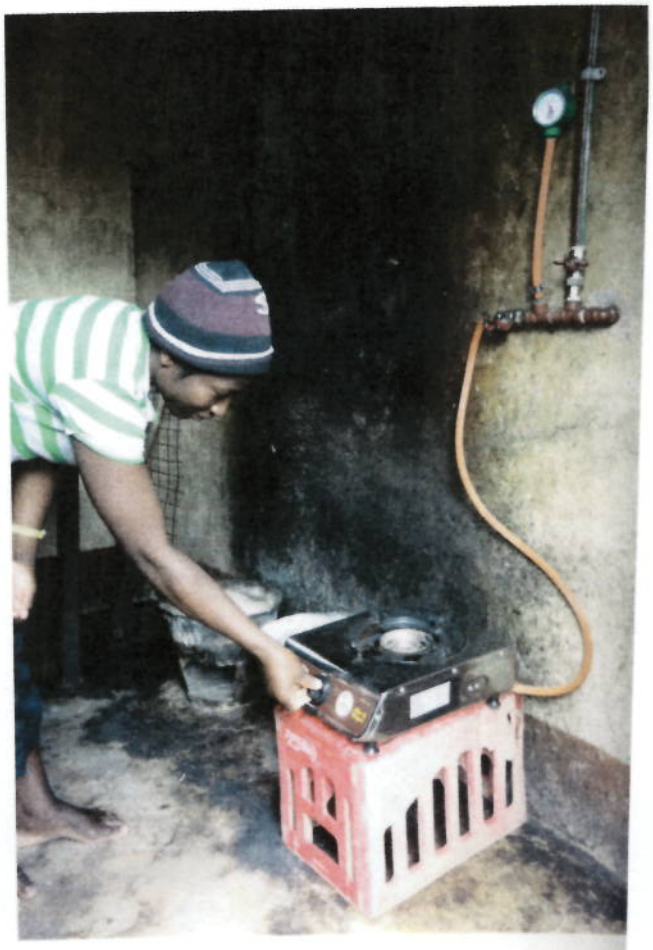
Table 2:

Economic, social and environmental impacts of Apiculture intervention

	Economic	Social	Environmental
Benefits	Revenue generation	Poverty reduction and esteem	Reduced deforestation and increased afforestation
	Increased household income	Increased food Security	Increased biodiversity resulting from afforestation and conservation efforts
	Increase agricultural productivity from pollination	Increased social cohesion	
	Employment	Increased income for female headed households	
Costs	Investment and operation cost	Injury and possible human mortality from bee attacks	

1.6.3 Biogas

The primary impact of biogas production is generation of natural gas for cooking which has an economic value comparative to the Liquefied Petroleum Gas (LPG). Alternatively, the benefits of biogas production can be valued as the avoided cost of collecting fuelwood by the household. However, this valuation method will likely results in low value attached to biogas due to low rural wages, which is an index for the value of time. In rural Tanzania, women and children are traditionally tasked with collecting fuelwood. Due to the fuelwood scarcity, women and children can spend between 4 to 5 hours per day collecting fuelwood making approximately 4 trips a week. Therefore, based on the time allocated to collecting fuelwood, the avoided cost of fuelwood collection, which is translated as a benefits has a significant economic value to the household mainly through reallocation of time to income generating activities, such as agriculture, (livestock rearing and crop production) and studying.



Another economic impact of the project is the production of highly nutrient-rich substrate (bio-slurry), which can be used as organic fertilisers (Groot and Bogdanski, 2013). Three (3) of the consulted, one female and two male beneficiaries; from Nyampande Village, during household interviews on 18th October 2016,

indicated that during the planting season, they use bio-slurry organic fertilisers. The impact of the biogas plant is thus production of organic fertilisers and avoided cost of purchasing inorganic fertilisers. One female beneficiary from Nyampande Village further narrated: "*I use the waste products from the biogas to grow crops around the homestead, which has led to increased agricultural productivity and enhanced income generation*".

Socially, the project has the potential to increase family social cohesion and happiness. Beneficiaries noted that biogas project has reduced the time spent collecting fuelwood and can afford to spend quality time with their families and hence improve family bonding. One female respondent, for instance, explained that "boys *are participating in cooking, unlike in the past, which has given me ample time to participate in women group initiatives*". However, respondents did not elaborate why and how boys' participation in cooking has increased.

Additionally, through consultation with the stakeholders, family members indicated that prior to biogas initiatives, women who are generally tasked with fuel wood collection did not have enough time for hygienic and beautification activities. Now they have more time to care for their bodies, and the impact of the biogas project has been improved hygiene, particularly for women, which has contributed to increase their sense of wellbeing. This has not gone unnoticed by some of the men, who indicated that women are now more beautiful.

For the school children, the social impact of the project is that more time is allocated to schoolwork and increased ability to concentrate in class, as they are not tired from fuelwood collection. One female beneficiary, for instance reported that "*it was the job of women to fetch firewood, and children used to follow to collect firewood but nowadays, there is no need, and children have more time for their studies.*" Furthermore, the biogas project presents a potential to create a conducive environment for learning at home due to improved lighting system as opposed to dim kerosene lamps. Ultimately, biogas production would contribute to improved girl-child performance at school as per the discussion with the beneficiaries.

Another social impact of the project is improved health of female members who are generally tasked with kitchen-related chores. Using fuelwood produces smoke and other toxic gases such as carbon monoxide, particularly in poorly ventilated houses. This affects the health of women, particularly discomfort on the eyes and increase incidents of respiratory diseases.

Based on literature review, evidence for a causal role of domestic cooking smoke in chronic lung diseases is also strong. Multiple cross-sectional studies in developing countries have shown high rates of chronic respiratory diseases including chronic obstructive pulmonary disease among populations, who were exposed to indoor cooking smoke (Mishra et al., 1990; Ray et al., 1995). Likewise findings indicate that households that rely on fuelwood for cooking are exposed to the following effects (Smith, 2006; Smith et al., 2004):

- Acute infections of the lower respiratory tract (pneumonia) in young children;
- Chronic obstructive pulmonary disease, such as chronic bronchitis and emphysema, in adult women; and,
- Social discrimination from being associated with witchcraft practises due to misinterpretation of the look of the victims.

According to WHO (2012), nearly 2 million deaths annually are due to household air pollution from rudimentary biomass and coal stoves in close to 3 billion homes worldwide. Therefore, biogas, a clean energy source could reduce mortality from household pollution in rural Tanzania. The benefits associated with improved health include, happiness, improved productivity, family cohesion and economic saving from medical bills.

Another positive social impact of the biogas initiative that was reported by the beneficiaries in Sengerema District is reduced incidents of sexual harassment and rape/defilement that was regularly encountered by females and children during fuelwood collection trips. Intuitively, benefits of reduced incidents of rape (sexual harassment) are phenomenon such as emotional stress, trauma, and loss of income opportunity and societal rejection of the rape victims.

Furthermore, informants in Sengerema noted that the risk of snakebites and related death is potentially high during fuelwood collection and therefore households with biogas plants are less exposed to these encounters and impacts.

Environmentally, the benefits of biogas production project include reduced demand for fuel wood, which translates into reduced deforestation and degradation. Linked to reduced deforestation and degradation is

increased flow of ecosystem services from forests such as reduced soil erosion, maintained soil fertility, maintained habitat for wildlife species, improved microclimate and increased pollinators. Moreover, by reducing reliance on fuelwood, there will be reduced GHGs emission from Deforestation and degradation (IPCC, 2007; Phillip and Williams, 2004).

Production and use of organic fertiliser has environmental benefits mainly reduced pollution of water bodies, retained soil fertility and soil organisms. Thus, the soil structure and fertility is not permanently destroyed compared to inorganic fertilisers. Additionally, inorganic fertilisers are also known to have health negative impact on human health (WHO, 1978). Therefore, using organic fertilisers will result in improved health. Table 3 below summaries the positive and negative impacts of biogas production project.

Table 3:

Projected economic, social and environmental impact of Biogas project

	Economic	Social	Environmental
Benefits	Redistribution of labour to income generating activities	Reduced incidents of rape/ defilement	Reduced deforestation and forest degradation
	Avoided cost of purchasing fuel wood	Family cohesion due to more time spent together	Reduced water bodies pollution from inorganic fertilisers
	Avoided costs of inorganic fertiliser and other inputs	Improved students school performance and opportunities for better jobs	Improved soil fertility and maintained soil structure
	Revenue generation from increase in agriculture	Improved health from reduce exposure smoke and poisonous gases and from carrying heavy loads	Increase in pollinators population and species
costs	Investment and operation cost	n/a	Increased PH of the soils and eutrophication of the soils

1.7 Quantification and valuation of the costs and benefits

Quantification and valuation of the identified costs and benefits entails determining the numeric value and attaching the monetary value to the costs and benefits of the project respectively. This is an important component of CBA as the method deals exclusively with money as a common unity. Therefore, this section quantifies and value costs and benefits. Costs and benefits are projected based on the concept of real cash flow where costs and benefits are kept constant throughout the project lifespan and discounted using real discount rate. The benefits for the intervention can be categorised in two ways, being the project outputs and benefits that arise as the indirect impacts of the project. The indirect benefits were estimated as the net increase, which is the difference between without the project and with the project. On the other hand the direct benefits (project output) were estimates of actual benefits arising from the project.

1.7.1 Aquaculture

Under aquaculture, two types of fish farming are categorised and their economic analysis are undertaken separately. These are fish caging and fish ponds.

1.7.1.1 Fish caging

The project has supported 53 fish cages in Lake Victoria within Bunda and Sengerema districts. The fish cages exclusively breed Talapia fish. Total volume of all the cages is approximately 850 m^3. The carrying capacity of the small cage (20 m^3) and large cage (50 m^3) is estimated at approximately 2,000 and 5,000 fingerlings respectively. This translates into 100 fingerlings per m^3. Table 4 depicts construction costs for cages, floating house and motorised boat inclusive of the life jackets based on information from project proponents. Table 5 shows variable costs while table 6 shows costs for all cages.

Table 4:

Unit cost for Fish cage Items

Item	Cost (Tsh)
Cage (small)	3,000,000.00
Cage (large)	5,000,000.00
Floating house	13,000,000.00
Motorised boat	8,000,000.00
Life jackets (s)	25,000.00
Life jackets (m)	50,000.00
Life jackets(l)	75,000.00

Table 5:

Variable cost for Fish cage

Item	Cost (Tsh)
Cost of fingerlings	300.00
Cost of feed	40.00 per fingerlings per month
Fuel (JKT)	306,250.00 per month
Maintenance of boat	300,000.00 per year
Maintenance of cage	20,000.00 per year
Maintenance of house	130,000.00 per year

Table 6:

Fixed and variable costs for cage fishing

Item	Cost (Tshs.)
Cages	175,000,000.00
Floating house	13,000,000.00
Motorised boat	8,000,000.00
Life jackets	2,600,000.00
Fingerlings	23,763,000.00
Cost of feeding	25,347,200.00
Cost of labour	6,336,000.00
Fuel	8,450,000.00
Maintenance by boat	300,000.00
Maintenance of cages	20,000.00
Maintenance of house	130,000.00
Mortality of lake wildlife	
Reduced aesthetic of the lake	
Risk of drowning	

Total cost was estimated as summed cost as per Table 4 and they projected based on 6% inflation rate. The projected and discounted costs of the fish cage are as depicted in Table 7 below. The annual cost are the operational costs and include cost of feeding, cost of fingerlings, labour, maintenance cost as per Table 5. They are a function of the operations of the cages.

Table 7:

Projected and discounted costs for cage fishing

	Total Cost	Discount Total Cost
2015	198,600,000	198,600,000
2016	64,346,200	62,899,511
2017	64,346,200	61,485,348
2018	64,346,200	60,102,980
2019	64,346,200	58,751,691
2020	64,346,200	57,430,783
2021	64,346,200	56,139,573
2022	64,346,200	54,877,393
2023	64,346,200	53,643,590
2024	64,346,200	52,437,527
2025	64,346,200	51,258,580
2026	64,346,200	50,106,138
2027	64,346,200	48,979,607
2028	64,346,200	47,878,404
2029	64,346,200	46,801,959
2030	64,346,200	45,749,716
	Total	1,007,142,799

Projections of benefits of the fish cages (Table 8) were based on the assumptions that, the average market weight of Tilapia is 800g and the maturity period is 8 months and a mortality of 10% as per discussion with experts. Equations below were used to estimate the parameters in Table 8. For other benefits such as improved household nutrient, improved social cohesion, it was difficult to estimate the economic value.

Revenue = carrying capacity *mortality* market price of fish

Improved lake productivity = net fish catch*prices of fish * fish farmer

Income from reduced fishing = net time saved * income * number of fish farmer.

Table 8:

Estimated benefits from cage fishing

Benefit	Value (Tsh)
Revenue	427,734,000.00
Improved lake productivity	15,750,000.00
Income from reduced fishing period	1,312,500.00
Improved household nutrition	n/a
Improved social cohesion	n/a
Reduced illegal fishing	n/a
Total	444,796,500.00

*N/A – Not applicable

Table 9 below depicts the projected and discounted benefits for the cage fishing over the project period.

Table 9:

Projected and discounted benefits for fish caging

	Benefits	Discounted Benefits
2015	0	0
2016	444,796,500	434,796,187
2017	444,796,500	425,020,711
2018	444,796,500	415,465,016
2019	444,796,500	406,124,160
2020	444,796,500	396,993,314
2021	444,796,500	388,067,755
2022	444,796,500	379,342,869
2023	444,796,500	370,814,144
2024	444,796,500	362,477,169
2025	444,796,500	354,327,633
2026	444,796,500	346,361,323
2027	444,796,500	338,574,118
2028	444,796,500	330,961,992
2029	444,796,500	323,521,009
2030	444,796,500	316,247,321
Total discounted Benefits		5,589,094,728

1.7.1.1.1 Net Present Value for fish caging

Net Present Value is simply summed discounted benefits less summed discounted costs.

Based on the projected discounted costs and benefits, the NPV for fish caging is estimated at Tsh. 4.5 billion over a 15-year period. Thus, the fish caging is highly economically viable from the economic, social and environmental point of view. This is because the discounted benefits exceed the discounted cost by a margin of Tsh. 4.5 billion on a 15-year period.

1.7.1.1.2 Sensitivity analysis of fish caging

The responsiveness of the calculated NPV was assessed based on the following scenarios:

- Increased mortality of 20%;
- Decline in prices by 20%;
- Increase in operational costs by 25%; and,
- A discount rate of 10%.

Based on the above scenario, the estimated NPV for fish cage is estimated at Tsh. 2.53 billion. Therefore, even with high mortality rates, significant decline in fish prices by 20% and increase in operational costs by 25%, fish cage intervention remains a highly economic viable option.

1.7.1.2 Fish ponds Farming

This is another type of aquaculture pilot intervention that has been funded under the UNDP/UN ENVIRONMENT initiative. Various consultations were conducted in the project areas to quantify and value the identified costs and benefits of fishponds. Currently there are 10 fishponds of which eight (8) are managed by JKT while community groups manage the remaining. The total surface area of ponds as reported by the beneficiaries is approximately 6,000 m^2. The ponds in Bunda District are exclusively for catfish while those in Bukoba Rural are for Tilapia. Based on consultation with the stakeholders, Table 10 depicts the estimated operational and fixed costs for construction and operation of fishpond per m^2 as reported by interviewed respondents and confirmed by the UNDP/ESRF responsible personnel.

Table 10:

Average cost of constructing and maintaining pond/m2

Item	Tsh./ m2
Fixed costs	
Construction of pond per m^2	2,000
Nets (fence and top cover) & poles	2,000
Operational costs	
Cost of Water pumping per m^2	500
Cost of pipes	200
Fingerlings (price per fingerling)	400
Cost of fingerlings per m^3	2,500
Cost of feed (price per cad fish)	320
Cost of labour per fish	36
Cost for Security per cad fish	216

On the basis of the estimated costs, Table 11 depicts the total costs and discounted for ponds in operation.

Table 11:

Projected and discounted total Cost

	Total Cost	Discounted Cost
2015	33,600,000	33,600,000
2016	101,200,000	98,924,731
2017	101,200,000	96,700,617
2018	101,200,000	94,526,507
2019	101,200,000	92,401,278
2020	101,200,000	90,323,830
2021	101,200,000	88,293,089
2022	101,200,000	86,308,005
2023	101,200,000	84,367,551
2024	101,200,000	82,470,724
2025	101,200,000	80,616,544
2026	101,200,000	78,804,051
2027	101,200,000	77,032,308
2028	101,200,000	75,300,398
2029	101,200,000	73,607,428
2030	101,200,000	71,952,520
Total discounted costs		1,305,229,580

The benefits for the fishpond were estimated on the basis on maturity period of 8 months and the weigh sale of 2.5 kg - for catfish. Table 12 depicts the projected benefits for the catfish for the 6 ponds that are currently operational and assuming a 10% mortality rate. Th projected benefits were estimated as a function of carryin capacity of the pond, mortality rate and the market pric of catfish.

Table 12:

Projected and discounted benefits

YR	Total benefits	Discounted Benefits
2015	0	0
2016	297,000,000	290,322,580
2017	297,000,000	283,795,289
2018	297,000,000	277,414,749
2019	297,000,000	271,177,663
2020	297,000,000	265,080,805
2021	297,000,000	259,121,021
2022	297,000,000	253,295,231
2023	297,000,000	247,600,421
2024	297,000,000	242,033,647
2025	297,000,000	236,592,030
2026	297,000,000	231,272,757
2027	297,000,000	226,073,076
2028	297,000,000	220,990,299
2029	297,000,000	216,021,798
2030	297,000,000	211,165,003
total discounted Benefits		3,731,956,378

1.7.1.2.1 Net present value for Fishpond Farming

Based on the estimated discounted costs and bene NPV for the ponds exclusively rearing catfish at market weight of 2.5 kg is estimated at Tsh. 2.4 billi Therefore, the net benefits exceed net costs by Tsh. billion over a 15-year period. Consequently, the fishp initiative is highly economically viable over a 15 y period.

1.7.1.2.2 Sensitivity analysis for fish ponds farming

The responsiveness of fishponds was assessed based on:

- Increased mortality of 20%;
- Market weight of 2 kg;
- Decline market price by 20%;
- A discount rate of 10%; and,
- Increase in operational costs by 25%.

Based on these scenarios, the NPV was estimated at Tsh. 448 million. Though the estimated NPV is highly responsive to changes in mortality, market prices and operational costs, the project is still highly profitable.

1.7.1.3 Impact of fish farming at the district and national level

Fish farming (both in cages and ponds) is one of the potential flagship projects within and around Lake Victoria. The domestic and international demand for fish has remained high and presents great opportunities for scaling up aquaculture through the PEI. Currently, the project is still at a very small scale to have traceable socio-economic and environmental impact at the district and national levels. However, increasing the scale of operation of the aquaculture would have economic, social and environmental impacts to the local/district and national levels. Some of the potential impacts of the project when significantly expanded will include:

- Employment creation;
- Contribution to country's GDP;
- Improved ecosystems and ecosystem service such as improved water quality most of which households are dependent upon;
- Poverty reduction and alleviation from improved incomes and employment; and,
- Nutritional value and hence health improvement

Most of the stated socio-economic and environmental benefits will be realised through value chain addition and multiplier effects. Through fish processing, scaling up the project would result in establishment of complementary firms that support the fish industry. This would include supply of ice, storage, refrigeration transportation sector and improved infrastructure. Therefore, through value chain addition from harvesting, processing, transporting and marketing, there will be employment creation and revenue generation. Ultimately, this would contribute to district and national employment and GDP. Additionally, through the multiplier effects, it is expected that there will be other companies such as packaging, marketing and transport that will be set up in the proximity of the aquaculture farms. Ultimately, increased employment opportunities would contribute to the FYDP II goals and poverty reduction objectives will be achieved thus contributing to increased development of the region.

1.7.2 Apiculture intervention

A total of 136 beekeeping groups are being supported under the UNDP/UN ENVIRONMENT initiative in Bunda, Ikungi, Nyasa and Ileje districts in Tanzania. Among these, there are 100 groups in Ikungi, 10 groups in Nyasa, one group in Bunda and 25 groups in Ileje districts. There are currently 350 beehives that have been supplied by the intervention. There are two-harvest seasons per year in the country due to bimodal rainfall events. The volume of one beehive is approximately 20 litres. The proportion of wax to honey is estimated at approximately 1 to 15 litres. Based on the information gathered from beneficiaries' consultations, Table 13 depicts the fixed and operational costs of one (1) beehive. The selling cost entails the cost of time incurred in selling honey.

Table 13:

Total Cost for one beehive

Item	Cost (Tsh.)
Cost of Beehive (investment)	45,000.00
Harvesting	20,000.00
Packaging	10,000.00
Transport	2,000.00
Selling	4,000.00

Based on the operational cost per beehive, Table 14 depicts the projected and discounted costs for 500 beehives for the whole PEI intervention. Total costs as depicted in Table 14 is product of unit cost of beehive and the total number of beehives while years two (2) to 15 exclude construction costs.

Table 14:

Projected and discounted costs for the apiculture

YR	Total cost	Discounted costs
2015	22,500,000	22,500,000
2016	18,000,000	17,595,308
2017	18,000,000	17,199,714
2018	18,000,000	16,813,015
2019	18,000,000	16,435,010
2020	18,000,000	16,065,503
2021	18,000,000	15,704,304
2022	18,000,000	15,351,226
2023	18,000,000	15,006,086
2024	18,000,000	14,668,706
2025	18,000,000	14,338,911
2026	18,000,000	14,016,531
2027	18,000,000	13,701,399
2028	18,000,000	133,93,352
2029	18,000,000	130,92,230
2030	18,000,000	12,797,879
Total discounted benefits		248,679,174

The benefits for the 500 beehives are in terms of revenue generated from wax and honey as well as from the improved agricultural harvest. However, there are other non-quantifiable benefits, which are equally important. Due to lack of data on relationship between numbers of hectares, which can be pollinated by one beehive, the benefits from agricultural productivity were excluded from CBA analysis. Table 15 depicts the project benefits for one beehive and Table 16 shows the projected revenue for the whole project.

Table 15:

Benefits per beehive

Product	Quantity	Price (Tsh)	Revenue (Tsh)
Honey	30 l	6,500.00	19,5000.00
Wax	3 l	13,000.00	39,000.00
		Total	354,000.00

Table 16:

Projected and discounted benefit the overall apiculture intervention

Year	Cost	Discounted Cost
2015	117,000,000	117,000,000
2016	117,000,000	114,369,501
2017	117,000,000	111,798,144
2018	117,000,000	109,284,598
2019	117,000,000	106,827,564
2020	117,000,000	104,425,772
2021	117,000,000	102,077,978
2022	117,000,000	99,782,970
2023	117,000,000	97,539,560
2024	117,000,000	95,346,588
2025	117,000,000	93,202,921
2026	117,000,000	91,107,450
2027	117,000,000	89,059,091
2028	117,000,000	87,056,785
2029	117,000,000	85,099,496
2030	117,000,000	83,186,213
Total Discounted Benefits		1,587,164,633

1.7.2.1 Net Present Value of apiculture intervention

Based on the projected discounted costs and benefits of the apiculture, the derived NPV is estimated at Tsh. 1.3 billion. Therefore, apiculture intervention is highly economically viable. The discounted benefits mainly from increase in maize production, selling of honey and wax far exceeds the discounted total costs over a 15-year period. Thus, apiculture has a very high NPV simply because the inputs and operational costs are extremely low compared to the revenue generated. In addition its impact of crop yield is significantly high.

1.7.2.2 Sensitivity analysis

The responsiveness of the estimated NPV was tested based on following scenarios:

- Decreasing the yield by 50% (10 litres per beehive);
- Increasing operational costs by 25%; and,
- Increasing the discount rate to 10%.

Based on these changes, the NPV for apiculture was estimated at Tsh. 63 million. Although still a highly viable economic activity, the NPV is highly responsive to changes in production, increase in operational costs and discount rate.

1.7.2.3 Impact of apiculture on the district and national level

Similarly, apiculture project is still at a small scale thus it does not have tangible impacts that would be felt at district and national levels. However, expansion of the project accompanied by the relevant policy instruments would result in multiplier effects and value chain addition that may result in significantly tangible impacts to the district and national levels. Furthermore, through processing of both honey and wax (a value addition process), the project would result in establishment of complementing industries, transportation sector and improved infrastructure not only in the production zones but also at national levels. Therefore, through value chain addition in the processes of harvesting, processing, packaging, transporting and marketing, there will be employment creation and revenue generation. Ultimately, this would contribute to GDP at the district and national level and employment.

Additionally, through the multiplier effects it is expected that there will be other companies such as packaging, marketing and transport that will be set up in the proximity of the apiculture farms/reserve zones.

Consequently, apiculture is likely going to contribute to pro-poor economic growth that will potentially close the gap between economic growth and poverty. Importantly, it is an economic activity that has the potential to benefit both women and men and create an opportunity for women to engage in income generating activities.

1.7.3 Biogas production

The biogas programme supported 10 households. Consultations indicate that the beneficiaries operate the plant at least 15 days in a month as they are currently supplementing fuelwood with biogas. On average the households use 40 litres of cow dung and four buckets of water for production of biogas per day for the 15 days of the month. The cow dung is generally collected from the adjacent kraals with minimum or no labour costs. Consultations with experts reveal that maintenance costs are approximately 5% of the total investment cost.

Based on these findings, the costs and benefits of the operation of biogas plants were estimated. Table 17 below depicts the fixed and variable costs for one (1) biogas plant per year.

Table 17:

Estimated Fixed and variable costs for one biogas plant

Type of Cost	Unit cost (Tsh)	Cost per Year (Tsh)
Investment	1,850,000.00	1,850,000.00
Maintenance costs	92,500.00	92,500.00
Labour cost (Cow dung)	500/hour	90,000.00
Labour Cost (Water)	500/bucket	180,000.00

Based on the fixed and variable costs for one (1) biogas plant, Table 18 depicts the projected costs for ten (10) biogas plants.

Table 18:

Total cost and Discounted Total Costs for Biogas intervention

YR	Cost	Discounted cost
2015	18,500,000	18,500,000
2016	3,625,000	3,543,499
2017	3,625,000	3,463,831
2018	3,625,000	3,385,954
2019	3,625,000	3,309,828
2020	3,625,000	3,235,413
2021	3,625,000	3,162,672
2022	3,625,000	3,091,566
2023	3,625,000	3,022,059
2024	3,625,000	2,954,114
2025	3,625,000	2,887,697
2026	3,625,000	2,822,773
2027	3,625,000	2,759,309
2028	3,625,000	2,697,272
2029	3,625,000	2,636,629
2030	3,625,000	2,577,350
Total discounted Cost		64,049,972

The benefits of the biogas production were also estimated on the prevailing operational conditions of using biogas

plants for cooking 15 days in a month. Total cow dung used is approximately 100 kg and the total methane produced per month is approximately 15 litres, which translate into 150 litres per year. Quantification of methane is based on Abubakar and Ismail (2012) estimation that the methane content is 0.15 l/kg of cow dung. The price of LPG was used to estimate the value of methane, as they are substitutes. Time saved was based on the findings from the consultations with the beneficiaries. Prior to biogas plant beneficiaries made 3 to 4 trips with each trip lasting 5 hours collecting fuelwood. Biogas plant reduced trips to 2 trips per week. However, the duration of the trip remained 5 hours. Minimum salary was used to estimate the economic value of time saved by the biogas plant.

Reduced deforestation was estimated under the REDD+ programme where carbon credits can be sold in a market. The reduced fuelwood, carbon content and price of carbon were used to estimate the value of carbon, which can be sold in the market. The benefits were simulated over a 15-year period. Table 19 depicts the benefits from one (1) household biogas plant.

Table 19:

Economic and environmental benefits of Biogas plant

Benefits	Quantity (units)	Value (Tsh)
Energy generation	205 kg/year	461,250.00
Time saved	360 Hours/year	180,000.00
Organic fertiliser	7200kg/year	72,000.00
Reduced deforestation	1440 kg	63,360.00
Avoided cost of fuelwood	1440 kg	144,000.00
	Total	920,610.00

Based on the estimated benefits for one (1) biogas plant, Table 20 depicts the projected future and discounted benefits for 10 biogas plants over a 15-year period.

Table 20:

Discounted benefits for the biogas intervention

Yr	Benefits	Discounted benefits
2015	9,206,100	9,206,100
2016	9,206,100	8,999,120
2017	9,206,100	8,796,794
2018	9,206,100	8,599,017
2019	9,206,100	8,405,686
2020	9,206,100	8,216,702
2021	9,206,100	8,031,966
2022	9,206,100	7,851,385
2023	9,206,100	7,674,863
2024	9,206,100	7,502,310
2025	9,206,100	7,333,636
2026	9,206,100	7,168,755
2027	9,206,100	7,007,580
2028	9,206,100	6,850,030
2029	9,206,100	6,696,021
2030	9,206,100	6,545,475
total discounted benefits		124,885,438

1.7.3.1 Net Present Value of the biogas interventions

Based on the projected costs and benefits of the ten (10) biogas plants, the NPV is estimated at Tsh. 60 million. The interpretation of this NPV is that over a 15-year period, households with biogas plant realise net benefits in excess of Tsh. 60 million. Thus, discounted benefits of biogas plant exceed associated discounted costs by Tsh. 60 million. It is important to note that the derived Tsh. 60 million comprises of quantifiable benefit thus, the overall benefits are higher than the estimate ones. Consequently, the biogas plant intervention is highly viable and sustainable in the long run.

1.7.3.2 Sensitivity analysis

Sensitivity analysis involves determining the responsiveness of NPV to changes in the values of the variables mainly increases in operational costs, change in discount rates and decline in prices. With an increase in operational costs by 25%, decline in market price of

benefits by 20% and a discount rate of 10%, the estimate NPV for the biogas plants is approximately Tsh. 33 million. There is a significant decline in the net benefit on approximately Tsh. 33 million, however, the intervention is still highly viable.

1.7.3.3 Impact at district and national level

Due to the fact that this initiative is still at a small-scale level, the project does not have impacts at both the district and national levels. However, considering the positive social and environmental benefits of the project already explained, scaling up the project has enormous potential to positively impact the district and national economy.

Biogas has the potential to contribute to poverty reduction in the country. This can be by reducing the burden on women for collecting fuelwood, thus enabling them to engage in economically gainful employment activities. One such activity, which was noted by beneficiaries in Sengerema, is growing groundnut mainly by women. This thus presents income-earning schemes, which could contribute to poverty reduction. Additionally, reducing girls' workload of collecting fuelwood would enable them to concentrate on their studies. It is expected that the project will contribute to girls' improved school performance and possibly act as a catalyst for reducing gender inequalities that are highly prevalent in the rural areas.

Furthermore, the project has a potential of processing and packaging biogas in gas cylinders for sale. This presents ample opportunities in terms of employment, poverty reduction and contribution to the district and national GDP.

Most importantly, the project has the potential to contribute to food security through increased agricultural productivity. This would be largely through the production of bio-slurry. Consequently, the project has the potential to enhance and sustain conservation agriculture and hence contribute to district and national food security objectives.

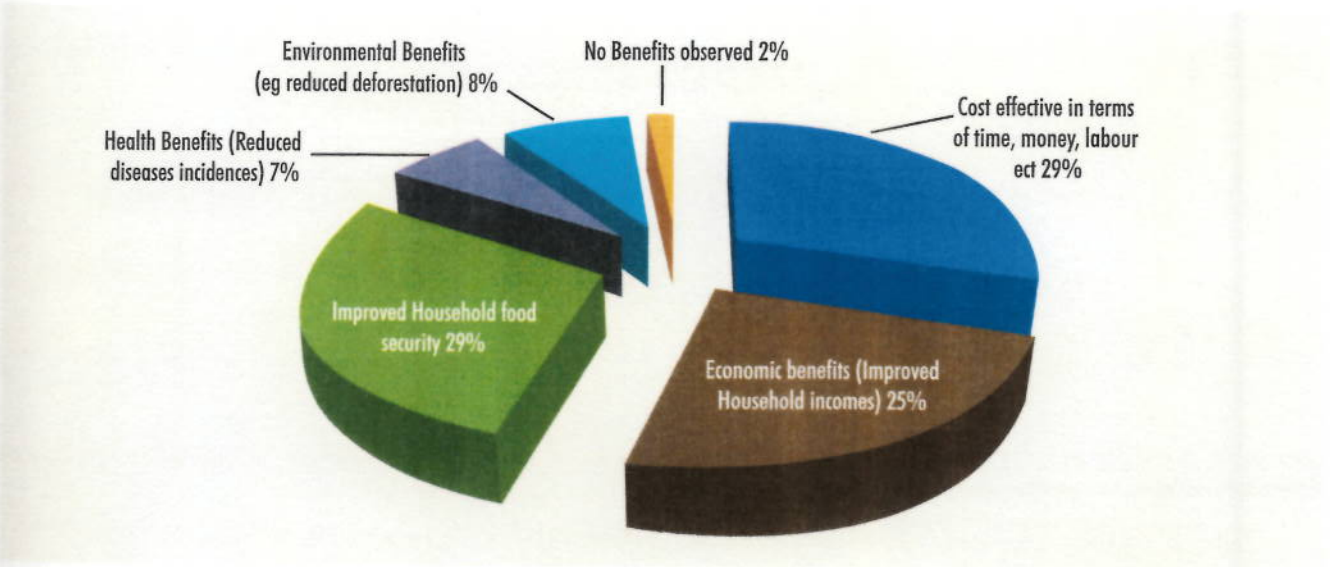
Another benefit of the project at the national level include contribution to the country Intended Nationally Determined Contribution (hereinafter INDCs) target of reducing the country's national GHG emission as well as reduction of deforestation which is currently wide spread nationally. Therefore, through reduced deforestation, the project is likely going to enhance flow of forestry ecosystems services, which are support rural livelihoods.

1.8 Overall impacts of p-e project on livelihood security

Fieldwork findings show that respondents experience various benefits and improvements in their livelihood as a result of the p-e projects. Figure 2 presents specific benefits that project beneficiaries reported to have gained from their engagement in PEI initiatives. The findings show that 29% of respondents mentioned improved household food security. Furthermore, 29% of the household respondents mentioned benefits associated with increased cost effectiveness of their livelihood activities in terms of time, money, and labour. These were followed by 25% who highlighted economic benefits such as improved household incomes. The environmental benefits were related to health and environmental sustainability such as reduced deforestation.

Figure 2:

Contributions of p-e project to household livelihoods

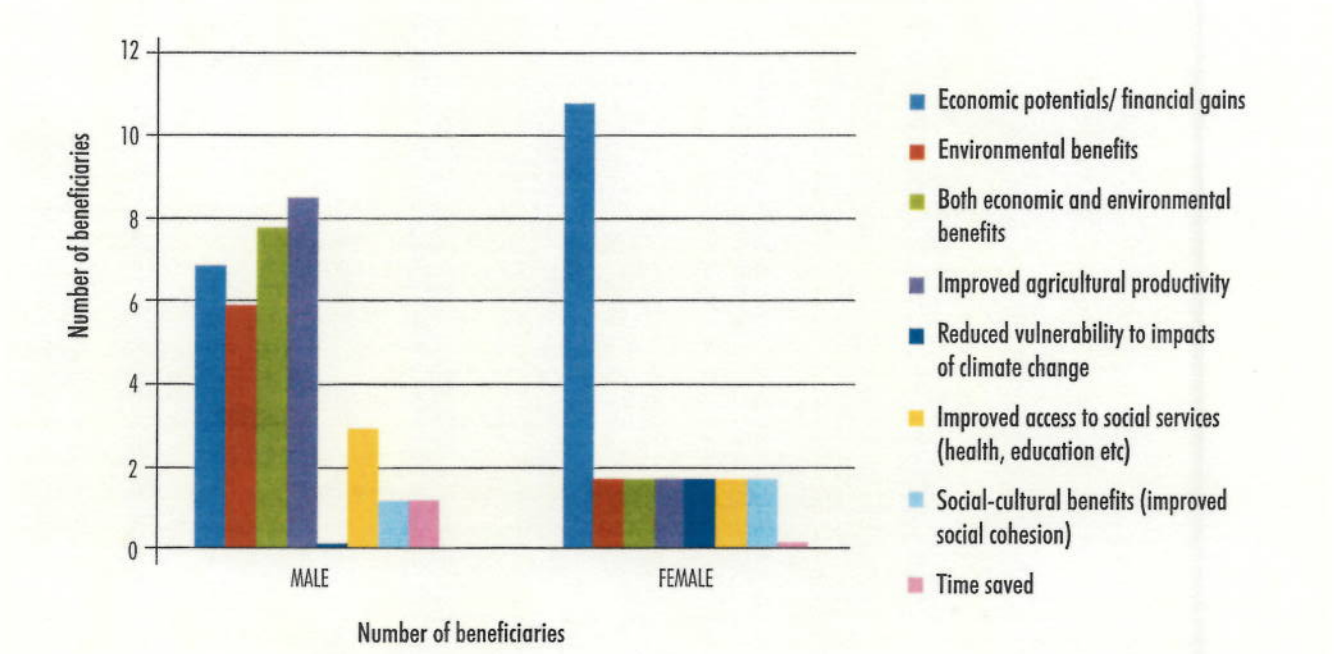


The overall impacts of the p-e projects on livelihood security from the perspective of women and men respondents are indicated in Figure 3. The findings show that both men and women experience economic, social and environmental benefits from the projects.

However, the study also finds differences in women and men's experiences of the benefits. While a high proportion of women highlight economic gains, more men also point to environmental benefits and improved agricultural productivity.

Figure 3:

Contributions of PEI on livelihoods from gender perspective



Furthermore, the findings show there are social-cultural benefits associated with engagement in PEI activities (Figure 3). The study also reveals that gender roles in the household are changing as a result of PEI interventions. For instance, previously it was rare to see men involved in ensuring household's energy needs specifically engaging in collecting firewood for cooking. But this has changed with the introduction of biogas plants, where men are more involved in ensuring constant and reliable supply of biogas for cooking and lighting by maintaining the biogas production system. One for the reasons for the engagement of men in energy supply could be due to the fact that biogas production is more mechanical and requires men's involvement.

1.9 Conclusions

All the UNDP/UN ENVIRONMENT projects (i.e. Apiculture, Aquaculture and Biogas production,) are economically viable over a period of 15 years and if other benefits could be quantified the NPV would increase. Of these interventions aquaculture has the highest NPV of Tsh. 7.9 billion (fish cage and fish ponds farming) followed by apiculture at Tsh. 1.26 billion. Biogas, although recorded the lowest NPV, (Tsh. 60 million) has the most social and environmental benefits some of which cannot be quantified. Additionally, one of the reasons that biogas production recorded the lowest NPV is that its piloting has been significantly small relative to the other options. Compared to the other options, biogas production does not directly generate revenue but it has the potential to generate high social and environmental benefits relative to the other options. Compared to other interventions, apiculture has the lowest investment costs followed by the biogas project.

1.10 Recommendations on p-e project scale-up

As indicated in details, NPV for the pilot p-e projects show that the projects are economically viable. The PEI viability comprised of economic, social and environmental costs and benefits over a 15-year period. At the current scale of operation, benefits were only

limited to households. However, in order to achieve wide scale benefits that will impact district and national levels, the following recommendations are made:

- *Up-scaling of p-e interventions across the country*: Increase the scale of operation of all the intervention (Apiculture, Aquaculture and Biogas production) in relevant agro-ecological zones taking into consideration existing opportunities. This will ensure that the environmental and social positive impacts of the initiatives are realised at both the district and national levels.

- *Development of Operational Guidelines p-e projects*: The operational guidelines should guide the operations of the projects (Apiculture, Aquaculture and Biogas Production) to minimise the social and environmental costs. Consequently, the guidelines should have safeguards to minimise issues of conflicts, environmental standards amongst others. At the same time, they should be used to maximise the benefits from the projects.

- *Mainstreaming p-e projects in district and national planning system*: Currently, the Poverty-Environment projects are not integrated and supported at the district planning level. Lack of mainstreaming and integration results in inadequate support for the operations of the p-e projects. Thus, it is pertinent they are mainstreamed in decision making to ensure adequate provision of financial, human resources for planning and marketing the associated products of the projects

- *Establishing policy framework and instruments*: It is also pertinent that policy framework and instruments are established for the Poverty-Environment projects. This will create a conducive environment and support structures for their operations. The legislation framework should clearly highlight policy instruments that should support the various projects. For instance, biogas project is not likely going to wield the intended benefits as long as there is uncontrolled fuelwood collection and deforestation.

- *Creating relevant synergies*: Creating synergies with other economic activities, whereas, currently, most of the initiatives have by-products that could support other initiatives such as production of Azolla and bio-slurry. It is therefore important that a platform is created to enhance synergies between these initiatives and other economic activities such as conservation agriculture (apiculture and biogas production).

- *Promoting Climate Change Adaptation*: In order for biogas production to be a success, it is important that at the national level it is recognised under INDCs. This will create a platform for domestic and international funding through climate change funds and mechanisms.

- *Institutional Arrangements*: Institutional arrangements need to be made more efficient so as to strengthen integration of the interventions in the district development plans as well as increasing the uptake of the same by local communities. Therefore, poverty-environment mainstreaming committee need to be established at the district level for executing the poverty reduction and environmental sustainability projects

- *Monitoring and Evaluation:* This is an important instrument for project evaluation and improved performance. Therefore, through improved institutional arrangement, it is important that timely M&E is undertaken to optimise the operations of the implemented project. Through M&E system factors that inhibit optimal operations of the projects will be identified and eliminated.

- *Set-up a loan facility for household implementation:* It is also important that a loan facility is established in the rural areas to finance households willing to invest in the projects.

- Resource mobilisation: Similarly, the results from this study should be used to mobilise resources from the donors and government.

2

Business proposal for p-e up scaling

2.1 Introduction

This section presents a business proposal for scaling up the p-e projects mainly apiculture, aquaculture and biogas production. The overall objective of this business proposal is to present an investment case to the investors mainly GoT, Development Partners and private sector on p-e project scaling-up. Importantly, the business proposal clearly highlights the impacts of p-e scaling-up on poverty alleviation and environmental sustainability from the income generation perspective.

The ultimate goal of the p-e project scale-up is to stimulate inclusive green growth that will achieve poverty reduction and environmental sustainability.

2.2 Justification of scaling up of the Intervention

Tanzania's rich environmental resource is key to the country's economic growth and developmental transformation. However, noticeable environmental resources underutilisation has contributed to the country being one of the world's poorest. While the country has recorded sustained economic growth since 2007, poverty levels remain high and with a population of over 45 million people and an estimated 28% living below the basic needs poverty line, Tanzania is faced with challenges of ensuring sustained economic growth and the simultaneous eradication of poverty and reduction of inequalities. Moreover, little progress has been achieved towards significantly reducing hunger and malnutrition over the years.

Consequently, for the government to realise national objectives of poverty reduction and environmental sustainability, there is a need for an inclusive sustainable economic growth model that balances environmental sustainability and poverty reduction.

It is against this background that the Pro-poor Economic Growth and Environmentally Sustainable Development project has piloted sustainable livelihood interventions to demonstrate their efficacy in reducing poverty and attaining environmental sustainability. The poverty-environment related projects that have been implemented in the six districts are apiculture, aquaculture and biogas production.

In order to mobilise financial support from relevant stakeholders, mainly the government, on piloted projected scale-up a cost benefit analysis was undertaken. Purposely, the economic analysis of these piloted projects was to generate enough evidence on their impact in terms of poverty reduction and environmental sustainability. From the economic analysis, mainly through consultations with the beneficiaries, non-beneficiaries and government officials the following are some of the impacts that were identified and formed the basis for CBA:

- *Household income generation:* apiculture and aquaculture have a potential to generate income for the households engaged in these activities. Therefore, these economic activities have the potential to lift household from the poverty datum line. In addition, biogas project has the huge potential to indirectly generate household income by reducing household time allocated to fuelwood collection and hence engage in meaningful employment or income generating activities.

- *Women participation in income generating activities:* this is another benefit that was highlighted by the beneficiaries. It was noted that prior to piloting apiculture and aquaculture, women were not engaged in beekeeping. This has changed with the pilot projects, which have provided women with skills and equipment to engage in the economic activities and contributed to change the perception in the communities that the activities were only for men.

- *Reducing work burden for women and children:* women and girl-child are generally over-burdened with household activities such as cooking and collection of fuelwood. Regarding fuelwood collection, time for the majority of women and children was estimated at approximately 4 hours and involved 4 trips per week and undertake 2 trips per week each one involving 4 hours. Therefore, biogas project reduces time allocated to fuelwood collection.

- *Improved health of women and children:* cooking with fuelwood produces smoke and gases mainly carbon

monoxide which affect the health of women and children as they are often the ones engaged in this activity. Some of the diseases associated with cooking with fuelwood include acute infections of the lower respiratory tract (pneumonia) in young children, chronic obstructive pulmonary diseases such as chronic bronchitis and emphysema in adult women. In the study women indicated that they no longer suffer from itchy eyes due to smoke and red-eye disease.

- *Reduced deforestation:* biogas production has the potential to significantly reduce the demand for fuelwood. The positive environmental impact is reduced deforestation and forest degradation. Forest ecosystems are multi-functional and therefore reduced deforestation and degradation will optimise flow of ecosystem services such as reduced soil erosion, watershed properties, sedimentation regulation into water bodies and increase species diversity.

- *Reduced illegal fishing:* this is one of the positive environmental impacts associated with fish caging in Lake Victoria. The impacts associated with reduced illegal fishing included increased lake productivity in terms of increased fish population and size of fish caught.

On the basis of the identified economic, social and environmental impacts both positive and negative, a full CBA was undertaken. As the projects have long time objective, a 15-year projection period was adopted. Table 21 depicts Net Present Values for the pilot project.

Table 21:

Pilot project CBA results

Project	size	NPV (Tsh.)
Apiculture	500 beehives	1.26 billion
Aquaculture (fish cages	2,350m^3	4.73 billion
Aquaculture (ponds)	6,000 m^2	3.172 billion
Biogas plants	7 plants	59.47 million

The CBA results indicate that for all the piloted projects, the discounted benefits exceed discounted costs. Therefore, the piloted projects are highly viable to generate income for the household involved in their operations. It is important to note that actual NPV for the piloted projects is higher than the reported one as the projects have social benefits many of which were not quantified due to their qualitative nature. Therefore, in addition to generating household income, the pilot projects have social and health impacts which will contribute to family happiness, social cohesion and improved health. All these impacts are likely going to contribute indirectly to improved household welfare. Therefore, scaling up the pilot project has the potential to support the GoT to close the gap between poverty and economic growth and at the same time transform the economy progressively towards a green economic growth.

2.3 Feasible solutions/proposed solutions

Promoting local economic development through the implementation of sustainable livelihood interventions can contribute to address some of the current socio-economic and environmental problems in Tanzania. The cost benefit analysis has shown that the piloted projects (apiculture, aquaculture and biogas production) have positive socio-economic and environmental impacts and the potential to improve the livelihoods of women and men through the more sustainable use of natural resources and improved climate resilience. Therefore, scaling-up the interventions will contribute to national priorities of promoting green local economic development and employment for women and youth.

2.4 Proposed p-e Scaling up and Budget

In order for the p-e project expansion to significantly reduce poverty and achieve environmental sustainability, it has to cover a significant rural population. However, given the size of the rural population estimated at approximately 70% of country's population, it might not be possible to raise sufficient funds to support even 10% of the rural population. Identifying the most optimal scaling up is deemed to be the most challenging aspect of this exercise. Therefore, increase the existing pilot project by a factor of 10 was adopted with the possibility of future expansion. Emphasis should be given to projects operated by the community groups to ensure that benefits are shared between the groups. Therefore, scaling up should emphasis on aquaculture and apiculture, which can be operated by the community. For some of the projects, which were implemented at a very small scale (biogas and fish ponds), expansion was increased by more than a factor of 10 (Table 22).

Table 22:

Proposed scale-up of the poverty- environment projects

Project type	Current	Scale-up
Aquaculture (fish cage)	53	500
Aquaculture	10	500
Apiculture	500	5,000
Biogas plants	10	200

2.5 Budget for poverty environment project scale up

This section presents details of the budget for the project scale-up. All activities are identified and costed based on the current market prices for the items. Emphasis is put on initial costs, mainly construction costs. Budget was done for each project.

2.5.1 Apiculture

This project will involve purchase and distribution of 5,000 beehives to the beneficiaries. The other items that will be distributed to the beneficiaries are protective clothing and smoke guns. Table 23 shows the items and unit price and the total budget for apiculture project.

Table 23:

Budget for Apiculture

Item	Quantity	Price (Tsh)	Subtotal (Tsh)
Beehives	5,000	45,000	225,000,000
Clothing	100	40,000	4,000,000
Smoker bee	100	24,000	2,400,000
	Total		231,400,000.00

Table 24 depicts the projected operation cost for the beehives from consultation with the beneficiaries.

Table 24:

Operational costs for Apiculture

Item	Cost (Tsh)
Harvesting	100,000,000.00
Packaging	50,000,000.00
Transport	10,000,000.00
Selling	20,000,000.00
Total	180,000,000.00

2.5.2 Biogas production

Biogas production involve construction of the biogas plant (fermentation chamber), installation of biogas pipes to transmit produced methane, supply of biogas single-plated stoves and lighting system. Table 25 depicts budget for the proposed biogas project scale-up.

Table 25:

Budget for Biogas production

	Quantity	Price (Tsh)	Sub-total (Tsh)
Construction of biogas plant + cooking stoves	200	1,850,000.00	370,000,000.00

Based on consultation with the stakeholders and beneficiaries, Table 26 shows the operational costs for biogas plant. Maintenance cost was assumed to be approximately 5% of total investment cost from the expert assessment.

Table 26:

Operational cost for scaled up biogas plants

Item	Cost (Tsh)
Maintenance cost	18,500,000.00
Cost of water	18,000,000.00
Cost of cow dung	36,000,000.00
Total	72,500,000.00

2.5.3 Fish cage

This project involves construction and installation of the fish cage in a water body. Activities that are undertaken entail monitoring, guarding the cages and feeding of the fingerlings. Table 27 depicts itemised budget for the fish caging based on expansion of 500 cages.

Table 27:

Budget for fish caging

Item	Quantity	Price (Tsh)	Sub-total (Tsh)
Fish cages	500	5,000,000.00	2,500,000,000
Floating house	25	13,000,000.00	325,000,000
Motorised boat	25	8,000,000.00	200,000,000
Life jackets	100	50,000.00	5,000,000
	Total		3,030,000,000.00

The maintenance and operational costs for fish cage included replacement of the nets, fuel costs, maintenance of floating house and feeding costs. Table 28 depicts the projected costs for 500 cages.

Table 28:

Operational costs for scaled-up fish cage

Item	Quantity	Unit cost (Tsh)	Sub-total (Tsh)
Fish cages	500	20,000	10,000,000
Motorised boats	25	300,000	7,500,000
Maintenance of houses	25	130,000	3,250,000
Motorised boats service	25	300,000	7,500,000
Feed cost	5,000	320.00@500 cages	800,000,000
Cost of fingerling	5,000	300.00@500 cages	750,000,000
Labour costs	50	2,880,000	144,000,000
Fuel	25	2,500.00@ 8 boats	500,000
	Total		1,722,750,000.00

2.5.4 Fishpond farming

This is another type of aquaculture which has been assessed which shows great potential for contributing to poverty reduction. Scaling up of this activity will involve construction of the ponds. It is assumed that fingerlings are the operational costs implying that they are supplied and not reared by the operator. Table 29 depicts the budget for the construction of 500 fishponds of approximately 40 meter by 20 meters.

Table 29:

Construction costs for fishponds

Item	Quantity	Unit cost (Tsh)	Sub-total (Tsh)
Construction	500	2,000.00@200 meters	200,000,000.00
Fencing	500	1,500.00 @ 200 meters	150,000,000.00
	Total		350,000,000.00

Table 30 shows the estimated operational costs, which include labour costs, cost of fingerlings, feeding costs and maintenance for the fishponds.

Table 30:

operational Costs for Fish ponds

Item	Quantity	Unit cost	Sub-total (Tsh)
Pond maintenance	500	200@40m*20m	80,000,000
Fingerling cost	2000	400@500 cages	400,000,000
Cost of feed	2000	320@ 500 cages	320,000,000
Labour cost	50	500@8640 hours	216,000,000
	Total		1,016,000,000.00

2.6 Projected revenue for the project scale-up

This section projects the benefits of the project based on the information derived from CBA results. The benefits are projected per project and the overall benefits of the projects discussed.

2.6.1. Apiculture

The benefits from apiculture include production of honey and wax. In addition, apiculture through cross-pollination has the potential to increase agricultural productivity. However, the agricultural benefit has been omitted from calculation due to complexity of the relationship between number of beehives and hectares that can be pollinated. Estimation of the revenue is based on the following assumptions:

- Harvest per beehive is 20 litres;
- Harvest is done twice a year; and,
- The proportion of wax to honey is 1:15 ratio.

Based on these assumptions, annual production of honey and wax is as depicted in Table 31 below.

Table 31:

Annual honey and wax production

Production	Beehives	Yield/beehive	Total harvest
Honey	5,000	20ltrs @2 seasons	200,000 litres
Wax	5,000	1.3ltrs @2 seasons	13,000 litres

Based on the reported market for honey and wax, Table 32 below depicts projected revenue from apiculture per year.

Table 32:

Revenue generation from honey production

Product	Price/litre	Quantity (l)	Revenue (Tsh.)
Honey	6,500	200,000	1,300,000,000.00
Wax	13,000	13,000	169,000,000.00
	Total		1,469,000,000.00

2.6.2 Biogas production

A realistic assumption for biogas production is that it will not replace fuelwood as the source of energy in the rural areas. But it will constitute approximately 25% of the household energy for cooking. Based on this assumption Table 33 depicts biogas production and its economic value.

Table 33:

Biogas production per year

Product	Quantity	Biogas plants	Total quantity	Price (Tsh)	Sub-total (Tsh)
Biogas	150	200	30,000.00	3,000	90,000,000.00
Organic fertilisers	1,200	200	240,000	10	2,400,000.00

2.6.3 Aquaculture

Aquaculture involves fish caging and fish ponding. The stocking rates for fish caging and ponds are approximately 6.5 and 5 respectively. It is assumed that fish caging is exclusively for Nile Tilapia while ponds rear catfish. The maturity period for Nile Tilapia and catfish is 8 and 12 months respectively. Table 34 depicts fish production and estimated revenue from fish sales.

Table 34:

Revenue projection from aquaculture

Fish	Cage	Stocking	Kg	Price/kg	Revenue (Tsh)
Nile Tilapia	500	5,000	1,687,500	6,000	10,125,000,000.00
Catfish	500	2,000	2,250,000	4,000	9,000,000,000.00
			3,937.5 tons		19,125,000,000.00

2.7 Net Present Value for p-e project scale-up

The projected revenue for the project scale up is based on the estimated benefits of the scaled-up projects. A discount rate of 8.5% and an inflation of 6% are used to project future costs and benefits. Furthermore, it is assumed that first year of project implementation will not generate revenue. Table 35 shows projected total benefits and cost for the scaled up.

Table 35:

Projected total benefits and cost for the p-e scale up

	TC (Tsh. Million)	TB (Tsh. Million)
2017	3981	0
2018	2991	20686
2019	3171	21928
2020	3361	23243
2021	3563	24638
2022	3776	26116
2023	4003	27683
2024	4243	29344
2025	4498	31105
2026	4768	32971
2027	5054	34949
2028	5357	37046
2029	5678	39269
2030	6019	41625

Based on the projected total costs and benefits, the NPV for the project scale-up is estimated at Tsh. 143 billion over 10 years. Therefore, the project is highly viable over a defined time scale. The project will contribute to poverty reduction from income generation at the household level, creation of employment and establishment of support industries such as transportation, storage facilities and infrastructural development. Consequently, scaling up the poverty-environment projects is likely going to start a chain reaction of other economic activities that will generate more income than the original increase. Furthermore, it is important to note that these economic activities have social benefits such as improved diet, improved health from using clean renewable energy, and reduced workload for women. Therefore, the total economic value, which comprises of economic, social and environmental benefits, is higher than reported.

2.8 Demand for the products

The products for the proposed scaled-up projects include honey, wax, fish, Azolla, cooking gas (Methane) and bi-slurry. Demand analysis for these products was undertaken at the local level, as the initial market for these products will be at the local level/national level.

2.8.1 Honey and wax

Demand analysis for honey was assessed based on consultation with beneficiaries and through literature review on honey consumption in the country. Consultations with the apiculture beneficiaries was undertaken to gauge the demand for honey at the local level. All the beneficiaries indicated that honey demand exceeds supply. Beneficiaries noted that all their honey harvests are sold as soon as they arrive at the market.

In addition to qualitative analysis of honey demand, literature review was undertaken to gauge the demand for honey in the country. It is estimated that 90% of all honey produced (10,000mt) is consumed locally as food or input for making local beer. The global demand for pure honey is constantly exceeding supply (International Trade Centre, 2014). Demand for honey and beeswax in the world market is very high and the demand for Tanzania honey and beeswax exceeds supply (Mwakatobe & Mlingwa, Undated). It is estimated that current production is far below the potential of the country. For instance, it was estimated that Tanzania had the potential of producing 138,000 MT of honey and the current production is less than 10% of the potential (International Trade Centre, 2014). The markets for

the honey and wax for Tanzania honey and wax are as depicted in Table 36 below.

Table 36:

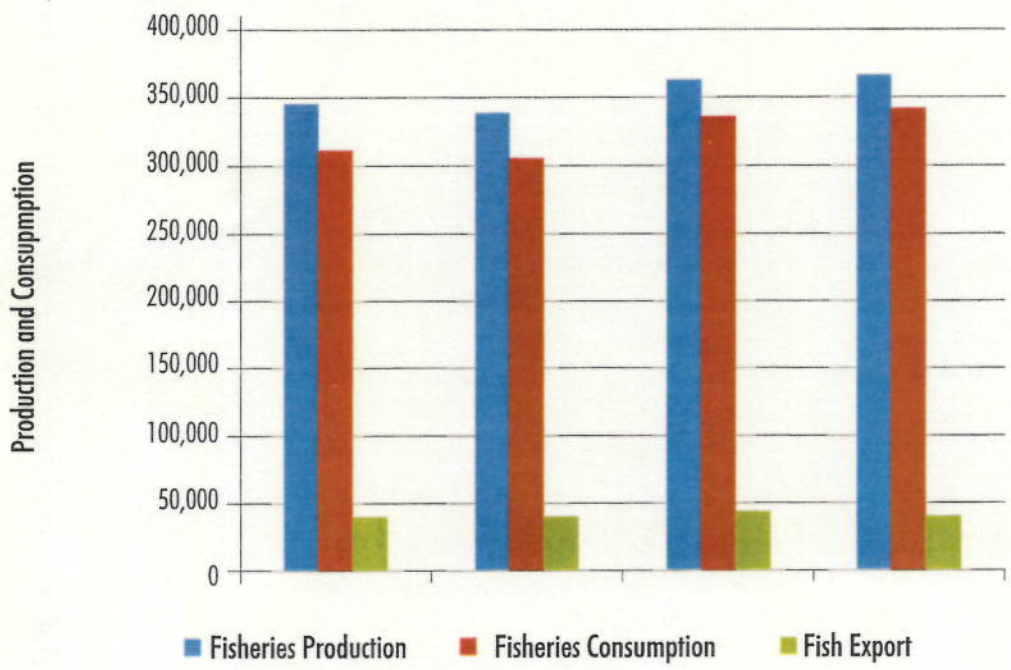
Markets for Tanzanian honey and wax

Locally	Urban Centres
Regionally	Kenya and Uganda
Globally	European Countries, United Arabs Emirates, Oman, Japan and USA

Figure 4 below depicts Tanzania honey and beeswax production over the years. As indicated, honey production has been on the decline due to deforestation for agricultural activities (Mwakalobe and Mlingwa, undated).

Figure 4:

Honey and bee wax production over time



Consequently, over the years there has been a decline in honey and bee wax exports. This presents an opportunity for the poverty-environment apiculture scale up to close the declining gap and increase honey and bee wax production.

2.8.2 Fish

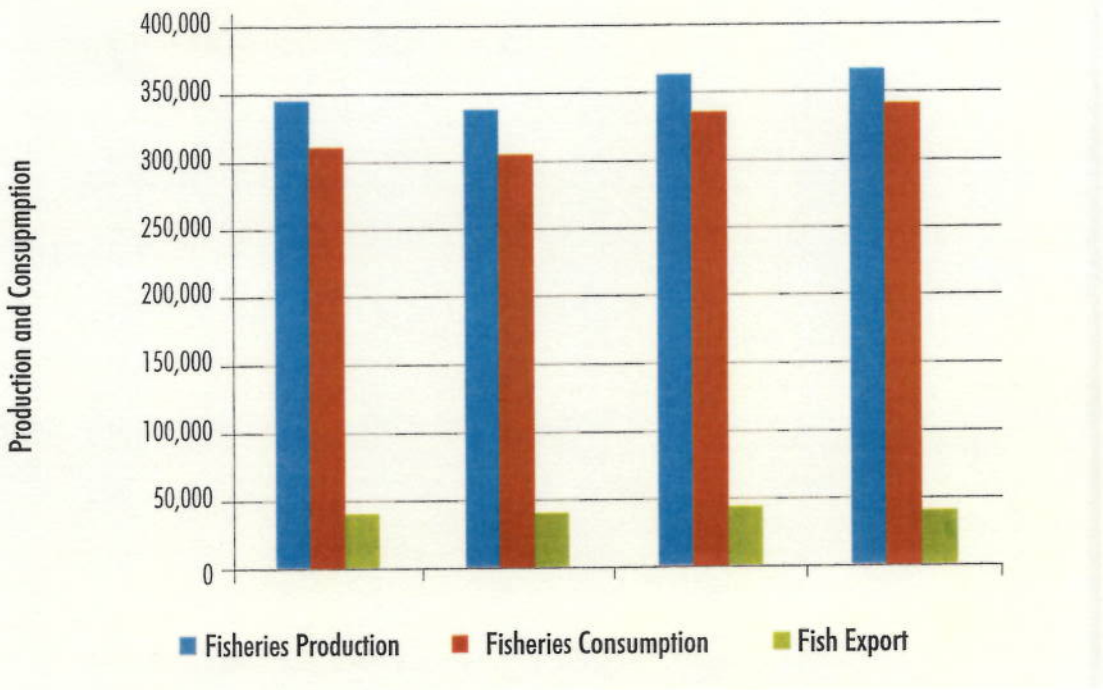
The domestic demand for fish in Tanzania has been extensively analysed by various research organisations (Aquaculture, 2016). The conclusion is that the demand outstrips supply mainly due to the following reasons:

- Population growth in the country;
- Prevalent use of traditional methods and tools such as both inefficient and destructive to fish habitat/ breeding ground; and,
- Lack of adequate infrastructure and proper handling of day catch which results in high percentage of wastage.

Currently, the fish demand deficit is estimated at approximately 400,000 tons per year (Aquaculture, 2016). Other assessment depicts a scenario where fish production exceeds domestic demand as depicted in Figure 5 below. However, it is important to note that fish consumption is constantly increasing in the country which presents an opportunity for fish project scale-up.

Figure 5:

Fish production and consumption trends over time Tanzania



Source: Fisheries Statistics (2013)

2.8.3 Energy

Tanzania has under-developed energy sector with less than 15% of the country's population having access to electricity (Uisso, undated; Msyani, 2013). In the rural areas, it is estimated that only about 2% of the population have access to electricity. Consequently, it can be concluded that 98% of the rural population are dependent on biomass (fuelwood) energy (Uisso, undated; Msyani, 2013). Therefore, based on the current energy demand situation and the fact that fuelwood is no longer a renewable resource at the rate it is exploited and current scarcity, the demand for alternative renewable energy is growing exponentially. A snap shot demand survey for the biogas in Sengerema District revealed a strong demand by the households. The main reasons for the high demand for biogas production plants by the households are the following:

- There is acute scarcity of fuelwood in rural Tanzania. The respondents/households indicated that they have to travel long distances to collect fuelwood. On average women and children spend 4 to 5 hours per day collecting fuelwood and they make 4 trips per week.

- High social cost of fuelwood collection. Linked to traveling long distances and frequent trips, it was revealed that the social costs are high. These are mainly in terms of incidents of sexual harassment, opportunity cost of studying, rape/defilement incidents and snakebites.

2.9 Support structure for p-e sustainability

Although the pilot projects have shown a strong NPV and hence financing sustainability, there is a need for comprehensive institutional and policy structure in place to ensure continuous operations. Support should be in terms of access to markets, M&E, training and mentoring. Some of the fundamental parameters that must be addressed are:

- Development of Operational Guidelines for Poverty Environment projects;
- Mainstreaming poverty-environment in district and national planning system;
- Establishing policy framework and instruments;
- Creating synergies with other economic activities;
- Including the p-e projects under National Adaptation and Mitigation Actions (NAMAs) and Intended Nationally Determined Contributions (INDCs); and,
- Improved coordination through strengthened Institutional Arrangements.

These issues are discussed under institutional arrangement, policy paper and recommendations.

2.10 Financial support strategy

Evidently, initial scaling up will require significant financial injection. While CBA results should incentivise the government to fund scaling-up, there are other additional funding options that should also be actively pursued. Therefore, a multi-pronged financial strategy is proposed comprising on donor funding, setting up credit facility for funding and government financing. These funding mechanisms are discussed below:

Donor funding: the biogas project is a renewable energy initiative which has the potential to reduce emission from deforestation and forest degradation. Such projects are legible for funding from various climate change funding mechanisms mainly:

- Green Climate Fund;
- The Special Climate Change Fund;
- Adaptation Fund;
- Africa Climate Change Fund; and
- Least Developed Countries Fund (LDCF)

Thus, there is a need for the government under the Department of Meteorology or the climate change focal point to develop proposal for funding the biogas project in the rural Tanzania. In addition, biogas is one of the initiatives that falls under Reduced emission from Deforestation and forest Degradation (REDD programme. It is therefore important that the countries develop the REDD+ programme and engage in carbon trading to generate revenue for financing the biogas projects in the country.

Credit facility: aquaculture and apiculture are highly profitable projects, which are in a position to service soft loans. Therefore, there is a need for the government to set-up a credit facility to finance these projects. It is recommended that the loan for these projects should attract zero interest as a way of incentivising the rural communities to participate in these projects. The credit facility can be in the form of micro loans facilities.

International Donors: This is another avenue for financing scaling up the p-e projects in the country. There are a wide range for organisations that fund poverty and environmental related initiatives and projects such as Global environmental Facility, United States Agency for International Development (USAID), Japan International Cooperation Agency and others. Therefore, proposals should be developed for funding scaling-up of the piloted projects.

2.11 Conclusions

The p-e projects were piloted to demonstrate that investments in sustainable use of natural resources would help to reduce poverty and enhance natural resources sustainability. Consistently, the results from CBA indicate that these projects are highly viable and can reduce household poverty. All the piloted projects displayed positive NPV, which imply that the projects would achieve pro-poor economic growth.

Based on the initial CBA results, an assessment of the project scaled up by a factor of 10 from the pilot project was undertaken. The results showed that an investment of Tsh. 3 billion will result in Net benefits of Tsh. 140 billion over a 10-year period. This expansion would be catalytic for achieving green growth, which could reduce poverty, inequality and enhance environmental sustainability. In addition, it should be used as demonstration to other households on the impact of p-e initiatives.

A robust institutional structure must be set up at the district level to oversee the expansion of the pilot projects. Equally important will be structures in place to ensure that there is access to markets. Critically, a Credit Facility must be set up at the district level to finance increased investments in similar projects.

Reference

Abubakar, I, U, S. B and Ismail, (2012) Anaerobic digestion of Cow dung for biogas production. ARPN Journal of Engineering and Applied Science Vol. 7 no2.

Andersson, J and Slunge, D (2005) Tanzania-Environmental Policy brief. Swedish International Development Cooperation Agency.

Aquaculture (2016). Tanzania agriculture. http://tanzaniainvest.com/agriculture/opportunities-exist-in-aquaculture-as-tanzania-experiences-shortage-of-400000-tonnes-of-fish-ministry-of-agriculture-says

Aquaculture (2016). Tanzania agriculture. http://tanzaniainvest.com/agriculture/opportunities-exist-in-aquaculture-as-tanzania-experiences-shortage-of-400000-tonnes-of-fish-ministry-of-agriculture-says

Bradbear, N (2009). Bees and their Roles in Forest livelihood. Food and Agriculture of the United Nations.

Cameron, F (2002) IPN now ubiquitous in Scotland. Intrafish, 19th September http://intrafish.com/article.php?articleID=27242

Environment Africa (2011). Sustainable Livelihoods – Beekeeping in Zimbabwe "bees keep trees" http://www.environmentafrica.org/2011/05/sustainable-livelihoods-%e2%80%93-beekeeping-in-zimbabwe-bees-keep-trees/

Gerlach, F., Grieb, B., and Zerger, U (2013) Sustainable Biogas Production: A handbook for organic Farmers. FiBL Projekte GmbH, Postfach 90 01 63, 60486 Frankfurt am Main Germany

German, L.A., A. Tiani, A. Daoudi, T. M. Maravanyika, E. Chuma, N. Beaulieu, H. Lo, C. Jum, N. Nemarundwe, E. Ontita, G. Yitamben and V. Orindi (2010). The Application of Participatory Action Research to Climate Change Adaptation: A Reference Guide.

Groot, L and Bogdanski, (2013) Bioslurry=Brown Gold: A review of scientific literature on the co-product of biogas production. Food and Agriculture Organisation of the United Nations.

International Trade Centre (2014) Tanzania: Honey Sector synthesis report and development roadmap. ITC 54-56 Rue de Montbrillant 1202, Geneva, Switzerland

IPCC, (2007). Climate change: Impacts, adaptation and vulnerability. Working Group II Contribution to the IPCC Fourth Assessment Report.

Kifuko, R (2015) The state of Cage Fish farming in Uganda: Actors, enabling environment, Challenges and way forward. International Journal of Education and Research. Vol 3. No. 3

Lalika, M.C.S (2009). Beekeeping for income generation and coastal forest Conservation in Tanzania. Bees for Development Journal, Vol 88: 4-6

Mazorodze, T. B (2015). The contribution of apiculture towards rural income in Honde Valley Zimbabwe. Presented at the National capacity Building Strategy for Sustainable Development and Poverty Alleviation Conference (NCBSSDPA) 2015) may 26-28, 2015, American University in the Emirates, Dubia

Mmasa, J. L. (2007) Economic analysis of honey production and marketing in Hai district, Kilimanjaro, Tanzania.

http://suaire.suanet.ac.tz:8080/xmlui/handle/123456789/269

Mishra VN, Malhotra M, Gupta S. Respiratory disorders in females of Delhi. J Indian Med Assoc 1990 Mar;88(3):77-80.

Msyani, M. C. (2013) Current status of energy sector in Tanzania: Executive exchange on developing an ancillary service market. USEA-Washington DC 25th -2nd March 2013

Mwakatobe, A. and Mlingwa, C. (Undated) Tanzania-The status of Tanzanian honey Trade-Domestic and International Markets. Tanzania Wildlife Research Institute, P.O. Box 661, Arusha, Tanzania

Philip, M.F. & F.L. Williams (2004). Tropical deforestation and greenhouse gas emissions. Ecological Applications, 14(4), 982 – 986.

Ray D, Abel R, Selvaraj KG. A 5-yr Prospective Epidemiological Study of Chronic Obstructive Pulmonary disease in rural south India. Indian J Med Res 1995 Jun;101:238-44.

Rao, A.B. (2011). Biogas for Rural Communities. TD390 Supervised learning: Study report

SADC Trade (undated) Trade information brief: Honey. Trade and Industrial Policy Strategy (TPS). 814 Church Street. Arcadia House. Pretoria.

Smart Farmer Magazine (2016). Keeping bees can greatly boost crop production. Smartfarmerkenya.com/keeping-bees-can-greatly-boost-crop-production/

Smith, K. R (2006) Health impacts of household fuelwood use in Developing countries . UNASYLVA Vol 57 no 224 pp41-44

Smith, K.R., Mehta, S. & Maeusezahl-Feuz, M. 2004. Indoor smoke from household solid fuels. In M. Ezzati, A. Lopez, A. Rodgers, S. Vander Hoorn & C. Murray, eds. *Comparative quantification of health risks: global and regional burden of disease due to selected major risk factors*, pp. 1435–1493. Geneva, Switzerland, WHO.

Staniford (2002). Sea cage fish farming: an evaluation of environmental and public health aspects (the five fundamental flaws of sea cage fish farming) Paper presented at the European Parliament's Committee on Fisheries public hearing on 'Aquaculture in the European Union: Present Situation and Future Prospects', 1st October 2002: http://www.europarl.eu.int/hearings/20021001/pech/programme_en.pdf http://www.europarl.eu.int/committees/pech_home.htm

Susanto I.R. (2015). Sustainable Organic Farming for Sustainable Environmental Health:

A Social Development Model. International Journal Of Scientific & Technology Research Volume 4, Issue 05, May 2015 ISSN 2277-8616

Uisso, P.J. (undated) Rural Energy and Innovation in delivery of modern Energy Services to rural Areas. Rural Energy Agency, Dar Es Salaam

UN ENVIRONMENT and UNDP (2015) National Communication Strategy on Environmental Sustainability and poverty Reduction (2015-2019).

UNDP (2015). Tanzania Human Development Report 2014: Economic Transformation for Human Development. Economic and Social Research Foundation. 51 Uporoto Street Dar Es Salaam

Uisso, P.J. (undated) Rural Energy and Innovation in delivery of modern Energy Services to rural Areas. Rural Energy Agency, Dar Es Salaam

Wingqvist, O. G (2010). Tanzania Environment and Climate Change Policy brief. Environmental Economics Unit. Department of Economics, University of Gothenburg, Sweden.

WHO (2012) Health indicators of sustainable energy in the context of the Rio+20 UN conference on sustainable development. Initial findings from the WHO expert Consultations 17-18 may 22.

WHO (1978) Environmental Health Criteria 5-Nitrates and N-Nitroso compounds. Geneva World Health Organisation