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Enterprise Budgets for Improved Stoves: The Case of Murang'a, Kisii Central, Bomet and Transmara Districts

-Main Report Edition 2-

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Nairobi, March 2010

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Abbreviations, Acronyms and Definitions

Abbreviations and Acronyms

CF	Cash Flow
CF-D	Discounted Cash Flow
€	Euro (1 Euro ≈ KES 100 at the time)
GM	Gross Margin
GPS	Geographical Positioning System
HH	Household
IRR	Internal Rate of Return
Kg	Kilogram
KES	Kenya Shillings
PD	Person-day
PSDA	Promotion of Private Sector Development in Agriculture
PU	Production Unit
US $	United States Dollar (1 USD ≈ KES 76 at the time)

Definitions

Gross Income/Gross Margin: Total incomes minus all costs except family labour costs
Gross Margin per Person Day: Gross Income/Gross Margin divided by family labour person days
Liners: Clay insulators used in construction of firewood-consuming stoves for reducing energy loss
Jiko Kisasa stove: A fuel saving stove installed with a liner
Mud Rocket Stove: A fuel saving stove installed with an insert or mud-bricks
Internal Rate of Return The annualized effective compounded return rate which can be earned on the invested capital, i.e., the rate of yield on the investment. It is the rate of interest for the capital that is required to make all investments (including the valuation of family labour) just break even the returns over the total life cycle of the investment.
Cash flow: This refers to the difference between the total costs (including labour) and the Total revenue of an investment per year.
Discounted Cash flow: this refers to the annualized present value of an investment projected cash flows using a discounting rate that is the opportunity cost of capital.
Person Day: This is a normal labourer working day that consists of 6 to 8 hours.

1.0 Executive Summary

To make reasonable and profitable enterprise decisions, investors/farmers and relevant stakeholders need accurate and reliable information. A worked out budget helps to assess all costs and benefits accrued from the enterprise hence enabling stakeholders to know whether the investment is economically viable when compared with other available alternatives. This paper presents the enterprise budget report on two energy saving stoves- Jiko Kisasa and Mud Rocket Stove. Internal Rate of Return, gross savings, incomes and costs have been used as tools to determine the benefits of the stoves compared to the usual 3-stone open fire place common in rural households. The first part of the report addresses production aspects of liners and the second part installation aspects of both the Kisasa and Rocket stoves respectively.

The average cost of production for one Kisasa or Rocket liner is about KES 96 and sells at KES 120 to KES 200 depending on the demand in the market. The 1620 liners are made in 12 batches of 150 pieces per month which is the capacity of an average kiln and 1 cycle takes a month.
A mean gross margin of KES 390 per person-day means the business is sustainable and more worthwhile than earning from casual labour at a daily rate of about KES 200.

Profitability in the stoves enterprise is controlled by the capacity of the kiln and the frequency of burning. Assuming a kiln of 150-200 capacity and operated only 4 times per month, the annual gross savings rise four-fold. Assuming a family of 4.5 persons working 365 days a year, their individual daily income from the enterprise is KES 155; roughly double the considered poverty threshold of USD 1 (KES 76) per day.

With the same assumption the labour required per year labour also rises four-fold to 992 PD (Both Family and Non-Family). Assuming the family can only afford 450 PD (300 from husband and 150 from wife), the rest must be sought from casual labourers. If 1 labourer affords 300 PD in a year, then the enterprise will have to engage 2 casuals. Hence the enterprise is a good rural employer.

Tables 1a and 1b below represent a summary of some of the key findings of the study.

Table 1a: Summary Results of Economic Indicators of Stove Liners Production per Year[1]

PARAMETER (KES)	Production (1620 Liners)	Production per Liner
Revenue	194,400	120[2]
Capital Costs	130,636	81
Total Costs	155,491	96
Gross Margins/Year	63,764	39
Gross Margins/PD	390	0.2
Family Labour (PD)	166	0.1
Non-family Labour (PD)	82	0.05

Profitability in the stoves liner production is determined by the capacity of the kiln and the frequency of burning. Assuming the burning is done weekly (4 times a month), the gross

[1] The enterprise has a lifespan of 5 years based on the useful lifespan of the kiln and sheds
[2] The 5 year mean price is KES 108 since liners are produced for only 6 months in the first year

margins per year is KES 254,856. If family is composed of 4.5 persons, the daily earning per calendar-day is KES 155 which is more than double the considered poverty threshold of USD 1 per day or KES 76. Hence, such a family would be considered well off.

With the same assumption the labour required per year also rises four-fold to 992 PD (Both Family and Non-Family). Assuming family can only afford 450 PD (300 from husband and 150 from wife), the rest (542) must be sought from casual labour. If 1 labourer affords 150 PD in a year, then the enterprise will have to engage 4 casuals. Hence the liner-production enterprise is a good rural employer.

Table 1b: Summary Results of Economic Indicators of Installed Stove per Year

PARAMETER (KES)	Twin liner Jiko Kisasa	Twin burner Mud Rocket
Direct Saving	9,744	10,344
cost of installation	2,886	3,185
capital cost per year	4,818	7,451
Gross savings/Year	4,926	7,086
Gross savings/PD	445	620
Family Labour	11	11
Hired Labour	0.1	3.2

The cost of installation for the Kisasa stove is lower than that of Rocket stove though the fuel consumption is comparable. But eventually, the Rocket stove accrues more benefits since it demands less maintenance costs and the benefit of accommodating different sizes of cooking pots.

Since improved stove technology adoption is not an enterprise as such to the family, income and employment effects can only be viewed from the installer's point of view since it is an income generating activity. Assuming the installer has 300 PD in a year dedicated to the activity, he/she can ideally install 6,000 Kisasa stoves; but practically only 1,500 with the rest of the time spent moving from homestead to homestead or 94 mud Rocket stoves (1 Kisasa requires 0.05PD while 1Rocket stoves requires 3.2 PD including follow up labour). This means the installer can manage 5 Kisasa stoves or 3 Rocket stoves per day. This translates to an annual income of KES 150,000 from Kisasa or a mere KES 28,200 from Rocket stoves (installers charge KES 300 per PD). Since one installer does a mix of the two, the average annual income is KES 89,100; which translates to an income of KES 244 per calendar-day. Hence, stove installation is a moderately lucrative business.

2.0 Introduction

To make reasonable investment decisions enterprise budgets are necessary to be worked out, to assess costs and benefits, in order to see if an enterprise is worthwhile and how it performs in comparison with available alternatives. This paper presents stoves enterprise budgets.

The economic model used in the analysis of the enterprise aims at analyzing all the inputs used and comparing them with the revenue/savings/implied incomes generated to eventually help households, producers, installers and stakeholders to assess the economic value of an enterprise in different regions. Households will be empowered to decide which among the stoves that would be economically most beneficial to them.

This study was conducted between September and December 2009 in Murang'a, Kisii Central, Bomet and Transmara districts. The location of the households and producers was identified using the Geographical Positioning System.

3.0 Methodology

3.1 Agro-ecological and Socio-economic Conditions of the Study Area.

Since January 2006, GTZ - Private Sector Development in Agriculture (PSDA) programme has promoted the utilization of fuel saving stoves in Kenya at household and institutional level. This has principally involved the promotion of the Maendeleo Kisasa stove. In the early stages of the project the reasons limiting the Maendeleo stove producers achieving their full potential in production and marketing, were assessed. A survey of 29 stove production centres (10 of these had been supported by GTZ in the 80s) in 16 districts was carried out in August 2005, and the results formed the basis for the intervention by the new project.

A second survey conducted in February 2006 showed that:

- 96.8 % of the population used firewood for cooking.
- 87.5 % of the population used traditional three-stones cooking.
- 4.8% of the households used Maendeleo stoves (improved firewood stove), which corroborated the findings of the Ministry of Energy study of year 2002, in which the results showed that 4% of the population used the improved stoves.
- The average firewood consumption was 1.2 kg per person per day (PD), while the national figure stood at 1.5 kg per PD.

The project has focused on addressing the problems identified during the assessment in August 2005; namely to scale up the production and sales of the Maendeleo stove (branded Jiko Kisasa). The following targets were set: At household level 225,000 people; at institutional level 9,000 people; Private entrepreneurs 1,000 people.

To achieve these targets, the project has been:

- Stimulating private sector and community-based organizations (CBOs) to participate on all levels of the stove development chain, promoting a commercial approach to all stove activities, by persuading households to invest in buying stoves, and setting up private business ventures, as this will be the driving force which will eventually ensure sustainability.
- Focusing on each level of the market (sales, installation and utilization), so that all activities and strategies are geared to increasing uptake of the stoves.

- Capacity building to empower community members with the appropriate technical skills. This will reduce the role of institutions in the quality control, coordination, monitoring and evaluation of the stoves. Operating within existing government structures and staff, to bring on board local networks and political ownership, vital in supporting the project.
- Creating opportunities in stove activities for those directly and indirectly affected by HIV/AIDS in order to create opportunities to save time, money and labour. Sensitizing the community to support the creation of a market for stoves

Murang'a and Kisii Central districts were some of the districts visited and entrepreneurs interviewed in the enterprise budgeting assignment.

Murang'a is one of the districts of Kenya's Central Province. Its capital town is also now named Murang'a but was called Fort Hall in colonial times (before 1963). It is inhabited mainly by and is considered the home of the Kikuyu, the largest tribe in Kenya. The district has a population of 348,304 (1999 census).

Murang'a and surrounding districts on the eastern slopes of the Aberdare Range show an upward increase in rainfall and in the length of the agro-humid period which is characteristic of increasing altitudes, due to the effect of the south-eastern trade winds. The annual average rainfall reaches a maximum of 2,700 mm at 2,500 m. From this altitude up to the forest line and down to about 2,200 m, it is so wet, cold and steep that the area is not recommended for agriculture

Kisii highlands are divided into few agro ecological zones with high potential. The highlands have high population density with some areas having as high as 950 persons per square Kilometre. The annual rainfall is not only high with an average of 1200 to 2100 mm but also reliable. The major agro ecological zones of Kisii highlands are:
- Tea-Dairy zone
- Wheat/Maize pyrethrum zone
- Coffee-Tea zone
- Lower Midland sugarcane zone.

The major soil units in the Kisii region are the upland soils with top soils rich in organic matter. They have moderately high natural fertility and are intensely farmed.
The population per household in Kisii region is on average 5 persons per household.

3.2 Study Model/Approach

The study was conducted in a step-wise approach described below:
Step 1: Interviewing a few farmers/households (at least 4) for initial data
Step 2: Building the Economic Model using the data from the few farmers/households. Here, Important gaps are identified and the interview checklist is improved to address the gaps
***Step 3*:** Interviewing few more farmers/households (at least 4) for verification of the first data and addressing the gaps identified in a second location.
Step 4: Improving the Economic Model using the new data
Step 5: Validation of data: Involves sharing the results with several stakeholders in the particular value chain/thematic area and identifying technological innovations
Step 6: Refining the Economic Model using the feedback from the focus group session
Step 7: Moving to a second location and repeating the procedure.
***Step 8*:** Documenting and presenting the complete Enterprise Budget

PART 1: PRODUCTION & SALE OF LINERS

4.0 Results and Discussions: Production & Sale of Liners

In the following chapters the main important results shall be presented and discussed. This chapter addresses the production of liners followed by the economic analysis of installed stoves in the next chapter. Further elaborations on conditions, assumptions and details of calculation are made in a separate Annexes report.

4.1 Revenue from Sale of Liners

In the table 2 below, it shows that the production of 150 liners per month (assuming that this is the number the shed and the kiln can accommodate at any one time) would produce about 900 units in the first year since there are 6 production cycles (6 months). In the first 6 months the producer will have to set up the sheds and kilns. Selling at KES 120 per liner, the producer is able to make a commendable sale of about KES 216,000 per year from year 2 to year 5. This translates to a monthly turnover of KES 16,200 or 135 units per month.

Table 2: Stove Liners Sales (in KES) per Year

YEAR	UNITS	PRICE/UNIT	SALES
1	900	120	108,000
2	1,800	120	216,000
3	1,800	120	216,000
4	1,800	120	216,000
5	1,800	120	216,000
Total	**8,100**	**600**	**972,000**
Mean	**1,620**	**120**	**194,400**

4.2 Costs and Capital for Liners Production

From table 3 below, it is evident that major costs of investment are made in the establishment year that includes the setting up of structures, buying of tools and many more. A small scale producer will have to invest about KES 160,550 at the start as the capital to set up the production unit. The cost goes down in the following years to about KES 123,220 per year. An average capital (without considering the family labour) of about KES 130,686 is required per year. This would translate to about a cost of KES 81 per piece (KES 130,686 divided by average of 1620 liners per year). The total costs are on average about KES 155,541 per year or KES 96 per unit when family labour is considered.

Table 3: Costs (in KES) per Year

Year(s)	Capital without Family Labour	Total Cost
1	160,500	186,075
2 to 5	123,170	147,845
Total	653,180	777,455
Mean	130,636	155,491

4.3 Net Income

Net income is reached when all the costs including the cost of implied labour costs are considered and subtracted from the revenue gained. This is also referred to as the cash flow. From the table 4 below, it is clear that a production unit producing 1,620 units of liners per year, will break even at the third year with a net income of KES 58,085. This is the point where he will be able to gain back the cost of establishment investment in the first year and losses in the second year and make some income. The income however turns positive in the second year. This shows that the enterprise is profitable.

Table 4: Net Annual Revenues

Year	Revenue	Costs	Net Income	Cumulative Net Income
1	108,000	186,075	(78,075)	(78,075)
2	216,000	147,845	68,155	(9,920)
3	216,000	147,845	68,155	58,235
4	216,000	147,845	68,155	126,390
5	216,000	147,845	68,155	194,545

4.4 Gross Margins

Gross income/gross margin includes all incomes minus all costs - except family labour. In this calculation, the cost of family labour is not considered because the entrepreneur does not pay him/herself, though we don't capture family labour in gross margin we do so in net income calculation since family labour may present an opportunity cost where the entrepreneur could possibly earn income using his labour elsewhere. From table 5 below, the mean gross income per year in the production of 150 liners per cycle is KES 63,714.

Gross income per Person Day is the return to labour. This shows the payment that the family/entrepreneur labour is worth per person-day (6 to 8 working hours) if they were to be paid. The average gross margin per PD is KES 390 which is more than twice the normal casual wage of KES 150 per day in the areas under study.

Table 5: Gross Margins per Year and Per Person-Day

Year(s)	GM	PD	GM/PD
1	(52,500)	171	(308)
2 to 5	92,830	165	564
Total	318,820	829	1,949
Mean	63,764	166	390

4.5 Labour Requirements

From table 6 below, there is intense use of labour in the first year with about 171 family-PD and 122 PD non-Family labour. The considerable need for non-family labour in the first year is justified by construction of sheds and the kiln. This however reduces to about 72 PD in the following years for the work of moulding and inserting the pot rests on the moulds. On average, about 166 PD of family labour are consumed and about half (82PD) non-family required per year. This shows an impressive engagement for the family and employment for the local community all year round.

Table 6: Labour Requirements (in PD) per Year

Year(s)	Family labour	Non-family labour
1	171	122
2 to 5	165	72
Total	829	410
mean	166	82

4.6 Internal Rate of Return

Internal Rate of Return is the annualized effective compounded return rate which can be earned on the invested capital, i.e., the rate of yield on the investment. It is the rate of interest for the capital that is required to make all investments (including the valuation of family labour) just breaks even the returns over the total life cycle of the investment.
Production of liners has an extremely high Internal Rate of Return of 79%. This means the business repays its investment costs very fast and the business is lucrative.

4.7 Production Income and Employment Effects

Profitability in the stoves enterprise is determined by the capacity of the kiln and the frequency of burning. Assuming the burning is done weekly (4 times a month), the gross margins per year is KES 254,856 (63,714 X 4). If family is composed of 4.5 persons, the daily earning per calendar-day is KES 155 which is more than double the considered poverty threshold of USD 1 per day or KES 77. Hence, such a family would be considered well off.

With the same assumption the labour required per year also rises four-fold to 992 PD (Both Family and Non-Family). If normally the family can only afford 450 PD (300 from husband and 150 from wife), the rest (542) must be sought from casual labour. If 1 labourer affords 300 PD in

a year, then the enterprise will have to engage 2 casuals. Hence the enterprise is a good rural employer.

4.8 Sensitivity Analysis

Sensitivity analysis shows the reaction of IRR by changing the prices of different components. In this case, the reaction was tested by changing the prices by 10 percent (%). From table 7 below, it is clear that the selling price of liners is the most sensitive. A change by -10% caused a change in IRR from 79% to 38% and a change by +10% changed the IRR from 79% to 128%. Materials and labour required were moderately sensitive with tools almost insensitive.

Table 7: Impact on IRR of changing the prices by 10% for various components

PRICE CHANGES	-10%	0	10%	sensitivity
Output				
Liners	38%	79%	128%	Very sensitive
Materials				
pottery clay	85%	79%	73%	moderately sensitive
pottery sand	83%	79%	74%	"
Labor				
Family	86%	79%	72%	moderately sensitive
Non-Family	87%	79%	71%	"
Tools				
polythene papers	79%	79%	79%	Rather insensitive
Knife	79%	79%	79%	"
Sieve	79%	79%	79%	"
Water	80%	79%	78%	"

From the table, it is clear that the selling price of liners determine the profitability of the stoves production enterprise compared to materials and, labour and tool costs. Producers would gain/lose more by a slight change in price

PART 2: INSTALLED STOVES

5.0 Results and Discussions: Installed Kisasa and Rocket Stoves

In the following sub-chapters the main results discussed concern the economic analysis of installed Kisasa and Rocket stoves. Further elaborations on conditions, assumptions and details of calculation are made in a separate Annexes report.

5.1 Fuel Saving per Household per year

Generally, the Rocket stove saves more on firewood than the Kisasa stove. Both stoves have enabled farmers to do away with charcoal and use insignificant number of match boxes since

they both retain glowing embers throughout. When the savings are interpreted in money terms, Kisasa stoves are able to save on overall KES 9,744 and Rocket stoves 10,344 per year. On average, the Rocket stove is more efficient at 85% of fuel saving while Kisasa follows with 82.5%. Both stoves considered together achieve an average saving of 83% on fuel.

Table 8: Fuel Saving (in quantities and KES) per Household per Year

	UNITS	price per Unit (KES)	Consumption Before Stoves		Consumption now		Savings (KES)		% Savings	
			Kisasa	Rocket	Kisasa	Rocket	Kisasa	Rocket	Kisasa	Rocket
Firewood	Pack[3]	50	108	108	36	24	3600	4200	**67**	**78**
Kerosene	Litre	60	36	36	6	6	1800	1800	**83**	**83**
Match box	Box[4]	3	60	60	12	12	144	144	**80**	**80**
Charcoal	Bag[5]	700	6	6	0	0	4200	4200	**100**	**100**
Total							**9,744**	**10,344**		
Mean									**82.5**	**85**

NB: The table above represents the user's perceived saving in consumption of firewood, kerosene, match boxes and charcoal before and after installing the improved stoves.

5.2 Costs and Capital

Costs of installation

A twin-liner stove requires an average cost of about KES 2,886 while a twin-burner Mud Rocket Stove will require about KES 3,185. In the table below, it is clear that the both types of stoves are cheap to install requiring such a small amount of capital. The cost is even much more insignificant considering that water, murram; sawdust and ash are locally available in most households. Further, supply of installation labour from the household could lower the cost further down. This shows that stoves are affordable to many households rich and poor (table 9).

[3] 1 debeful of ballast weighs approximately 20 kg
[4] I matchbox has 40 sticks
[5] 1 bagful of charcoal weighs 35 kg

Table 9: Cost of Installation (in KES) for Kisasa and Rocket Stoves

	Twin liner Jiko Kisasa	Amount	Unit	Price	Total
A.	Liners	2	No	150	300
B.	Ballast	2	Debe[6]	20	40
F.	Murram	300	Kg	1	300
G.	Water	100	Litre	1	100
H.	Ash	2	Kg	3	6
J.	Hardcore	2	Debe	20	40
I.	Installation labour	5	PD	150	2,100
	Sub Totals				**2,886**
	Twin burner Rocket	**Amount**	**Unit**	**Price**	**Total**
A.	Insert	2	No	300	600
B.	Sawdust	40	Kg	5	200
F.	Murram/sub soil	200	Kg	1	200
G.	Water	120	Litre	1	120
H.	Ash	15	Kg	3	45
J.	Hardcore	2	Debe	10	20
I.	Bricks	5	piece	10	50
J.	Installation labour	13	PD	150	1950
	Sub Totals				**3,185**

5.3 Running/maintenance Costs (Without Family Labour)

A twin-liner stove requires an average cost per year of about KES 4,818 while a twin-burner Mud Rocket Stove will require about KES 7,451. In the table below, it is clear that the both types of stoves are cheap to run/maintain requiring such a small amount of capital. The cost is even much more insignificant considering that firewood and maintenance materials like water, murram and ash are locally available in most households. This shows that stoves are affordable to many households rich and poor.

[6] 1 debeful of ballast weighs approximately 20 kg

Table 10: Costs (Without Family Labour) required (in KES) per Year

Each year	capital without family labour	
	Kisasa	**Rocket**
1	5,602	6,101
2 to 10	4,731	7,601
Total	48,181	74,510
Average	4,818	7,451

5.4 Net Indirect Savings

The net indirect savings results from deducting all costs (including the cost of family labour) from the gross savings per year. Table 11 below shows that a household with kisasa can save up to KES 3,223 per year after incurring the cost of installation and also the household with the Rocket saves up to about KES 5,370 per year. It shows that the Rocket stove incurs fewer expenses than the Kisasa in the long run.

Table 11: Net Savings for Kisasa and Rocket Stoves per Year

year	Net Savings	
	Kisasa	Rocket
1	2,342	2,743
2 TO 10	3,363	5,662
Total	32,609	53,701
mean	3,261	5,370

5.5 Labour Requirements

Installation and maintenance of the Kisasa and the Rocket stoves takes little labour of about 11 family-PD, 0.05 non-family PD and 11.4family-PD, 3.2 non family-PD respectively. Much of the labour is consumed during installation of the stoves. The other labour requirements are minimal maintenance and repairs of the stoves. This means the stoves are not too demanding on the households hence the technology is adaptable to all households. For rocket stoves there is a higher labour requirement than Jiko Kisasa because the rocket stoves requires extra labour for follow up after installation and training users on lighting up and maintenance. This is done by the installer himself. Also mud rocket wears out easily due to abrasion from firewood charging and therefore necessitates frequent repairs and maintenance. Table 12 below depicts the labour requirements in person-days.

Table 12: Labour Requirements (Family and Non-Family) in PD per Stove per Year

Year(s)	Family labour	Non-family labour	Family labour	Non-family labour
	Jiko Kisasa		Mud Rocket	
1	12	0.5	10	1.5
2 to 10	11.0	0	11.6	3
Total	111	0.5	114	32.1
Mean	11	0.05	11.4	3.21

5.6 Gross Savings

Gross savings includes all savings made by the improved stoves to a household in terms of the fuel saved/replaced expressed in money terms minus all costs of installing that stove and the daily maintenance of the stove including the labour spent - except family labour. In this calculation, the cost of family labour is not considered because the household owner does not pay him/herself for the own time he/she spends installing or using the stove. Though we don't capture family labour in gross margin we do so in net savings calculation since family labour may present an opportunity cost where the farmer could possibly earn income using his labour elsewhere. From table 13 below, households with twin-liner Kisasa and a twin-burner Mud Rocket Stove are able to make a gross saving on average of KES 4,926 and KES 7,086 respectively per year in terms of the amounts they used to spend on fuels. This would translate to a return to labour of KES 445 and KES 620 per PD for Kisasa and Rocket stoves respectively. This means the Rocket stove has better returns to labour than Kisasa.

Table 13: Gross Savings per Year and Per Person-Day for Kisasa and Rocket Stoves

	Kisasa			Rocket		
year	**GS**	**PD**	**GS/PD**	**GS**	**PD**	**GS/PD**
1	4,142	12	345	4,243	10	424
2to 10	5,013	11.0	456	7,402	11.6	638
Total	49,259	111.00	444	70,861	114.4	619
mean	4,926	11.10	444	7,086	11.44	619

5.7 Installation Income and Employment Effects

Since improved stove technology adoption is not an enterprise as such to the family, income and employment effects can only be viewed from the installer's point of view since it is an income generating activity. Assuming the installer has 300 PD in a year dedicated to the activity, he/she can ideally install 6,000 Kisasa stoves; but practically only 1,500 with the rest of the time

spent moving from homestead to homestead or 94 mud Rocket stoves (1 Kisasa requires 0.05PD while 1Rocket stoves requires 3.2 PD including follow up labour). This means the installer can manage 5 Kisasa stoves or 3 Rocket stoves per day. This translates to an annual income of KES 150,000 from Kisasa or a mere KES 28,200 from Rocket stoves (installers charge KES 300 per PD). Since one installer does a mix of the two, the average annual income is KES 89,100; which translates to an income of KES 244 per calendar-day. Hence, stove installation is a moderately lucrative business.

6.0 CONCLUSIONS AND FINDINGS

The use of energy saving stoves has in no doubt saved on the expenditure of small households. This can be attested by the popularity of the stoves in the districts under study. The following are the conclusions and findings made on the study:

- ✓ Profitability of liner production is largely determined by the size of the kiln and frequency of firing
- ✓ Liner production business breaks even in the 3rd year for a production unit with a 150 capacity kiln and firing 4 times a month
- ✓ Production of liners has high gross margins (and profit) as denoted by the high Internal Rate of Return of 76%
- ✓ Production business largely utilizes household labour but is a good rural employer with expansion of production
- ✓ Households with Kisasa or Rocket stoves have a perceived saving on fuels of around 83%
- ✓ Rocket stoves are more efficient than Kisasa stoves.
- ✓ Avocado oil is used for polishing the surface of the stoves making them impervious to water hence lowering maintenance costs. This is a new technology requiring further research
- ✓ Installation of stoves is lucrative and a good rural employer
- ✓ Production of liners and installation of stoves is an equal-gender undertaking though tilted more in favour of men
- ✓ Other recorded advantages of Kisasa and Rocket stoves over the 3-stone open fire place:
    - Smoke reduction in the kitchen since the stoves have a higher combustion efficiency
    - Heat retention in these stoves is very high hence cooking is faster. This reduces the amount of firewood used
    - Better organization of kitchens since the stoves consume a smaller area and are permanently fixed to one location
    - less soot prevalent in kitchens
    - Less smoke-related health complications especially allergy hence a saving on hospital bills
    - Less risks of kitchen items catching fire
    - Better food taste as a result of less contamination from smoke
    - Participation of more men in cooking

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