Adoption and sustained use of energy efficient stoves in rural Uganda

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Abstract: In 2011, Energy saving (mud) stoves were introduced in villages around the Kachung Forest plantation in rural Uganda as part of an effort to support local sustainable development. Initial fieldwork showed that the stoves had not been adopted as much as the apparent benefits would suggest. This has been a common issue with improved cooking stove projects around the world. In order to find out why the stoves are not adopted, 67 women in charge of the cooking were interviewed additionally participant observations of cooking, other daily work routines and building stoves conducted, as well as interviews with other relevant stakeholders. Results show that women struggle to find enough firewood and are bothered by the smoke produced when cooking, which makes them generally very interested in improved mud stoves. Indeed many women had adopted a local version of the mud stove in order to ease the burden of firewood collection. The reason for not adopting a mud stove in general can be mainly attributed to work burden in constructing it. As for the more sophisticated energy saving mud stoves introduced, additional factors were that the implementation strategy shows weaknesses in how the knowledge on how to build the stove is supposed to spread. Further, the stove introduced is rather complex in the way it is supposed to be built, which makes it difficult to spread the knowledge of how to build it. The implementation strategy needs to be revised under consideration of the local circumstances in order to achieve a higher adoption rate.

Keywords: Sustainable Development, improved cooking stoves, Uganda, new technology adoption

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Adoption and sustained use of energy efficient stoves in rural Uganda

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Summary: Today, more than 3 billion people worldwide still use solid fuel e.g. wood or charcoal for cooking. Often in open fire places which have an extremely inefficient combustion and produce a lot of smoke, this results in significant health, time and work burden for women who are typically in charge of the fire wood collection and cooking. Further, the inefficient use of solid fuels may also put an extra drain on forests and climate. One way to improve these issues and reduce the burdens on women is recourse to energy efficient improved cooking stoves. A local NGO implemented energy saving mud stoves in villages in rural Uganda. The purpose of the stove project was to reduce firewood consumption and hence ease the burden of firewood collection for women and young girls. In addition the stove produces less smoke which can help to improve women’s health. Another advantage of the stove is that it does not need to be purchased as it can be build out of local materials (mud). While improved cooking stoves have been introduced all over the world, the adoption rates and success have been rather limited. The aim of this thesis was to find out why the stove has not been adopted as much as the apparent benefits would suggest. This was investigated by interviewing women who are responsible for the cooking from villages within the project area.

The results show that women struggle to find enough firewood and are bothered by the smoke which makes them generally very interested in improved cooking stoves. Further, the stove has a good reputation among stove users and non-users. There were two main reasons for people not adopting the stove. Firstly, the work burden in constructing the stove is a challenge. Women in the villages have an extensive work load which gives them little time for rest or recreational activities. Preparing the mud for the stove is physically very demanding and can be very difficult especially for people who are sick, old, pregnant or injured. Secondly, the stove is rather complex to build, meaning it needs exact measurements and considerations. It was common that people did not master how to build it correctly and thus could not show it to others. The idea of training some people from the villages who then go back and show other people how to build improved cooking stoves out of local material did not work out and was one of the key weaknesses in the implementation strategy.

Keywords: Sustainable Development, improved cooking stoves, Uganda, new technology adoption

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## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ART</td>
<td>Agency for Rural Transformation</td>
</tr>
<tr>
<td>CDM</td>
<td>Clean Development Mechanism</td>
</tr>
<tr>
<td>CIA</td>
<td>Central Intelligent Agency</td>
</tr>
<tr>
<td>ESS</td>
<td>energy saving stoves</td>
</tr>
<tr>
<td>GIZ</td>
<td>Deutsche Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)</td>
</tr>
<tr>
<td>LC1</td>
<td>local chief one (head of a village)</td>
</tr>
<tr>
<td>NFA</td>
<td>National Forest Authority</td>
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<tr>
<td>NGO</td>
<td>Non-Governmental Organisation</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<td>WHO</td>
<td>World Health Organization</td>
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All names of people interviewed in the village have been changed in order to protect their privacy.
1 Introduction

As a part of complying with the requirements in the Kyoto protocol, Sweden is through the Swedish Energy Agency buying carbon credits from a tree plantation in Uganda. The Norwegian company Green Resources manages the forest plantation located within the Kachung national forest reserve in Uganda. The licensed area covers a total of 2,669 hectares of land plantation, planted mainly with pine and eucalyptus with a plan for logging as a part of "sustainable forestry" (Green Resources, 2013a). Since 2011, the plantation is registered as a Clean Development Mechanism (CDM) project, at the United Nations Framework Convention on Climate Change (UNFCCC). Making it possible for the carbon credits generated by the plantation to be sold on the carbon market (UNFCCC, 2017a). As CDM project Kachung plantation is supposed to contribute to mitigating climate change and meeting the rising demand of wood products from well managed plantation forest, while supporting local sustainable development through generating jobs and other benefits to local people around the plantation (CDM Executive Board, 2011; UNFCCC, 2017b). One of the community development initiatives that Green Resources has undertaken to support local development is the implementation of an energy saving cooking stove built out of local material. The implementation of the stove has been carried out in collaboration with a local non-governmental organisation (NGO) called Agency for Rural Transformation (ART).

The purpose of the stove project was to minimize firewood consumption and thus, ease the burden of firewood collection, which is primarily done by women, promoting environmental conservation and hence mitigating climate change (Jackson, 2011a). Further, women included in the project were given the opportunity to use the knowledge of the energy saving stove technology as an income generating activity (build and sell the stoves). Additionally, the stove produces less smoke than traditional open fire places; indoor smoke is related to several health problems (Boy et al., 2002; Rehfuess et al., 2006) and thus the stove can help to improving women health. The type of stove promoted in the studied project is an improved cooking stove made out of local material also referred to as mud stove. The traditional way of cooking with biomass over open fire is connected to a range of health and environmental problems. Thus, the implementation and promotion of (low cost) energy saving cooking stove, which could reduce negative impacts of cooking with biomass seem to be a valid and promising project. Nevertheless, initial interviews with women in the villagers surrounding the plantation showed that people had not adopted the stoves as much as the apparent benefits would suggest. Short interviews did not manage to shed light on what the reasons behind this was (Hajdu, 2014).

The issue of solid fuel use in cooking and its negative consequences is not unique to the Kachung area; improved cooking stove projects have been carried out all over Uganda and in all parts of the developing world. Agenbroad et al. (2011) state: “[…] improved biomass cooking stove programs have the potential to impact indoor air quality, deforestation, climate change, and quality of life on a global scale.” However, the success of improved cooking stove projects in general has been rather low. This thesis aims to investigate how and why the improved cooking stove is adopted or not in the case described above. Not much research has been carried out on the topic of implementation and adoption of locally built improved (mud) stoves. These thesis aims to fill the research gap.

Research objectives

This thesis focuses on understanding the reasons why energy efficient stoves implemented by ART and Green Resources in the villages around Kachung Plantation in Uganda have not been adopted as much as their apparent benefits would suggest. This involves the understanding of food cooking processes, fuel wood collection and other daily routines of women as well as understanding of the implementation process itself. The following research questions help to fulfil the stated objectives:

1. How does the traditional three stone stove preform in comparison to the mud stove(s) (e.g. firewood consumption, smoke, cooking performance), according to people who use them?
2. How and why do people adopt or not adopt the new energy saving stove?
3. What are the various issues surrounding the implementation process/strategy that could explain spreading or not spreading of the stove in specific instances?

Successful stove projects are rare and understanding the reasons for adoption and how the information about the stove is spread may assist program designers and policy makers to improve future projects. In the case of mud stoves build out of local material the research carried out has been limited, this thesis aims to contribute in closing this research gape and make future project more successful and sustainable. This case study uses interviews and participant observation in order to shed light on the issue. The uptake of new technology is a well reported struggle in development work. The theory of social shaping of technology is used to highlight the relation between the social and technical component of new technology and can help to explain the failure or success of new technology in practical application.
2 Background

Today, more than 3 billion people worldwide still use solid fuel (wood, charcoal, crop wastes, animal dung, and coal) for cooking (WHO, 2016a). Even though the share of households relying on solid fuel for cooking has declined between 1980 and 2010 from 62 per cent to 41 per cent see Figure 1, due to the overall population growth the absolute number of people relying on solid fuel remains stable (Bonjour et al., 2013). Especially Africa has not progressed as fast as other regions in the world. The percentage of households using mainly solid fuels has only decreased by 10 per cent points from 87 per cent to 77 per cent between 1980 and 2010 and it is still the region with the highest share of solid fuel use.

![Figure 1 Relation of population using solid fuel as the main source of cooking fuel in low- and middle income countries (Bonjour et al., 2013)](image)

The numbers for Uganda are even higher, fuel wood is with 88.1 per cent the number one source of energy according to the 2014 Uganda energy balance (Ministry of Energy and Mineral Development, 2014). The World Health Organisation (WHO) reports that over 95 per cent of the population of Uganda uses soiled fuel for cooking along with many other countries in sub-Saharan Africa (WHO, 2015, 2014). Due to the negative effects connected to the use of solid fuel on human and environment, a reduction of solid fuel use through improved cooking stoves seems like a promising opportunity for Uganda. The next two sub sections of this chapter will guide through the main issues associated with the use of solid fuel (in cooking) and give some background on improved biomass cooking stoves.
2.1 Issues related to the use of solid fuel (for cooking)

The use of solid fuel is connected to a wide variety of issues, from significant health risks to deforestation, and climate change. Especially open indoor fires or cooking places as shown in Figure 2, which are very commonly used in the research area, are particularly harmful. Women and girls, who are traditionally responsible for the cooking and gathering fire wood, are disproportionally negatively affected.

![Figure 2 Traditional three stone stove](image)

2.1.1 Health risks

The World Health Organization (2016a) states that “Household air pollution is the single most important environmental health risk factor worldwide” and has caused approximately 4.3 million premature death in 2012. The largest source of indoor air pollution is likely to be the use of solid fuel for cooking (and heating) (Smith et al., 2004). House hold air pollution from inefficient cooking technology and fuel can cause a range of health problems (WHO, 2016b). Kim et al. (2011) summarised available information on potential health risk associated with the use of solid fuel, which include respiratory diseases such as upper and lower respiratory infections, chronic obstructive lung diseases, tuberculosis, lung cancer and asthma, but also non-respiratory illness such as cardiovascular diseases, ischaemic heart disease, strokes and nasopharyngeal cancer (Kim et al., 2011; WHO, 2016c). Furthermore, smoke generated by open fires can irritate the eyes and cause cataract (Saha et al., 2005). A study by Siddiqui er al. (2005) shows that acute symptoms such as eye congestion and inflammation are more commonly reported among younger women, they suggest that prolonged exposure may results in an adaptation and tolerance to wood smoke. Thus, older women may not perceive the smoke as so disturbing as younger women might do. Other health risks include lower birth weight and infant mortality (Kim et al., 2011; WHO, 2016b). The level of exposure to pollutants depends mainly on the type of fuel and stove used as well as the location of the kitchen (e.g. inside or outside, close to the living/sleeping area) and the ventilation, but most importantly on the time the individual is exposed to the polluted air (WHO, 2016c). Further, cooking over open fire is also linked to a high risk of burns and large numbers of physical injuries are caused by solid fuel stoves. Scalds are especially common with young children as pots with hot food and liquid on simple stoves on the ground (e.g. three-stone-stoves) can easily be knocked over (WHO, 2014).
2.1.2 Time and work burden for women

As so often, the hardest burden falls on women and children (especially girls). They are the primary procurers and users of household fuel and thus bear the biggest health and work burdens (WHO, 2016a). Gathering cooking fuel can consume a considerable amount of time for women and sometimes children and therefore limits the time for other income generating activities, recreation or even school (WHO, 2016b). Literature reports that women can spend several hours a day on collecting firewood (Jan, 2012). Deforestation (see also 2.1.3) is a major problem in many developing countries, which as result limits the availability of firewood. That means women have to go further to find sufficient amount of firewood and trekking remote areas for hours. This in turn can put women and young girls at higher risk for sexual violence, especially in conflict or post conflict areas (Chynoweth and Patrick, 2007). Alternatively, they have to turn to lower quality wood and other biomass such as cassava stumps and palm leaves which burn much faster and thus need to be collected more frequently. Further, lower quality wood and biomass requires more attention while cooking to not go off (since they burn very fast) which requires women to stay close to the fire and again prevents them from doing other work or rest.

2.1.3 Deforestation, carbon emissions and climate change

Forests are vital for sustainable ecosystems and human survival. They offer watershed protection, prevent soil erosion and mitigate climate change. Nevertheless, deforestation is an issue all over the world and the situation in Uganda is particularly severe with an annual change rate of forest of -3.3 per cent between 1990-2015 (FAO, 2015). This makes Uganda one of the countries with the highest deforestation rate in the world. The causes of deforestation are diverse. In Uganda direct causes of deforestation are linked to land use change for agriculture and non-agricultural use such as human settlements and mining and extraction of wood for timber, charcoal and brick burning (Waisswa et al., 2015). The use of biomass as a primary source of energy puts an additional strain on natural forest, especially under the consideration of a growing population in many developing countries and thus a raising demand for timber, charcoal and bricks. Although, firewood is extremely important as a source of energy, firewood collection for cooking is not regarded as a major cause for deforestation. Much of the wood collected is already dead, and collection rates are typically below the regeneration rate (May-Tobin, 2011). Nevertheless, deforestation and limited access to protected forest areas (or plantations) makes it more difficult for women to find enough firewood for their cooking. While energy saving stoves (ESS)es are certainly not the solution to stop deforestation, well planned stove projects may help to raise awareness to the limitation of forest resources and make a contribution to put less pressure on forests and climate.

2.2 Improved biomass cooking stoves

Cooking over open fire on traditional three-stone-stoves is common in the study area as well as in other parts of the developing world. Besides, the problems mentioned above traditional stoves have advantages too; they are free, the materials are easy to collect, the fuel can be gathered (mostly) for free and, they do not require days of work or a particular set of skills to assemble or use. Additionally, they fit all pot sizes. Moreover, an open fire can provide warmth, light and a sense of comfort; in many cultures the traditional three-stone-stove fires constitutes the centre for the household and often hold a cultural value (Feldmann and Otremba, 2015). Therefore, it is understandable that the three-stone-stove has been around for such a long time. Nevertheless, the disadvantages weigh out the benefits of this traditional stoves and an alternatives are energy saving or biomass improved cooking stoves.

There is a wide range of improved cooking stove models out there as shown in Figure 3. They can be made out of clay, mud or metal, be portable or stationary and they can be made for use with different fuels manly in the form of biomass. However, all of these stove have one thing in common, the combustion is much more efficient and complete than with traditional open fire cooking places.
Hence, they can save fuel and produce less harmful emission (Feldmann and Otremba, 2015). Another way to distinguish the stoves is: if there have to be purchased (industrial produced stoves) or can be built out of local material e.g. mud stoves assuming the knowledge on how to build the stove is at hand. Even though the stoves are mostly kept at a low cost, the initial investment coast can still be too high, even though the benefits of an improved stove weigh out the initial investment coast as Jan (2012) describes it see more in section 3.2. Further, industrial produced stoves can often not be purchased in rural areas. Thus, improved mud stoves seem like a perfect option for remote areas.

Figure 3 Samples of improved cooking stoves (GIZ cited in energypedia, 2014)

Mud stoves have been around for a while and in general it is not always possible to distinguish between ‘modern’ and ‘traditional’ mud stoves, some traditional mud stoves can be very modern in terms of combustion efficiency and lower emission. On the other hand, very modern looking stoves might not perform well. Nonetheless, “Compare to an open fire, every stove with an appropriate combustion chamber is already an improved one (Feldmann and Otremba, 2015)” It is important to specify what kind of improved stove is used in the different projects and research since there is a wide range in performance properties between different types of cooking stoves regarding the amount of fuel use and emissions produced (MacCarty et al., 2010).

In the case of the ART project which is used as a case study for this thesis, low cost improved cooking stoves built out of local material (mud stoves), and therefore affordable, were focused on. The materials for this type of stoves can typically be gathered for free and locally. The stoves introduced by ART are the Lorena Rocket stove (not further discussed since it was not used in the villages where the interviews have were conducted) and the shielded Rocket stove, see Figure 4, both work with the same combustion principle (Jackson, 2011b; Kabuleta, 2008). The stove was developed by the Ugandan Ministry of Energy and Mineral Development with the support of the German Technical Cooperation (GTZ/GIZ).
The stove is designed to achieve a maximum heat transfer to the food because 90 per cent of the pots surface area is heated and the isolation through the mud mixed with the grass minimises heat losses, see Figure 5. The stove uses the rocket technology which consists of an insulated elbow-jointed combustion chamber that increases combustion efficiency and retains heat while also raising the cooking pot to the hottest point above the flame (Jackson, 2011b). This results in less use of firewood compare to three-stone-stoves (Kabuleta, 2008). As a result firewood can last up to two to three times longer than with a traditional open fire. However, field studies show that the firewood saving are likely to be rather somewhere between 20 and 40 per cent under field conditions (MacCarty et al., 2010; Ochieng et al., 2013). Other advantages include easy use during cooking, since the stove will not go out unless the user stops adding firewood. There is no need to blow at the flame in order to keep the fire alight as in the case of the three-stone-stove. They are also safer to use since the fire is shielded and hence the likelihood of accidents and burns especially to children is reduced (Kabuleta, 2008). However, in order to achieve the full benefits it is vital that the stove is built in the right way, see Figure 5. It is important that there is a good draft into the fire; in case of the rocket stove this is ensured through the air inlet and the burning sticks should be lifted from the ground so that the air can escape under the sticks (Bryden et al., 2006). Insulation of the fire through the mud/grass mixture walls helps the fire to burn hotter and thus burns more combustible gases and produces less smoke. The stove has to be built under consideration of the right measurements and the use of the recommended material, in order to achieve optimal combustion and therefore all the benefits (Kabuleta, 2008). See also Figure 13 Measurement table for stove construction (Kabuleta, 2008).
Feldmann and Otremba (2015) say there is no ideal cooking stove or a one size fits all solution due to the diversity in cooking methods and food around the world. Culture habits and different preferences as well as climate condition and availability of fuels determine what type of stove works best under the given local circumstances. Thus, even well designed stoves which work well under laboratory conditions may fail in real life application. The next chapter will dive deeper in to the challenges of making technology work for poor people.
3 Theory and literature review

In development work, projects often fail to achieve the desired outcome even though they seem to be well planned and follow logical assumptions as Li analysis in her book in several case studies (Li, 2007). In the case of the Kachung stove project, firewood is scare and firewood collection and smoke are a burden to the women and girls. Thus, the introduction of an improved cooking stove made out of local material seems to be the perfect solution, and the expectation is that people should be eager to adopt the new stove. Unfortunately, the reality is more complex and there are many factors involved in the uptake of new technology. Misinterpretation or neglect of local circumstances is the weak spot of many well intended projects (Li, 2007).

In the first part of this chapter, the concept of social shaping of technology is discussed and how it challenges the linear view on new technology. It provides a more complex picture on how ‘successful’ technology is shaped. The second part looks at research carried out all over the developing world, analysing the complex and diverse reasons of the limited success of stove projects.

3.1 Social shaping of technology

Social shaping of technology is not a single theory but rather a broad concept which argues that the relationship between technology and society is a mutual one, where one is shaping the other. In the broadest sense it is an opposition to technological determinism and attempting to demonstrate social influence on the direction of technological change (Russell and Williams, 2002). It opposes a linear model of technology, in which technology is essentially seen as an autonomous entity which follows an internal logic and direction, and has a determinate impact on society thus moulds society to suit its needs (Russell and Williams, 2002, p. 36). The linear model of technology has the idea of technological development being a one-way flow of information, ideas and solutions; starting from basic science, through research and development, to production and distribution of the technology through the market to the consumer (Williams and Edge, 1996). In development-work practice, this might mean funds are granted to scientists, whose results are handed to for example governments or NGOs who are expected to deliver to a targeted audience (Leach and Scoones, 2006, p. 29), under (too) little consideration of the unique local social circumstances.

On the contrary to the linear perspective, Williams and Edge (1996) argue that on every step in generating and implementing new technology choices are made between different technical options; and along with purely ‘technical’ considerations, a range of ‘social’ factors affect which option is selected, thus influencing the technology and its social implication. Following this argumentation if technology and technology implementation strategies are formed by a given society or social group, a universal application of such technology might be limited in success due to the diversity of social circumstances in other countries, regions or populations. Russell and Williams (2002) reason that the impacts of technology which are intentionally or unintentionally emerging depend on local conditions which contradicts the modernist views of neutral technology with universal application and consequences. This is not to say that there are no technologies which are produced in a generic way to allow them to be applied widely. Some technologies are transferred successfully and largely unchanged but to what extent and how technology can be produced as a standardised domain requires an understanding of local processes of appropriation and use (Russell and Williams, 2002).

Social Shaping of Technology examines the content of technology and explores the specific context around the technological innovation by examination of the organizational, political, social, economic and cultural influences that shape the design and use/uptake of the technology (Howcroft et al., 2004). Jørgensen et al. (2009, p. 8) state that:

“Technological development should be seen as a ‘bricolage’, a mixture of different elements, and technological change as a continuous process, where technology and social and environmental aspects are co-shaped during research, development and application of technology in society.”
In the case of the Kachung stove project the replacement of the commonly used open fire places with improved cooking stove technology with all its advantages seemed like a broadly applicable solution to all the issues connected to the traditional way of cooking. This view of the existence of a ‘universal fix’ to a problem, where the main task is an efficient transfer of knowledge/technology has dominated research and development for decades (Leach and Scoones, 2006). However, development projects and promoting new technology can fail in practice for reasons poorly understood by those who are implementing them. Technological choices as well as the strategy of promoting the uptake of them have to be adjusted to local conditions, livelihoods, knowledge and social impact (Leach and Scoones, 2006).

The main challenge is to engage people, especially poor people in decision about innovation and technology. Leach and Scoones (2006, p. 59) claim that the current views of science, technology and development see people as:

“[…] passive beneficiaries of plans developed with formal scientific expertise and implemented through public sector institutions and global funds."

One approach to improve success of new technology is to engage citizens in the issues involving science and technology. By seeing themselves as actors rather than passive beneficiaries, poor people might be able to assert their needs. This could be done through increased dialogue and consultation in early stages of projects (Cornwall and Gaventa, 2000). Missing out on involving the people who are supposed to benefit from the new technology can make the best intended programs fail (Li, 2007). The needs and concerns of targeted audience need to be addressed and taken seriously, despite whether the concerns are ‘reasonable’ or seem to be ‘irrational’ (Leach and Scoones, 2006). This raises another question, to what extend are poor people able to articulate their concerns and in what form should this dialogue take place (Cornwall and Gaventa, 2000). For this, new institutions are needed which bring together poor people, frontline workers, scientist and policy-makers in a way which promotes a dialogue about long-term futures and technology options, about more immediate science and technology priorities, about technology adaptation to local contexts, and about risks and uncertainties and ways to regulate these (Leach and Scoones, 2006).

Real life projects have repeatedly shown how the implementation of new technology fails because the specific social, cultural, economic and environmental local circumstances are underestimated. The next section will present research on stove projects from all over the world, many of which have not been very successful.

3.2 The failures and successes of improved cooking stove projects

Stove projects have been carried out all over the developing world. Mainly with the same main objectives, reducing solid fuel consumption hence combatting deforestation and improved health condition for the user. Other objectives are reducing the time burden of fire wood collection and combating climate change. Unfortunately the success of improved cooking stove programmes has been limited (Lewis and Pattanayak, 2012). The lack of wide spread adoption of ESS has been documented in many developing countries and a range of studies have been conducted. Jan (2012) states that, the benefits of improved cooking stoves are always outweighing the cost of the stove. Nevertheless, while extremely beneficial on an economic, social, health and environmental perspective, the slow rate of adoption of those types of stoves is common. He describes a key set of barriers; such as lack of education (especially women), reduced participation of women in household decision making, lack of awareness of health and environmental hazards related to poor use of solid fuel and low income. But also insufficient funds allocated to such projects and poor monitoring systems for the long term stove use are among the central factors. In the particular study area (rural Pakistan) Jan (2012) identified lack of awareness, motivation and institutional support as most important factors for the low adoption rate. Another study conducted in urban and rural Sudan (El
Tayeb Muneer and Mukhtar Mohamed, 2003) came to similar results, it stressed in particular that on the one hand women are the main decision maker when it comes to household related tasks such as cooking, however, the man often controls most of the family’s finical resources and the price of the improved stove in the case study was rather high compare to women’s purchasing power. Other stove projects had limited success due to inappropriate design of the cooking stove. In a study conducted by Bielecki and Wingenbach (2014) in rural Guatemala on adoption and use of improved cooking stoves shows that traditional open fire provided benefits that the new stove could not, namely a source of warmth (important in the region where the study was conducted) and light. Further, cooking time, food type, family size and occasion were important factors affecting the cooking method hence type of stove used. The study revealed that there is considerable range of social, cultural and functional needs with in a community which has to be considered while designing a stove.

Urmee and Gyamfil (2014) reviewed papers on improved cooking stove programs from around the world with the goal to determine their success factors, the form they should take and the role played by different stakeholders. They found that many programs collapsed soon after the donor funding finished and that most programs focused only on distribution and did not take in to account local culture, social and economic background of the target areas or considered the cost and availability of biomass. The main reasons for collapse were: poor implementation strategies, inappropriate technology, lack of community participation and lack of training. Even programs initially perceived as successes were not self-sustained due to a lack of trained people, maintenance and/or low quality product. This essreflects that:

“\textit{No stove program can achieve its goals unless people initially accept the stove and continue using it. (Ruiz-Mercado et al., 2011, p. 7557)\textit{}}”

The motivating factors to invest in an ESS are the availability and / or cost of biomass. Since the benefits for the households adopting are more significantly if biomass resources are scare (Eshetu, 2014). On the other hand, the health dimension seems (perhaps surprisingly) to be one of the least motivating factors to invest in an improved cooking stove. Mobarak et al. (2012) found that women in rural Bangladesh perceived indoor air pollution not as a significant health hazard and thus prioritized other basic needs over improved cooking stoves.

Perhaps one of the most interesting study to review for this thesis, because of its similarity to the ART stove project, was conducted by Wallmo and Jacobson (1998) in western Uganda. In 1993-95 three-pot Lorena mud stoves (not the same type of mud stove ART was promoting) were introduced in 10 parishes. Members from each parish had been trained and after demonstrating their ability in stove construction became then stove promoter in their community for the NGO. The local settings were also similar in the sense that targeted audience were mostly households who were farming on a substance level and for whom firewood scarcity was a problem. The surveys showed that respondents who were using the stove had a positive perception on the improved stove. The perceived advantages included the ability to cook more than one item at once, firewood saving, quick cooking and smoke and accident reduction. Over all the stove had a good reputation among users and non-users. Nonetheless, around half the stove users would use the traditional three-stone-stove in addition because pans were too large to fit on the mud stove, difficulties in lighting the fire, in case of visitors (cooking for more people), plus the three-stone-stove provided a source of warmth. The high cost of the stove was the primary reason for not adopting since some material need to be purchased. However, the stove construction was done by the trained stove promoter who would get paid by the NGO for each stove they build. Unfortunately, the study does not give number for the adoption rate. The study provides more interesting results too many to cover them in the scope of this thesis for more details see Wallmo and Jacobson (1998).

Besides Wallmo and Jacobson’s study it appears that most studies concerning the adoption of ESS or improved cooking stoves have been on projects where people had to purchase a factory stove, while the project from ART had a different approach, with a stove built from local material (see section 4.2). There is not much literature available on the specific issues surrounding the locally made mud stoves and their implementation and use. In fact, many studies examined for this thesis, fall short on explaining which type of improved cooking stoves they refer to. Furthermore, most studies also do not
give much background on the implementation process or strategy. Hence, it makes it difficult to compare the results of these studies to the results of this thesis.
4 Case study

The stove project was implemented in a rural area in Uganda in 2011/12. Uganda is an eastern African country lying across the equator bordering on Kenya, Tanzania, Rwanda, Democratic Republic of Congo, and South Sudan. The country administration is divided in 117 districts and further subdivided into counties, sub-counties and parishes. In 2015, Uganda had a population 39 Mill people more than double as many as in 1990 (World Bank, 2016a) and it is expected to continue to grow on a 3.22 per cent rate, which is among the highest in the world (CIA World Factbook, 2016). Despite the fact that the population has more than doubled, Uganda still managed to decrease the number of people living in absolute poverty 9,8 M in 1992/93 to 6,7 M in 2012/13 (Ministry of Finance, Planning and Economic Development, 2014). Nevertheless, the country still lags behind in several important non-monetary areas such as sanitation, child nutrition, education and access to electricity (World Bank, 2016b). In fact firewood is still the number one source of energy (Ministry of Energy and Mineral Development, 2014). Especially in rural areas firewood and charcoal account for 97 per cent of the cooking energy (Uganda Bureau of Statistics, 2016a). While the population is growing and hence the demand and competition over natural resources such as firewood, ESS schemes as set up by the forest company GR are reasonable projects.

Forestry in Uganda is a complex, while forests are a precious source of a variety of natural resources appropriate management is a challenge due to a lack of resources. Therefore, bringing in external actors to establish and manage certified forest has been seen as promising opportunity (Mwima et al., 2004). As a result it was possible for GR to lease land from the Ugandan government to establish the Kachung forest plantation (Hajdu et al., 2016). Green Resources (GR) is a private Norwegian company with plantations in Tanzania, Mozambique and Uganda (Green Resources, 2013b). In Uganda GR operates through a subsidiary, Busoga Forestry Company, and manages two plantations: Bukaleba and Kachung. Both plantations have been established within government-owned Central Forest Reserves (Green Resources, 2013c). The Kachung plantation was acquired in 2007 and the company holds a 49 year renewable license for tree planting (Green Resources, 2009). The license area covers a total of 2. 669 ha of which 546 ha are set aside for conservation. The plantation grows trees for saw timber and transmission poles as well as sequencing carbon as a CDM project (Green Resources, 2013a). As a CDM project the plantation is supposed to contribute to mitigation of climate change and meeting the rising demand of wood products from well managed plantation forest, while supporting local sustainable development through generating jobs and other benefits to local people around the plantation (CDM Executive Board, 2011). As part of the community development work GR constructed a children’s ward at the local health centre, protected and renovated local water sources and has contributed to a comprehensive HIV/AIDS sensitization program. Further, under cooperation with ART, GR introduced the ESS project (see section 4.2) in the 14 villages surrounding the plantation (Green Resources, 2013a). However, forest plantations like the ones established by GR are not without controversy (see more Hajdu et al., 2016; Lyons and Westoby, 2014), when GR acquired its license for Kachung reserve people were still farming and living inside the reserve. Thus, through the establishment of the plantation some people lost farmland and had to resettle (Hajdu et al., 2016).

The following two parts describes the study area and local circumstances in greater detail as well the set-up and implementation process of the ESS project and the roll of GR and ART.
4.1 Study Area

The study focuses on rural villages located around the Kachung Central Forest Reserve which is located 30 km south from Lira in the administrative district and county of Dokolo and sub-county of Agwata in the Northern part of Uganda see map of the area in Figure 6. Within the reserve is a forest plantation run by Green Resources. The stove project was implemented in the 14 villages\(^1\) surrounding the Kachung Central Forest Plantation, namely: Te-amon, Abenyonya A, Abenyonya B, Acuna, Apeti A, Apeti B, Agolowelo, Okile, Aputi, Agengi, Tetugo, Okwor, Omukuceke and Bung see Figure 6 (Green Resources, 2012). At the time of the study there were no settlements with in the Forest plantation. The land use activities in these villages include small scale farming at a subsistence level which commonly includes livestock grazing. 91.1 per cent of the inhabitants earn their living through subsistence farming; very few people are employed and paid for their work on a regular base (Dokolo district lokal government, 2009). Agriculture is based on the Lango farming system, which heavily relies on human labour and simple tools such as hoes, pangas and ox ploughs. Farmers plant mostly subsistence crops along with some cash crops. The majority of the population in Dokolo district still lives under the poverty line of 1 dollar a day (Dokolo district lokal government, 2009). Other land use activities of the local community include fuel wood collection and char coal burning. Both activities are extremely important to the local community since they provide energy and the means for cooking (PDD, 2012). In spite of firewood playing major role as household energy it is less important for lightning, most people use some form of paraffin (Uganda Bureau of Statistics, 2016b), that means open fire play less of a role regarding light.

During initial fieldwork in the area made by Hajdu et al., (2016) local people expressed mixed feelings regarding the plantation project. Some, who had gotten jobs or taken part in other activities connected to the project, felt that their lives had improved, but many felt that their lives had been negatively impacted. This was primarily because they were no longer allowed to use the agricultural land that they had cleared in the forest in earlier years and which was very fertile and that they could no longer collect firewood (Hajdu et al., 2016). After the field work performed by Hajdu and Fischer in 2014, the question of the use and adoption of the ART stove and the potential issues around its implementation was formed and identified as a potential research question for a master thesis. That was the starting point for this thesis.

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\(^1\) At the time of implementation 2012, due to political administrative units they had expanded to 17 villages in 2015 (Nsamba et al., 2016)
Figure 6 Map of the Kachung forest plantation (Green Resources, 2012)
4.2 Implementation of the stove project by Green Resources and ART

On the 19th of April 2011, ART handed in a proposal for a project with the title: *Promotion of Efficient Energy Saving Technology (Cooking stoves) among households living in the Kachung Central Forest Reserve* to Green Resources. The project had a budget of 21 881 000 UGX and was implemented by ART between October 2011 and March 2012 (Jackson, 2012a). ART - Agency for Rural Transformation is a local community based organisation established in 2008 with the goal to bridge the gap between service providers and users in the rural communities. They are member of the Dokolo NGO forum and legally registered (Jackson, 2011b).

The main purpose of the project was to ease the burden of fuel wood collection for women, minimise fuel wood consumption and promote environment conservation and thereby mitigating the effect of climate change (Jackson, 2011b). The main objectives were:

- Promoting environmental conversation by promoting tree growing within the project area (this part will not be further focused on within the scope of this thesis)
- Reduce the emission of GHG and thus mitigating climate change
- Increase productive time of women and ease the burden of firewood collection
- To build a chain of social-technicians/ trainers within the women enterprise in order to promote this technology as an income generating activity (Jackson, 2011b)

The project strategy has several parts, the first part of the project activities was to mobilize and sensitize primary and secondary stakeholder in all 14 villages and workers from the forest plantation, on the trends and challenges on environmental conservation and the importance of ESS. Additionally radio talk shows focusing on the topic of the danger of environmental degradation and the importance of conservation through tree planning and the use of EES were held (Jackson, 2011b, 2012a). Part of the project was also the promotion of agro-forestry technologies and practices, and tree growing among beneficiaries. With the aim to encourage inter-cropping of fuel wood trees and promote environmental sustainability. This included handing out of seedlings from the plantations nursery to beneficiaries (Jackson, 2011b). However, this part of the project will not be further investigated in the frame of this thesis. Regarding the stove implementation, according to the ART’s project proposal and progress reports (Jackson, 2011b, 2011a), community groups of at least 40 members are supposed to be formed in each of the 14 villages. The formation of these groups is done through community meetings and entry in the group was on voluntary basis. Within these groups 10 representatives are identified by the group to undergo training on how to build ESSs. These would then pass on the knowledge to the remaining members of the group. Further, from the training received, the group should turn into a pool of skilled artisans able of selling the stove and skills to other households outside the project area and thus generate and income to the project beneficiaries. However, this does not mean that the training or the implementation process has actually taken place in this form, the process reports which ART had to hand in on a monthly base already suggest that the implementation process did not necessary followed the suggested strategy.

Challenges named by ART in their process report regarding the implementation of the stove were: The implementation activities had repeatedly put on hold due to monthly disbursements of funds and delays in releasing the funds (Jackson, 2011c, 2012a, 2012b). ART had to hand in monthly process reports in order to get funding for the next month. Further, demand in neighbouring villages outside the project target scope needed to be harmonized (Jackson, 2011c). Additionally, in December most participants were occupied with harvesting crops which resulted in late coming to the training. Further, the participation of men in the training was poor since cooking is considered a woman’s responsibility, 80 per cent of the participants were women (Jackson, 2011a). According to GR semi-annual Environment and Social Impact Report 2015, the use of the ESS was monitored in 2014. It was found that 8 out of the 12 villages monitored have members still using the stove. Failure reasons were attributed to inability of some trained members to master the craft of
building the stove as well as the inability to train other community members or help them to make the stove (Green Resources, 2016).
5 Methods

The data collection for this research project consists of three main parts and was carried out over a period of seven weeks field work. In the first part information on the stove project was gathered through semi structured interviews with GR and ART in order to gain an understanding on the planning and implementation process of the stove project. Through the field work in the villages it was discovered that Caritas also introduced an improved mud stove in the villages prior to ART. Following this discovery, project manager from Caritas were contacted and interviewed. Additionally, an on-going stove project site which had a similar implementation concept as the ART project was visited and the project responsible ones, National Forest Authority (NFA) and GIZ, were interviewed on site. The second part of the project was the most comprehensive one where people from the villages in which ART introduced the ESS were interviewed. People who were in charge of the cooking and/ or had been trained on how to build ESS were targeted for semi structured interviews. Out of the 14 villages where the stove was introduced three villages have been picked for field work see more in section 5.2. The villages are marked with a red circle in the map of the forest plantation see Figure 6. For the first two parts semi-structured interviews were chosen because they provide a guideline of question that serve as checklist of topics but also give the freedom for flexibility based on the flow of the interview; the wording and order of the questions can be modified to address the individual circumstances. Additionally, unplanned follow up questions can be included, according to the information given by the interviewee (Robson, 2011). The third part consisted of participant observation though actively taking part in women’s daily work and a stove building training, in order to gain a better understanding of the work burden and conditions surround the cooking and stove making. Participant observation has the advantage of directness. People are not just simply asked about their views, feeling or attitudes (Robson, 2011). It can be observed how different tasks affect the women in their daily life or are handled by them. Combined with actively doing the tasks too it provides a broader picture of the local circumstances.

Staff from ART gave great guidance through the formal protocol of introduction to the different local authorities and the local chief in the villages. The fact that the ART staff were familiar with the villages and the authorities made it easy to gain access and acceptance by the local community. Authorities on all levels were very friendly and seemed to be interested in the findings. For the field work in the villages an interpreter had been recruited locally to help with translation. Table 1 shows a summary of the data collected. In total 72 semi structured interviews were conducted and a total of 63 households were visited. In a few cases more than one person per household was interviewed due to the fact that the person in charge of the cooking was not the same as the person who had been trained in building ESS. The table also shows the approximate number of households per village. Additionally, five extensive interviews with different stakeholders were done. Besides the interviews five participant observations were carried out. The distribution of the amount of interviews conducted in Te-amon and Abenyonya B was purely due to logistical resource reasons since the driver was shared with another student and compromises needed to be made. However, according to the results the overrepresentation of one village over the other in terms of numbers of households interviewed does not seem to a problem since the results of the interview were constituent.
Table 1 Overview of the collected data

<table>
<thead>
<tr>
<th>Actors</th>
<th>Interviews</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH in Villages:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bung (ca. 55 HH)</td>
<td>12 short</td>
<td></td>
</tr>
<tr>
<td>Te-amon (ca. 80 HH)</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>Abenyonya B (ca. 120 HH)</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>Organizations:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Resources</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ART</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Caritas</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>NFA</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>72</td>
<td>5</td>
</tr>
</tbody>
</table>

5.1 Interviews with different organisations and NGOs

Interviews with staff from local organizations have been conducted, in order to acquire a better understanding of the local context. The contact and set up of meetings with GR and ART was done via email before the arrival in Uganda. All interviews with local organisations were conducted in English, the help of an interpreter was not necessary. The interviews were recorded and transcribed, during the interviews additional field notes were taken.

In the case of GR the Kachung plantation manager and the communication manager were interviewed on the background of the forest plantation, the relationship of the local people with GR and the implementation of the stove project. For a further understanding, the published Environmental and Social Impact reports published by GR were studied. The interview with ART was hold with the project manager. He and an ART project assistant were also helping in getting in contact with the local communities and authorities. Additionally, the project proposal and all the process reports, ART handed in to GR were studied. After discovering that Caritas had implemented ESS stove too, Caritas was contacted and two interviews were done with the director of Caritas Lira and the operation officer for food security. This gave the opportunity to gain more understanding of implementation strategies. Through a related research project it was discovered that the National Forest Authority with the support of the GIZ was implementing ESSs, similar to the ones implemented by ART in Kachung, in a different district. The set up and the implementation process at this stove building site were almost identical to the one in Kachung this might be due to the fact that both projects had support from the GIZ. Therefore the training site see Figure 7 was visited in order to get a first-hand impression of a stove training and a better understanding of the implementation process. In addition to visiting the site an interview with representatives from NFA and GIZ about the implementation strategy and long term expectations was conducted.
5.2 Field work with households in villages around the Kachung plantation

The stove project had been implemented in the 14 villages surrounding the Kachung plantation. For the field work, three villages were chosen for data collection namely, Bung, Te-amon and Abenonya B. The latter was recommended by Green Resources and ART because of the interesting case of Anna\textsuperscript{2}. She was taking part in the stove training and according to ART the biggest success story. She managed to turn her acquired knowledge into a small income generating activity, by selling the ART stoves. The other villages were chosen due to good accessibility under recommendation of ART. Before the start of the field work in the three sample villages, meetings were set up with the local leaders of the villages (LC1) and other representatives of the villages. The student was introduced with the support of ART and opportunities for questions were given. In all three villages the representatives as well as the rest of people were very open and friendly. The research questions were approached through in-depth interviews with women who are in charge of the cooking, and/or had been trained on how to build ESS (which incl. men), and through participant observation in garden work, cooking and stove making activities. The interviews in the villages were mostly conducted with the help of an interpreter. Only a few people in the villages chose to occasionally answer in English. The majority of the interviews were recorded if the participants would allow it, and all records were later transcribed. The vast majority of women (and men) were very welcoming and interested to talk. Only two interviews were disregarded due to the fact that the participants were drunk or seemed to be mentally confused in some way. However, they were still included in the statistic on the type of stoves used.

The majority of interviews were conducted in Te-amon and Abenonya B due to the fact that it was possible to move around freely in these villages. As in the case of Bung, the LC1 was following the student from household to household which lead to a rather tense and stressed interview atmosphere. In some cases the LC 1 would comment on answers given by the interviewees or even answer for them. The LC1 did not necessary seem to aim at influencing the data collection but the constant

\textsuperscript{2} Names have been changed
presents did not contribute to a comfortable and relaxed environment and led to rather short answers and little dialog between the parties. This resulted in the decision to focus predominantly on Te-amon and Abenyonya B. The interviews in Bung were discontinued after only 12 short interviews were conducted. In general, the interviewed households were found by randomly walking through the village and going from households to household and asking if the women in charge of the cooking would be interested in talking. Most of the women were interested to be interviewed and invited us into their homes. The focus of the interviews was not just on the ART mud stoves but on the performance, spreading, utilisation, and pros and cons of mud stoves in general.

The interview with the women in charge of the cooking were always started with an open question where they were invited to just ‘tell a bit about their cooking and if they are any problems or not’. This was done to get a first impression of how the women perceive their cooking and eventual problems connected to it, without given any input and suggestion from the student’s side. According to the answers follow up questions where ask. For all the interviews with the women there was a check list with topics which are supposed to be covered in the interview. This list was slightly adjusted over the course of the interviews to follow up on new discoveries. During the interviews the women (and one man) were ask if they could point out community members who have been trained in how to build mud stoves. In order to find and interview as many people as possible who had taken part in any form of training by ART but also by Caritas. As, this people are the key for the introduction of the improved mud stoves to the community at large and hence the spreading and success of the stoves. Thus, these people can help to shed light as to why the program(s) is/are not as successful.

Additionally to the interviews with the people in the villages, participant observation was used to gain a better understanding of the women’s daily work load and cooking practice. Active participation in different daily tasks such as garden work, fetching water, cleaning the housing area, cooking on different types of stoves, and taking part in stove building training was vital part of the data collection. The latter activity was conducted by Anna a woman who had been trained by ART. However, it is likely that the training was motivated due to the on-going field work and might not have taken place otherwise. The practice around firewood collection and issues regarding firewood was only briefly touched one since this was part of a separate research project see Giertta (2016). The availability of firewood is an important issue; however, if and in what way the plantation contributes to the availability firewood is not object of this thesis neither were the effects of the plantation on the local livelihood in general.

5.3 Analysis

During and after the field work all the collected data, photos, recordings and additional field notes were organized and all the interviews on record were transcribed by the student herself. Each individual interviewee was given an own folder with (if gotten permission) pictures for reference of the person interviewed, their cooking stove/ place, additional field notes taken and transcription of the interview(s). After all the data had been organized, it was read in its entirety and initial ideas noted. Thematic coding was used to process the data. First, parts relevant to answer the different research question were given codes in a systematic way such as stove performance, adoption, advantages. This was done through the entire data set. In the next step potential themes within the codes were identified. The result of the coding was compiled in a comprehensive table together with links to relevant quotes. Triangulation has been used to compare the data gathered from the interviews and observation to literature and documents from ART and GR e.g. process reports annual report in order to ensure the validity of the data/ results.
6 Results

This chapter is divided into four sections. The first section outlines the general cooking routines in the villages and the work load for the women in charge of the cooking; as well as what the women in charge see as the biggest challenges regarding cooking and the type of cooking stove used in the three villages. The next section looks at how the traditional stoves preform compared to mud stoves according to the women who are using them. The third section presents the findings on how and why people adopt mud stoves. The final section looks specifically at the ART stove project and its project strategy. It presents factors which could explain the limited spreading of the stove.

All names of people interviewed have been changed.

6.1 General cooking routines and set ups

The general cooking routines were more or less the same in the households in all three villages. However, there are small differences between dry and wet season, with the latter season being much more labour intense, since most of the garden work is done in the wet season. That means there is more time available for firewood collection and recreation during dry season. It is important to keep in mind that the field work was carried out during wet season and some perception e.g. on firewood and stove building could be different during dry season when the interviewee have more spare time available.

During wet season, the women would go to the garden by dawn around 07:00 o’clock to plant crops or do weeding. Around 10:00 they return to their homes and start with house work which includes cleaning around the house, washing themselves and children, setting fire and start boiling beans for lunch. Beans are a staple food and are eaten almost every day together with cassava and cassava bread (thick porridge made from cassava flour). The cooking time for beans is three to four hours, which means they need a lot of firewood especially with traditional stoves. Moreover, three-stone-stoves need a lot of attention so the fire does not go off which means women cannot go far from the fire to do other tasks. In the afternoon around 14:00 or 15:00 o’clock women would often return to the garden and continue weeding and planting crops. In between all these tasks they also need to fetch water around two to three times a day, collect firewood and sell their crops on the market. Women usually cook twice a day while for the second time it was common to reheat the leftovers from lunch for supper. Around 18:00 o’clock people would eat supper and finish off their days. The majority of the households cook inside and most people had a kitchen hut separate from their dwellings, where they do the cooking either on traditional stoves or on different type of mud stoves. Only very few women, all of whom used the traditional stove, did their main cooking outside. Besides the cooking, it is a common practice in a lot of households to set fire outside in the evening on the traditional three-stone-stove to gather the family around the fire, tell stories and warm water for bathing or reheat food, although, this is more commonly practiced during dry season due to the lower work load.

6.1.1 Issues surrounding the cooking according to the women in charge

There are a lot of issues regarding cooking with solid fuel as described in section 2.1, which the improved cooking stoves try to address. Notwithstanding, are these the same issues women experience in their daily life? In order to find out the women in charge of the cooking were invited with an open question to tell “a bit about your cooking; what is easy what is difficult or if there are any problems.” Interestingly almost all the women interviewed answered in a similar way. The number one issue is firewood.

“Cooking itself is not very hard, there is nothing difficult about cooking but the problem is all about firewood”
“[…] cooking alone wouldn’t be hard really, but we don’t have firewood.”
“What troubles me about the cooking is all about firewood, getting firewood in this area is very hard for us.”

The women named many reasons as to why it was so difficult to find enough firewood. The most common reason mentioned was the forest plantation and that they are no longer allowed to cut trees there. One woman said that they are allowed to collect the trimmings but that this kind of trees in the plantation (mostly alien pin trees) is meant for timber and it is not good quality firewood, because it burns too fast. Good quality firewood is difficult for the women to get in any case, since many native, old grown trees outside the plantation have been already cut down and used for timber, firewood or charcoal burning. Another reason which makes the firewood collection more difficult in this area, are the wetlands and swamps see map in Figure 6, which makes it more difficult to move around for firewood collection, especially during wet season when the wetlands are flooded. Due to the limited availability of quality fire wood some women turn to lower grade biomass such as cassava stems and leaves of palm nut tree; both of which burn very fast and therefore need to be collected more often and require more attention during cooking since the fire tends to go off easily. The issue of firewood becomes even more pressing if personal circumstances such as pregnancy, old age, sickness, injuries or other family circumstances come in. One woman who had nine children, eight of whom were boys and only one girl whom she was still breast feeding, described her difficulties in gathering firewood:

“I am always very tired when I come from the garden, I want to rest but there is no one really who could help me.”

Another woman who was sick said that she had to make one of her girls drop out of school in order to help her to get enough fire wood. Furthermore, the women feel like that the issue of fire wood is increasing and that it is becoming more difficult to gather enough firewood. When asked about other problems or difficulties regarding the cooking less than a handful of women named smoke as another issue by themselves. Only if then asked directly about the smoke they named it as a problem. However, the reactions to smoke were mixed. Some saw it as something they simply had to live with, like it is nothing they can change.

“The smoke is there, there is no way I can prevent the smoke, and I have to cook for my husband and children so I have to bear it. “

“Yes, the smoke is there but since I am a woman I have to bear it.”

Nonetheless, some were aware of the negative impact smoke might have on their health:

“There is a lot of smoke and I am suspicious that I do not see things properly these days and I suspect the smoke.”

When asked what could be better or easier about the cooking one woman who was using the three-stone-stove explained:

“If I can whisper for anything, if there to make a stove then at least to make something that does not produce all that much smoke like the local traditional one and at least something that cannot really consume much firewood, it really would sustain the old people at least they can also struggle and get something and cook with the little firewood they have gathered.”

In order to reduce these struggles many women have adopted different types of stoves as described in more detail in the next chapter.
6.1.2 Stoves used in the research area

During the visits in the households it was found that there are several different types of stoves in use, see Table 2. Notwithstanding, all households were using firewood as the main source of fuel. Only two households occasionally used paraffin. Some households could sporadically use charcoal if there was money to buy it. In total only three households had a ‘modern’ manufactured metal or clay stove but all of them would use other types (mud and/or three-stone-stoves) of stoves additionally. In general it was common for people to use a combination of mud stoves and traditional stoves. Table 2 shows what type of stoves were used by the households interviewed. For example in Te-amon, 22 out of the 36 households interviewed were using some type of mud stove. Out of these 22, 8 additionally used a three-stone-stove on different occasions. Only 14 used exclusively the traditional three-stone-stove. The results were similar in all three villages and the majority of the households are using some type of mud stove. The table also shows how many of the interviewed households would (still) use mud stoves implemented by ART and Caritas and how many people interviewed had received training by ART or Caritas. In the case of the ART stove four more households had used the ART stoves before but the stoves got spoiled and have not been replaced (yet) for various reasons.

Table 2 Stove used by the households interviewed in the research area

<table>
<thead>
<tr>
<th></th>
<th>Bung</th>
<th>Te-amon</th>
<th>Abenyonya B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of HH visited</td>
<td>12</td>
<td>36</td>
<td>15</td>
</tr>
<tr>
<td>Total Mud stoves (additional use of 3StSt)</td>
<td>7 (4)</td>
<td>22 (8)</td>
<td>12 (4)</td>
</tr>
<tr>
<td>- ART mud stove (people trained)</td>
<td>0 (1)</td>
<td>0 (2)</td>
<td>4 (2)</td>
</tr>
<tr>
<td>- Caritas mud stove (people trained)</td>
<td>3 (4)</td>
<td>3 (2)</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Traditional stoves only</td>
<td>5</td>
<td>14</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 2 shows what type of stoves were used by the households interviewed. For example in Te-amon, 22 out of the 36 households interviewed were using some type of mud stove. Out of these 22, 8 additionally used a three-stone-stove on different occasions. Only 14 used exclusively the traditional three-stone-stove. The results were similar in all three villages and the majority of the households are using some type of mud stove. The table also shows how many of the interviewed households would (still) use mud stoves implemented by ART and Caritas and how many people interviewed had received training by ART or Caritas. In the case of the ART stove four more households had used the ART stoves before but the stoves got spoiled and have not been replaced (yet) for various reasons.

Traditional open fires were mostly found in the form of three-stone-stoves as shown in Figure 8 to the left, at times they could also been dug down in to the ground to gather the fire better see Figure 8 to the right. The traditional stoves produce a lot of smoke and some of the women who were using only the traditional stove would do their cooking outside in order to escape the smoke. This improves the problem of the smoke but it also means that the wind is taking away the fire and it takes longer for the food to be ready and the fire needs extra much attention in order to not go off see more in the observation report on cooking on a traditional three-stone-stove in Figure 9.

Figure 8 Traditional open fire stoves, left) three-stone-stove, right) dug down whole in the ground
The majority of the households (around 65 per cent) interviewed were using some type of mud stove for their cooking. However, the quality of the mud stoves varied significantly and the performances in terms of firewood saving and smoke reduction can expected to vary considerably. Figure 10 shows the ART stove which was, as the Table 2 shows the least common model among all the households interviewed. In the households interviewed in Bung and Te-amon no ART stoves were found which were still in use. Some people used to have one but they got spoiled and they did not build a new stove yet (some expressed interest in building a new one again). The majority of the mud stoves used in the villages were local ones which resemble the stove in Figure 10 to the right, which GR calls in their report ‘local energy saving stoves’ (Green Resources, 2016). The materials to build the stove were similar for all mud stoves and could usually be gathered locally (soil from anthills or clay soil, swamp grasses, banana leaves and stems and sometimes bricks).

After I helped Hanna in the garden we went back to her home and started fixing the housing area which included preparing the fire for lunch. Hanna usually cooks outside unless it is raining. We used palm leaves and cassava stems to set the fire since this is all she had. Even though both Hanna and my interpreter are very experienced with cooking over open fire, we struggled to get the fire started and even more so to keep it running, since the wind kept blowing the fire apart. We had to start several times over again before the fire was ready to put on the food; but even then the fire required constant care in order to not go off, because of the wind and the low burning quality of the cassava stems. Especially, while starting the fire but also throughout the cooking process the fire needed to be blown a lot in order to get started and stay alive. This did not leave much time for other things to take care of and it was not possible to walk further away to fetch for example water. According to Hanna cooking beans could take 3-6h, during this time where she cannot do much else.
The other type of stove which had been implemented in recent years was introduced by Caritas see Figure 11 to the left. The Caritas stove distinguished itself from the others by having three openings which allows it to cook three things at once and an additional cooking place which can be used with charcoal. Overall mud stoves have a limited life span and in some cases the mud stoves were in rather poor condition as seen in Figure 11 to the left. These stoves are likely to not have many benefits left.

Even though an income statistic was not part of the data collection, the households using ‘modern’ ESS as introduced by ART or Caritas or metal stoves were households which seemed to be better off in general, judging from the condition of the dwellings and housing features e.g. brick walls, metal roofs, rain collectors, radio.
6.2 Stove performance advantages/disadvantages

It is crucial to understand that all mud stove are not created equal and that the performance and benefits vary significantly depending on how well the stove is made. As described in section 2.2 in order to get an optimal combustion, which produces little smoke and uses less firewood, the stoves need to be built in the right way. In all three villages there was a range of different mud stoves models to be found. With the ART likely to be the most sophisticated one in terms of performance properties according to the construction manual. The people in the village were asked about the general advantages of mud stoves, sometimes they would report about the difference between the different types. But most comments refer to mud stoves in general unless stated differently. Over all there was a positive attitude towards mud stoves with some people even stating that everyone should get one because it can make one’s life much easier.

6.2.1 Advantages of the mud stove

Women who were using a mud stove were asked about the differences in performances compared to the three-stone-stove; since all of them had used the traditional stove on some point or are still using it in addition to a mud stove. The number one advantages named by everyone was that mud stoves are ‘firewood saving’ or ‘energy saving’.

“If you have a mud stove made very well it will work better than the three-stone-stove because the three-stone-stove uses a lot of firewood [...]”.

Following this understanding the women were also asked about how long a bundle of firewood will last in comparison. On average they reported that a bundle could last twice as long when using a mud stove compared to a traditional stove, some even reporting as high as three to six times longer. There are many factors influencing the firewood consumption from the way the stove is built, over the quality of the firewood to the location of the fire place (e.g. inside or outside). However, the firewood saving seem to be often over reported when compared to the field test result in the scientific literature see section 2.2 which claim that 20 to 40 per cent are more realistic. Nevertheless, no one has said anything negative about the firewood consumption of the mud stove. Even the people who were not using a mud stove have at least heard about its firewood saving properties.

Smoke, was another advantage of the mud stoves commonly mentioned. While smoke was not named as clearly and often as the issue of firewood it still was an important factor. The women who were using the mud stove said that smoke is no longer there or at least less than with the three-stone-stove.

“Those days when I was using the three-stone-stove I could get a lot of smoke, I would have it in my eyes and my nostrils. I would feel like the flu is attacking me, I would feel a lot of headache. Now it is better.”

While visiting different kitchen during cooking it was obvious that the local women are far away from having a smoke free kitchen even with the use of the ART stove; but proper constructed mud stoves were undoubtedly an improvement to traditional open fire like the three-stone-stove. The observation report in Figure 11 describes the smoke conditions in an indoor kitchen during cooking with a traditional three-stone-stove.
Besides the two main issues of firewood and smoke the women named other positive aspects about mud stoves regarding its cooking performance. Women were now able to leave the fire alone without worrying that fire goes off. This means they could do other work like, fetching water or go to their garden or simply take a break. One woman explained it like this:

“If you were to be visitors and I would cook for us, I would sit here and the food would cook there with no smoke and you would not realise that I was cooking for us, just sitting here I would send some children to go and check for me; I would just sit with you and then surprisingly I would bring us something to eat.”

While on the other hand, with a three-stone-stove it is not really possible to go far away since it is necessary to keep organizing the fire so it does not go off see Figure 12 Observation - cooking on a three-stone-stove and mud stove inside. Women also described the mud stove as faster since the fire gets gathered in the stove and is not spreading and thus everything gets hotter.

The food prepared in the villages on a daily bases does not varied much, the staple are beans, cassava and the ‘local bread’ (very thick porridge based of cassava flour). When it comes to the use of the stove with different dishes the women had mixed opinions, some said the mud stove is good for all dishes, while others complained that it is difficult to ‘mingle’(mixing) the local bread on the mud stove since the stove can crack especially when preparing larger portions. On the other hand, some

Sara was an elderly lady I interviewed and she invited me back to cook with her. Her place was really well taken care of; she had a separate kitchen hut with a mud stove and a fixed three-stone-stove as shown in the picture. The lunch consisted of beans, posh, spinach with tomatoes and simsim paste; this was much more luxuries than the average lunches in the village. When I arrived at her place to cook with her the fire in the mud stove was already set and the beans were boiling. After finishing the prep work we all entered the kitchen and Sara started to set an additional fire on the three-stone-stove. As long as only the mud stove was burning the smoke was very noticeable but tolerable. However, as soon as the second fire was burning the smoke became quickly unbearable to me. My eyes started to sting and water so much that I could not see anymore and I had to step outside. Even though I tried hard to stay with Sara and my interpreter inside the kitchen as much as possible, I had to repeatedly go outside. Sara did not seem to have as much problems with the smoke as I had; her eyes were watery but no tears were running down. She told me that she is used to it. My interpreter had fewer reactions to the smoke than me as well but still seemed to be more sensitive than Sara. The kitchen had no openings in the walls so the smoke could only escape through the thick grass roof. It was a relief to be done with the cooking in the kitchen and to step outside, but I would feel a sting in my lungs for the rest of the day. It was not difficult to imagine that the smoke must possess a significant health hazard.
women said it is much easier to ‘mingle’ the local bread on a mud stove since the stove is fixed to the ground and the pot is secured and not moving like with the three-stone-stove where the stones can roll around. In this case personal preference but also the number of people cooked for seems to play a role (if large portion need to be made the mud stove might not handle it).

When asked about the taste some people responded that the food taste different since the smoke does not enter the food; the food cooks ‘smarter’, ‘it smells nicer’ However, about the same amount of people said that there is no difference in taste. Over all taste does not appear to be a very significant factor, it would only come up when directly asked about: if there is a difference in taste when comparing the two stoves. Some women also reported that the mud stove is cleaner than the traditional stoves since the ashes are not flying around everywhere in the kitchen, especially when they are blowing the fire. Additionally the ashes do not enter the food since the stove is raised from the ground and the combustion chamber is closed off.

People who have never used a mud stove still seem to have a positive perception of them. When asked if they had heard anything about the mud stove, they all answered that they are supposed to be better with fire wood.

“I think it can save firewood and it is faster.”

There was also no one of the people interviewed that did not know about mud stoves. Overall, mud stove have a good reputation among uses and not users.

6.2.2 Disadvantages of the mud stove

Even though the mud stove seems to have an overall good reputation, there were a few concerns regarding its durability. Some people reported that their stove has gotten spoilt due to cracks. However, most women explain that it is really important to maintain the stove by frequently smearing it with more mud. Giving the nature of its building material a mud stove will not last forever and needs to be rebuilt on some point.

“The stove keeps disturbing me, sometime it will get spoiled at all then I have to repair it [...]”

Due to the more fragile nature of the mud stove, some women said that the three-stone-stove is better if there is the need to cook for many people, since it can handle bigger pots. However, some people have started to build a second or third mud stove in order to be able to cook faster or for more people. None of the stoves in the households interviewed had a proper chimney, only very few would have originally some kind of opening in the wall to lead the smoke outside the kitchen, but even those were often closed by the women since it was seen as a too big of a fire hazard since all the kitchens were covered with a grass roof. It was not uncommon that kitchen roofs would set fire; two of the households interviewed had no roof over their kitchen since they recently had burned down. Even though the amount of smoke is less with the mud stove, especially women and children are still exposed to significant amount of smoke.

Some negative comments regarding stove design were made about the stove Caritas introduced see Figure 11 to the left hand side. The Caritas stove has three openings which allow the women to cook three things simultaneously. However, most of the time people do not need to cook three things at once; in this case the fire would come out of the pot openings not used which would disturb the women in their cooking.

“I feel using it is difficult because I need to be cooking three things at the same time so I would use it when I am timely bad, if I have only one thing to cook I prefer the three-stone-stove.”
But following this dislike about the caritas stove one group of women came together to use their knowledge and build their own variations of the Caritas stove which only has one opening, which shows that the women are taking own initiatives and are interested to improve their way of cooking.

6.2.3 Additional use of three-stone-stove

Despite the advantages of mud stoves some people would still use a combination of three-stone-stove and mud stoves. People who used both stoves would normally do their main cooking on the mud stove and use the three-stone-stove for special occasions. In case of visitors or bigger family gatherings people would use the three-stone-stove as an additional stove. Because it is also suitable for all pot sizes, since the stones can be adjusted, even for very big pots if needed. Furthermore, the three-stone-stove offers some additional benefits which are not directly connected to the cooking itself. It acts as a centre of social gathering; it is common practice that women gather their family around the fire outside where they warm water for bathing and share stories. This can be practised almost daily during dry season but is less common during wet season due to the higher work load and the occasional rainfalls. Some women mentioned that sitting around the fire helps to keep away mosquitoes. Two older women also said that they keep using the three-stone-stove for traditional reasons

“[…] I want my children to see that this is our tradition”.

It is worth noting that cooking stoves do not play a major role in lighting; most households would use some form of paraffin candles.

6.3 Adoption of mud stove

Around 64 per cent of the households interviewed have adopted some form of mud stove, most of them were built between the year 2012-2015. However, the stove implemented by ART and caritas did not seem to be as successful, most of the mud stoves were some variation of the local mud stove. All the households interviewed knew or had at least heard about mud stoves. Why or why not households adopt improved mud stove depends on a variety of factors.

6.3.1 Reasons for adopting a mud stove

As mentioned before fire wood is the number one issue concerning cooking and the biggest motivation for adopting a mud stove. Many women were looking for a way to help them to reduce the burden of firewood collection. While the fire wood situation is becoming a more pressing issue, more and more women are eager to adopt. One woman told that she had only recently adopted the mud stove but had known about it for two years.

“By then before making the (mud) stove I have known about the stove, there was plenty of firewood. I could not really bother myself after all there is much firewood, why would I bother myself to build a stove. By the time now I thought to myself let me call for someone (to build the stove) and help me really to save the little firewood I could get.”

While firewood plays the key role in adopting the stove, other factors were interesting to the women as well. Such as the fact that the stoves produce less smoke, especially women with already pre-existing conditions such as asthma were looking for a way to reduce the burden of smoke. Further, the women understood that the stove gathers the fire, which makes it easier to keep it running and thus requires less attention which gives them the opportunity to do other things without worrying that the fire goes off. Women also mentioned that the modern mud stove looks ‘smart’ and ‘nice’ if it is nicely
made. Especially the ART stove was perceived as more sophisticated and modern this was most notable in Abenonya B were the stove was most successful.

6.3.2 How people get to know and adopt mud stoves

The way how the mud stoves spread was more or less the same in all three villages. Social relationships were key; people who knew how to build a mud stove would show it to or build it for other family members, friends or neighbours. However, there are differences between the stove which have been implemented by ART and Caritas and local mud stoves.

The ‘local’ mud stoves had been the most successful one in terms of spreading. In general women would just teach each other how to build one. This knowledge usually spread from family to family, neighbour to neighbour or friend to friend. The information about the mud stove is passed on by word to mouth, and observation. All the women interviewed new about mud stoves. It was common practice if a woman was interested in getting a local mud stove to go and ask for help from a neighbour, friend etc. who has one. Normally the person with the knowledge would tell the person who was interested in getting one, to collect the materials and prepare the mud, and then they would come and build or help building the stove for them. Most local mud stove in the households interviewed have spread this way. The women usually would not request money for sharing their knowledge or their help to build a stove for another person. When asked about if they would demand money to help other people they seemed rather surprised about this question. In general the women seem to form a strong community and support each other. They form small groups where they help each other in garden work and other tasks. The women would also recommend the mud stove to each other:

“Someone told me that if I would make the mud stove it would be better than the three-stone-stove and I have realized that this mud stove does not consume much fuel."

Nevertheless, not all women would ask for help in some cases women would simply observe other people’s stoves and then try to build it for themselves.

“I just build it myself, the person did not help me, I was just trying to model, trying to build what I saw, it is not very nice like the other one from my friend. I was just trying to build something that could help me.”

The occasions when people paid someone to build the stove were typically if the person building had been formally trained. One woman from Te-amon who had been trained by ART had built mud stoves for other women in the village for a small compensation, (even though the stoves she built was not the way ART stove was supposed to be build but rather compared to the local mud stove).

In the case of the Caritas stove, a community group was formed through the Catholic Church as part of a bigger development project. A few people were trained within the community group and were then supposed to build stoves together within this group for all group members. Some stoves did spread this way. People outside the group were not targeted. However, the case of the Caritas project is not the main scope of this thesis and is therefore not discussed in more detail.

6.3.3 Reasons for not adopting the stove

The reasons for not adopting the stove were diverse and could not be pinned down to only one issue. People do not seem to actively decide against the mud stove. As stated before mud stoves have overall a good reputation and it is well known that the stove can help to reduce fire wood consumption. Nevertheless, one reason seems to stand out as to why people have not adopted a mud stove (yet), which is the physically demanding work, in preparing the mud see more in the observation report from day one of the stove building training in Figure 15. Particularly, people with health issues, injured or otherwise handicapped, the elderlies, women who are pregnant or have recently given birth.
are likely to struggle with the hard work of preparing the mud. Overall, the average work load for a woman in these villages is very high and physically demanding especially during wet season when most of the garden work is done. Women are often main responsible for the garden work and usually singly responsible for fetching water, collecting fire wood, taking care of children or sick family members among many other tasks. Depending on the family situation some women e.g. if children are away for school or have moved away, do not get much support in their comprehensive daily work load. Thus, finding the time and energy to prepare the mud might be difficult even if it is only one day work and could help them in the long run.

People who have made a mud stove for themselves and were ask to show it to other people, often reported that they are willing to help others if they are interested and get the material (preparing the mud). But it was a common issue that women failed to prepare the mud. When asked if the women who have a mud stove have helped others to build one they often replied that they wanted to but the others failed to prepare the mud.

“People come and say come and make me the stove. But whenever I go I would find that this people have not made the mud.”

“[...] I really feel that they want the stove but it is really hard for them (to prepare the mud).”

Furthermore, the subject of cooking is seen as women’s responsibility and thus the matter of building stoves. Therefore, men rarely engaged in the issue of stove building despite the efforts of ART and Caritas to also involve men in the stove building training. There were the cases of two young couples where the husbands supported their wives in the stove building but unfortunately, that was still the exception.

Another reason for not adopting a mud stove was financial limitations. Some women assumed that it must be costly to buy a stove or get someone to build for them. However, they often had not asked anyone about it e.g. what the stove cost and who can build them. One woman said that she did not want to ask anyone because she did not have any money. It was common that women assumed it coast money and must be expensive but when asked they did not know how much it could be. In some cases women were also not sure who to turn to since it is not common practice to enter another women’s kitchen and thus do not know who is using a mud stove. For some women it could be difficult to get help or ask for help from other people to building the stove. One woman who had been part of the Caritas project group said that she was sick when the group built the stoves together at the different group members’ homes and since she could not help them at the time she felt she could not ask them to come and build for her.

In the specific case of the ART stove some people knew that it was possible to buy it from Anna (she was trained by ART and had managed to build the stove successfully for sale see more Figure 14) but were still hesitant since they had heard it might crack.

“I heard from someone that the stove might crack that has made me not that interested because I might waste my money.”

Additionally, people did not seem to have an idea how much the ART stove would cost. But seemed to think that is was more expensive than it actually is. When told how much the stove would cost people seem to be surprised and more interested. Overall the ART stove has a good reputation among the people who have heard about it. One woman who was very interested in the ART stove Anna made but said:

“The one Anna makes it is hectic work to make and it is also difficult to transport the stove from Anna’s place to my place.”

Transport can be in general difficult since most people do not have the means; only few people own a bicycle or in this case more important a wheelbarrow. This is an important point if someone wants to buy a mud stove since they are heavy and need to be transported with care to avoid cracking. Besides
transporting a finished stove, transport also plays a role during the building process since several kilos of clay or anthill soil need to be transported to the place where the stove is supposed to be constructed. This is again especially challenging for women who are handicapped in one way or another. Nonetheless, that women face several challenges and struggles they are still very interested in improved cooking stoves; only very few women did not seem to be keen in changing their way of cooking and showed little interest.

“I have been hearing it from people whenever I go out, people telling me these stoves (mud) are better [...] but me I am used to the three-stone-stove now.”

However, these women were an exception in the villages studied. In the case of the ART stove project additional reasons were identified as to why the adoption of the stove did not go as anticipated.

6.4 Implementation of ART stove

There are different approaches of how to implement and spread the knowledge of improved mud stove. This chapter will focus specifically on the case of the ART stove project and its implementation strategy. The actual training itself was carried out by ACDI/VOCA a development organization whose staff was trained by the GIZ. They were subcontracted by ART since ART itself did not have the necessary knowhow on ESS. The stove implemented is a shielded Rocket stove. The results draw from different interviews with NGOs, people who have been trained by ART, other women from the villages and people who have been trained at similar stove projects. Additionally, an on-going mud stove training site was visited, which had the same implementation strategy set up as the ART project. The idea of the training in short was, people from each village get trained, go back train others and those again would train others and create a chain of knowledge. Additionally, the women could start building the stove for sale and thus generate a small income. However, there are some weaknesses to the strategy which could explain the limited success in spreading of the cooking stove. The following sub headings will deal with each weakness in turn.

6.4.1 The stove is too complex

The stove introduced by ART is quite complex when compared with the local mud stove. It requires exact measurements and ratios, from how to prepare the right ratio of grass and soil in order to get the optimal mud mixture, to the different measurements for the stove. The stoves are fitted to the size of the pot intended to be used later; a smaller pot equals smaller stove and the measurements of the overall size of the stove and the combustion chamber need to be adjusted accordingly see Figure 13. There are many aspects to consider in order to get an optimal combustion and hence preforming stove.
The number of people who have mastered the skill of building accurate stove is unknown. The people interviewed who had taken part in the training gave very mixed answers as to how many people have mastered the skill. After visiting an actual training site, talking to training staff and interviewing people trained, it is concluded that it is rare that people completely master the skill of building the stove. While visiting a NFA stove training site, the instructor pointed out mistakes made by the trainees. The majority of the stoves built on the site by the trainees had some kind of construction mistake(s) which will reduce the overall performance efficiency of the stoves. Furthermore, even if people managed to build the stove during the training properly the knowledge might still get lost over time if the person who has been trained does not practice to build stove frequently enough due to the complexity. Mud stoves in general are not going to last forever due to the nature of the construction material; they need to be rebuilt normally after two to three years. After this time it might be difficult for people to recall how to build the stove in all the details, if they have not been practicing it during that time, since the stove requires more than building a ‘mud case’ to place a cooking pot on. Further, in order to build the stove correctly some materials are needed, most importantly a tape measure, a wheelbarrow and spade to pack the soil. Trained people say it important to have this material.

“[…] Those stoves need accurate measurement, like what you put inside the banana stems, in needs accurate measurement […] This makes it very hard for us to continue with the training (of other people in the village) cause if you train something you need something which is really accurate. Not just you say maybe I put this amount, it needs to be accurate.”

While the ART training took place during the less work intense dry season, some women were still busy harvesting which resulted in late coming to the training. Problems to attend the training in full are likely part of the reason why not everyone managed to master the skill of building accurate stoves.
6.4.2 Too few people trained

The number of people trained was not the same as the project proposal initially suggested (see section 4.2). The proposal document talks about forming of community groups of 40 people in each village and within this group 10 people were supposed to be trained on how to build stove; which then were supposed to train the remaining group members when they return to the village. However, the final report of ART speaks of 42 trained people ‘artisans’, three from each village this is supported by the results of the field work. Yet, the report also states that 700 beneficiaries have been trained on stove construction and maintenance and 684 households have constructed ESS which would equal around 48 stoves per village none of the latter is supported by the field work findings as shown in Table 2. ART stated in one of the first interviews that it was difficult to get people motivated to take part in the project, especially men. They printed themed t-shirt in order get people more interested. In total five trained people were interviewed. Two out of the three people trained in Te-amon and Abenonya B and one in Bung. The number of people trained in each village is too little to sustain the knowledge or even spread the information about the stove, since there are too many potential (personal) obstacles which could limit the spreading of the stove by the people trained. In the case of Te-amon, one woman moved away in marriage, the other person became sick right after the training and the third person did not manage to master the skill and in addition became pregnant, leaving no one who could inform or train other people in the village. This shows that it would have been important to follow the original plan of training more people in each village and follow up on the training. However, GR has stated that a returning to the villages with another round of training was planned. Nonetheless, there was a success story in Abenonya B where one of the trainees managed to use her knowledge to make a small income by selling the stoves see Figure 14.

Anna has been pointed out by GR and ART because she represents the biggest success story of the training. She was one of the two women trained in Abenonya B and was now well known for her stove building skills even beyond her own village. When she returned from the training she started building the stoves and invited people to look at them when they would pass her home. She also built several stoves for family members. During the holidays she builds stoves together with her children for sale. She said she had built over 50 stoves so far and is saving the money to build a house out of bricks. She would later hold a training session at her place in which we got to participate.

Figure 14 The case of Anna: a trained woman who managed to turn her stove building skills in a small business
6.4.3 Too much work to build, takes too much time to train people

The idea was that people should bring the knowledge back to their villages and train others who then in return train others and thus create a chain of knowledge transfer. However, the instructions as to how this should work or what the participants are supposed to do seems to have been rather vague. The chain of knowledge idea was not tied to any terms and conditions, e.g. is the knowledge to be passed on free of charge, how many people should be trained, or how a stove building training should look like.

Firstly, to train other people takes a lot of time for those who are doing it as well as for those who are attending it. During the field work period Anna (see Figure 14), organized a stove training, to which she invited other women and showed them how to build the ART mud stove. As the description of the training in Figure 15 and Figure 16 shows, the training consisted of two full days of work with two days of no work in between. Additionally, extra time for collecting the mud, which Anna had done in advance and time spend for walking from household to household to inform people about the upcoming training. Beyond the two training days the stoves were left to dry for around a week during which time they needed to be smeared with mud to avoid cracking and covered whenever it rained. It is estimated that the time spent was around 18-25 hours. This is time in which the person who leads the training cannot do any other work and does not receive any compensation and misses out on work which could potentially generate an income. Additionally, the work is very tiresome as described in the participation report in Figure 15. Almost the same is true for people attending the training; however, most women did not attend the training in full length due to their other work or family obligations and thus might also not fully master the skill of building stoves.
When we (me and my interpreter) arrived at Anna’s place for day one of the training, only Anna was there. So we started the training on our own, by going to the nearby swamp land to collect swamp grasses. The grass was packed to a big bundle and carried back to Anna’s place; this part of the work was rather easy. Back at Anna’s place we cut the fresh swamp grass together with normal dried grass with a panga in one cm pieces. During that time the first participants joint the training. The next step was to mix the grasses with the special type of clay soil mud under adding of water. Anna had collected the mud for the training already prior to the training. By the time we started to mix the mud with the grasses around 10 women had arrived to the training and joined in, all of them seem to be familiar with the process of preparing mud. After all the local huts are build out of mud too. The mud was first roughly mixed with hoes and then forth fully beaten with strong ca. 1 m long sticks, pushed together and beaten again until the mud got a homorganic texture. This process took approximately one and a half to two hours. Since we prepared a rather large amount of mud this part of the work was very exhausting. The women would take turns in working on the mud since it was such hard work and I was not able to keep up with them. Mixing the mud with the grass until the mud has the right consistency was the most demanding part of the entire building process. I understood that one needs to be in good physical condition to be able to prepare the mud.

The finished mud was put together in a pile and covered with banana leaves and left to ferment for two days. Up to this point little explanations or instructions were given. It seems like everyone was familiar with how to prepare the mud.

![Figure 15 Day 1 of the stove training - preparing the mud](image)

When comparing the stoves built on the second day of the training with instruction in the GIZ stove construction manual smaller construction mistakes become visible (bypass air inlet is not placed right). This construction error has been also a common mistake at the NFA training site pointed out by the training instructor. This shows again that even people who have shown great appreciation for the knowledge given to them like Anna still make mistakes while building the stove.
We returned two days later when the actual stove building took place. Again there were around 10 women of different age some of them had been there already on the first day. Men did not take part in the training; however, there were some young boys around.

The actual stove building part was fairly easy work and not as tiring as preparing the mud. Only a few simple things were needed: banana stems, tape measure, panga, sauce pan and a small piece of tar. Anna started out with putting down a round mud base. On this day she explained everything step by step, explained the measurements and demonstrated all steps. The participants would start working on several stoves simultaneously and help each other out while Anna would keep checking. By the end of the day, 5 stoves had been constructed and left for drying.

![Figure 16 Day 2 of the stove training - Building the stove](image-url)

Further, it was unclear what was going to happen with the stoves built during the training. Neither Anna nor the participants were sure how to handle the situation. Most people attending the training assumed that they could take a stove home, but when asked if anyone has talked about this matter they all said no. When Anna was asked about if she can keep the stoves for sale so she would get some small return for her work she said: people will not really accept to leave the stove behind since they have also participated in making the stove. Further, only five stoves had been constructed and more people took place in the training. This puts Anna in an uncomfortable situation. Unfortunately the training took place in the end of the field period; therefore it is unknown how this issue was solved. Nonetheless, considering all this it is understandable that most people do not find the motivation to organise a training session for other people. A clear set of rules and conditions would have been important. More guidance or advice should have been given at the original training on how they should handle stove trainings in their communities.

It is difficult to say in how far the training was motivated by the students present; the same is true for the fairly high turn up of participants at the training. People who have been trained including Anna stated in initial interviews that people had shown little interest in trainings but were interested in the stove in general.
“We came and started training people but the turn up was very poor. People wanted the stove but they did not want to engage themselves in making the stove. So we realized we could not keep making for this people the stove.”

According to ART attracting people for the original stove training was also not easy. People needed to be motivated to come to the training. ART designed and handed out t-shirts for the participants in order to get more people interested. As stated before many women already have a quite demanding work load which makes building the stove rather difficult as one of the trained woman explained it:

“We used to make the stoves together (her and Anna) and sold them but since there also are issues of farming the land, at time we become so committed in the issue of farming we leave the issue of the stove.”

However, the physical work load to build either of the mud stoves appears to be almost equal, since the most difficult part is to prepare the mud.

What the trained people have exactly done after they came back from the ART stove training is unclear. Some claimed that they have trained or at least tried to train others but none of the interviews with neighbours and other women from the village confirmed that. In the case of Bung the only person who was trained by ART and interviewed stated that she has not done any training since most people know how to build this type of stoves anyway, which was obviously not the case. As a result, the chain of knowledge idea did not work as planned for this type of stove. At the point this study was conducted, it was not possible to find any evidence that people outside the group of people originally trained have learned how to build the ART mud stove.

Considering all the work and time which is going in to a stove building training, to build stoves for sale might be the better option for the people who have been taking part in ART training, if there are physically well enough to do so.

“[…] People wanted the stove but they did not want to engage themselves in making the stove. […] So we could make the stove together could sell them off to those who are interested and that is what we did.”
7 Discussion

The goal of this thesis was to understand why the energy saving mud stove implemented by ART and GR in the villages around the Kachung forest plantation is not being adopted as much as its apparent benefits would suggest. This also required me to understand how and why people adopt Energy Saving Stoves and how the different stoves perform according to the people using them, as well as the weaknesses of the current implementation strategies. This understanding can result in suggestions for how implementation can be improved in future projects. These questions have been approached in a case study format, by conducting semi-structured interviews with relevant stakeholders, and with women in 63 households from three different villages. Interviews with the women in charge of the cooking were the main focus point of this study. These interviews were supplemented by participatory observations of different daily activities.

At first it is important to understand the women’s daily routines since they are the one in charge of the cooking and all related tasks. The women living in the villages have a substantial amount of physically demanding work to do every day, and time for recreational activities or rest is limited. Especially, tasks like cooking, firewood collection and fetching water among others are considered the responsibility of women and girls. Considering the high work load women have and the negative impacts from traditional open fire reduce the pressure on women is important. Thus, there is undoubtedly a need for energy efficient stoves which can help with the burden of firewood collection which was the number one concern of the women regarding the cooking due to the limited availability of firewood. The burdens and risks of firewood collection on women is well documented in the literature (Chynoweth and Patrick, 2007; Jan, 2012; WHO, 2016b). The firewood scarcity explains why around 65 per cent of the households visited had adopted some form of mud stove in order to help them to save firewood. Especially the decreasing availability of quality firewood in the study area motivates the adoption. The literature refers to the availability of biomass as a central factor in the interest and uptake of improved cooking stoves (Eshetu, 2014). The lack of fire wood stands out as the major concern of all the women involved in the cooking. Besides the issue of firewood, women named smoke as another problem in their cooking but it is perceived far less important compare to the issue of firewood. While some women especially younger ones or women with health issues e.g. asthma describe the smoke as a disturbing factor in cooking, others seem to just have accepted it as a fact they simply have to live with because’ they are women so they have to bear it’. The study by Siddiqui et al. (2005) suggests that women may build a higher tolerance to smoke with longer exposure and thus have less acute symptoms. This correlates with the observations in the villages during the participant observations but also by the feedback in the interviews were younger women are more likely to ‘complain’ about the issue of smoke than older. Older women gave more commonly the response that they are women so they just have to bear it. For the women in the study of Mobarak et al, (2012) the health dimension were one of the least motivating factors - women would prioritize other basic needs over improved cooking stoves since the health hazard through indoor air pollution was not perceived as significant enough. The women interviewed seem to be aware that the smoke is influencing their health negatively or at least suspect it. Nonetheless, in general the reduction of smoke appears to be a positive perceived benefit of mud stove but not the main motivating factor to adopt a mud stove unless women had pre-existing health conditions. In summary the women who were using the mud stove observed several important benefits such as firewood saving, reduction in smoke, improved cleanliness (since ashes stay inside the stove), and less tending of the fire; the latter gives the women the opportunity to do other work or rest. Even non-users were aware of the firewood saving properties and some of the other benefits.

Besides the advantages named and the overall positive perception of mud stoves, some problems were frequently named. Due to the nature of the building material the mud stove is prone to cracks, which makes it also less suitable when there is the need to cook for a large number of people or to make some of the local dishes, which demand strong stirring. However, this resulted rather in the additional use of a three-stone-stove when needed, than as a reason for not adopting a mud stove at all. The additional use of traditional stove is also documented in Wallmo and Jacobson’s(1998) study of
another stove project in Uganda. The same seems to be also true for the ART stove, meaning the performance of the stove itself does not appear to be the reason why people do not adopt the stove. However, the data on the ART stove was limited since only four out of all the women interviewed were (still) using the ART stove.

For the spreading of the mud stoves social relationships were the key factor especially in the case of the local mud stove. A person with the knowledge (of how to make one) would show it to other family members, neighbours or friends or help if being asked. The idea of creating a chain of knowledge seems to work in the case of the local mud stove. Women would share their knowledge with other women free of charge and usually help to build a stove provided that the other person prepared the needed materials in advance, namely the mud. Many of the local mud stoves and some ART stoves had spread this way. Yet, not everyone has adopted a mud stove even though fire wood is scare. Financial limitation was common reason named for not adopting a mud stove. Interestingly most people who named this as a reason had not asked anyone about the cost of a stove or who could help them to build one. One explanation for this could be that people did not dare to ask anyone or enquire about the stove assuming that they would have to decline because of financial reasons. Financial reasons have been commonly named in the literature as a reason for low adoption rates (El Tayeb Muneer and Mukhtar Mohamed, 2003; Jan, 2012). Further, even if they knew that they would not need to pay for it some people especially the poorest and sick might have difficulties to find someone to make the stove for free since it is often all about reciprocity. Women in the villages do form a social bond and engage in labour sharing activities. Nonetheless for some people it might be difficult to get involved in labour sharing activities since they might not have the social capacity or are too sick. Meaning they do not have anything to offer and thus miss out on the opportunity to get a (local) mud stove even though people typically do not charge money to share their knowledge. Another major obstacle is the hard work required in preparing the mud for the stove. Even if people would know someone who can show them how to build a stove they would typically demand that the mud would be prepared and ready. This physically most challenging part of building the stove was a common reason for people not to adopt the stove. Especially elderly, sick or injured people, pregnant women etc. are likely to have difficulties preparing the mud in addition to their already comprehensive work load, even if they would benefit from the stove in the long run. The issue of the physically challenging work load in building the stove has not been discussed in any of the studies reviewed for this thesis. However, most studies do not seem to talk about energy saving stoves build out of mud.

In the case of the ART stove adoption rate has been extremely low, even though the stove has an overall good reputation and is considered as more advanced and sophisticated than the local mud stove. This can be attributed to several reasons. Firstly, the stove is rather complicated to build in the sense that it needs accurate measurements, other construction considerations and some smaller construction tools e.g. tape measure. Due to its complexity, it is rare that the people trained master completely how to build the stove correctly. This could also been at a training site visited. Further, even if people did master to build the stove during the training due its complexity it is likely that the knowledge of how to build the stove correctly will get lost over time if not practiced frequently. Even if a construction manual was handed out or notes were taken, paper is not likely to sustain long under the living conditions in the villages thus there is no way for the people to recall the details of how to build the stove. The chain of knowledge idea which is working for the simple local mud stove is not likely to work for the ART stove. Assuming the people trained by ART would show it to some family members or neighbours, it is not likely that most of them would pick up on how to build the stove correctly and be able to show it to others because of its complexity. If the stove building is not practised regularly the knowledge is not likely to be sustained over a longer period of time. Due to the nature of the building material the stove needs to be rebuilt eventually after a couple of years and then it might be difficult to recall all the details on how to build it. This could also explain why the people whose ART stove got spoiled have not rebuild it. Secondly, in average only three people per village were trained which is too few considering the fact that not everyone masters the skill, some people might not be able to do the hard work which is required for preparing the mud due to sickness or injury, some might get married off to another village or get pregnant etc. and thus cannot build stoves or show other people how to build one. This was the case in one of villages, all
the people who had been trained had fallen under one or more of the above named circumstances and thus there was no one left to spread the knowledge.

The approach ART took to also target men for the stove training is important even though they face difficulties in getting them interested. Their support in building stoves could help women to overcome the physical challenge in building a stove. Furthermore their involvement in the issues of stoves might be also a small step towards braking up traditional gender roles and thus lead to more equality.

The idea of people coming back from the training and start training other people is unrealistic. Even if the person who has been trained has mastered the craft and is physically fit, it takes too much time and energy to train others, time for which they do not get paid and in addition cannot do other work which might provide them with an income. Another constrain was that no instruction on how a training should look like, how should it be set up and how it should be compensated were given to the women. Thus, even if women were willing to spend time and energy in training others; more problems need to be solved, such as, what is supposed to happen with the stoves built during the training or who might get one of the stoves produced during the training. Otherwise these issues can put the person who conducts the training in an uncomfortable position as happened at a training conducted in one of the villages. Poor implementation strategies and lack of trained people has also been a common cause of failure in other stove projects studied (Jan, 2012; Urmee and Gyamfi, 2014; Wallmo and Jacobson, 1998).

Besides the instruction to train other people, ART trained people were also told they could use the knowledge acquired to generate a small income by building the stoves for sale. One woman actually managed to make stove building a small side business, she had sold over 50 stoves and was known beyond her village for her stove making skills. This woman managed to spread more ART stoves than all the other people trained together from the villages studied. Hence, to build and sell the stove seems like viable option for the stove to spread. Yet in this case, the trained women should also be given some instruction and recommendations as to how they could set up a small side business. For example, give simple marketing instruction. However, in order to determine if the stove built for sale is a viable option to spread the stove, a better understanding of the social economic circumstances in the area is useful e.g. is the price the stove can be sold for so people can still afford it high enough to make the work of building a stove profitable. Further, a few people who were thinking of buying the stove, were concerned the stove might crack and thus were hesitant to buy it or did not know how to transport the stove to their home and hence preferred to turn to the local mud stove. The issues of maintenance and transport would also have to be addressed within the project in order to improve uptake.

The quality of the mud stove found in the study area varied considerably but compared to traditional three-stone-stoves most mud stoves were an improvement. This raises the question how much better the ART stove performs under field condition in comparison to a well-made local mud stove. While an ideally built ART stove may perform better than a local mud stove under laboratory conditions, the situation may be different under field conditions, meaning the stove is not hundred per cent exactly built or has deteriorated with use, which is a common reality. This question was outside of the scope of this thesis but it could be relevant to know if the simple version of the local mud stove is good alternative to the ART stove since the knowledge transfer works much better with this type of stove. Additionally, since the majority of the people already adopted a local mud stove the incentive to switch to an ART stove might be rather low, since many of the general benefits perceived are the same e.g. fire wood saving and less smoke, even though the benefits are more distinct with the ART stove. It might be like upgrading a working refrigerator, yes a new one would use less electricity and might make less noise but the general benefits are the same thus investing time and money in getting a new one might not be the highest of priorities.

It is problematic to compare some of the findings to other studies since most of the literature found does not refer to locally built mud cooking stoves. Further, the scientific research articles often fell short in explaining what exact type of stove was used or how the implementation strategy looked like (e.g. Bielecki and Wingenbach, 2014; El Tayeb Muneer and Mukhtar Mohamed, 2003; Jan, 2012; Mobarak et al., 2012; Urmee and Gyamfi, 2014). Thus, it is difficult to relate some of the results to other studies. Nonetheless, this study shows, as many other studies in the field of social shaping of technology have before (Leach and Scoones, 2006; Li, 2007), the importance of considering the local context when introducing new technology. It appears that the performance design of stove is not the
problem as it has been the case in other studied stove projects (Bielecki and Wingenbach, 2014); but rather the transfer and sustain of the knowledge on how to build this specific type of stove and the additional physically demanding work which comes with building the stove. This shows that even technology with good performance design, adapted to the needs of women in charge of the cooking e.g. firewood saving and producing less smoke, can fail because of neglecting the local circumstances. Even though the idea of stoves made out of local inexpensive material sounds promising and caters to people with little disposable income; the work it entails can still be a big obstacle in an area where it is common for people to suffer under a great workload worsened by diseases like malaria or diarrhoea, injuries, pregnancies, old age and other circumstances like a poor social network.
8 Conclusions

Improved cooking stoves are an important tool to ease the burden of firewood collection and the health hazard that indoor smoke represents for women and girls. The study showed that women in the research are interested in improved cooking stoves, and are already building them using a local design. However, the additional work burden in constructing mud stoves might limit some women from adopting them. Overall, people interviewed have a positive attitude towards mud stoves and the pressing issue of firewood shortage will continue to make women interested in improved cooking stoves.

As for the more sophisticated ART mud stove, the implementation strategy shows significant weaknesses which limit the successful spreading of the stove. The implementation strategy needs to be revised in order to secure a higher success rate, including finding ways of using simple and robust measuring sticks or some other form of local material that can withstand the local conditions and be used to remember the various exact measurements needed for making the stoves. It is also necessary to change the initial stove building training in order to achieve a more sustainable outcome. This could be done by testing if the people being trained have mastered the craft and then grant them a financial compensation for training other people or put more emphasis on building the stove for selling. Follow ups on the projects are vital. Until the implementation strategy has not changed the simpler local mud stove models are more likely to spread even though they may not have as pronounced benefits as the stove introduced by ART.
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