Sustainable Sanitation and Energy for Improved Living Conditions in Rural Areas of Kyrgyzstan, Central Asia

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Abstract
This study was conducted to investigate the opportunities for upscaling sustainable locally-made technologies for improved living conditions and implementing the SDG targets 5, 6 and 7 in rural areas of Kyrgyzstan. Innovative sustainable technologies using local material have been introduced in rural Kyrgyzstan and local capacities have been built during the last 5 years. The technologies included: urine diverting dry toilets (UDDT) for safe sanitation, energy efficient stoves (EES) in the house and solar water heaters (SWH) for hot water by solar energy. The technologies have been successfully adapted and implemented, and they are appreciated by the villagers, especially by the women. A gender sensitive survey with a cost benefit analysis was done and additional qualitative and quantitative data were assessed in order to understand the opportunities and barriers for upscaling the technologies.

Keywords: sustainable sanitation, solar water heater, ecological sanitation, energy efficient stove, micro finance

INTRODUCTION

The population of the Kyrgyz Republic remains largely rural with 64 % of its population residing in rural areas. There is a big gap between rural and urban lifestyle. Rural inhabitants face many problems in daily life: lack of safe sanitation, WASH related diseases, energy poverty (lack of heating, light and fuel) and low nutritional status. Consequently villagers are confronted to health issues that are closely related to their limited access to safe drinking water, inadequate sanitation facilities and poor hygiene practices. As an evidence of the extent of these water-related issues, diarrhoeal diseases are the main drivers of child mortality, causing 35 deaths per 100,000 children under five. This places Kyrgyzstan to the bottom of the ranking with regards to this statistic across the pan-European Region (WHO, 2015).
The districts Issyk Kul and Naryn belong to the poorest of the country. In this region, sustainable technologies for energy and sanitation were introduced; urine diverting dry toilets (UDDT) solar water heaters (SWH) and energy efficient stoves (EES) were adapted to local conditions, capacity built for institutions and masters, awareness built among the population through demonstration and resource centres set up. In the frame of the Agenda2030, especially the SDGs 5 (gender equality), 6 (water and sanitation) and 7 (energy) have been addressed (UN 2015). The sustainable technologies are the following.

Urine diverting dry toilet (UDDT): The urine diverting dry toilet (UDDT) or ecosan toilet is an sustainable technology, which can be implemented inside the house or attached to the house (WECF 2015). The ecosan toilet does not need water for flushing, it does not smell, nor does it attract flies. Urine diverting toilets do not mix urine and faeces by using a separating toilet seat. Urine is collected and stored in a reservoir. Faeces, which are collected underneath the toilet, must be directly covered by dry materials such as sawdust, soil, ashes, or a mixture of those. The toilet products, urine and faecal compost, can be used as organic fertilisers (Winblad & Simpson-Hébert 2004). Urine is a liquid fertiliser containing nitrogen, phosphorus, potassium and many

micronutrients. Faecal compost is a soil conditioner and fertiliser. The safe application of urine and faecal compost requires some health considerations, according to WHO (2006). The UDDT technology has been introduced in Kyrgyzstan by WECF six years ago and is already known in the project area (Jorritsma et al. 2009).

Solar water heater (SWH): Warm water for washing, cleaning and laundry is an important factor for comfort and hygiene in daily life. Sun is everywhere on earth and shines for everybody. It can also be a source of energy for the households. Kyrgyzstan has an annual average insolation of 4.1 KWH/m2/day. Solar water heaters, also called solar collectors, use the energy from the sun for water heating and work without electricity supply. They provide hot water for showers, kitchen use, washing clothes and depending on the size, heating the house. Households using solar collectors have no extra fuel consumption for warm water heating and save money, which they would otherwise have spent on fuel. SWH are especially applicable for regions with high solar radiation and cold winters. They have been adapted to local conditions and constructed locally (WECF 2014).

Energy efficient stove (EES): Energy efficient stoves burn fuel more efficiently and produce less smoke than conventional ovens because of a better combustion efficiency. Different types of stoves have been installed, from simple ones for cooking only to the ones for heating where hot air is guided through a space inside an interior wall of the house. Most ovens are used for both heating and cooking. Through the installation of such stoves, a family will not only reduce household fuel consumption, but also may improve family's health. The energy efficient stoves can heat a house with any kind of fuels, such as coal, dried dung and wood.

METHODOLOGY

This paper is based on the results of a field survey among 407 villagers (161 women and 246 men) from 9 villages in Issyk Kul and Naryn oblast, who were asked.
The questionnaire comprised questions on the following topics:

- the current situation in households regarding energy, sanitation and personal hygiene
- the demand and willingness to invest in the innovative technologies (EES, SWH and UDDT).

The questionnaire included open and closed-ended questions. The villagers filled in the questionnaire on their own and were free to respond as they see fit, without being limited by some predetermined parameters. Some respondents preferred to answer anonymously. The interviewers were present and were sometimes asked for clarification, as some respondents spent more time on specific questions, or had additional interrogations.
The sample of respondents for the questionnaire was chosen in a practical manner. It was decided to get a cross-section of the communities, which means that males and females from different social and age groups were surveyed. Interviewers walked down the streets and asked every tenth person to fill the questionnaire.
Additional sources of information were used, which included informal interviews, monitoring the results of objects constructed in the context of the project, and reviewing guest books at 8 demonstration centres in the project area. Data for the cost-benefit assessment were gathered from project managers, a couple of villagers and prices in local markets.

Cost benefit analysis

The quantitative assessment uses a time period of 10 years with an annual discount rate of 10%. Soft indicators like health, comfort and time saved are not included in the analysis because figures are very subjective, but they are nevertheless considered in section 5.2. The calculations are based

on the assumption that the household have to replace their toilet, stove or bathing facility or that a new house is being constructed.

Qualitative assessment
The soft indicators in terms of health benefits and improved living conditions brought about by these innovative technologies are difficult to quantify. Nevertheless they play a crucial role for householders when it comes to deciding whether to invest or not. The open questions were used to gather some qualitative data about the situation and the technologies.

RESULTS

Current situation in households regarding energy, sanitation and personal hygiene

Household conditions and gender aspects
69% of the respondents haven't got running water inside the house. In general, women are in charge of the water provision (72% of the respondents). In some families, responsibilities are shared with men, and in many cases, with children. Usually, the whole family is involved in fetching water for the household; in 84% of families, children have responsibilities to bring or collect water along with adults. The time spent to collect water varies from 15 minutes to 1 hour per day in the project villages. Water duties include carrying water and managing water storage. The practices vary a lot; buckets, pails, tanks or metal flasks are normally used.
The majority of respondents explained that men and women have equal responsibilities regarding agriculture. But in the households, women's labour burden was recognized by both men and women to be more intensive than men´s. Rural women are estimated to be two times busier with household-activities in comparison to men. Because of their household duties, rural women suffer more from the lack of adequate infrastructure (energy, running water, sanitation and hygiene). The time-consuming and intensive efforts required to meet basic needs reduces the potential for further income earnings, which aggravates the precarious situation of households.
The limited availability of water exacerbates the poor conditions for personal and domestic hygiene, which again increases the burden of family members, especially for women and children. Sanitary conditions were evaluated by majority of respondents as poor to moderate.
The majority of respondents (64%) are not satisfied with their living conditions. Such evaluation closely relates to the limited sanitation and hygienic conditions observed in rural Kyrgyzstan.

Energy
Rural women stressed that housekeeping during cold seasons is more time-consuming than in warm seasons. Additional activities include: kindle stove to heat house, cook and boil water for household needs.
Respondents preferred to use wood as fuel for the stove, as it is cheap and affordable. Coal is the second preferred type of fuel; it is accessible but expensive. Kyzyak (dried cow manure) is affordable everywhere in the villages, however it is not effective enough to heat the house. Kyzyak is normally only used for cooking. Gas and electricity are mainly used for cooking at home, starting from October till May. All villagers use combined types of fuel during winter as they usually save resources to insure availability throughout the entire season. Another way to save on fuel is to limit heating space at home. Traditionally, villages consist of houses with four or more rooms (more than 48 m^2). During cold days villagers usually heat one or two rooms (27 to 35 m^2) of the house. 96% of respondents (men and women) pointed out at the lack of resources in families as the main reason for heating limitations during cold seasons.

For heating and other needs, during cold months, an average rural family needs annually 2 to 5 tons of coal, which cost about €100-325, or 0.5 to 7 cubes of wood for the average cost of €15-115, or 1 to 5 freight cars of manure for the approximate cost €15-60. Most households don't have permanent foreseeable sources of income because job opportunities are often scarce in rural areas. Thus, it means that, during winter, households spend up to 50% of their income on heating. In order to alleviate such burden, villagers try to collect fuel in advance by purchasing and storing fuel whenever they have the financial capacity.
Rural families have to limit warm water consumption to up to 20 l per household (maximum water consumption of household is 50 l per day see figure 2), while daily consumption of warm water per person in Bishkek is 102 litres.

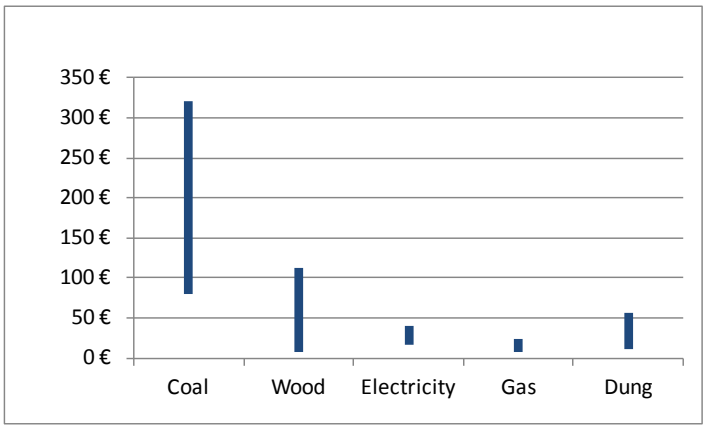

Figure 1: Annual costs for energy per household

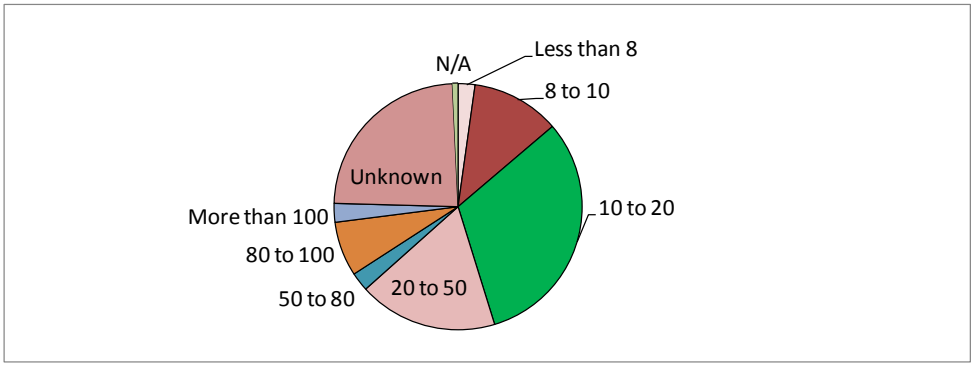

Figure 2: Quantity of warm water in l per day consumed by the respondents

Sanitation and hygiene
98% of the respondents have a traditional pit latrine at home. Most of the toilets are located far from the house (see figure 3). Pit latrines are constructed from poor quality materials by men and are not emptied when they are full but rather relocated. Some families and schools have a ventilated improved pit latrine, which is equipped with a ventilation pipe in order to avoid bad smell and vector related diseases. It is emptied from time to time (e.g. every 3rd year) and usually not relocated.

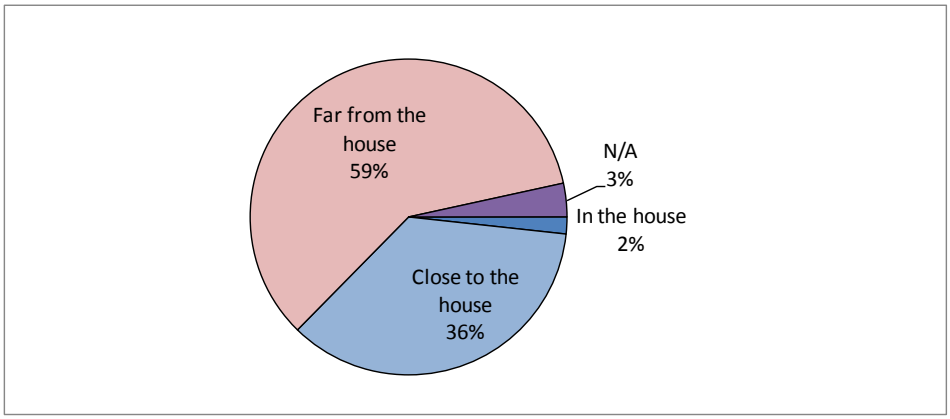

Figure 3: Distance of the toilet to the house

The toilets are difficult to use at night and during winter because of the absence of light and cold temperatures. This brings about complications, especially for women, who often report that they suffer from associated health problems such as urinary tract infections. Small children use potties in the house. Elder children (more than 6 years old) use the pit latrine, which poses a health risk on them. Stories have been reported of children who fell inside the pit. Most people have an aversion to pit latrines because of the smell and poor hygienic conditions. Latrines are cleaned regularly, once a week during summer time and once every two weeks to a month during wintertime, and the task is usually accomplished by women or girls.
Access to bath varies per season. Most people take a 'banya' 4 to 10 times a month. 30 to 40% of the respondents also take a shower 4 to 10 times a month, especially in the summer. In the summer, people sometimes use simple shower facilities with water tanks of 10 to 15 l. Informal interviews revealed that men and children make more use of this kind of facility. Women use these showers less due to warm water limitations. Also women (52%) indicated as a reason the lack of privacy of garden showers. Heating the water on open fire is usually men’s responsibility.

Cost benefit analysis
The UDDT has an initial investment cost of €427. A UDDT has an estimated maintenance cost of €26 starting in the second year. Every year, the UDDT produces fertilizers equivalent to about €40. In contrast when people construct a VIP latrine of the same quality they pay €293, yet the VIP needs to be emptied every 3 years for €80. A simple pit latrine costs €60 (including labour) and it needs to be relocated every 3 years.
Initial investment costs of a UDDT are relatively high in comparison to a simple pit latrine because of better material quality. The big advantage of the UDDT is that it can be integrated into the house, which reduces the real cost of its implementation as opposed to other detached alternatives.
In the graph, it can be seen that a UDDT is cheaper than a VIP latrine after 4 years. Because the pit latrine has to be replaced, the cash saved on relocation by using UDDT accumulates over the years, while the fertilizer (urine and faecal compost) adds to its financial benefit.

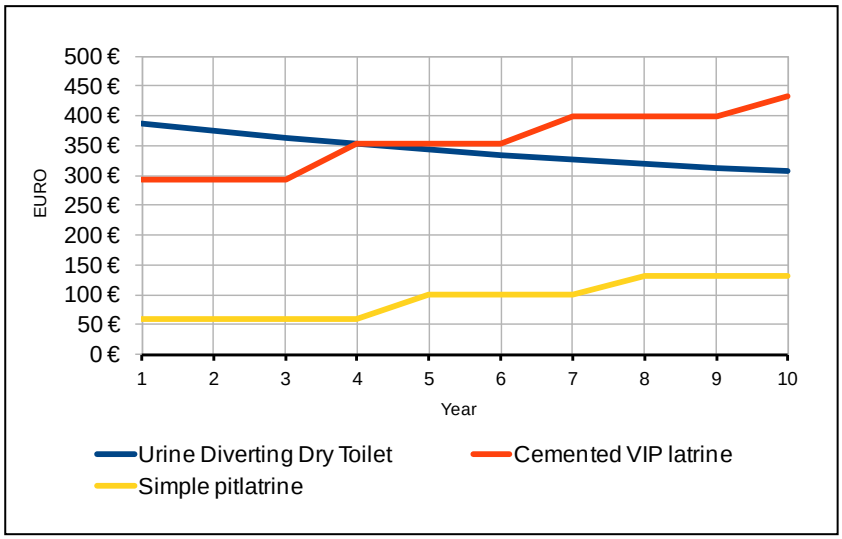

Figure 4: Cumulative and discounted costs of the sanitation technologies

The EES has an investment costs of €207 in case of a standard stove for heating and cooking and €150 for a simple stove only for cooking. A conventional stove costs €256. The EES uses 40% less inputs in the form of coal, wood and kyzyak to operate. According to the survey, people spend an average of €300 on these combustibles using traditional stoves, resulting in an annual saving of €120. In our model, we assume that after 5 years, the EES needs to be repaired for €80.

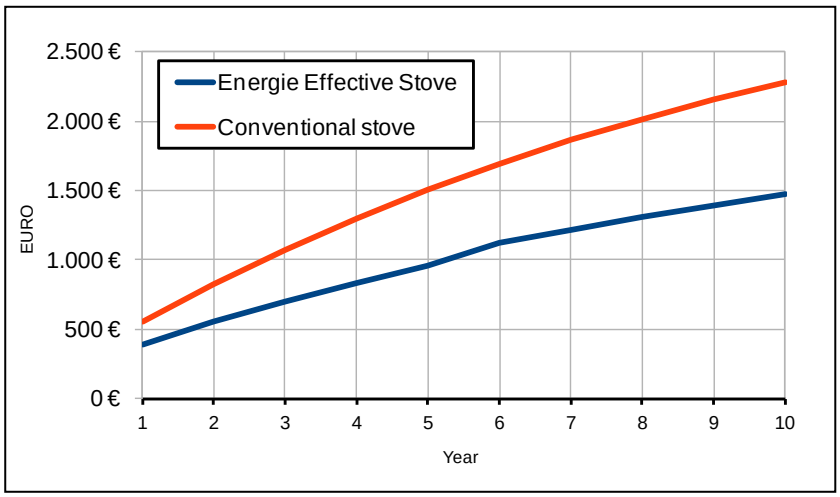

Figure 5: Cumulative and discounted costs of the stove technologies

The SWH has an investment costs of €293. After 5 years, the SWH needs maintenance for an estimated cost of €77. Additionally, €177 is needed to build a shower. The SWH saves €36 in fuels and electricity costs from water heating (calculated according to the insolation in Kyrgyzstan, the efficiency of solar collector and local energy prices). The construction of a new banya cost €565, and after 5 years, maintenance at the cost of €40 is needed. The cost for running the banya is approximately €150 per year assuming that the householders use the banya every week. Some people choose to go to a public banya where they pay approximately €250 per year.
You can see in the figure that a banya is far more expensive than a shower. Over a period of 10 years using the latter instead of the former can allow households to save up to €1400. A solar water heater saves €273 over 10 years compared to an electrical boiler, which cuts the costs of personal hygiene by half.

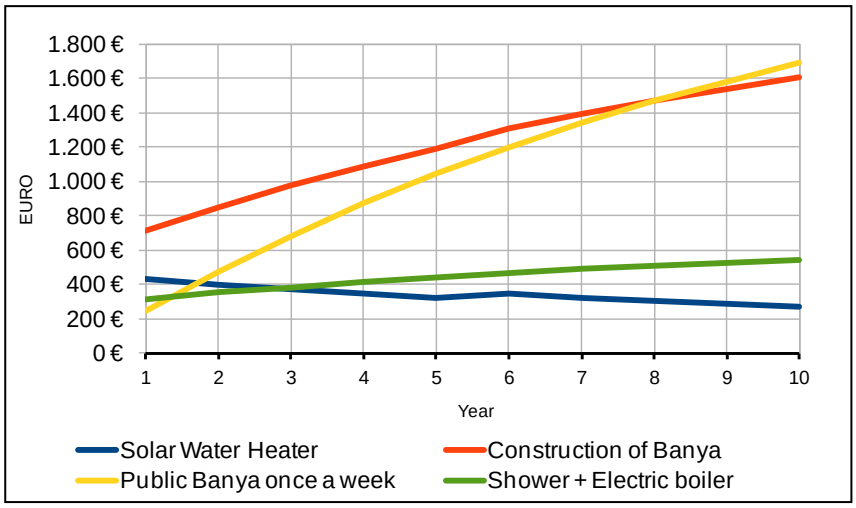

Figure 6: Cumulative and discounted costs of warm water solutions

Willingness to invest in the innovative technologies

Villagers were asked how much of their own money they would invest into the technologies. 6 to 11% of the respondents are willing to invest full of the costs of the technologies and 23 to 30% half of the costs. The highest willingness to invest is found for SWH. For EES and UDDT, there was a slightly lower willingness to self-finance the product. Differences between men and women are especially found for UDDT. 7% more men are willing to invest half of the costs of a UDDT.

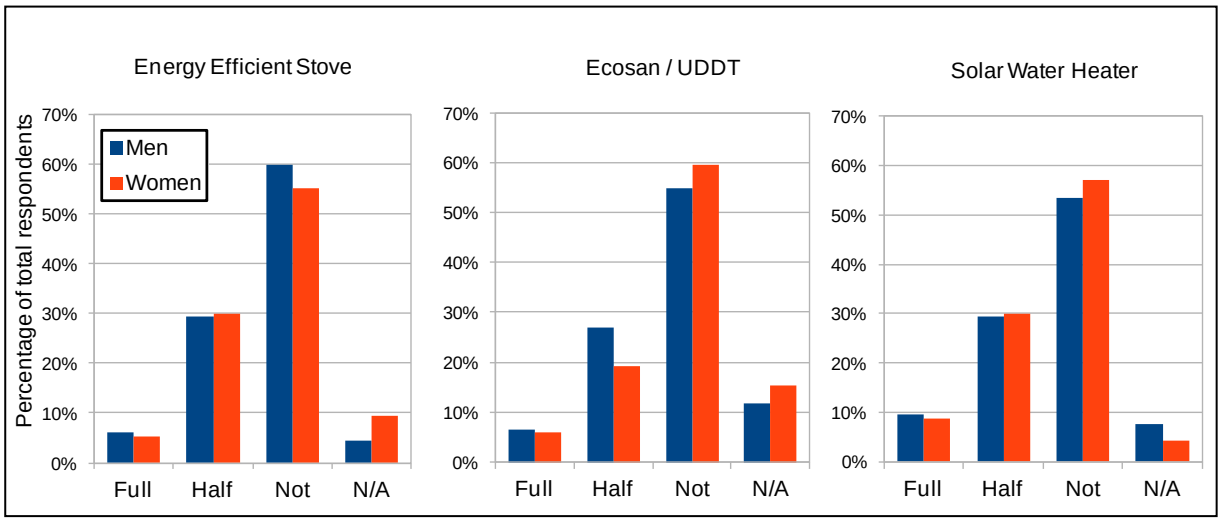

Figure 7: Willingness to invest in the technologies

Willingness to take a microcredit for the technologies

There are many micro finance institutions in Kyrgyzstan, however they operate with high interest rates (over 30%), which may apply only to a short-term commercial investment, but not for long-term non-commercial infrastructure investments. Villagers indicated that these rates are too high for them.

Villagers of the project area recognised the importance of investments in improved rural living standards through sustainable energy and sanitation. However, even though they obtained necessary knowledge and information, the respondents reported that they faced the problem of lack of financial resources. In the survey, we asked villagers about their willingness to take a low-interest (5%) microcredit. About 60% of the respondents (24% women) indicated that they would take a microcredit for one of the technologies. Most demand was expressed for EES and SWH (both around 30%) among the respondents who are interested to take a microcredit. UDDT showed less

interest (14%). The interest of EES was slightly more among men, for SWH about the same and for UDDT more among women.

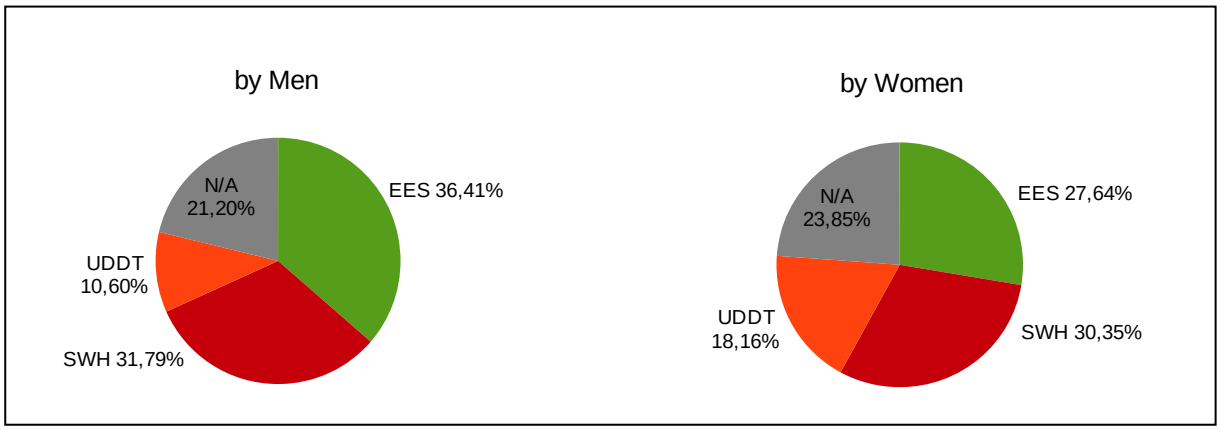

Figure 8: Willingness to take microcredit

Upscaling and barriers

All three technologies have been adapted and proven to be realistically implemented in the villages. Upscaling is now the overall objective. Henceforth, villagers must be able to purchase or construct the innovative technologies themselves with local support but without being dependent on any external donor support.

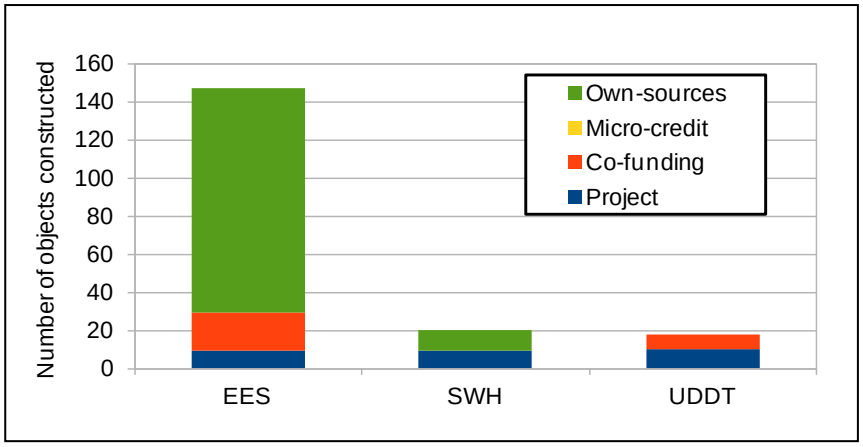

Figure 9: Number of technologies constructed during project duration of 2 years

The EES, SWH and UDDT were constructed at all of the 9 demonstration centres with project funding. The EES was the technology that was the most frequently replicated through villagers' own initiative (118 times). The trained masters were engaged by households to implement the EES. These replications took place without any project involvement. Villagers made their request to the trained masters and paid them. The SWH has been replicated 11 times in the same fashion, but the technology faced some technical problems in the beginning of the project. Eight UDDT were constructed with co-funding from the project.

When looking at barriers for upscaling, the villagers often do not know about innovative technologies. They stick to their tradition and are not aware that other technologies exist. In general, it can be said that people have an indifferent attitude towards innovations. They are neither 'nonbelievers' who will not take any initiatives by themselves and oppose all efforts, nor 'believers' who support innovations and are ready to invest. Instead, most people stick to their tradition or wait for external interventions. The willingness to take a microcredit or invest in the technologies

showed that 20 to 30% of the rural populations have a positive attitude towards these innovations. Regular consultations and trainings conducted in the frame of the project proved that knowledge and access to information plays an important role in changing this attitude.
Cultural norms are likely to influence the decision making regarding new home comfort technologies. For example 20% of the people are willing to use urine for agriculture, thus for 80% of the people, the use of urine might be a barrier to accept a UDDT. However, these norms can change over time. After implementation of the UDDT and successful demonstration of the use of urine, some people have changed their mind during the project time.
The use of banya for personal hygiene is another cultural norm. People might perceive a shower as inadequate for personal hygiene because they are not used to it, which forms a barrier to accept a SWH.
Villagers reported financial limitations to buy the technologies. However, the fact that 118 EES have been replicated through people's own resources shows that people are able to invest in new convincing technologies. This became also clear from the survey where about 23-30% indicated to be ready to invest half of the price of an UDDT, SWH or EES. The EES and SWH have a good economic pay-off, yet this benefit is especially visible for EES where people spend less money for their fuels in the winter. A shower and toilet are more likely to result in an increase of comfort instead of financial benefit. The benefits for a UDDT are predominantly related to the soft indicators, which makes them less concrete than monetary benefits, contributing to the lower rate of adoption of the technology. However, the number of replications shows that this is a slow process.
Technologies like UDDT and SWH involve changes in behaviour related to hygiene and social norms, while an EES does not feature this type of psychological barriers, as heating a house is not necessarily related to private life. Moreover there is no difference with regards to the operation of a conventional stove versus an EES. Therefore people are likely to perceive investments in EES as less risky as they are already accustomed to its principles and consequences.

CONCLUSIONS

The three technologies EES, SWH and UDDT are suitable technologies to improve the living conditions in the villages in Issyk Kul and Naryn oblasts, as they are much appreciated by the villagers, and more specifically by women, whose empowerment is a crucial component of development. The decision to buy an innovative technology for householders is perceived as a risk. For people living in poverty, the costs of the technologies are relatively high, and the investment often represents several months of income for the family. This study however proved that villagers who are challenged by current problems in their daily routine are ready to take risks to improve their comfort and security. This is confirmed by many self-financed replications of the EES during 2 years.
The EES have a good economic pay-off, are robust and people can directly observe their benefits by seeing the amount of fuels they save. These aspects are probably the reasons of high rates of replications. About 30% of the people in rural areas are ready to invest half of the costs in this technology and are likely to take a low-interest micro credit for energy efficient stoves.
SWH have good potential in the rural areas of Kyrgyzstan given the economic benefit and improvement of comfort. However, the model has known some major technical difficulties and people have an awaiting attitude. Nevertheless still 30% people are interested to take a low-interest microcredit for this technology.
About 14% of the rural inhabitants are willing to take a microcredit for urine diverting dry toilets. 23% are willing to invest half of the costs in this technology. The economical pay-off of the UDDT compared to a traditional pit latrine is limited, which indicates that people are willing to invest in comfort and hygiene improvement. The UDDT has a barrier concerning the use of urine in

agriculture. A significant behavioural change as well as operation and maintenance, cleaning and management of toilet products are needed to insure its success. That is why this technology requires more time to be implemented compared to the other technologies.
Upscaling the innovative energy and sanitation technologies can play an important role in developing a new perspective with regards to gender roles. These three new facilities can contribute to improve health, create opportunities to save resource and increase level of income in families. Traditionally, women take care of family and housekeeping. Thus, in many cases, women would be responsible for the effective functioning of UDDT, SWH and EES. This new role of women can potentially increase women's position in families, as they will get opportunities to control resources within the household. Men can benefit from new employment opportunities related to the implementation and construction of the products. In this view, the technologies can improve living conditions, and stimulate local economies in Kyrgyz rural areas. They contribute to the sustainable development goals SDG 5, 6 and 7 and can efficiently reach also the neglected rural population – leaving no-one behind.

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