PRACTICAL ACTION
Consulting

KIGALI INSTITUTE OF SCIENCE AND TECHNOLOGY

IMPACT ASSESSMENT OF THE CITT DISSEMINATED TECHNOLOGIES IN RWANDA.

FINAL REPORT 2006.

TABLE OF CONTENTS

ACRONYMS

CITT – Center for Innovation and Technology Transfer

KIST- Kigali Institute of Science and Technology

RTTP – Rural Technology Transfer Project

DfID – Department for International Development

EST – Energy Saving Technology

ES – Energy Saving

GoR – Government of Rwanda

VCA – Value Chain Analysis

BDS – Business Development Services

SP – Strategic Plan

ITDG – Intermediate Technology Development Group

IFAD – International Fund for Agricultural Development

Min Infra - Ministry of Infrastructure

SNV – Netherlands International Development Organization

UNHCR – United Nations High Commission for Refugees

EXECUTIVE SUMMARY

The Center For Innovation and Technology Transfer, CITT was established in the year 2002 under the umbrella of The Kigali Institute of Science and Technology KIST. Being the only technical institution in Rwanda, KIST has the role to spearhead technological advancement in Rwanda, hence the establishment of CITT, to specialize in technology development and transfer. The Center was established for the purposes of meeting technology needs of Rwanda in the process of economic development. Since inception The Center has focused on at least 5 sectors, mainly as agents of technology development and transfer as well as training service provision.

The Center secured funding from DfID to implement a 36-month technology development and transfer programme entitled Rural Technology Transfer Project, (RTTP). The project was to be implemented in 3 phases; Internal Capacity Building, Research and Project Start up and Technology Development and Transfer. The project eventually ran over 39 months.

CITT planned to develop and adapt fully at least 34 technologies between 2002 – 2006[1]. Out of the indicated 34 technologies, at least 4 can be stated as fully developed and adapted. These include; Biogas Technology, Waste management, Energy Saving Stoves, Energy Efficient ovens. The rest of the 30 technologies planned for development and dissemination are either still at development stage or have passed the development stage but are yet to be disseminated. Within the CITT programme log frame, for the same period of time, it is specified that, 'at least five fully developed and adapted technologies/products, annually'. It is apparent that this goal is yet to be achieved due to a number of challenges which will be elaborated within the body of the main report.

In view of the current PRSP focus, while some of the technologies envisaged for development are highly relevant, a few appear to be less relevant. The most successful technologies that CITT has managed to develop and disseminate well, have been the energy saving technologies and the biogas technology for institutional and household use. These are the technologies whose uptake has been high and which have resulted in high impact. These technologies have greatly addressed the escalating environmental concerns in Rwanda and still hold high potential to contribute to environmental regeneration and conservation.

In the area of training, CITT has mainly trained associations and individuals in food processing, construction of simple energy saving cook stoves and biogas plant construction & maintenance. These interventions have also resulted in significant impact, with at least 4 enterprises established and running and several employment and business opportunities created.

The positive impacts of CITT technologies and interventions have been significant. The disposable incomes for both households and institutions have increased due to application of CITT technologies. Living conditions of both households and institutions have improved both health wise and generally. Income generation has increased for primary and secondary producers. Employment creation has been realized while some cases of post harvest loss reduction have been registered. The application of ESTs, has reduced rate of deforestation in some areas. There have also been some bottlenecks too; some technologies intended for commercial application have not been successful not because of their utility but because the investors have made poor business decisions due to lack of advise. Out of the 224 beneficiaries of training sampled, about 65% have gone ahead to apply training skills for commercial purposes. Lack of starting capital has been the main hindrance.

Whereas, the CITT interventions are highly relevant to Rwanda and are in line with the current national poverty reduction strategy, the uptake of these technologies has been, on average, relatively low. This has

[1]. CITT Strategic Plan: 2002 – 2006, Page 5 – 7.

been occasioned by a number of factors, chief among them, the inability of CITT to establish mechanisms to work with private sector in the replication of technologies, but, further, limited access to resources by target end users. CITT being a government-funded agency has also been continuously faced with the challenge of limited resources.

Within its mandate, CITT has potential to address, directly and indirectly, many of the challenges and opportunities facing Rwanda currently. The assessment of CITT interventions also brings to light aspects of the CITT approach which can be enhanced in order to increase impact and outreach.

This report, constitutes the impact assessment of CITT interventions but also goes further to recommend how CITT can enhance impact and best realize its mission ‘to contribute to the poverty reduction in Rwanda through provision of needed innovative technologies and skills development programs to the communities’

1.0 OVERVIEW OF IMPACT ASSESSMENT FINDINGS

1.1 Introduction

The mission of CITT is in line with the current GoR PRSP as it states that its mission is to 'contribute to the poverty reduction in Rwanda through provision of needed innovative technologies and skills development programmes to the communities'. A further statement on the overall objective of CITT is: ' To develop relevant technological innovations and ensure their sustainable transformation and adaptability to the people who need them most'. In the 2002 – 2006 strategic plan of CITT, 5 sectors have been selected for technology development and transfer intervention. These include: agriculture, energy, shelter, transport and water. Over the 5 years of the CITT strategic plan, specific technologies have been identified for development and transfer[2]. Specific findings related to specific technologies are elaborated in this chapter.

1.2 Biogas technology

The biogas technology has been one of most successfully developed and transferred technologies. Biogas technology has been widely taken up by institutions, mainly prisons but also educational institutions. The institutional biogas has been applied primarily in availing highly affordable energy but a secondary application has been in waste management. The design of the biogas systems for institutional application has been pegged on institutions with high human occupancy, such as prisons and schools, as these operate by harnessing energy from human waste generated by the occupants. Savings in wood fuel energy realized from applying biogas technology have been on average 40%. For household use, the biogas systems mainly run on livestock waste and are therefore suitable for a household that has livestock within its compound. In the households sampled, biogas has replaced at least 80% of their wood fuel use.

CITT has installed biogas in at least 6 prisons in Rwanda. These are, Cyangugu, Rilima, Kimironko, Butare, Mpanga, Gitarama and Nsinda prisons. In these institutions, CITT trains prisoners and supervises them in the practical installation of biogas plants. Largely, the trainees provide the labor required and further, are trained in the maintenance of the systems, after installation. CITT has a number of independent biogas artisans on standby, who are contracted during biogas plant installation contracts. These artisans have all received training in biogas plants installation from CITT; about 70 of them directly[3], while a few are former prisoners who are trained while providing labor during prison biogas installation exercises.

This approach to the dissemination of biogas technology has been effective in some aspects. The biogas artisans interviewed during the assessment, testified that each of them has at least secured a contract to install household biogas systems, independently. Apart from that, they have managed to secure 3 – 4 month contracts with CITT, during prison biogas installation.

However, in a few instances some weakness in the CITT approach was identified:

1. The absence of technology manuals for reference has limited the ability of the beneficiaries in managing malfunctions of the technology. In the case of Rwaza secondary, the biogas plant is under performing due to a problem they are unable to diagnose independent of CITT. In Cyangugu, back flow of gas has caused serious corrosion of iron sheets in kitchen and ablution areas and metallic surfaces in the kitchen.
2. The absence of installation diagrams has also made it a challenge for institutions to manage systems well and independently. Mpanga Prison is one such prison.

[2] CITT Strategic Plan, 2002 – 2006. Page 5 - 7
[3] Figure provided by Emmanuel Kanigwa, CITT Deputy Director

3. The emphasis on training prisoners compromises the sustainability of the technology as prisoners' turnover is relatively high and can leave institution vulnerable.
4. Linkages between biogas technology beneficiaries and private biogas artisans are yet to take place, which means that CITT remains the main solution provider even after installation. Yet the capacity of CITT may not allow efficient delivery of required solutions.
5. There is excess gas produced in some of the institutions which necessitates them to continuously run biogas burners in order to avoid occurrence of gas explosions. A few have presented their needs to install systems for lighting using biogas as a solution to this but efforts to address this appear not to be forthcoming.

1.3 Energy Saving Technologies

The energy saving technologies have been developed at varied scales and acquired by low income to middle income households as well as institutions such as prisons and schools, and business enterprises such as hotels and bakeries. The thrust of these technologies is to reduce the intake of wood fuel and this has been tremendously realized. At institutions which have installed biogas, energy saving cook stoves have also been utilized to increase energy use efficiency.

At institutional level, ES community cook stoves have been widely taken up by schools, prisons, colleges and hotels. These are designed in such a way that the loss of energy is highly minimized so as to use very little firewood or biogas. Most institutions interviewed stated that the saving resulting from usage of ES cook stoves is 50%.

Hotels and bakeries, which have acquired ES bread ovens, have realized very great saving in energy bills. Alpha Palace Hotel previously used an electric oven to produce all the pastries requirements of the hotel. Although, the proprietor did not disclose figures, he stated that, 'The monthly electric bill used to be very very high but after installation of the energy efficient bread oven, the cut in the bill is so so immense'

Low-income houses, especially in rural areas, have installed cheap ES cook stoves constructed using mud and bricks, en mass. In a district known as Ngororero, close to 100% uptake of these cook stoves was registered, with up to 10% spill over effect in neighboring districts[4]. In the Mbungangali settlement scheme, 90 households have installed brick-type ES cook stoves without CITT's intervention. In Gihembe Refugee Camp, 2,500 households have installed mud-type ES cook stoves. Evidently, this technology has had a tremendous impact on households and the environment. On average, usage of wood fuel has reduced by between 60 – 75%. Muranguva Vedaste of Mbungangali settlement – Gisenyi stated, 'After installing an energy saving cook stove, the amount of wood that I could use for 1 day, now lasts for 3 days' Further, Musenuzi Munyamasoko of the same settlement stated, 'It took $3m^3$ of wood to produce 1 sack of charcoal which lasted for 2 weeks in my household, but now, the same amount of wood without being converted to charcoal, lasts 3 months when used with my energy saving cook stove'.

The energy saving cook stoves have been successfully disseminated due to the approach used by CITT in creating both push and pull market forces.

1. CITT has widely publicized the ES cook stoves, thus creating high public and government awareness of the technology.

[4] Audio-visual Monitoring report, Emmanuel Kanigwa, CITT, May 2006

2. CITT has trained a number of individuals and associations in the fabrication and installation of the ES cook stoves; Ngwino women association from Buliza district and Murambi women association, 25 demobilized soldiers, 106 artisans from Busegera district. These artisans have gone on to install ES cook stoves for households at a fee as well as train other artisans in the same field.
3. CITT has been instrumental in a cabinet decision that all households in Rwanda must have at least 1 ES cook stove by May 2007.
4. Collaborating with government and non-governmental agencies in the dissemination of ES cook stoves. E.g. Gihembe Refugee camp, where CITT collaborated with UNHCR in the installation of ES cook stoves.

1.4 Solar technologies

Solar lighting technology was sampled at the Arusha camp. It has served mainly the purpose of lighting households but also amounted to a number of benefits for users. Households, which previously spent a lot of money on paraffin, now spend much less, while school-going children can now do their studies at home comfortably. Availability of lighting means that house chores do not have to be limited by nightfall. However, the sustainability of this intervention may not be guaranteed due to a number of reasons.

1. The hardware used by households i.e. batteries may be too costly to replace and also the local availability of the same is not guaranteed.
2. The total fees paid for use of the system by the 500 households benefiting is not adequate to maintain running costs as indicated by the local area councilor who also leads the project steering committee.
3. The implementation of the project was not participatory as such and so the sense of ownership of the beneficiaries is very low. The steering committee still maintains that the project is CITT's and UNDP's and so these two agencies are fully responsible for footing any maintenance costs of the system.

CITT has installed solar water heating at the Gikonko health center which has mainly served to reduce the rate of deforestation in the surrounding area. Further, the center is able to disinfect hospital laundry and provide approximately 80 patients with warm bath water. The kitchen and laundry operations of the hospitals have also been made more easy and faster, thus leading to better efficiency.

1.5 Other CITT technologies

Other CITT technologies were sampled, but have not been widely disseminated and hence their impact has not been felt significantly. These include: Water harvesting technology, Juice Squeezer and Tomato processing.

1.5.1 Water harvesting

Water harvesting was sampled at Arusha Resettlement and Reintegration. The impact of this has been varied for different categories of residents. For primary going children, less time is now spent in fetching water – fetching from rivers and springs takes up to 1 hour, while water storage point takes only 10 – 20 minutes. Aged people, living alone now can be able to fetch water for themselves and not have to pay someone to fetch it. However, water is only available at the storage points during rainy season and 2 months after.

1.5.2 Juice Squeezer

The juice squeezing technology has been disseminated to at least 1 individual entrepreneur and 1 development agency, Concern Worldwide. The individual entrepreneur has established an enterprise in pineapple juice and wine making, within Kigali, with very high income potential.

The technology has potential for higher uptake, especially in areas where there is pineapple growing, although it still requires a lot of improvement. It is highly relevant in areas that do not have access to electric power and it has been effectively applied in minimizing post harvest losses. The proprietor, who requested anonymity, stated, 'I get pineapples from my farm and sell in the open market. I convert all the pineapples left over from sales, into juice and wine, which I sell – in fact my customers complain because I am not able to meet their demand for especially the pineapple wine'

1.5.3 Tomato processing

Tomato processing technology has been disseminated to 1 association – Dushyigikirane, according to records. The technology has largely been used in the commercial production of tomato paste. It has a production rate of 200 – 300 Kg of tomatoes per day. The market for the end product is vast and mainly in Kigali and so the income potential of this technology is high.

In conclusion, the technologies and interventions are relevant and though not expressed, the demand for them is present.

2.0 SPECIFIC FINDINGS

2.1 Number and category of beneficiaries of CITT technologies

The impact assessment sampled 24 project sites of CITT interventions. The list of the sampled beneficiaries is as indicated in Table 1 in Annex section.

According to the information gathered from total persons interviewed, at least 3,750 people have benefited directly from CITT.

Out of the 3,750 beneficiaries

- 108 individuals have benefited from training only. These are:
    - Zion Temple Women Association - 10
    - Biogas artisans - 8
    - Kacyiru womens association - 32
    - Dushyigikirane Association - 58

- 507 individuals in the Dushyigikirane Association have benefited from a combination of training and access to appropriate technology. These were trained in bakery and tomato sauce production and in addition to this obtained energy saving oven which now benefits the 507 members and a tomato-processing machine. The training was given directly to only 58 members of this association

- 3,090 households have benefited from access to appropriate technology
- 7 institutions have benefited from accessing appropriate technology specifically energy saving technologies
- 6 business enterprises have benefited from access to affordable capital equipment
- 90 other individuals have benefited from institutions applying CITT technologies

This number is not inclusive of all the artisans who have undergone training in biogas systems installation and proceeded to obtain employment as well as contracts to install a number of biogas systems. The total number of these artisans, as recorded by CITT is approximately 70, but only 8 biogas artisans were present in an impromptu FGD held during the assessment.

For purposes of determining the indirect beneficiaries of CITT interventions, it was modestly estimated that for every income-earning individual, there are 7 dependants. This was only done where, either a household or an association involved in enterprise, have benefited, but not a standard business enterprise such as a hotel. For institutions such as prisons and schools, the occupants were considered as beneficiaries mainly because they directly interact with the technologies. For example, where biogas or wood fuel community cook stoves are installed, inmates in prison and also students are involved in kitchen operations.

As a result, it was approximated that there are 43,049 indirect beneficiaries of CITT interventions.

Within this number, the following are covered:

29 individuals have benefited from obtaining direct employment through CITT interventions. Bakery and food processing enterprises which have been established as a result of CITT training and technologies have employed this number of people.

23 individuals or enterprises have benefited from establishing a business in supplying inputs or transport provision etc to CITT direct beneficiaries

150 households situated around Lake Kivu and over 200 fishermen whose livelihoods depend on Lake Kivu, have benefited from impact of CITT intervention – Cyangugu area, where households and fishermen were suffering the consequences of severe air and water pollution caused by poor waste management by the Cyangugu prison

21,941 women, men and children belonging to households where at least one member has accessed appropriate technologies and/or training

640 underprivileged individuals including, 500 widows and 140 orphans

18,629 individuals residing in institutions which are utilizing CITT appropriate technologies.

1,368 boys and girls in schools and 69 other people in institutions.

At this point, it is not easy to determine conclusively what percentage of the direct and indirect beneficiaries constitutes women or men.

According to CITT records:

A total of 248 people have directly benefited from accessing technology

A total of 21 institutions have directly benefited from accessing technology

A total of 224 women and men have directly benefited from accessing training in the areas of food processing, energy stove making and ICTs

2.2 Financial benefits of CITT technologies and interventions

2.2.1 Introduction

There have been commendable financial benefits realized by the beneficiaries of CITT technologies and training interventions. Some have been direct while others have been indirect.

CITT training programmes have mainly been in the area of food processing.

The CITT technologies have been both direct utility purposes while some technologies have served specifically as capital resources for income generation. Both these have resulted in benefits for the direct users as well as indirect beneficiaries.

The direct utility technologies sampled are; institutional and household biogas, institutional and household energy saving cook stoves, solar water heater, solar lighting and water harvesting.

The technologies applied for income generation purposes include; energy saving bread oven, tomato pureeing machine, Juice extraction and sauna and steam bath.

2.2.2 Financial benefits of end utility technologies

The actual financial benefit analysis of the technologies is contained in **Annex 5**

2.2.2.1 Biogas

Institutional level: Mpanga prison, Rwaza Secondary and Gitarama prison

The application of biogas at institutional level has resulted in significant reduction in cost of energy. Biogas cook stoves at institutional level are running on gas generated from human waste. The cost of installation of biogas systems ranges from $35,000 for a 150$m^3$ plant and $100,000 for a 400$m^3$ plant. These are biogas plants for large institutions with an occupancy of between 2,000 – 5,000 people. For biogas plants below 150 m^3, the cost is below $35,000. The cost of maintenance is very low at 2% of the cost of installation per annum. The estimated life span of the institutional biogas systems is 20 years.

For large institutions, 10 years worth of annual savings are approximately equivalent to the cost of installation of a biogas system. While annual savings for 4 years can cover cost of maintenance over the lifespan of the system and the cost of depreciation.

With records showing that at least 7 prisons, namely; Cyangugu, Kimironko, Butare, Gitarama, Nsinda and Mpanga have installed the above described biogas systems, there is potential for an average saving of $55,200 annually on energy. If the remaining prisons in Rwanda install similar biogas systems, the annual saving is likely to double.

Small scale institutions: Gako Organic Farm & Training center

Smaller institutions such as households and farms have installed biogas systems running on waste from livestock, mainly cows dung and urine. Households with as low a number of cows as 2 and as high as 20, have installed biogas systems.

Gako Organic farm was sampled for small-scale biogas systems. This is a farm as well as a training center specializing in organic farming techniques. The farm trains close to 10 existing and potential farmers every three months. Previously, their annual expenditure on wood fuel for training was $120. However, after installation of biogas system, the use of wood fuel has altogether been eliminated and further the proprietor and farm workers use the biogas generated for domestic purposes.

At a cost of $17,500, this system will have a payback period of 58 years, if it runs on the current capacity. If the usage was to double, since the capacity of the system can accommodate it, then the payback period is likely to be at minimum 29 years.

Conclusion: It appears that biogas plants of smaller capacity have longer payback periods of time as compared to larger capacities of biogas plants. This does not diminish the benefits of this technology as the benefits are relative not only the actual costs but other costs such as cost on environment, availability and cost of alternatives etc.

2.2.2.2 Energy Saving Cook stoves

These are improved wood stoves that are highly efficient in usage of wood. These stoves are highly insulated and largely minimize loss of heat to the atmosphere to ensure that maximum heat generated from the wood is utilized for cooking. Besides the energy efficiency benefit, the cook stoves have also served to eliminate smoke emissions in operation areas.

Institutional level: Gakoni Youth Polytechnic, Mpanga Prison,

Large institutions which have installed energy saving cook stoves have realized 50% cutback on wood fuel usage. An example is Mpanga prison which has a population of 5,827 prisoners and has realized a saving of $12,000 annually on wood fuel expenditure. The institution has 6 units of energy saving wood fuel cook stoves. The payback period is slightly more than 2 years.

Gakoni Youth Polytechnic has a population of 860 students who are boarders and has realized a saving of $2,000 on wood fuel expenditure. The institution has 3 units of energy saving cook stoves. The payback period is approximately 6years.

Conclusion: Once again, the observation is that the fewer units used, the longer is the payback period. But these technologies are paying back in other ways – especially the saving made on cost of environment.

Household level: Gihembe Refugee Camp- Byumba, Mbungangali Settlement Scheme- Gisenyi, Arusha resettlement and reintegration camp- Gisenyi

The cost of household energy saving wood fuel cook stoves ranges from $1 to $4. The life span of these systems is 3 years. The maximum cost of maintenance is $0.5 per year.

Households which have installed these cook stoves have realized between 60 – 75% saving on wood fuel expenditure. A household previously spent $10 monthly on wood fuel but now spends between $3 - $5 per month. The saving per year ranges from $36 to $60 per household using the energy saving wood cook stoves. The average annual saving is $48 per household. This is representative of an increase in disposable income per household.

In Gihembe Refugee Camp, a total of 2,500 households have installed the energy saving cook stoves, which implies that the saving of the households combined is $120,000 per annum.

In Mbungangali, 90 households have installed the energy saving cook stoves, which implies the combined saving of the households is $4,320 per annum.

In Arusha Resettlement, 500 households have installed the energy saving cook stoves, which implies the combined saving of the households is $24,000 per annum. These cook stoves were designed to utilize briquettes but currently are running on wooden chips.

If the approximately 1 million households all over Rwanda acquire these technologies, then there is potential to bring about an aggregate saving of $48 million annually. This is an astronomical figure but quite close to realistic as it has been established that 90% of the energy used in Rwanda is from wood fuel.

2.2.2.3 Solar lighting

This was sampled at Arusha Resettlement and reintegration.

The solar power generation unit has been installed at a high point within the resettlement. All the original 500 households have batteries which are charged at the generation unit, at least once weekly per household. The project was funded by UNDP who sub-contracted KIST to install the hardware. In turn, KIST sub-contracted a South African firm to do the actual installation.

Previously, the households used paraffin for lighting purposes and on average would spend 3,000Frw, approximately $6 per month on paraffin. Currently, each household pays 300 Frw, approximately $0.6 per month to have their batteries charged.

However, discussion with the project management team, revealed that the collections of 300Frw from each of the 500 households is still not adequate to meet their running costs and their plans are to request further assistance from UNDP to meet the running costs. This is in an indication that the project may not be sustainable if the households do not increase their monthly fee.

2.2.2.4 Solar Water heating

This was sampled at Gikonko Health Center.

Although the institution did not buy wood fuel in cash, it used to raise about $4m^3$ worth of wood fuel per week from patients who could not afford medical fees. This is valued at $24 per week and $288 per annum Since installing the solar water heater in 2004, this wood is no longer required as the heater is able to generate hot enough water, throughout the day. This, though not direct, has removed expenditure on wood fuel by the hospital.

2.2.3 Financial benefit: Technologies applied for income generation

2.2.3.1 Energy Efficient Bread oven

These were sampled at Kigali and Butare towns:

Kigali: Alpha Palace Hotel, Dushyigikirane Association

Butare: Matar Supermarket, Mont Huye Motel

The ovens run on wood fuel and are operated on small to medium scale production of baked items ranging from bread to cakes.

Alpha Palace Hotel previously used an electric oven to produce all the pastries requirements of the hotel. Although, the proprietor did not disclose figures, he stated that, 'The monthly electric bill used to be very very high but after installation of the energy efficient bread oven, the cut in the bill is so so immense'

The saving realized by Alpha Palace can be approximated at $100 per month and $1,200 per annum. Implying that over a period of 3 years maximum, the total investment can be paid back.

The hotel is currently putting measures in place to utilize the oven for additional 5 hours in order to produce pastries for selling outside the hotel by mid 2006. This business, in the approximation of the proprietor, is likely to fetch a net monthly income of $300 at minimum.

The **Dushyigikirane Association** has a fully-fledged bakery unit at its location in Buliza. The bakery unit has been in operation since 1995 but was using a traditional oven. The traditional oven had very low production but consuming a lot of firewood. In 2003, the association received an energy efficient bread oven from CITT through an IFAD project. The oven has had very high production rate but consuming very little firewood. Where as 'the traditional oven could enable the group to meet only 20% of the Buliza area current market demand, the energy efficient oven has enabled them to meet almost 100% of the market demand'. The manager of the bakery unit, Anastasia Akimana, stated this. Before the association could meet the local area demand, all the bread sold in that area was coming from Kigali.

This bakery unit realizes a daily profit of $24 and a monthly profit of $720, implying the total annual profit is $8,640.

The traditional oven produces only 30% of the bakery products while the energy efficient oven produces 70% of the products. This implies that the energy efficient oven generates an annual profit of $6,048.

This profit is not only benefiting the association in general but also the 9 employees of the bakery unit, each of who earn on average $53.5 per month and $642 annual income.

Bakery business is only one of the several business lines that this association has. However, it is the leading source of income for this association. Through this business, the association has been able to contribute significantly to the construction of 140 houses for widows in the Buliza area and the purchasing of a goat for each of the 500 orphans supported by the association.

At the **Mont Huye** Motel, the oven was under utilized and thus not operating profitably. Only 14 loaves of bread are baked after every two days for motel residents. This is not justifiable given that Butare has several bakery enterprises which are able to meet demand of the entire town. Although the justification given was that the motel did not want to lack bread during power outages, it still did not make business sense for the motel to invest in this oven.

At **Matar supermarket**, the oven was purchased in 2004 and only operated well for 2 months after which it broke down and resulted in very cumbersome operation for a period of 3 months. The oven was abandoned after this and has never been operated. In stead the proprietor, Mr. Tarik, has invested in a traditional oven which now produces '200 kgs of product as opposed to 50 kg of product yielded by the CITT oven'.

2.2.3.2 Sauna and steam bath

These were sampled at: New Blue Sky Hotel – Nyagatare and Heroes Bar (affiliate of Alpha Palace Hotel – Kigali, Remera area)

The sauna is a concept which has picked up in many urban areas of Rwanda. The sauna at the **New Blue Sky Hotel - Nyagatare** area is very popular with residents of that area, mainly NGO workers, as well as with people residing as far as Kigali. The sauna peak days are Wednesday, Thursday and Friday where at minimum 15 clients attend. The net profit per month from the sauna is approximately $240 and annually $2,880.

The payback period for the sauna is therefore close to 0.5 year.

2.2.3.3 Tomato processing machine

No information was available on this equipment both in the field and at CITT. Dushyigikirane possess this technology but have yet to put it to use due to the scarcity of certain ingredient in the market. In their approximation, they will be able to process between 200 – 300 Kg. of tomato daily as they have immediate market for the tomato paste product. This will only be possible during the tomato harvest seasons which occur at least twice every year. It is not possible to approximate the profitability of this technology, as the information available is inadequate.

2.2.3.4 Juice extraction

This was sampled in Kigali- though the sampling was partial due to reluctance of the proprietor to give the assessment team information that could incriminate him. He is currently operating without RBS certification but selling his products discreetly.

Pineapple juice fetches a much higher market value than raw pineapple. However, the preparation of the pineapple for the extraction process takes slightly longer. The juice is sold directly and some percentage as wine. The cost of the juice was not given and the frequency of production was not given but according to the information of the proprietor, he is unable to meet his customer's demand for pineapple wine. However it is approximated that he fetches $720 from a sale of 120 litres which is extracted from 240 Kg. of pineapple. This is as opposed to the $200 he would fetch for 240Kg of whole pineapple.

2.2.4 Non financial benefits of technologies

2.2.4.1 Environment

The technologies sampled have potential to significantly contribute to environmental conservation.

Wood fuel constitutes 90% of the fuel used in Rwanda[3]. This has had an enormous impact on the environment due to an extremely high rate of deforestation to meet energy needs of the population. The CITT energy technologies have greatly addressed the issue of environmental degradation through availing alternatives to wood fuel like in the case of biogas as well as energy saving alternatives that have reduced wood fuel consumption by approximately 60% on average.

At institutions such as prisons, schools and farms, application of biogas systems have seen the usage of wood fuel being altogether eliminated or drastically reduced. In prisons and schools, biogas systems have replaced 40% of the wood fuel systems, on average. Mpanga prison installed 4 energy saving biogas cook stoves to replace 4 out of the 10 fire wood cook stoves.

In Rwaza secondary school, 2 biogas cook stoves were installed to replace 2 out of the 5 fire wood cook stoves. In Gako Organic farm and training center, biogas has replaced wood fuel system 100%[5].

The energy saving cook stoves targeted for large-scale use and domestic application has been highly successful in cutting down the demand and consumption of wood fuel. While all institutions sampled, indicated that the reduction on wood fuel consumption was 50%, a few household users of the ESS indicated between 60 - 75%.

In conclusion the benefit to the environment has primarily been that the rate of deforestation has been reduced where the energy technologies have been applied. But there are secondary benefits which will arise as a result of this e.g. preservation of water catchment areas, climatic consistency etc.

2.2.4.2 Economic growth

These technologies have the potential to contribute to the growth of Rwandan economy in the following ways:

- the establishment of small industries engaged in the production and servicing of these technologies
- Small industries engaged in the commercial production of various consumer items and services, using CITT technologies
- Increasing access to products and services that are in scarce supply within the country and thereby reducing import bill
- Direct creation of employment opportunities – through training provision, up take and commercialization of technologies
- Indirect creation of employment opportunities through emergence of value chains'

Currently, the technologies transferred by CITT may not contribute to economic growth to a significant level, but with the scaling up of technology dissemination efforts, this aspect may be realized to a detectable level.

2.2.4.3 Welfare

The welfare of the direct and indirect beneficiaries of CITT technologies and trainings has generally improved. The beneficiaries sampled gave an indication of the following improvements in their welfare:

1. Better access to education for school going children
2. Food security for households with direct beneficiaries
3. Ability to afford health services
4. Increased self-esteem of women and men who are now in gainful employment
5. Better quality of life

According to Anastasia Akimana of Dushyigikirane, 'it is difficult to find a child not attending school even if [he or she] is an orphan, in this area of Buliza. We have been able to tackle poverty to a comfortable level'.

Kacyiru women's group representative, 'There was a time that most of our members had no means of income and would generally be involved in daily struggles to survive. But now I am proud that at least every 3 days of the week I leave the house to go to a place I call 'my office' and be able to bring back money for food at home'.

[5]. However, as earlier stated biogas is only meeting 80% of the household energy needs. The remaining 20% constitutes electric energy used for lighting mainly and running light electric equipment.

Musenuzi Munyamasoko of Mbungangali settlement, ‘Women and children used to suffer in kitchens during meals preparation, but since the installation of energy saving jikos, they are no longer exposed to smoke from burning wood’.

The Director of Gitarama prison, “The prison and its environs used to have a permanent smell so that the cells were intolerable and the surrounding area had a permanent awful stench.

Since the installation of the biogas system, the community around the prison have been asking my staff, ‘what became of that bad smell which used to come from the prison?”

Mrs. John De Dieu, living close to the Cyangugu prison, ‘life was unbearable here before the prison installed the biogas. The stench was so bad so that we could not sit outdoors, homes were few here by then, all the prison waste flowed to the lake so that even the fishermen could no longer be able to get customers for their fish. To visit an inmate in the prison was not easy at all. But now, all that has changed and as you can see there are more people living here and the road close by the prison is now frequently used. The stadium is once again in use- as you can see today, primary children are in the stadium celebrating the African child day’

2.2.4.4 Income levels and food security

The occurrence of poverty in Rwanda is 67% and coupled with this a prevalence of high land pressure. The livelihood system of most households in rural areas is based on small scale farming due to scarcity of land resource and limited establishment of industries. As a result of this, the productivity per household is very low and subsequently, the household income from agricultural produce is low.

CITT technologies may not have increased household incomes in most instances, but they have led to an increase in disposable income, both at household and institutional levels. The reduction in demand for wood fuel by 50% at institutional level and 60 – 75% at household level implies commensurate reduction in expenditure on fuel. These technologies have therefore been relevant in terms of addressing poverty at household levels, through increasing household disposable incomes.

At institutional levels, this has resulted in cutback on budgetary allocation for operations. Biogas technology harnessing human waste, developed for use by institutions with high rate of human occupancy, has managed to significantly reduce the expenditure on fuel by institutions such as prisons and boarding schools.

The prevalence of high land pressure has also led to the scarcity of wood fuel in some regions such as Umutara Province. James Munanura who is a Senior Project Officer at the Umutara Satellite Center stated that, ‘Fire wood is becoming very scarce in this area such that there have been incidents of families going without a meal, not because the food is not there, but because there is no fuel’. Although these communities are food secure, the shortage of energy sources is likely to compromise their ability to remain food secure. Availability of energy saving cook stoves to these communities means that they can now be able to utilize existing wood fuel resources at a much lower rate.

2.2.4.5 General

Generally, the energy technologies have resulted in improved health conditions at end use points such as institutional kitchens and household kitchens, as a result of reduced exposure of operators to smoke emissions. The risk of respiratory diseases has been reduced through availing cleaner fuel in the case of biogas and incorporation of efficient smoke exhaustion systems in the case of energy saving stoves. The beneficiaries of these technologies are mainly women and children who spend close to 40% of their time daily in kitchens and men who are the main operators in institutional kitchens.

The biogas technology has resulted in enhanced management of waste and improved health conditions at institutional level. The risk of outbreak of diseases associated with poor waste management such as cholera, typhoid and dysentery has been minimized. 'Before the biogas was installed, it was not unusual to lose patients at a rate of 1 per week here in Cyangugu and all because of diseases related to poor waste management such as cholera', the prison director.

In Ngororero district, it appears there has been close to a 100% uptake of the household energy saving cookstoves[2]. This is a testimony on how the technology has been relevant to the rural households.

3.0 SUSTAINABILITY OF THE TECHNOLOGIES

3.1 Introduction

The sustainability of the technologies can be assessed in the light of the following considerations:

1. The ability to sustain availability of these technologies at affordable cost
2. The ability to apply these technologies for cost effective operation /commercial production
3. The ability of these technologies to meet the national demands for products and services
4. The comparative cost analysis of alternatives to locally sourced technologies vis a vis imported substitutes.

3.2 Affordability

One fact that needs to be appreciated at the onset of this analysis is that Rwanda as a country is faced with the challenge of being landlocked, and further has limited natural resources. This has implications on cost of capital and non- capital goods, whether imported or produced locally. Therefore, availability of technologies at affordable cost may have to contend with this factor. Most materials required for production of equipment is sourced from neighboring countries at a much higher cost than if Rwanda was able to directly source the same. Importation of equipment also implies that the country is likely to incur high costs of initial investment as well as maintenance. Therefore, the pursuit of developing appropriate technologies locally and adapting existing technologies to the Rwandan context is highly relevant and suitable. It might take a lot of effort to develop cost effective technologies, but it is achievable, as demonstrated in the case of the energy saving mud stove which evolved from the sheet metal cook stove versions.

Ultimately if a technology serves its purpose – whether as an end utility asset or a capital good, the availability of this technology is of greater importance than its cost. Although cost is given a lot more consideration by the market, where financing options are available and information on the technologies' return on investment is attractive, the technology uptake will still be high.

Based on a general appraisal of CITT technologies, both in the field and at the CITT workshops, there is still a lot of room for optimal design achievement for close to 70% of the technologies. A number of the technologies are either over engineered and also have room for scaling down material specification. For example, the animal spray equipment currently under development could be fabricated out of lighter gauge pipes. This implies that with further development, these technologies could be made more affordable. However, it is an appreciated fact that, the scarcity in variety and availability of engineering supplies in Rwanda could limit the flexibility of technology designs. It is prudent at this point, to comment that the energy technologies i.e. cook stoves and biogas appear to be the most optimized designs so that minimal further development is required to make them more affordable.

3.3 Cost effective operation /commercial production

At least 9 were seen in operation or at least demonstrated.

Cost effective operation implies that the value of inputs during operation should be much lower in comparison to the value of outputs realized at the end of the operation. This is most applicable in production lines. In relation to an end utility, cost effective operation implies that the value of inputs during operation should be much lower in comparison to the benefit realized through the output. The inputs would still be same as in production but the output would be either tangible or intangible.

An example would be biogas system, whereby the inputs are waste materials, labor, maintenance etc., while the output is energy. In this case, the value of this energy can only be assessed in comparison with alternative energy e.g. electric power, to gauge level of benefit. The issue of sustainability in the light of cost effectiveness of a technology arises due to the potential for target users of the technology to abandon the technology if a more cost effective alternative is identified OR if the inputs required are not easily accessed either due to scarcity or cost[6].

Out of the end utility technologies sampled, institutional biogas and the energy saving cook stoves, both at institutional and household levels, demonstrated very commendable cost effectiveness. Given the extremely low cost of inputs for the institutional biogas systems and the derived utility of the output, the cost effectiveness can be rated as high as 80%. As for the energy saving cook stoves, the cost effectiveness can only be a comparison with alternatives. When compared with the open fires previously used, institutions are now realizing a saving of 50% on average, while households are realizing between 60 – 75% saving on wood fuel. Further, cooking times have been reduced e.g. at Gakoni Youth Polytechnic which has a reduction of 2 hours on cooking time and households at Ngororero which one interviewee stated on video, 'if one is not careful in attending a cooking meal, your food will burn as the food is now cooking in a very much short time than before'

Out of the capital goods category, the energy efficient oven, demonstrated high cost effectiveness. In the case of the Alpha Palace Hotel, the proprietor operator stated that all it takes is three medium-sized logs to operate the oven for a 12 hour shift and produce all the pastry requirements of the hotel especially when the hotel is full to capacity e.g. during conferences. This oven is compared with the alternative that the hotel previously used of an electric oven. [Refer to section 2.2.3.1] The Dushyigikirane Association, traditional oven was found to use more firewood but produce much less product, whereas the energy efficient oven used much less fire wood but produces much more products – indicative of cost effectiveness.

The juice squeezer was appraised at both CITT workshops, at the Umutara Satellite Center and partially at a Kigali enterprise. Demonstration was not possible any of the times but from appraising the technology, it was possible to analyze its cost effectiveness. The operation of this machine will require quite a number of people e.g. for a 6 hour shift one might require a minimum of 4 people each to work for 1.5 hour. The design of the machine is such that it will require quiet some effort to operate. Further, the efficiency of juice extraction may be low due to inherent design features. The open design also increases risk of product contamination which implies that the market value of the product may not be high and spoilage might also diminish volumes sold in the market.

---

[6] Ray Hollands report October 2004:A good example of this is the case highlighted on the viability of the briquette cook stoves at the Arusha camp in the absence of raw materials for briquette making.

The sauna system did not demonstrate a lot of cost effectiveness in operation, although the proprietor of the business is able to break even in less than 1 year. The sauna, due to its design has to run continuously whether it is in use or not. Out of the 60 hours of operation, the sauna is only in use for a maximum of 35 hours per week. In order to improve the cost effectiveness of this system, there is need for a re-design to enable operators achieve instant switch on or switch off[7]..

3.4 Relevance of technology to national needs

Once again, the energy technologies, especially the biogas, energy saving cook stoves have ranked very highly in meeting national needs. The need being met by these technologies is primarily access to affordable energy and alleviation of environmental degradation. These technologies are likely to be sustainable even in the future as the benefits are realized both at institutional levels and grassroots level. The benefit of increasing disposable household income in itself is able to drive the uptake of these technologies at household level, without much external effort. This has already happened in some parts of Rwanda e.g. Ngororero district.

The other pressing national need is generation of employment and income opportunities through emergence and growth of industries. The technologies developed at CITT have a very high potential to bring about the fulfillment of this need. CITT has developed/adapted a range of technologies which can be applied as capital goods, with examples such as; the energy efficient oven, brick making, juice squeezer, tomato processing machine, rice threshers, maize shellers, among others.

3.5 Locally produced vis a vis imported technologies

Currently, with the 67% occurrence of poverty and a weak industrial base, appropriate technologies which can find application enough to address the constraints and opportunities of the target users, may remain acceptable for Rwanda for a medium – long term period. However, as domestic wealth is generated, businesses grow, high level investors enter the market and market forces come to play, there is likely to be a shift in technology preference. Lessons from other developing countries show that, no matter, the growth of industry, the SME sector has always remained relevant, either as direct providers of services and goods to the market or as sources of goods and services to major industries. The SME sector is the main target end user of CITT technologies (especially the capital goods)

In the example of Kenya, SMEs have remained the main sources of furniture, simple machinery etc. despite the entry of big industry players. Drawing from this lesson, appropriate technologies will remain relevant for a long period of time. Although we cannot ignore the possibility that as the market gets exposed to better technology alternatives; users may gradually shift away from appropriate technologies.

[7]..However, in respect of the fact that the alternative to this appropriate design of a sauna would imply astronomical investment, this equipment is relevant for the purpose and context envisaged.

4.0 INTERACTION BETWEEN CITT AND BENEFICIARIES

4.1 Technology and training needs identification

CITT has been interacting with beneficiaries mainly during the technology needs identification stage. This has been achieved through a combination of various approaches:

1. Direct needs assessment and
2. Indirect needs assessment

4.2 Direct needs assessment

These have been conducted through participatory means such as holding Participatory Rural Appraisals with self-help groups, farmers and communities. These have enabled CITT to understand the resources available to the target groups, their current livelihood systems and the opportunities to improve these systems or diversify. The end result is that CITT is able to decide on the trainings that are relevant for the target groups as well as the technologies that they could apply.

Another way of direct needs assessment has been achieved through the student community attachment programme, the first of which took place in the year 2005 and the second round is ongoing. The students from KIST are sent out to work closely with various communities in various parts of the countries, with a view to enhancing their understanding of the needs of these communities. The students are required to report back to the WTCD their findings and in turn WTCD submits these to TRD unit which initiates the technology development process, if resources are available. Whereas this is a useful process for CITT, there are still further steps that can be taken to enhance the effectiveness. Recommendations to this effect are contained in **Section 6.0.**

4.2.1 Market surveys

CITT has conducted at least one market survey, under the facilitation of the NUFFIC TA, Jos De Beus. Through this survey, it has been possible to conduct a market scan, where by one can understand what products are currently in the market, demand and supply levels of the same, consumer trends and attitudes and market opportunities etc.

The objective of the market survey conducted and therefore its intended application are however not clear at this point as it was not possible to obtain the report on findings. This limits the level of analysis on how this tool of needs assessment is useful or can be made more useful.

4.2.2 Technology development stage

This is a stage where CITT has not managed to interact well with the beneficiaries. For most technologies, the development stage has mainly been handled by CITT in isolation. It is not clear whether this has been so due to time, man power or financial constraints. It was not evident if there has been any technology apart from the household cook stoves which have undergone continuous development.

This limitation in interaction with beneficiaries has had an effect on how comprehensively the technologies are tested and continuously modified. However, an interview with CITT staff at Umutara satellite center, indicated that there is no agreed procedure of obtaining feedback from technology users except in the course of spontaneous interaction.

During the inception stage of the Umutara satellite center, a stakeholders' workshop was held where technologies were demonstrated and 'there was interest generated in the public about the technologies', to quote James Munanura. There are also plans to erect a shed to house all technologies and demonstrate them in Nyagatare. While these two steps may serve to generate interest and even some demand for some of the technologies, the results may take too long a time period to manifest. This may also not elicit adequate significant feedback that can be applied in further technology development.

One evident fact is that, while some technologies have been tested under real life environment, several are yet to benefit from this. The recommendation here is that all technologies be tested under real life conditions. CITT can look for resources to have a stock of technology prototypes which can be loaned to target users for a given period of time on a revolving basis, with certain conditions. One of the conditions would be that the user must provide information on performance of technology, to CITT on a regular basis, should allow interested parties to familiarize with the technology while in their custody etc. CITT should take responsibility of maintenance and repair, for purposes of deepening understanding on technology. This has proved to be an effective means of involving beneficiaries in the technology development process.

In all the sites visited where CITT technologies were in use, although the accolades were profuse, at least one or two complaints about the technologies were cited. In several cases, it appears that the users do not know how to go about letting CITT to know about their problems or getting CITT to correct failures. In a few instances, the challenge is that the users are not very clear of CITT's role in correcting technology failures. The results of this situation are many, but just to cite a few:

1. Down time of equipment and therefore incurring unnecessarily high costs while using alternatives. E.g. Mpanga prison where some pans are not in use because the bottoms burnt out within 6 months. Gitarama prison which basically has to discharge all the biogas generated into the atmosphere due to incomplete installation, while still incurring high costs of using wood fuel.
2. Inefficient operation of equipment due to improper installation e.g. Rwaza Secondary where the biogas generation has declined over time, Gakoni and Mpanga prisons where despite the provision on the cook stoves for smoke exhaustion, the kitchens are filled with smoke due to poorly installed chimneys.

While this issue has to do with response time of CITT or failure of CITT to be on top of things in terms of monitoring performance of technologies, it mainly has to do with the fact that CITT may not have capacity to engage in technology development as well as operate as a commercial enterprise. It is requisite that CITT prioritize the development of a clear plan on how to address this challenge. This point will be pursued further in **Section 8.0** of this report.

4.2.3 Technology transfer

This has been handled averagely as far as interacting with beneficiaries is concerned. There is adequate transfer of information and skills to the beneficiaries in some cases, while in some, this is not the case. The deficiencies noted include;

1. CITT has not managed to engage private sector effectively in the technology transfer process. This has implied that CITT gets directly involved in technology replication, denying private sector this opportunity of commercial production of technology. However, without exonerating CITT much, it needs to be appreciated that CITT is mainly funded by GoR, which provides just enough funding for operations and maintenance. Without specific and adequate funding for technology development and transfer, this has necessitated the center to engage in commercial production of technologies in order to make ends meet.

2. Failure to impart basic knowledge and skills on the primary users of the technology – e.g. Rwaza secondary, where it appears no one has any idea on biogas basics, New Blue Sky Hotel, where workers/proprietor had no knowledge on how to deal with a simple issue such as clogged chimney
3. Poor selection of trainees – in prisons, it appears prisoners only have been trained on biogas mechanisms and maintenance and in few prisons, some members of staff have knowledge and skills on the same. This is fragile as turnover of prisoners is guaranteed and could leave prison vulnerable.
4. No evidence of documentation of information on technologies e.g. on design, simple maintenance and troubleshooting etc. This affects the ability of users to manage technologies independently and increases reliance on suppliers/sources of technology.

4.2.4 General observations

One finding of the assessment was that there are so many technology needs and training needs nationally, some of which were expressed and some implied. A number of people interviewed during the assessment expressed quiet a number of needs. Some of them upon hearing about some of CITT's technologies were marveled and were eager to get more information and ultimately acquire the technologies. This was amazing given that a good percentage of the people sampled, have had direct interaction with CITT team. But this pointed to a weakness in the communication effort of CITT.

4.2.5 Collaboration of CITT with other agencies

During the preparation of programmes, there is no evidence that CITT has collaborated with other agencies in doing this. However, there has been commendable collaboration between CITT and GoR, evidenced by the support of GoR, both financially and policy wise, in the installation of biogas plants in prisons. GoR has co-financed some of CITT's programmes, an example of which is the RTT Project, which the GoR co-financed. CITT has managed to collaborate with various donor and humanitarian agencies in the implementation of their programmes. Examples are the collaboration with the Red Cross, SNV Rwanda/MinInfra in installation of biogas in GoR prisons and rural households, collaboration with UNHCR in installation of cook stoves in 2,500 households at Gihembe.

CITT trained military personnel – both present and demobilized soldiers, in energy saving technologies so as to enable them incorporate these in their community outreach initiatives.

4.2.6 Range of options on CITT technologies

The range of technology options provided to the target beneficiaries has been low but in view of the time period of 3 years and the available human resource, it has been a good trial.

There is certainly room for the range of technology options to be widened – based on the opportunities present in Rwanda and even on the inquiries from the ground. However, a word of caution would be that CITT should analyze the range of technology that is feasible to develop within a certain time frame and within their capacity. This is in order to avoid spreading wide and thin.

5.0 SUMMARY OF IMPACTS AND KEY OBSERVATIONS OF THE CITT PROGRAMME

5.1 Impacts

1 The disposable incomes for both households and institutions have increased. An example is the application of ESTs resulting in reduction of expenditure on wood and other fuel by 40 – 60%.

2 Living conditions of both households and institutions have improved both health wise and generally.

- Before the intervention of establishing a biogas plant at Cyangugu prison, the living conditions at both the prison and the surrounding areas were despicable, with waste being channeled into the lake via open trenches. The air quality was extremely poor while the life forms in a portion of the lake were threatened, along with the livelihoods of fishermen who could no longer get market for their catch. However, the installation of a biogas plant, also by default took care of the waste management issue.
- At Arusha camp, the availability of solar lighting and water storage close to the settlements has made the lives of the residents better. Children can now read after dusk, house chores can easily be done after dusk, the time spent fetching water is minimized when water is available at the storage points, among other benefits.
- Patients at the Gikonko health center were exposed to the risk of re-infection before the health center could be able to obtain hot water for disinfecting laundry and cutlery. Warm bath water was not commonly available for the patients. However, this was addressed by the solar water heater installation.
- Prisoners who are involved in kitchen duty at prisons and students involved in kitchen activities, as well as women and children who spend a lot of time in kitchens, now enjoy smoke free environments in the kitchen, with comfortable temperatures. This is a result of applying ES cook stoves – both household and institutional.

3 Income generation has increased for primary and secondary producers. This is so especially for beneficiaries of food processing training and technologies.

- Fruit farmers can now be assured of market for a bigger percentage of their products and at a higher price, now that the products are in high demand from processors. Further, the losses of fruit have been minimized, due to the technology of processing, which implies that equally, there is an increase in income from primary products.
- Producers of juice, jam and baked products are also generating a lot of income from selling their products, which on average have satisfactory market demand.

4 Employment creation has been realized

- Established bakery enterprises – have employed at least 6 people for direct production and at least 5 other people in distribution and marketing.
- Individuals trained in biogas technology and are now conversant with biogas plant installation. At least 8 of them who were sampled attest that they have secured each 1 private contract to install household biogas. A few artisans have secured 2 private contracts. Further, they have employed other individuals, who are either biogas artisans or masons, to undertake these contracts.

5 A few cases of post harvest loss reduction have been registered. The example of the Kigali based entrepreneur who has established a pineapple farming enterprise and has been able to convert all fruits that remain unsold at the end of a market day into juice and wine. On average, he used to lose 240kgs of fruit but now all of that is converted to products having long shelf life.

6 Due to application of ESTs, rate of deforestation has reduced in some areas. In Gikonko, 4 m^3 of wood would be sourced from the area around the health center, for the purpose of boiling water for disinfecting hospital laundry. Currently nil wood fuel is used as the solar water heater is sufficing.

7 Some technologies intended for commercial application have not been successful not because of their utility but because the investors have made poor business decisions due to lack of advise. An example is the earlier stated case of the proprietor of Mont Huye motel who invested in a bread oven without good business opportunity justification.

8 Out of the 224 beneficiaries of training, about 65% have gone ahead to apply training skills for commercial purposes. Lack of starting capital has been the main hindrance – this was indicated by groups interviewed, e.g. Zion temple which took a long time to start due to lack of capital. Lack of access to critical inputs has also been a main hindrance.

The Kigali based pineapple processor, was for a long time, unable to identify a source for bottle capping machine, crown corks, bottles and he has also not been able to obtain RBS certification, to date.

5.2 Summary of key observations

5.2.1 CITT approach and structure

1 The current establishment of CITT is inadequate to amount to significant impact in all the sectors, which CITT is focusing on. These sectors are: agriculture, transport, shelter, energy, water. CITT has a lean staff establishment, both at the headquarter as well as field offices. Further, to this, CITT does not have comprehensive sector specific expertise. The result of continuing to focus on all five sectors in a broad sense, would be, diffuse impact and outreach of CITT interventions.

2 The role of program/projects management has been built into the CITT director role. This could contribute to strain of the director whose role should be 95% pure organizational management. This would also compromise the quality of program/project outputs and progress.

3 Monitoring and evaluation component of CITT is weak- there is little documentation/ evidence of program tracking and reporting. The effect of this is that the institutional memory base is weak and depends heavily on individuals rather than being pegged on to a system.

4 Cohesion and coordination between various departments within KIST and CITT needs improvement. Lack of these, has occasionally led to disjointed efforts and loss of opportunities to synergise and enhance impact of CITT and KIST overall. For example, the student attachment program, which has a very high potential to contribute to KIST and CITT goals, has not been well integrated and implemented.

5 While CITT direct interventions may be addressing some relevant issues, some critical issues have remained unattended and this has led to slowed rate of impact realization. For example:

- The ESTs are addressing the issue of deforestation and environment in a very specific way, but on the other hand, technology users continue to use wood fuel and endanger the environment, because there exists very little effort towards leading the public in environmental regeneration and sustainable fuel sourcing.
- While the trainees of fruit processing have received the skills to process fruit, a number of them are unable to begin business or to run their businesses effectively, due to the inability to address practical challenges such as sources of packaging labels, limited knowledge of the certification process, start up capital etc.

5.2.2 Other key observations

1 The value for money for some of the technologies developed is not much and CITT should focus resources on technologies which will have wide spread ripple effect and leave the rest for SMEs e.g. sauna, seesaw pump. The technologies which CITT invests in should impact the lives of more people and address more critical challenges.

2 CITT does not appear to put significant consideration on commercial models while developing technology solutions and this has resulted in the low up take of technologies in some cases or inefficient application. This is with the exception of the animal spray and the Arusha solar lighting project. A commercial model tends to look at the entirety of a business/industry, in the light of the other actors within it and places measures in place to ensure that interrelations and the constraints and opportunities in the industry are harnessed towards a certain end. Technology in itself may not address the needs within an industry hence, there is need to consider issues on how to make the technology more accessible and effective to as many target end users as possible.

3 CITT interventions (training and technology) have in some instances increased beneficiaries' dependency mentality specifically those given free with 'incentives'. Discussions with a few beneficiaries of CITT trainees reveal that they have developed some level of dependency but probing further, it is evident that this arises out of the format of partnership they have had with CITT. For example, a few stated that they receive transport, meals and accommodation during training sessions.

This ought not to be the case and CITT needs to adopt BDS approaches in as many interventions, as possible, whereby beneficiaries pay at least a significant part if not all of the cost of training. This can be adopted for especially ToTs and other service providers. CITT should avoid directly engaging in service provision but rather develop a crop of service providers.

4 SMEs involved in metal working sector, had very little idea of how they could work with CITT while others viewed CITT as a competitor

5 Majority of interviewees had limited information on the comprehensive range of technologies and services offered by CITT despite CITT's radio publicity program e.g. are Alpha Palace Hotel, Gakoni Youth Polytechnic]

6 Biogas technology has been very successful – however, indications from some of the institutions are that there is little good will from the administrative units as they have personal, vested interest in continued use of wood fuel.

7 Some cases of non-functioning technologies due to failure or incompletion. Examples as described earlier are; Matar supermarket, Gitarama prison and Cyangugu.

6.0 KEY RECOMMENDATIONS

1 CITT needs to resolve sector focus and thematic areas **urgently.** This could be based mainly on one specific priority area of the PRSP but still contribute to the other priority areas. e.g. agricultural transformation, rural development, private sector development. The Options for CITT are: select **one sector and multiple themes OR one theme and multiple sectors**, as illustrated in the tables in **Annex 2**.

2 CITT needs to review the needs assessment approach and adopt more broader/comprehensive methods of understanding target sectors/beneficiaries. e.g. of methods include value chain/sub-sector studies, PESTE analysis etc. these will enable CITT to identify its niche within the sector as well as relevant collaborators to involve in program implementation

3 CITT can enhance the student community attachment programs as follows

a. It is apparent that this student attachment has not been well linked to the currently established satellite centers. This has potential to bring conflict between the satellite center programmes and the students' interventions. CITT and KIST should look at the possibility of linking the two in such a way that the satellite centers are able to identify ways in which the students on attachment can be integrated to ongoing programmes with communities.
b. Further, students' targets and work plans should be developed based on the satellite center's work plan and it should be a joint exercise.
c. The center can play the day to day monitoring and supervision role of the students on attachment while WTCD can schedule periodic monitoring and supervision.
d. There is also a need to ensure that the community understands well the role and mandate of the center and that of the student's on attachment. The relationship between the student and the community needs to be well defined, documented[8] and understood fully by students, communities and KIST/CITT staff.
e. There is need to build into the curriculum of the students a course on community development in preparation for the student attachment – so that the students can be fully equipped with approaches in mobilizing, developing and interacting with communities.

4. CITT should engage a full time program/projects manager qualified in private sector development to manage CITT programs and reporting to the CITT Director. This will ensure that the Director focuses more on organizational management and the Program/Projects manager focuses on the overall management of programs. Although the current focus of the GoR is to attain a lean staff in government institutions, this option can be adopted especially within donor-funded programs, to ensure efficient delivery of program objectives.
5. A 'closed loop' program design and implementation cycle approach should be adopted. This means that all functions of a CITT programs should be interrelated and systematic in such a way that CITT is able to stratify program into various stages i.e. Programming, Identification, Formulation, Financing, Implementation, Evaluation and Review, Lessons generation and then back to Project formulation. The benefits of this are: better internal coordination and collaboration, more structured running of programs and maintenance of focus

6. Establish a monitoring and evaluation function to coordinate M&E within CITT as well as program review and design.

[8] There should be a Guideline for students for community attachment, which can state the attachment objective, expectations placed on the student, conduct with community, etc.

7. Develop a database for tracking CITT interventions and beneficiaries. This should be mainly fed by; M&E outputs, Student community attachment reports. [Students can be provided reporting templates which can be directly fed into this data base] and Program staff reports

8. CITT should develop manuals for all tested technologies for end users to make technologies more user friendly and to firmly establish performance levels and capacity
9. Technology production guidelines complete with engineering drawings, should also be developed to facilitate replication by private sector
10. There is need to appraise technologies which have been developed by individual innovators independent of CITT and explore possibilities of adapting/adopting these instead of 're-inventing the wheel' e.g. traditional oven, bottle capping, micro hydro. Appropriate mechanisms for promoting and directly benefiting private sector developed technologies, should be put in place

11. CITT staff require orientation on various private sector development approaches/techniques such as the Market/BDS Development, Value chain analysis/ program design, Sub-sector analysis and program design, among others.
12. CITT requires to embrace a more integrated approach to technology development and transfer. Few examples of how this can be done, include:

    a. Design interventions around commercial models in order to enhance sustainability of technologies [e.g. market/BDS models, value chain development models]
    b. Develop comprehensive business packages to interest entrepreneurs and provide elaborate information on the business potential of technologies and skills
    c. Establish business advisory services – these do not necessarily need to be part of CITT and can be private.
    d. Establish a commercially run business information facility to provide product specific information to target beneficiaries on input suppliers, services, price guidelines, markets etc. CITT can establish and run this facility at very low cost by example, using student interns to manage centers on a commission basis and by selling information at an affordable price.
    e. Collaborate with reputable MFIs to develop suitable financial products and lending options e.g. micro leasing, to increase access to finance and capital by beneficiaries.
    f. Support existing and potential SME production units in sourcing fabrication and manufacturing machine tools, affordably [ref. Strategic Plan 2002-2005]. This can either be done by linking them to suppliers of affordable machine tools or by CITT investing in the development and production of simple machine tools.
    g. Employ two-tier approach to marketing to kick start:

        - Market successful technologies and products directly to end users to stimulate market demand. One way of doing this is
        - Market business opportunities in technology replication to interest SME technology providers/producers

    h. Contribute to better policy environment through lobbying government to promote successful technologies. An example of this was the influencing of cabinet decision for all households in Rwanda to have ES cook stoves.

ANNEX 1: TERMS OF REFERENCE

The Consultant agrees to conduct an impact assessment of the CITT technologies as an evaluation process to know the actual influence of the disseminated technologies to the beneficiaries, reporting directly to the Director of CITT. The assignment will be between the 15th. May and June 23rd. 2006

Objective: The objective of the study is to assess the livelihoods and social impacts on individuals, communities and associations that have been exposed to CITT training and/or technology transfer programmes.

Scope of work: The assessment team will collect information from a range of CITT "beneficiaries" (individuals, communities and associations) and assess the impact which the training and possible new technologies have had on their livelihoods including changes in income, status, well being, social capital etc.

The assessment will pay in particular attention to the approach adopted by CITT and to see to what extent the participants have participated and influenced the design and the execution of the programmes. The survey should also try to establish to what extent the new technologies are a priority of the people concerned and if other options were discussed.

Methodology: The consultants will select a number of different technologies (waste management/ biogas at individual households, food processing, improved stoves, water harvesting, compressed bricks are possible examples but this list may be adapted during the inception of the survey after discussions with key stakeholders).

The consultants will visit a number of CITT field project sites and will collect information through participatory methods such as discussions with individual stakeholders, focus groups and key informants. The consultants will also assess if the technologies have impacted positively or negatively on others that have not been involved directly. They will specifically collect information on:

- Who and how many persons are directly benefiting from the CITT intervention?
- Are the technologies likely to have a real financial benefit to the target groups/ persons to be attractive and sustainable in future? Are there other, non financial benefits that will make these technologies attractive?
- Has the programme impacted positively or negatively on other people that were not directly engaged in the programme?
- Did the programmes have a different impact on men and women?
- Describe the interaction with CITT during the different stages of the programme: first encounters, meetings, discussions, presenting of technologies, implementation of training, follow-up etc. How did the target groups perceive the attitude and approach of the CITT staff?
- Did CITT involve other organizations in the preparation and implementation of the programme?
- What options were provided to the communities that participated? One solution or were more options presented/discussed?

The information collected from the field visits will be discussed with CITT staff to hear and incorporate their point of view.

Outputs from the assignment: Prepare an assessment for each of the selected technologies with information consisting out of quantitative data, anecdotal information, case studies etc. This information can be presented as annexes attached to the main report.

ANNEX 2: METHODOLOGY

The evaluation team selected the following technologies and areas of focus;

1. Biogas / waste management at institutional and household level
2. Food processing
3. Energy saving stoves
4. Low cost housing technologies]
5. CITT approach and structure

Visited a total of 24 CITT field project sites within Rwanda.

The evaluation was spread evenly within the 4 provinces of Rwanda, i.e. Northern, Southern, Western and Eastern

A total of 44 informants were interviewed – these are listed in **Annex 3**

Several categories of interviewees were sampled and included: individual technology users, households, institutions, hotels, other small and medium scale enterprises, training beneficiaries - both rural and urban based.

Information was collected and validated through various methods:

- Desk review of CITT project reports
- Face to face interviews with key informants and individuals
- Focus group discussions with multiple beneficiaries/stakeholders
- 'Triangulation' of information
- 'Snow balling' approach in identification of beneficiaries

ANNEX 3: LIST OF INTERVIEWEES

NAME	INSTITUTION	POSITION
1. James Munanura	Umutara Satellite – KIST	Senior Project Officer
2. Sylvia Mbabazi	New Blue Sky Hotel	Sauna Manager
3. Francis Ngarambe	New Blue Sky Hotel	Proprietor
4. Peter Claver Kabanda	Umutara Youth Polytechnic	Principal
5. Godfrey Waiswa	Gako Organic Farming	Assistant Farm Manager
6. Sebugabo Manasseh	Gitarama Prison	Prison Director
7. Medal Senkayire	Gitarama Prison	Prisoner incharge of Biogas
8. Loititia Uwimbabazi	Gitarama Prison	Social worker
9. Kalimba George	Mpanga Prison	Prison Director- Admin.
10. Kacyiru Women's Group	Kacyiru Women's Group	Member
11. Bayinga Alex	Alpha Palace Hotel	Owner/proprietor
12. Dorocella Kantarama	Dushyigikirane	Sewing/Knitting cell leader
13. Dusave Imana Emmanuel	Dushyigikirane	Agricultural specialist
14. Anastasia Akimana	Dushyigikirane	Baking cell leader
15. Musenuzi Munyamasoko	Mbugangali Settlement – Gisenyi	Charge' de development
16. Sister Martha	Rwaza Girls Secondary	Director
17. Olivier Gahire	Gihembe Refugee Camp	Cook stove technician
18. Professor Nelson Lujara	CITT	Director
19. Emmanuel Kanigwa	CITT	Deputy Director
20. Hannington Musinguzi	CITT	Marketing Officer
21. Clarisse Dusabamahoro	LWF	Agronomist - RFTDC
22. James Rubakisibo	LWF	Manager of RFTDC project
23. Marie Bertille	Matron in Charge	Gikonko Health Center

24. Nzigiye Emmanuel	Bakery manager	Mont Huye Motel
25. Segushimu Ansetti	Acting Manager	Mont Huye Motel
26. Tarik	Proprietor	Matar Supermarket
27. Edward Rwakojo	Director	Cyangugu Prison
28. John De Dieu	Owner	Cyangugu household
29. Leonea Nyirameyi	Resident	Arusha Settlement
30. Bisenga Innocent	Executif	Arusha Settlement
31. Tegeri Gad	Coordinator project	Arusha Settlement
32. Tuyyishime Vimonste	Solar Technician	Arusha Settlement
33. Nsengiyumva Munyangabo	Solar Technician	Arusha Settlement
34. Immaculata Nyirabuseruka	Housewife	Kibungo Village
35. Hijiro Tharaisisse	Resident	Kibungo Village
36. Twizeyimana Celeste	Resident	Kibungo Village
37. Bisengyimana Etienne	Resident	Kibungo Village
38. Rosemary Kyokunde	Secretary	Zion Temple project
39. Nyiramgwera Teresa	Treasurer	Zion Temple project
40. Nsengiyumva Frederic	Biogas artisan	CITT
41. Kalihangabo Francis	Biogas artisan	CITT
42. Mbungo Tharicisse	Biogas artisan	CITT
43. Ndahimana Simon	Biogas artisan	CITT
44. Mirasano Stany	Biogas artisan	CITT

ANNEX 4: SECTOR FOCUS EXAMPLES AND ILLUSTRATION

Table 1: One Sector – multiple themes focus

Sector focus	Thematic area -examples	CITT niche	Others
Agriculture	Enhanced market access	Product quality, value addition technologies,	Product promotion,
	Post harvest loss reduction	Solar driers, chillers, storage	Capacity building of farmers, farm inputs access
	Scale up agricultural productivity	Irrigation /water pumping technology	Capacity building of farmers, farm inputs access
	Agriculture modernization	Agriculture technology development	Policy, finance
Energy	Access to energy options	Solar, wind, biogas, micro hydro, ESTs etc	Finance, policy
	Decentralized energy supply	Solar, wind, biogas, micro hydro, ESCs etc	Finance, policy
water	Enhanced water resource management	Rain water harvesting/storage, hydra rams, water catchments technology	Policy, water catchments management
	Equitable access to water resources	Percussion drills, water harvesting, affordable storage, hydra rams	Policy
Shelter	Affordable housing for the poor	Low cost building materials development, low cost production equipment, low cost house designs	Policy, finance
	Livable urban and rural settlements	Appropriate technology	Physical planning, policy

Table 2: One Theme multiple sectors focus

Thematic area	Sector	CITT niche	Others
MARKET ACCESS	Agriculture	Value addition technology	Production cost reduction
		Secondary product quality improvement/standardization	Primary product quality management, sustainable production
		Skill-based capacity building of secondary producers - business, technical	Product promotion
		Business information	market linkages
	Transport	Transport technologies for goods and people transportation to market	Policy
		Appropriate roads, paths & bridges improvement and maintenance technologies	Finance, community mobilization, policy
	Energy	Affordable energy sources/technologies	Policy
		Access to energy	

ANNEX 5: BENEFICIARIES ANALYSIS MATRIX

PROJECT SITE	INTERVENTION	DIRECT BENEFICIARY CATEGORY	NUMBER OF DB	INDIRECT BENEFICIARY CATEGORY	NUMBER OF IB
New Blue Sky Hotel	Sauna	Business enterprise - hotel	1	Employees	3
				Local residents	55
				Input suppliers	7
Umutara Satellite Center					
Gakoni Youth Polytechnic	community cook stove	Educational institution	1	Boys and Girls	868
				Staff	14
Gako Organic Farming and Training Center	Biogas	Farming enterprise	1		
Gitarama Prison	Biogas	Prison - GoR	1	Prisoners and staff	8270
				Community members	
Mpanga Prison	Biogas	Prison - GoR	1	Prisoners and staff	5823
Mbungangali Settlement - Gisenyi	ESS	Households	90	Women, men, children	630
Rwaza Girls Secondary School	Biogas	Educational institution	1	Girl child	500
Gihembe Refugee Camp	ESS	Households	2500	Women, men, children	17500
Alpha Palace Hotel	Bread oven	Business enterprise - hotel	1		
Dushyigikirane Association	Bread oven, Tomato processing & training	Women and men	507	Widows	140
				Orphans	500
				Employees	14
				Transporter	2
				Suppliers	7
				Community members	
Kacyiru Women Association	Juice & Jam training	Women	32	Dependants	210
				Suppliers	7
				Employees	10
Kicukiro area artisans		Small enterprises			
Ruyumba Farmers Training and Demo Center	Biogas	Training institution	1		
Gikonko Health Center	Solar water heater	Patients	90		
		Institution	1		

Mo Ntuye Motel - Butare	Bread oven	Business enterprise - hotel	1		
Matar Supermarket - Butare	Bread oven	Business enterprise - shop	1		
Cyangugu Prison	Biogas	Prison - GoR	1	Prisoners and staff	4536
Cyangugu Households	Waste management			Households	150
				General population	
		Fishermen			200
Pineapple processing unit - Kigali	Juice squeezer	Business enterprise	1	Dependants	7
				Employees	2
Arusha Settlement and Reintegration	Solar lighting, rain water harvesting & storage, ESS	Households	500	Dependants	3500
Bugesera district ESS training sites - 3	ESS training	Households			
Zion Temple fruit products sales unit-Kigali	Juice & Jam training	Business enterprise	10	Dependants	70
		HIV /AIDS infected			
		Unemployed			
Biogas artisans - CITT	Biogas training	Men *	8	Dependants	24
TOTALS		**DIRECT BENEFICIARIES**	**3,750**	**INDIRECT BENEFICIARIES**	**43,049**

ANNEX 6: TECHNOLOGY ISSUES – FINANCIAL BENEFIT ANALYSIS

A.5.1 Biogas

Institutional level: Mpanga prison, Rwaza Secondary and Gitarama prison

1. The application of biogas at institutional level has resulted in significant reduction in cost of energy. Biogas cook stoves at institutional level are running on gas generated from human waste. The cost of installation of biogas systems ranges from $35,000 for a 150$m^3$ plant and $100,000 for a 400$m^3$ plant. These are biogas plants for large institutions with occupancy of between 2,000 – 5,000 people. For biogas plants below 150 m^3, the cost is below $35,000. The cost of maintenance is very low at 2% of the cost of installation per annum. The estimated life span of the institutional biogas systems is 20 years.
2. The costs incurred on wood fuel annually varied with the population of the institution.

   500 people institution, $2,240 spent annually on wood fuel

   5000 people institution, $23,000 spent annually on wood fuel.

   8,000 people institution, $36,000 spent annually on wood fuel.

3. With the sampled institutions having successfully replaced 40% of wood fuel stoves with biogas units, the savings are as follows:

   500 people institution, $896 annual saving

   5000 people institution, $9,200 annual saving

   8,000 people institution, $14,400 annual saving

4. For large institutions, 10 years worth of annual savings are approximately equivalent to the cost of installation of a biogas system. While annual savings for 4 years can cover cost of maintenance over the lifespan of the system and the cost of depreciation.

Smaller institutions

Previously, their annual expenditure on wood fuel for training was $120. However, after installation of biogas system, the use of wood fuel has altogether been eliminated and further the proprietor and farm workers use the biogas generated for domestic purposes. The combined needs of the farm and the household when wood fuel was used amounted to $300 per year. The gas produced currently is double the total needs of the farm and household. At a cost of $17,500, this system will have a payback period of 58 years, if it runs on the current capacity. If the usage was to double, since the capacity of the system can accommodate it, then the payback period is likely to be at minimum 29 years.

A.5.2 Energy Saving Cook Stoves

Institutional level: Large Scale

The cost of large-scale energy saving wood fuel cook stoves ranges from $3,650 to $2,800. The life span of these systems is 6 years, while the maximum cost of maintenance is $200 per year.

Large institutions which have installed energy saving cook stoves have realized 50% cutback on wood fuel usage.

500-people institutions previously used $2,240 annually on wood fuel. Current usage of wood fuel is $1,100.

5,000-people institution previously used $23,000 annually on wood fuel. Current usage of wood fuel is $12,000.

Mpanga prison has a population of 5,827 prisoners and has realized a saving of $12,000 annually on wood fuel expenditure. The institution has 6 units of energy saving wood fuel cook stoves at a cost of $3,000 per unit – in total, $18,000.

The maintenance cost over 6 years, is $7,200. The total cost of the systems is $25,200[9].

The payback period is slightly more than 2 years.

Smaller institutions

Gakoni Youth Polytechnic has a population of 860 students who are boarders and has realized a saving of $2,000 on wood fuel expenditure. The institution has three units of energy saving cook stoves. These were purchased at a cost of $2,800 per unit – in total, $8,400.

The maintenance cost over 6 years is $3,600. The total cost of the systems is $12,000.

The payback period is approximately 6years.

Household level

The cost of household energy saving wood fuel cook stoves ranges from $1 to $4. The life span of these systems is 3 years. The maximum cost of maintenance is $0.5 per year.

Households which have installed these cook stoves have realized between 60 – 75% saving on wood fuel expenditure. A household previously spent $10 monthly on wood fuel but now spends between $3 - $5 per month. The saving per year ranges from $36 to $60 per household using the energy saving wood cook stoves. The average annual saving is $48 per household. This is representative of an increase in disposable income per household.

In Gihembe Refugee Camp, a total of 2,500 households have installed the energy saving cook stoves, which implies that the saving of the households combined is $120,000 per annum.

[9] Sum of cost price and cost of maintenance and depreciation

In Mbungangali, 90 households have installed the energy saving cook stoves, which implies the combined saving of the households is $4,320 per annum.

In Arusha Resettlement, 500 households have installed the energy saving cook stoves, which implies the combined saving of the households is $24,000 per annum. These cook stoves were designed to utilize briquettes but currently are running on wooden chips.

If the approximately 1 million households all over Rwanda acquire these technologies, then there is potential to bring about an aggregate saving of $48 million annually. This is an astronomical figure but quite close to realistic as it has been established that 90% of the energy used in Rwanda is from wood fuel.

A.5.3 Energy Efficient Ovens

The ovens run on wood fuel and are operated on small to medium scale production of baked items ranging from bread to cakes. The cost of these ovens ranges from $1,333 and $2,000. The life span of these units is estimated to be 6 years with an annual cost of maintenance of $200. Therefore the total investment of the unit ranges from $2,533 and $3,600.

Alpha Palace Hotel previously used an electric oven to produce all the pastries requirements of the hotel. Although, the proprietor did not disclose figures, he stated that, 'The monthly electric bill used to be very very high but after installation of the energy efficient bread oven, the cut in the bill is so so immense'

The daily cost of wood use for the oven is approximately, $1.5, implying monthly the cost of fuel is $45. At this cost, the oven is engaged over a period of 12 hours daily. A commercial oven has a minimum rating of 5Kw, which would imply that it consumes 60Kw hrs per 12-hour shift and 1800Kw hrs monthly. For a unit cost of $0.08 per unit, the total cost of operating this oven is approximately $144 per month.

The saving realized by Alpha Palace can be approximated at $100 per month and $1,200 per annum. Implying that over a period of 3 years maximum, the total investment can be paid back.

The hotel is currently putting measures in place to utilize the oven for additional 5 hours in order to produce pastries for selling outside the hotel by mid 2006. This business, in the approximation of the proprietor, is likely to fetch a net monthly income of $300 at minimum.

The **Dushyigikirane Association** has a fully-fledged bakery unit at its location in Buliza. The bakery unit has been in operation since 1995 but was using a traditional oven. The traditional oven had very low production but consuming a lot of firewood. In 2003, the association received an energy efficient bread oven from CITT through an IFAD project. The oven has had very high production rate but consuming very little firewood. Where as 'the traditional oven could enable the group to meet only 20% of the Buliza area current market demand, the energy efficient oven has enabled them to meet almost 100% of the market demand'. The manager of the bakery unit, Anastasia Akimana, stated this. Before the association could meet the local area demand, all the bread sold in that area was coming from Kigali.

Currently, the unit consumes 100 Kg of wheat flour daily for the production of assorted baked products. With the addition of other ingredients, on average the total weight of products could be 160Kg daily. The average unit cost per Kg. of plain baked product is $1, with a profit margin of $0.15 per Kg. Therefore the daily profit of the bakery unit is $24 and monthly profit is $720, implying the total annual profit is $8,640.

A.5.4 Sauna

These were sampled at: New Blue Sky Hotel – Nyagatare and Heroes Bar (affiliate of Alpha Palace Hotel – Kigali, Remera area)

The cost of the technology is approximately $360. The life span of the technology is 10 years with an average maintenance cost of $100 per year. The total investment is $1,360.

The sauna is a concept which has picked up in many urban areas of Rwanda. The sauna at the **New Blue Sky Hotel - Nyagatare** area is very popular with residents of that area, mainly NGO workers, as well as with people residing as far as Kigali. The sauna peak days are Wednesday, Thursday and Friday where at minimum 15 clients attend. The charges per client are $3 and therefore the monthly income of the sauna is $540.

The costs incurred include salaries for 3 employees who are paid on average $50 so that the total expenditure on salaries is $150. The expenditure on wood fuel is $80 while the bill for toiletries is $15 monthly. The overheads are approximately $55.

The net profit per month from the sauna is approximately $240 and annually $2,880.

The payback period for the sauna is therefore close to 0.5 year.

This was sampled in Kigali- though the sampling was partial due to reluctance of the proprietor to give the assessment team information that could incriminate him. He is currently operating without RBS certification but selling his products discreetly.

A.5.3 Juice Squeezer

The cost of the machine is $250. It is able to produce between 90 - 120 litres of juice in 1 hour from 240 Kg of pineapple, using 2 laborers. This product fetches a much higher market value than raw pineapple. However, the preparation of the pineapple for the extraction process takes slightly longer.

The juice is sold directly and some percentage as wine. The cost of the juice was not given and the frequency of production was not given but according to the information of the proprietor, he is unable to meet his customer's demand for pineapple wine. Information sourced indicates that juice concentrate fetches $6 per liter in the market, therefore implying that the 120 litres of juice fetches a total of $720 per batch as opposed to $200 for the 240Kg pineapple.