Trans-SEC

Innovating pro-poor Strategies to safeguard Food Security using Technology and Knowledge Transfer

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Trans-SEC

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Final report on feasibility and income potentials of using complementary biomass production in agricultural crop production systems (month 32) in WP6.3

Summary

Over 90% of rural households in Tanzania rely on biomass energy for heating and cooking. High harvesting pressure on native woodlands for extraction of wood for fuelwood, construction materials and other wood products are coupled with limited supply of wood from native forest, leading to the acute shortage of cooking energy in semiarid sites like Dodoma. To cope with this problem, farmers often use crop residues and livestock manure as a source of cooking energy. However, this approach accelerates land degradation and nutrients depletion because of disruptions of the nutrient cycling processes and lack of soil cover. Therefore, UPS were designed to address the cooking energy and land degradation problems through integrating improved cooking stoves as well as fast growing tree species to supply wood and improve soil fertility.

Complementary biomass production for energy purposes gains attention in rural areas where former sources of energy were depleted. In Tanzania, like many other sub-Saharan countries, communities use traditional cooking stoves for cooking and heating (Eleri and Eleri, 2009; Belward, 2011). Traditional stove cooking technology results into adverse health, livelihoods, and local environment as well as climate change impacts generated by household biomass burning by communities. The use of improved firewood cooking stoves might be contributing much to the economic wellbeing of the community, through several ways including reduced firewood consumption, time savings in firewood collection and during cooking and low pollutants emissions. On the other hand, increased intensity of resource extraction of woody biomass, extending the sustainability of regrowth rates or consumption of stocks, leads to degradation and deforestation.

The implementation of the UPS "Improved cook stoves" and the UPS "Improved tree planting" tackles the problem of firewood shortage from both ends, the consumption as well as the production side of biomass / firewood. Success of the implementation, usage and further dissemination of both UPS "improved cooking stoves (ICS)" and "improved tree planting" strongly depend on the awareness of the need for trees due to firewood consumption and other activities. We found reasons for a higher awareness in those villages located in the region of Dodoma with an already severe and increasing pressure on forest reserves as figure 2 (walking distance) indicates. The situation of firewood availability in the region of Morogoro is less severe. Accordingly ICS construction is characterized by minor importance in allocating labour and other resources to the UPS leading to lower speed of ICS dissemination.

Trans-SEC sought for improving methods for utilization of fuel-wood, aiming for higher cooking efficiency, health via smoke reduction and time savings for women. Different types

have been explored in field trips, and a type advantageous for rural areas selected was. Those improved stoves could be manufactured from experienced trainers within the village. Used materials (clay, iron and bricks) as well as design and functionality were successively developed and closely adapted to demand and existing technologies – motto “improve the improved stoves”. The farmer groups, consisting of subgroups with 3 - 8 individuals from all sub-villages, were trained on constructing stoves, firewood preparation (storage and drying) and in providing their services in stove construction to other HH. The trainer concept was established to share, disseminate and sustain the knowledge among village households. The objective is to save up to 40% of firewood but also to raise awareness of safety issues and indoor air pollution or of the recovery of ash as fertilizer.

Figure 1: The mud stove of Trans-SEC - a variation of the rocket Lorena stove originally developed from APROVECHO

Background situation of forests and trees resources in Trans-SEC case study villages with special emphasis on the energy and cooking situation at household level

Study area and firewood situation

Our research was carried out in 4 villages of two climatically differing regions of Tanzania: 1) The predominantly sub-humid Morogoro region (600-800 mm annual precipitation) with flat plains, highlands, and dry alluvial valleys. Here, the food systems are more diverse, primarily based on maize, sorghum, legumes, rice, and horticulture, with livestock, whereby the latter is less integrated in the livelihood system. 2) The semi-arid Dodoma region (350-500 mm annual precipitation) that is predominantly characterized by flat plains. The food system is primarily based on sorghum and millet with a strong integration of the livestock component (Mnenwa and Maliti, 2010; Liwenga 2003). The Morogoro region contains areas with different levels of sensitivity concerning food security, while the areas in the Dodoma region are usually characterized by more uniform, high food insecurity.

In the following section we will provide more insights to the background situation of firewood and trees by presenting the results of several FGD which were conducted in the four Trans-SEC case study villages in September 2014. On the one hand this may explain the selection of UPS by the villagers and on the other hand may enable the in-depth interpretation of quantitative and qualitative analyses of the survey data.
In detail we tried to understand

- origins of cooking energy, especially firewood sources (own plots, communal forests, markets, etc.)
- extent of firewood (and charcoal) consumption

- impact of distance to firewood collection sites on social and economic situation
- storage strategies and conditioning of firewood

Analyses will contribute to develop scenarios which cope with firewood scarcity leading in turn to jeopardizing the cooking energy supply.

Trans-SEC provided manifold pathways to obtain background information to align the UPS to the site specific situation: Focus Group Discussions (FGD) facilitated by ARI and MVIWATA and the analysis of the Trans-SEC baseline survey.
During field trips to the case study sides (CSS) of Ilolo and Idifu in Chamwino District, Dodoma Region and to Ilakala and Changarawe in Kilosa District, Morogoro Region first insights into the UPS implementation of WP 6.3 were gained. In FGDs with village leaders, extension officers, brick makers, pottery makers, farmers and livestock keepers, background for improved cook stove implementation and tree planting were discussed. Special emphasis was in this context on firewood demand for cooking, brewing, brick making and other common energy practices and needs of villagers.

Firewood collection and walking distance:
We choose this parameter to indicate changes and challenges faced by the rural population to gather firewood for energy supply of households. In the following section we outline results from the Trans-SEC baseline survey conducted in March 2014 to underline similarities and differences between the two CSS regions. In both areas (Kilosa District, Morogoro Region and Chamwino District, Dodoma Region) the forested areas are main sources of firewood, whereby 90% is collected and only 10% is derived from logging. The second source of firewood is based on communal areas; own plots and other places are still of only minor importance. There are big differences between the regions regards the time spent for collecting. Figure 2 displays average distances to firewood sources: 100 minutes in Chamwino with maximum of 200 minutes and 45 – 75 minutes in Kilosa

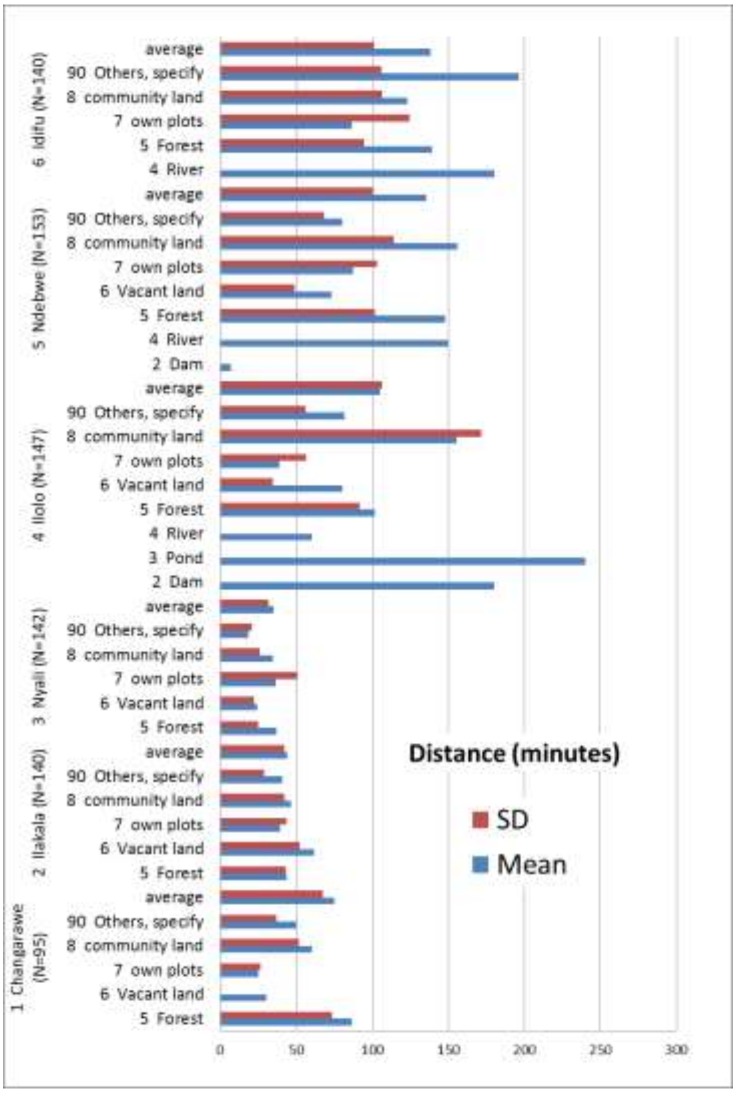

Figure 2: Time in minutes to reach places for firewood collection for the four CSS of UPS implementation and two reference control sites (Trans-SEC Baseline Survey)

Outlined distances to firewood sources do not adequately explain the time needed for firewood supply. It is also necessary to analyse the total time of reaching the forest, collecting firewood and coming back to the homestead. Also we have to take into account that highly utilized and therefore unsustainably or overused forests require increasing efforts to gather an entire headload of firewood. Latter ones are mirrored in higher weights of headloads - exceeding 30kg and more. In turn the increasing weights result in a decrease of walking speed and increased time for resting. During FGD of CSS of Chamwino, women reported comparably high figures for collection time (see figures in drawings of resource mapping). As a result, the collection times in CSS of Dodoma are two- to threefold higher than in those of Morogoro.

Firewood consumption in rural households

Results from the household baseline survey range from 63 – 90 kg of average firewood consumption per household and week. This value being slightly higher than generally accepted values of 2.5-3 t/year per HH in SSA (Adkins (2010)) indicates high variances among households and CSS villages.

The UPS had put high emphasis on the firewood consumption measurements to analyse the performance and success of the implementation of improved cook stoves. Our main assistance was to strengthen and activate own abilities in the villages by providing training and knowledge workshops. By mutually identifying the optimal approach and solution (given the fact that we are not design/stove focused) we perceive this task of ICS implementation as a participative "work in progress". After village group formation and construction of ICS we are now in the phase of developing measures and indicators for assessing impact and boost dissemination through events of cooking competitions.

Although even in Ilolo forests are still used as source of trees and firewood, the reported collection time reaches an alarming level. Former locations for firewood collection, for example, were close to local hills within the village boundaries which now are mostly deforested. As a result, the women collecting firewood have to travel to the next mountain range, which is accessed by collectors from other villages as well. Villagers worry that these places will not be available any more in the next year.

Brief background on forest issues in both of the villages of Ilolo and Idifu

In the mid 1990ies, the area around the village was covered by forest. This area was protected by the HADO (hifadhi ardhi Dodoma-land conservation initiative) programme which was funded by Germany through GTZ. HADO was originally put into practice in 1986. Via this initiative, villagers from surrounding settlements were prohibited from keeping livestock/ cattle and intruding the forest for agricultural activities. In the late 1990s and early 2000s however, HADO initiative started to become increasingly weak – anecdotal evidence refers to political manipulation (some political leader sought vote on expenses of degrading natural resource, forest so to say by allowing overgrazing and unsustainable agricultural activities in forest area).

Forest and firewood situation in Ilolo:

The village of Ilolo is located in Chamwino district, close to the township of Mvumi mission. It is now surrounded by deforested hills. The degradation of forest is occurring very fast. Within a few years (5-7) vast areas of forest have been cleared.
In September 2014 ZALF, together with Trans-SEC Partners of ARI and SUA, conducted two FGD to receive/gather background information on the current situation of firewood supply. The main aim was to achieve insights to assist the interpretation of the baseline survey data. Participants included the village heads, executive officers, farmers, members of Mazengo group (bee-keeper), subvillage heads and representatives from the environmental village committee. We aimed to balance out the participating women, men, elders and youth.
We discussed the status of forests in Ilolo and surroundings: There is no protected communal and there is no data available specifically on the acreage of remaining other forests for firewood collection. Forests on communal land however were identified which are open for legal firewood gathering. These places are hilly areas encircling the village (see following Resource Map of Ilolo). It was stressed that those hilly places are also used by residents of other villages. Nevertheless, the Ilolo village population is, due to proximity, using the hilly places for firewood collection more often than other villages.

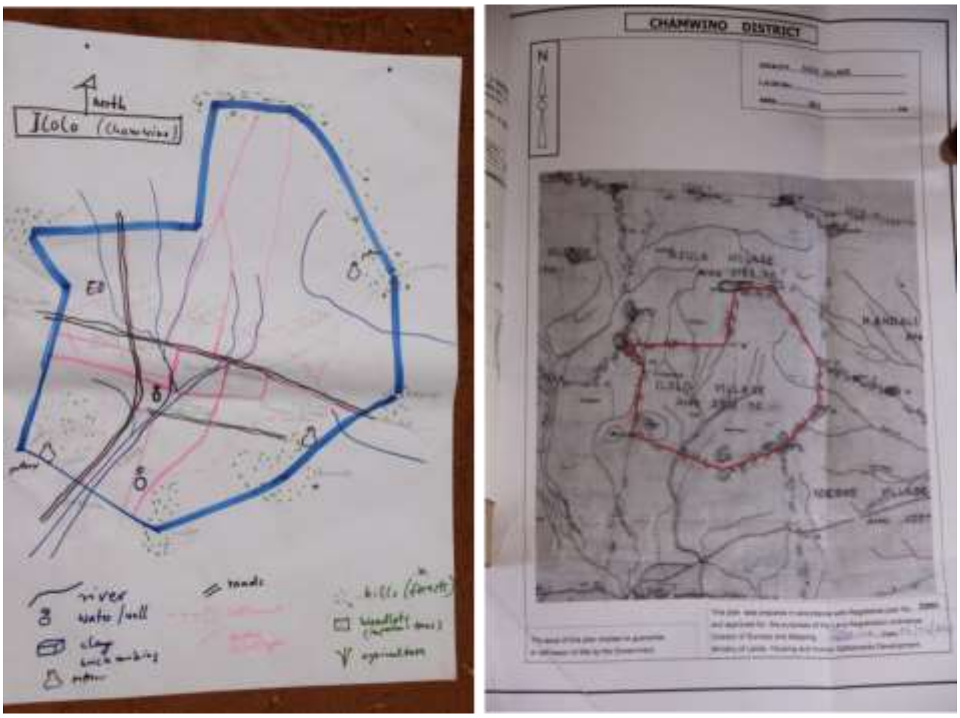

Figure 3: Resource map of Ilolo, places for main ICS materials (bricks, clay and water)

The map was drawn to outline (a) sub villages, (b) location of forests, (c) soil types, (d) hill tops, (e) wells, (f)schools, (g) sub villages (12), (h) pottery, (i) soil-clay, and (j) brick making. It was tedious work to locate the boundaries of sub villages.

According to the baseline survey 10% of households need less, 17% the same and 72% need more time to fetch firewood compared to five years ago. These results were confirmed by the participants of the FGI. . The households that presently use less or the same amount of time for wood collection assumed a lack of awareness of firewood importance (not collecting themselves or rich households using charcoal) or a likely proximity to the last existing source of firewood in the village, the mango trees.
Asked about how long firewood resources will last if no intervention will take place, the villagers answered, that apparently the firewood has almost finished, especially that of hilly side sections Mihongo and Misami which were usually used for firewood collection. FGD participants assumed that a firewood crisis is about to escalate.

The main reason for deforestation in Ilolo was attributed to some villagers conducting agricultural activities (growing crops) in those former forests so that tree felling was required (case of weakened HADU, see above in introduction of section). Villagers that are caught are generally disciplined through fee/charges while the specific regulation is set by the district council and implemented by wards. Although an Environmental committee is at work, participants of the FGD stated that only if education on the importance of tree planting/agroforestry is provided for all people and everybody is involved in protecting planted trees (especially due to ownership), tree felling will noticeable decrease and lead to possible reforestation in the area. Strategies of the village to cope with the high demand of firewood (e.g. willingness for participate in agroforestry in Ilolo; tree planting activities) were discussed controversially. Currently, in Ilolo village there are no improved (breeded) tree species for planting. The only thing done was to assist the regrowth of traditional trees (maotea ya asili) by protecting them by means of using thorns. It was argued that villagers that not participate in planting and protecting trees gained higher profits.

Figure 4: Village of Ilolo, to reforest the mountain top close to the village centre in the future is objective of the tree planters of the Mazengo and Bwawani trees nursery groups.

The Mazengo-Group (16 active member, 3 dormant member, sex ratio men 11 to women 8; member per sub village: Malicela 0, Kivukoni 0,Kisimani 1, Lusinde 1, Mpinduzi 2, Sabasaba 2, Mazengo 0, Nyerere 0, Sokoine 1, Jamhuri2, Madaraka 0, Bwawani 10) consists of some bee-keepers among the villagers. It was decided (after an initial push by the mission of the catholic church) to establish a tree nursery for growing trees at a hill top within the village for tree planting and to place their bee boxes. Intended types of tree species (usage) were a) Miti maji (shade, bee boxes, firewood), b) Uzazi wa mpango (shade, bee boxes) and an unknown species (flower for bees, firewood, bee boxes). The nursery is a joint venture together with Ilolo´s secondary school. Latter provide watering service in the area for the tree nursery. The main challenge was water supply management leading to poor survival rates of the trees at the nursery. Currently, the water supply of the whole village costs 400,000 TSh per month and water is purchased at 50 TSh per bucket.

Forest and firewood situation in Idifu:

In order to access additional information on top of the baseline survey, the TransSEC project conducted two FGD on bioenergy-wood supply and ICS. Currently, there is no protected forest owned by the Idifu village. Forest degradation and deforestation is occurring very fast. Specific data on the forest acreage is not available. Everybody is allowed to fetch firewood and cut trees in communal forests or other communal areas (hilly areas which are located at the south side along the village border or even beyond). Apparently this source of firewood has dwindled due to unsustainable consumption. The current forest is commonly used by all villages surrounding the mountains for firewood collection. If no intervention occurs, firewood will not be available any more in the mentioned reasons within a period of 1-5 years, according to the villagers. As main reasons agriculture (growing crops) and grazing activities were outlined. Additionally, houses at the foothills are increasingly affected by erosion.
Asked about how this deforestation can be decreased the FGD participants argued controversially:

1. Reduction of the current carrying capacity of cattle. Consensus among farmers with regard to the number of cattle to keep could not be achieved due to different involvement in livestock keeping (numbers varied between 5 and 20). This social/environmental conflict seems to be increasing as some farmers even left the meeting.
2. Some proposed to plant trees to stop erosion

3. They expect research to come up with new ways to stop degradation, but not by enforcing HADO again. It was argued that HADO deprived them from an important income source (selling livestock) and from an energy source for transport and cultivation (cow carts, oxen plough). They stated to be economical dependant on pastoralist practices.

The village has set up strategies to lessen the high demand of firewood. One was to strengthen the environmental committee which is already present but not active due to a lack of funds or income. It was pointed out that only if everybody would actively participate in tree planting reforestation, an increase of trees in the area is possible.
The baseline survey results indicate that within the last five years out of all HH 6% needed less, 15% the same, but 78% needed more time to fetch firewood. The villagers participating in the FGI confirmed these results. For those who said that time increase is not an issue, argued that some of them might have misunderstood the question. It was furthermore stated that decreases in firewood collection times are non-realistic and it was speculated that the question was either misunderstood or that the interviewees were not involved in firewood collection. Lastly it was argued that others might be those who are buying the firewood from other villagers. To illustrate this argumentation, the participants of the FGD outlined in length that previously 4 hours were spent daily for firewood collection. Currently, however, 5 hours are spent in two days for firewood gathering as now, the women have to go to the forest on the first day, and cut a tree and collect the wood at the following day. In summary, the overexploitation of forest resources for firewood collection has resulted in even more devastating tree cutting practices.
As outlined, the time to reach forests for villagers of Idifu is high. Additional information on distances to the forest and time for firewood collection will exemplary be shown in the resource map below.

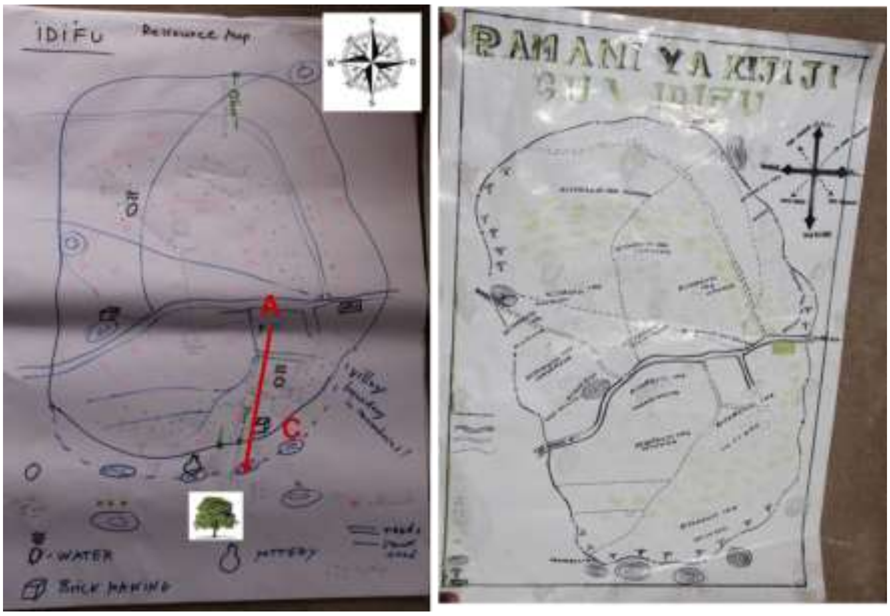

Figure 5: Resource map of Idifu, places for main ICS materials (bricks, clay and water). Example: 3hrs walk from primary school A to forest in first southern mountain range, 2 hrs of collecting, packed with headload the trip back is 4,5hrs (incl. resting).

The previously existing forests used for firewood collection in the mountains bordering the village in the South are now completely depleted. Villagers have to go to the next mountain range, which is used by three additional villages.

It is difficult to estimate the area required for tree planting to allow sustainable consumption of firewood on the one hand and to meet the total wood demand on the other. The main reason is that the village and forest areas are not surveyed in detail. Currently however, agroforestry is not practiced in the village. Education is nevertheless provided for all villagers on the importance of tree planting/agro-forestry so that villagers will plant and protect trees. Among the villagers, those who are not interested in tree planting have a larger share in comparison to those who are interested.

There is a nursery in the village, but the villagers are interested in establishing a sustainable group for tree planting. As a precondition, villagers agreed on the need of implemented and enforced by-laws, which have to ensure tree planting and protecting. A stepwise introduction on tree planting as well as a close connection to the tree planting group in Ilolo is highly recommended. Due to water shortages in Idifu the nursery of Ilolo has to be carefully extended. Participants of the focus group discussions and upcoming members of the UPS Group of “Improved Cook Stoves” proposed the name of the group “KIKUNDI CHA MAJIKO BANIFU”. All of them were involved in the baseline survey and are ready to organise the group and be trained or be trainers for themselves and others.

Best tree species for cooking: Firewood collection in Idifu is selective as there are some tree species better utilizable for cooking and others for brewing (traditionally they use green/wet biomass hence tree felling is necessary). The best tree species for cooking include: muhogolo, mzasa, and mkungugu (local names). Others which are rarely collected due to scarcity are mkabmbala, mfuku, mtema, mvugala, nguweli, mtundula, mkakatika, mpelemehe, msungina, mkologogwe. Usually these are cut nearly to the ground level, sprouting is minimal.

Issues raised from FGD with a stake in improved cooking stoves: Main type of cooking stove (CS) used was the “three stone stove”. However, there also exists a type of “improved cooking stove” which is designed by moulded clay replacing the stones. Concerning the cooking energy situation and location it was stated that most of the CS were kept indoor either in the main house or in a small room outside the main house.

List of dishes and time spent to cook: Mlenda relish about 30min; Uwele (p. Millet) after mlenda 30 min; mtama mweupe (sorghum) 30 min; safe-majan ya kunde (cowpeas leaves) relish 60-90 min; blanching of vegetables 60 min; rice cooked seasonally 60 mins. Maize flour 10-20 min. Pearl Millet is often cooked; firewood quantity used is proportional to the time spent for cooking.

Most villagers use clay pots while some use aluminium pots as cooking utensils; size of the pot reflects the number of consumers (e.g 10 people need as mass of the flour 5kg per pot). Cooking during ceremonial events: Usual meal during the ceremonies (June and July every year) is “makande” (mixture of maize and beans). The meal is prepared during the night and cooked for four hours. The trench (a ditch or long hole) dug on the ground with approximately 20 ^{x} 0.3 ^{x} 0.2 m and the firewood are filled along both sides of the trench. The cooking process may consume 2-3 oxen carts (20 bundles of firewood/oxen cart while 30kg of firewood/bundle).

Issues raised from brewing: 50 % of villagers are brewing from maize bran and fermented sorghum. One batch of brewing produces 8 bucket (20 litre each) of the local type of beer (commone). Each tin is sold at 7000 TSh. The process takes 12 hrs with different stages. The first step consumes a lot of firewood (2 bundles) in a short time while the second step consumes only one bundle for keeping heat of the brew for about 6 hours.

Issues raised from salt making: It is done throughout the year. In April-May 18kg salt is sold at 10,000 TSh while in other months of the year you get only 4,000-6,000 TSh. (additionally there is a barter system used i.e. 1kg of salt/2kgs of sorghum equivalent to 150 TSh). 3-5 oxen cart of firewood are needed per batch (ask again for the quantity of salt per batch >> equivalent to?). All types of firewood (wet and dry /fibrous and dense) are used for salt making.

Issues raised from brick makers: Business is done between May and November (dry season) while from November and onwards are dedicated for agricultural activities. (as a rule of thumb of 4 kg of firewood consumption per brick has to be discussed the next time). Types of bricks: Mud bricks, fired bricks, sand bricks (cement/sand). Usually clay sand ratio for mud bricks is 2:1. Water and clay resources are available throughout the year. Sand bricks are charged based on the number of the bag of cement. At costs of 4,000 TSh per bag of the cement, possible to process sand blocks at 25-35 TSh. They charge 100 TSh per mud brick and 200 TSh per fired brick. Approximately 400 bricks were needed to build one room of a house. Therefore transport is an issue, because of the need to use an oxen cart which can carry 100 bricks and cost 5,000 TSh per trip. They are interested in ICS making.

Issues raised from pottery / pot makers: A lot of firewood is needed: 4 head loads are burnt within one hour to create the heat for about 420 pots. Business is done from June to November. Pottery soil/clay is scarce compared to that of brick making. Collection of clay from hill areas, sieved, pounded, souked for 2 days, then moulded. Pots were dried before firing. They are interested in ICS making.

Other issues: Tools required for collection and preparation of firewood are machete, axe and mundu (version of machete). Reduction of length and size of firewood is done for cooking (small sized firewood) but for salting and brewing this is rarely done (big sized firewood).

The role of cooking fire for lighting is not an issue as they use kerosene lamps, solar lamps or even very durable dry cell battery torches.

Current practices for lighting-up fires of three stone stoves are (in order of relevance):

1. use of plastic bags and match boxes,
2. Use of dry grass and match boxes
3. Use of already lightened firewood from neighbour household (also very common)
4. During rainy season, dry stovers from maize and sorghum kept during dry season are used to light the TSS with match boxes.

Most active time for collection of firewood is spent between June throughout to November. During rainy season the number of villagers going to the forest is reduced drastically due to slippery and therefore unsafe conditions in the forest. Usually stockpiling is done during dry season. Since brewing activities requires wet/green biomass (burning more slowly and with less heat) firewood is collected throughout the year.

Résumé after discussions on sustainability aspects doing business as usual: "Within the very few next years there will be no more firewood left. The last mountain to collect firewood is encroached by more than four villages.” Asked to specify on the sustainability of the available source of firewood (possible endurance of current firewood removal practice) one by one, their answers ranged from 1 to 5 years.

Brief background on forest issues in both of the villages of Ilakala and Changarawe

Firewood collection situation in Ilakala:

One outcome of the baseline survey is that firewood collecting time has increased compared to the situation five years ago (about 7% HH needed less, 28% the same, but 62% more time to fetch firewood). Based on these results we discussed with the 10 participants of the FGD consisting of leaders of village (1) and subvillages (4), a village extension officer (VEO) (1) and members from the environmental committee (4) to analyse the situation of forest resources and firewood.

Ilakala village has a forest reserve (1000 ha) with beekeeping. There are still forests to collect firewood in the village (communal lands) but time for collecting firewood increases.

In FGD women outlined that four hours for firewood collection for households located in the centre of Ilakala (Schuleni) has to be separated into time to reach the forest (1 ½ hr), the collection time of about 1 hour (because they have to look for remaining pieces) and 1 ½ hours to return; time for the whole trip exceeds to six hours when the woman has to carry a baby. According to this situation they started to stockpile firewood for occasions like sickness or heavy rains.

Figure 6: Resource map of Ilakala, places for main ICS materials (bricks, clay and water).

Bolt letters in figure 6 illustrate some example of households distances to firewood collection: a) 2hrs trip from household A (subvillage of Mihogoni, close to the road) as well to forest in eastern part of subvillage. Example b) 2hrs trip from household B (subvillage of Shuleni) and household C (subvillage of Miembeni) to village forest in the north-east.

The FGD group mentioned the relevance of brick burning for the need of firewood as many villagers build up modern houses. The alternative usage of rice husks (residues from paddy growers) to burn bricks was discussed. In addition, this situation compared to the village of Changarawe was discussed. It was found that 75% of the people living in houses with roofs of grass. The main construction activity therefore is on poles and sticks for roofs and traditional walls out of wood are more frequent.

As group formation took place the same morning we additionally contributed to the process of UPS Group formation through awareness rising and training in basic knowledge on ICS (improved cooked stoves). Together with ca. 20 UPS group members we discussed needs for further improvements of already established ICS at a few households of Ilakala.

Firewood collection situation in Changarawe:

In the FGD, participants stated a decrease of firewood in the village forest. A few years ago there was plenty of wood. The for villagers of Changarawe time to reach forests is comparatively high because of (a) not living within the former village boundaries and (b) because of shorter distance to next urban settlement of Kilosa. Only women go to fetch firewood in a time of about approximately 5 hours. Background: Based on baseline survey we

learnt that firewood collecting time has increased, compared to the situation 5 years ago: 13% of HH needed less, 14% needed the same, but 58% needed more time to fetch firewood.
The participants ranked the importance for decrease of availability of firewood as follows: 1) charcoal, 2) new farms and 3) timber. Although the size of the forest is unknown they are very conscious about the impact of charcoal making for the forest: “If no intervention will take place in 2020 the forest will be gone. There will be no trees anymore, even no small trees.” In turn they projected a situation where the forest is still alive in 2020: without charcoal making. Charcoal is done by business men: before felling trees for charcoal, valuable trees of the forest stand are sold to timber traders. Villagers will come and start farming after clearance of land. If the soil is of good condition for farming even outsiders may come. A recent initiative (4 years ago) on tree planting offered training in growing teak, but failed due to lack of tree seedling availability and low awareness. Additionally, it was noticed that villagers cooperate with outsiders. There are plenty of possible sources for brick making in the villages. Especially close to the river there sites of good soil conditions that are easily exploited . In Changarawe there is no pottery by now.

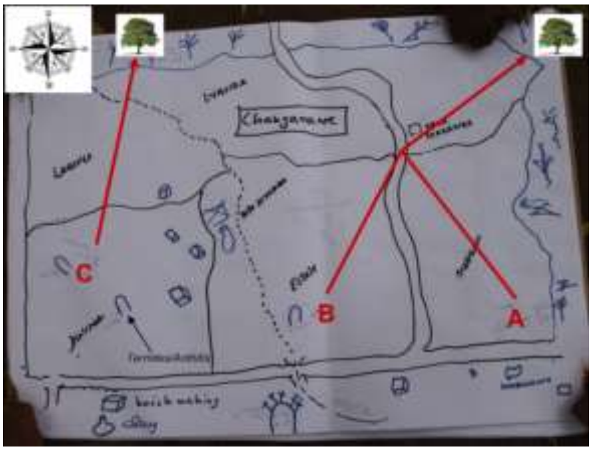

Figure 7: Resource map of Changarawe, places for main ICS materials (bricks, clay and water).

Bolt letters in figure 7 illustrate some example of households distances to firewood collection: a) 3hrs trip from household A (subvillage of Madizini, close to the road) as well as from household B (subvillage of Estate near termite-anthill) to forest in south-eastern mountains. Example b) 4hrs trip from household A (subvillage of Madizini, close to the road) with bus (2000 TSh fee) to forest in southern mountains. Example c) 2 ½ hrs trip from household C (subvillage of Dinima, far from road) to village forest in the east and additional collecting time of 45 -60 min.

Introduction to UPS and tasks of Trans-SEC WP 6.3

Procedure of UPS selection

Each household of the villages that had been randomly selected for the Trans-SEC baseline survey was asked to choose one to two of the success proven UPS to create and join the new UPS groups. The stakeholder decision process in the CSS from June to July resulted in the selection of the following UPS:

Table 1: Selected UPS of WP 6.3 in the case study villages (Selection process details: Numbers in brackets are representing beans and rank of the UPS).

Morogoro		Dodoma	
Ilakala	Changarawe	Ilolo	Idifu
Training* on improved stoves (24/3)	Implementation of trainer groups for improved stoves (23/2)	Training* on improved stoves (24/3)	Implementation of trainer groups for improved stoves (30/2)
		Implementation of improved wood supply; incl. tree nursery (25/2)	

* Training includes ICS construction but additional measurements will be reduced (see "Monitoring" sheet in Annex)

For detailed understanding of the process of UPS selection from 14th July until 30th July 2014 see WP 8.1, Mission-Report -Decision on Upgrading Strategies by farmers at each CCS, by Jana Schindler. During the UPS selection, villagers strongly emphasized the need to increase the household income. The main argument for improved stoves was the reduction of smoke and time consumed for firewood collection. In this report we therefore put a strong focus on the background of firewood supply and quality.

Implementation procedure for UPS "Improved Cook Stove"

Before group formation, an initial FGD with village representatives was conducted in Sept. 2014 to identify and incorporate existing knowledge about improved stoves in the village (and subvillages): Who has some experiences? Who owns or uses improved stoves? What are reasons and experiences for adoption?
A next FGD with households interested in the UPS of improved stoves focussed on a requirement analysis. Aim was to achieve background information, enabling a successful implementation of the UPS "improved cook stoves". The issues were as follows:

- General housing, kitchen situation
    - Indoor/outdoor (talk about occasions, preferences, income groups, …)
    - Single houses or rooms available for cooking, practice of natural ventilation of fresh air
- Needs to adapt stove design to single user (to be announced as work in progress)
    - Cooking habits, kind of food, knowledge about quality aspects, cultural diversity, meals from other countries/regions
    - Baking opportunities needed
    - Extending storage life of food by drying/heating
    - All day, celebrations, special occasions (brewing, hot tubes, washing, etc.)

It was agreed that UPS group members shall monitor the implementation performance. Training therefore will include reporting methods. Trained trainers from the UPS group shall construct, report the time of ICS construction, and repeatedly accompany households (HH) after ICS installation. Other issues discussed included i.a. type of trainers and members involved, HH type of stove and kitchen, date of installation, ICS stove usage and experiences compared to "3-stone-fires", meal types, nutrition status, and firewood savings (see monitoring sheet in Annex).

Figure 8: Theoretical instructions and practical training at site of newly constructed improved stoves

Short description of Trans-SEC UPS No. 5 "Improved Cook Stoves"

The farmer group of UPS No. 5 "Improved Cook Stoves" had received training on constructing small scale stoves for household use with one, two or three pot holes. After the material for the construction is prepared by group members, the training will be conducted as a stove building practice. The stoves will be built from mud, mud bricks and a combination of mud bricks, cement and metals (strong iron bars). In case of additional requirements potentially large scale cook stoves for commercial and large scale use (e.g. schools, potteries) will be constructed. Evaluation and testing will be realised in parallel with control tests of three stone fires (Adkins et al. 2010, MacCarty et al. 2010, Simon et al. 2014).

Figure 9: ICS constructed out of mud and bricks

The ICS improves methods for utilization of fuel-wood aiming at achieving higher cooking efficiency, health via smoke reduction fuelwood and time savings for women. Different types have been explored in field trials. Selected was an ICS type advantageous for rural areas. Improved stoves were manufactured by experienced trainers within the village. Used materials (clay, iron and bricks) as well as design and functionality will be successively developed and closely adapted to demand and existing technologies – motto "improve the improved stoves".

Construction training: 3 - 8 individuals from all sub-villages were trained on how to construct stoves, firewood preparation (storage and drying), and in providing the service of stove construction to other Households. The training of trainer concept was established to share, disseminate and sustain the knowledge among village households.

Farmer groups training on ICS implementation and improved stove design

The Trans-SEC groups came to an agreement for an ICS design and technology that was easy to implement and of low cost. The unified perspective aimed for a mud stove with a high firewood efficiency enabling a smoke free cooking process. This generates following triple benefits: 1) Health matters by evacuating smoke off through the chimney, 2) time savings during firewood collection due to high efficiency through mud/gras stove insulation as well as during cooking and least 3) improved and smoke-free handling of two pots in one time while having a better control of heat. Subsequent the built-in design of the ICS allows to do other things simultaneously and creates new kitchen experiences because men nowadays also appreciates to sit in the kitchen while women are cooking.

Additionally stove design was selected to achieve remarkable and visible advantages in a short time. Aim was combining smoke reduction, a high efficiency in firewood consumption due to insulation and an eased-up handling of cooking procedure. We found a promising low cost mud stove model in a stove programme from Uganda originally developed from Aprovecho (ref). Fortunately, this model was adopted during an EU Project in another village called Chololo Eco Village close to the CSS in Chamwino, Dodoma region. The Trans-SEC project approached experienced women from a group of trainers in Chololo for becoming trainers in the first place. The training raised construction skills for women becoming trainers and ensured a minimum of background knowledge in technology to allow constant incremental improvements of the stove units. A close and fast monitoring programme led to fast a reaction to tackle challenges like a) changes in chimney design for specific conditions of kitchens, b) repair cracks after produce of stoves appearing in mud from soils poor in clay, c) accompany of long drying period because of wet mud block needs more firewood in beginning and finally d) assisting UPS groups in cases of bottlenecks in material supply e.g. by providing technology for brick construction.

Figure 10: Example for design of new ICS including “changes” of chimney and height of stoves

After the first phase of ICS distribution among Trans-SEC ICS group members, a broad scientific basis for investigations and monitoring was established. In the next step constructors from the groups were encouraged to build additional ICS within the entire village. As result, in January 2016 as shown in Table 2 in Ilolo 62 ICS, in Idifu 94 ICS, in Changarawe 37 ICS and in Ilakala 32 ICS were constructed.

Table 2: Number of ICS group members in CCS villages, implementation status and further dissemination between January of 2015 and 2016.

Village name	Members	Adopters from February 2015 to October 2015	New adopters from November 2015 to January 2016	Total
Ilolo	**25**	**27**	**10**	**62**
Idifu	**23**	**39**	**32**	**94**
Changarawe	**35**	**2**	**0**	**37**
Ilakala	**15**	**11**	**6**	**32**
Total	**98**	**79**	**48**	**225**

The adoption process of ICS dissemination works independently of Trans-SEC. During the planning phase of the improved stove, special emphasize was put on enabling the villagers to construct the stoves without any support from external sources. The initial ICS users of the group were trained on how to construct a stove to disseminate the technology within the village without external input.

Success of the train the trainer concept

The implementation process includes the theory knowledge and the construction of the stoves and the insemination of information about stove efficiency, and economic and environmental benefits of using ICS to community members in order to be diffused or adopted easily by the community (Feng, 2003).

The first stoves were constructed in January/ February 2015. The initial ICS stove groups in the CCS amounted from 18 up to 30 member households which received a stove. The ICS groups were divided into three to four subgroups which acted partly individually. ICS for group members were built and distributed by trained ICS constructors within the group as a group task. After this phase of distribution among Trans-SEC ICS group members (to achieve a scientific basis for investigations and monitoring, the ICS constructors from the groups built additional ICS within the entire village. As result in January 2016 as shown in Figure x in Ilolo 62 ICS, in Idifu 94 ICS, in Changarawe 37 ICS and in Ilakala 32 ICS were built. It was identified from MWIVATA that the group of improved stoves in Ilakala managed to train non group members on UPS implementation, the farmers trained are 13.

Success of the implementation, usage and further dissemination of both UPS "improved cooking stoves – ICS" and "improved tree planting" strongly depend on the awareness of the need for trees due to firewood consumption and other activities. We found reasons for a higher awareness in those villages located in the region of Dodoma with an already severe and increasing pressure on forest reserves as figure 2 (walking distance) indicates. The situation of firewood availability in the region of Morogoro is less severe. Accordingly ICS construction is characterized by minor importance in allocating labour and other resources to the UPS leading to lower speed of ICS dissemination.

The adoption process of ICS dissemination works independently of Trans-SEC. During the planning phase of the improved stove, special emphasize was put on enabling the villagers to construct the stoves without any support from external sources. The initial ICS users of the group were trained on how to construct a stove to disseminate the technology within the village without external input.
It was amazing to see the verve how fast and decidedly the old traditional three stone fires were removed during the construction training, even those artisan made kind of three columnar fireplaces.
It was useful to bring the villagers being trained in the construction of the new ICS to the houses of the initial trainers in Chololo. Here they got the experience how the ICS were used helping to overcome the obstacle of waiting for a well-functioning stove during the drying process.
Especially the absence of eternal input is seen as benefitting self-help capacities. The concept of educating trainers on how to build ICS supports the approach to increase ownership of the ICS construction knowledge as well as the stove itself among the villagers. It was identified from MWIVATA that for instance the group of improved stoves in Ilakala had managed to train even non-group members on UPS implementation, the farmers trained are 13.
There was a close monitoring from construction to usage leading to further improvements of the implemented ICS. The challenge is to confirm the benefits stemming from initially aimed for technical principals and implement usage related requests (user needs) after cooking experiences.

Figure 11: Proper chimney designs as second step after ICS construction

To react on hindering factors of proper ICS usage was of special importance. The practice of using the firewood directly after collection leads to often higher moisture contents of wood resulting in difficulties at ignition or smoke arising.

Figure 12: Storage and drying of firewood. The right picture shows the principle of weighting piles of firewood in the end of 3-SF as well as in the beginning of ICS usage to easily demonstrate saving

The conduction of scientific stove testing CCT and KPT (controlled cooking test, kitchen performance test) through Master Students of Trans-SEC was accompanied by close monitoring of households wood consumption through ARI centres. For ladder we introduced an easy to conduct estimation procedure on kg wood consumed per day. Method was to a) weighting of a pile or the prevalent size headload of the household and b) noting the number of days needed for consumption. This was done in several repetitions in every household of the UPS group.

Monitoring visits after the first month of implementation were leading to additional training sessions.

Firewood preparation: drying and storage

It was reported that ICS users were complaining due to the challenge of wet firewood and the difficulty to ignite such firewood. A training was held to refer it as consequence of freshly collected, undried or inappropriate stored firewood and due to the small fire chamber of the ICS. Moreover this also results in smoke and higher consumption of firewood, which will thwart (counteract) the idea of ICS.
Therefore after implementing a proper functioning of the ICS (i.a. for easy fire setting and low smoke during ignition process) needs more efforts and awareness in the practice of drying and storage. As approach it was helpful to identify the former practice of storage. This was done only occasionally and less due to drying purpose but more due to other reasons. In Chamwino District, Dodoma for instance farmers are facing the firewood scarcity as the area has few trees because all the forests were completely cleared through deforestation. Here farmers were applying parts of firewood processing technology e.g. a pile of stored firewood that can't last less than three months. These farmers could be used as demo to encourage other farmers who are not practicing the firewood processing and storing.

The Trans-SEC training was held in two districts of Chamwino and Kilosa, comprising all four villages that are Ilolo, Idifu, Ilakala and Changarawe. The training was done on firewood processing (collecting, drying and storing) consisting of 1) collection of firewood (frequency, schedule for collection), 2) resizing of firewood (chopping into pieces of equal sizes), 3) drying procedure (on the roof, store room, sore in the kitchen place) and 4) measuring the pile to be used in the kitchen. This training will help farmers to have knowledge on firewood processing and storing, needed to encourage them to keep using ICS stoves.

Within regular ICS-groups meetings it was taught to look for a safe and dry place for piling firewood near the house. The roofing of freshly cut firewood is mentioned as unnecessary within the first months. For getting easily ignited firewood it is at least needed to keep it away from rain. A useful way could be an available room in the kitchen or in the house, at best close to the drying heat of the ICS. The amount of firewood for this last step of drying should suffice the firewood needs for cooking within the next 3 days, if replacing the consumed firewood day by day and obtaining a 3 day drying process in the end.

Training on firewood processing (collecting, drying and storing):

1. Collection of firewood (frequency, schedule for collection)
2. Resizing of firewood (chopping into pieces of equal sizes)
3. Drying procedure (on the roof, store room, sore in the kitchen place)
4. Measuring the pile to be used in the kitchen
5. Data recording on collection, drying and storing of firewood

Training outcomes

1. The training was done in two districts of Chamwino and Kilosa comprising all four villages that are Ilolo, Idifu, Ilakala and Changarawe. This training will help farmers to have knowledge on firewood processing and storing, this will encourage them to

keep using ICS stoves as it isknown that the ICS need well dried firewood for easy fire setting and low smoke during the ignition process.

2. In Chamwino District, Dodoma; some farmers are applying this technology of firewood processing and we used them as demo to encourage other farmers who are not practicing the firewood processing and storing. For example in some households, we found a pile of stored firewood that can't last more than three months without someone having to collect more. This is due to the firewood scarcity they are facing as the area does not have many trees because all the forests were completely cleared through deforestation.

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Figure 13: Drying of firewood at Idifu village and stored firewood in the kitchen

In Kilosa District, no single household is applying the process of drying and storing firewood for further use especially during wet season and getting well dried wood is a problem. The reason for not keeping firewood in storage places is due to the availability of firewood nearby their homestay because there are many good forests around their locality.
Actually, by not collecting more firewood and keeping in stores consumes a lot of time on firewood collection and also reduces the firewood quality that at the end of the day. ICS users will keep complaining about the stove not working properly without knowing the reason behind it. Normally the firewood ICS need well dried firewood of at least 15% moisture content, therefore with a habit of collecting firewood followed by immediate use without first drying it for at least three to four days will lead to inefficiency of ICS.
Through field observation, there is a low motivated user of ICS in Kilosa than in Chamwino, even the level of adoption in these districts varies extensively because in Chamwino the firewood used in the ICS is well dried compared to Kilosa where the users just collect and use the firewood without drying it.
All the members showed positive response on the new technology of firewood processing and they promised to apply it for best results of the ICS efficiency. The monitoring on firewood processing will be conducted by our team in the field under the supervision of Ogossy Gasaya who will be visiting the farmers once every month.

Brickmaking for ICS

The close monitoring of the project helped to identify and solve various issues facing project growing on time. This includes the low rate of adoption which is solved by supplying wooden boxes to each group to make their own bricks that will be used in ICS construction in case new member has no access to bricks as among the materials needed during construction.
In general possibilities for replacement of construction materials, pipes and insulation were topic of several UPS group discussion.

Implementation procedure for UPS "Improved Tree Planting"

Conducted FGD and key informant interviews in September 2014 aimed at an in-depth situation analyses for later UPS implementation. Task of MWIVATA is to establish the UPS groups subsequently. To assist the UPS group in managing their issues has to be done as the next step. Following questions after group formation may facilitate the group consolidation through structured discussion of rights and duties of the UPS group. Issues include:

- Organisational structure (managing board, chairman, treasurer, general meetings, etc.), Aim of the group
    - Incorporation of group aims into articles of association: Income, afforestation, erosion control, water retention, etc.
- Information on different shareholder models (community based ownership, contracts for single households, utilization of added value, etc.)
- Fees/contribution (financial or labour).
- Occurring responsibilities (voluntary tasks should be distributed on the shoulder of all members)
- Who are beneficiaries in case of group income? Important role of group chairman and treasurer (trust and reliability over life span of trees…).
- Are they facing imbalances?
- Agreement on a kind-of compensation to ensure sufficient performance of the most basic and important tasks (e.g. maintenance of nursery)?

In the end the group members should be enabled to agree on following questions:

1. Will I own the trees at the time of harvest? (Are there other models of participation?)
2. Will I be able to sell my forest products? (What is the group task in strengthening market power/capacity/competence?)
3. Will I have access to information on how to grow and maintain the trees? (Agreement on supervision plan: necessary periodical or running backing through experts, degree on involvement into monitoring and evaluation)
4. Will I have a good association to represent me? (How to empower the group to make sure points one to three are in place and will stay in place in the future?)

In a next step – after the UPS Group had successfully planted trees in the village - a program for monitoring and evaluation was developed:
Reporting for tree growth performance:

- Shoot diameter, length, weight after harvest (pruning).
- Tree spacing, density of stands, survival
- Root collar diameter (RCD),
- Diameter at breast height (DBH) and height assessments.

To achieve an understanding of impacts on yield and growth rates, additional parameters have to be observed and reported: i.a. site conditions, tree species, field preparation, maintenance (watering, pruning, weeding, fertilizing, pest control, etc.). In addition, our research will contribute to close agroforestry knowledge gaps by analysing the optimum spacing and interactions of boundary trees with nutrient management options to enhance crop yield. In order to fill knowledge gaps few trees may also be destructively sampled for dry weight determination for contributing to developing biomass equation to estimate biomass yield.
Training on tree and forest management will broaden knowledge on wood lots, shadow trees as single trees on plots, boundary tree planting as technologies for on-farm wood production to address land degradation problems in dry lands, time for cuttings (shoots to be newly planted), pruning branches and tree harvest.

Short description of UPS No. 4 "Improved Tree Planting"

This UPS aims at extensive tree planting in Ilolo village to cope with deforestation of the communal village forests. Optimal tree planting techniques will be announced in knowledge building and practical trainings to raise awareness and to enhance wood resources and guarantee a sufficient and sustainable biomass production for household energy uses. The potentially alternative usage of wood will also include timber for furniture, poles for buildings, etc.

Following tables of preliminary results outline the current situation of trees on own plots announced by households in the baseline survey. In upcoming analyses derived in UPS-Implementation and additional surveys we will assess the possible contribution of on-farm trees to sustainable energy consumption of households.

Table 3: On-farm trees owned by households (results from household baseline survey)

Village	1 Changarawe	2 Ilakala	3 Nyali	4 Ilolo	5 Ndebwe	6 Idifu
N=	50	78	86	56	73	68
(missing)	29	30	37	31	22	18
mean	14	21	10	57	17	26
SD	9	9	6	13	11	18
Min	1	1	1	1	1	2
Max	140	200	103	809	143	192

A low average rate of tree planting activities in all villages mirror low awareness and interests in the issue of tree planting. However, villagers in FGD showed increased consciousness towards tree planting due to firewood scarcities.

Table 4: On-farm trees planted last year by households (results from household baseline survey)

Village	1 Changarawe	2 Ilakala	3 Nyali	4 Ilolo	5 Ndebwe	6 Idifu
N=	50	77	85	51	65	61
(missing)	29	31	38	36	30	25
mean	2	2	1	5	1	1
SD	0	0	0	0	0	0
Min	0	0	0	0	0	0
Max	70	70	46	80	10	20

Tree planting in various locations (farm boundaries, woodlots or retention of naturally regenerating tree species) in farmlands and at homesteads are to provide an alternative source of woody biomass for supply of cooking energy (firewood and charcoal), wood products (e.g., poles & timber), fodder and other environmental benefits (e.g. prevention of soil erosion; pot. fertilization e.g. http://blogs.worldwatch.org/nourishingtheplanet/innovation-of-the-week-fertilizer-tree-systems-enrich-soils-naturally/). Capacity building on tree nursery and environmental education for farmers (individuals and farmer groups), extensionists, religious and academic institutions (especially primary schools) will be necessary for the success of this UPS.
There is proven success found in Tanzania as boundary tree planting work and the woodlot technology (planted and natural woodlands called Ngitilis) has shown great success at Ihumwa village, Dodoma , Mkundi in Morogoro and in Shinyanga and Tabora regions under the ICRAF and SUA research programmes.

Process and results of Trans-SEC contribution on tree nursery establishment for tree planting

At 23rd – 25th of October 2014 M. Mpanda (ICRAF) conducted a training on tree nursery establishment and management at Ilolo, Chamwino District, Dodoma. The objective of this training was to increase capacity on establishing and managing tree nurseries. Training was conducted at Ilolo village for three days including important techniques such as: (a) key site preparation activities, (b) practical training on substrate mixing processes (c) filling process of substrate into the polybags. Additionally, some group members were trained and practically engaged in arranging filled polybags into beds while other group members were trained on handling and direct sowing of seeds in the polybags.


Figure 14: Nursery establishment in Ilolo village.

Species selected for raising in the Ilolo nursery are found in Table 5.

Table 5: Important species raised in the Ilolo nursery

Species name	Uses
Tectona grandis	Timber, poles, fuelwood
Khaya anthotheca	Timber, poles, building material
Gliricidia sepium	Soil fertility, fodder
Afzelia guanzensis	Timber, poles, building material
Terminalia mentaly	Shade, ornamental
Acacia nilotica	Fuelwood, soil fertility, fodder
Caesalpinia pulcherrima	Live fence
Albizia lebbeck	Poles, fuelwood
Entandrophragma busse	Timber

During the three days of training only less than eight members of the Mazengo were found to be very firm in constant practice. Therefore a follow-up has to allow a junction of both groups, the Mazengo and the UPS-Group of “Improved wood supply” of Trans-SEC. This will additionally encourage the issue of tree planting in Ilolo.

In Ilolo tree nurseries were established in close collaboration with the villagers. While the tree nurseries are run by villagers, education on tree plantation, equipment for planting, as well as tree seeds are provided by the Trans-SEC project via ICRAF Tanzania. Assistance on village level is required due to several hindering factors. Often implementation is lacking because farmers lack information or planting material. Also legal considerations like insecure land tenure or government policies discourage farmers from planting tree (Scherr and Hazell, 1994).
After establishment of the tree nursery through the Trans-SEC UPS group of “Improved wood supply” (Bwanwani) together with the Mazengo group of tree planters more than 4000 trees were planted in the second year.
Seedlings of the following tree species were distributed for planting during the 2015 season: Gliricidia sepium (2,432 seedlings), Senna seamea (500 seedlings), Afzelia quanensis (n=150), Albizia lebeck (n=256), and Acacia nilotica (n=456) planted in field boundaries. Terminalia mentaly is an ornamental tree (100 seedlings) and was planted in settled landscapes such as school premises and at homestead. It is estimate that community nursery

in 2016 will produce about 15,000 seedlings (ICRAF Tanzania, Progress Report on nursery and tree planting activities, accessed 12.02.2016).

The way forward in management systems of tree planting

Appropriate tree species for on-farm wood supply depends on agroecologies and farmers preference. Planting spacings vary with species and site conditions but spacing of 3 x 3m or 3 x 4m is OK for semiarid conditions (Orwa et al.2009). Planting crops 3 m away from the boundary tree mitigate competition in semiarid sites like Dodoma (Kimaro et al., 2014).? trees planted in different locations.

Three agroforestry technologies (Boundary tree planting, Woodlot and Intercropping with cerelas) have been adopted at Ilolo. Boundary tree planting can go with any crop depending on farmer's choice as previous studies suggests that planting crops 3 m away from the tree rows mitigate competitions (Kimaro et al., 2014). Woodlots have been established on uncultivated marginal. Farmers also can adopt sequential cropping arrangements where trees and crops are rotated on the same piece of land in form of rotational woodlots or improved fallow systems (Nyadzi et al. 2003; Kimaro et al., 2007). Gliricidia sepium is the only tree species intercropped with cereals because it is comparable with crops in semi-arid areas when leaves are pruned regularly to provide green manure during the cropping seasons (Mkumba et al, 2006). Ideally with appropriate selection of tree species and management to minimize above- and below-ground competitions, agroforestry tree species can be successfully intercropped with agricultural crops including maize, millet, sorghums and sunflower (Lott et al., 2000).

Results of the ICS monitoring missions starting after 3 month of implementation

There was a close monitoring for the ICS from construction to usage leading to further improvements of the implemented ICS. The challenge is to confirm the benefits stemming from initial aimed for technical principals and implement usage related request after cooking experiences.

ICS usage and firewood consumption

Conduction of stove testing as CCT and KPT (controlled cooking test, kitchen performance test).
The Kitchen Performance Test (KPT) is the principal field in the homes of stove users –based procedure to demonstrate the effect of stove interventions on household fuel consumption (Lillywhite 1984). The two main goals of the KPT are (1) to assess qualitative aspects of stove performance through household surveys and (2) to compare the impact of improved stove(s) on fuel consumption in the kitchens of real households. To meet these aims, the KPT includes quantitative surveys of fuel consumption and qualitative surveys of stove performance and acceptability.

Stove testing will be proceeded as long as we have a participation of at least 20 households in each village: With our monitoring sheets we will cover most relevant aspects of the "Kitchen Performance Test" (KPT) by including quantitative surveys of fuel consumption and qualitative surveys of stove performance and acceptability. To demonstrate the impact of improved stove(s) on fuel consumption in the kitchens of real households and stove users we need to compare the ICS with their former stove namely the three stone fire (3SF). We hope to finally understand the stove's impact on fuel use and on general household characteristics and behaviours (Ruiz-Mercado et al. 2011).

For this reason, the protocol for the KPT is quite different from the protocols for the Water Boiling Test (WBT) and the Controlled Cooking Test (CCT).
Monitoring of wood consumption: Easy to conduct estimations on kg wood consumed per day. Method was weighting of a pile and noting days needed for consumption in several repetitions in every household of the UPS group.

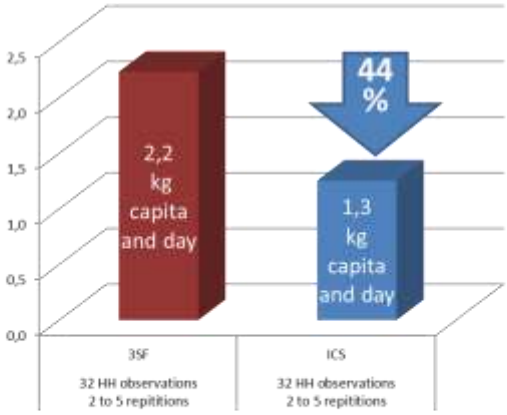

Figure 15: Results for firewood consumption derived from the monitoring activities on Trans-SEC UPS group members after ICS implementation vs. traditional 3-stone-fire users in Kilosa. Measurements of weighted piles of firewood and number of days until pile was finished were transferred into Trans-SEC monitoring sheets.

Besides the proven increase of efficiency through using the new ICS the KPT analyses of specific firewood consumption of ICS compared to 3-SF are indicating an extraordinary impact due to high or low performance of users or cooking abilities.

Table 6: KPT results for specific firewood consumption and cooking time

Mean over both meals			ICS	3SF	% ICS vs. 3SF	% 25 vs. 75 percentil	
time	25	min	58,3	77,5	75,2	42,9	ICS
	50		100,5	121,0	83,1		
	75		135,8	173,3	78,4	44,7	3SF
FW consumption kg per hour cooking time	25	kg/hrs	1,2	1,1	110,6	63,0	ICS
	50		1,4	1,5	95,8		
	75		1,9	2,0	94,7	54,0	3SF
Specic_FW_usage_per_kg_of_food	25	kg/food	1,0	1,8	55,6	12,8	ICS
	50		3,3	4,3	76,7		
	75		7,8	8,7	89,7	20,7	3SF

This finding was supported by the main difference of the firewood situation within the survey sites. In accordance of the already depleted resources in Chamwino District (Dodoma Region) we found a reduced consumption in both types of stoves here. In CSS there was a significant difference between ICS and 3-SF firewood consumption.

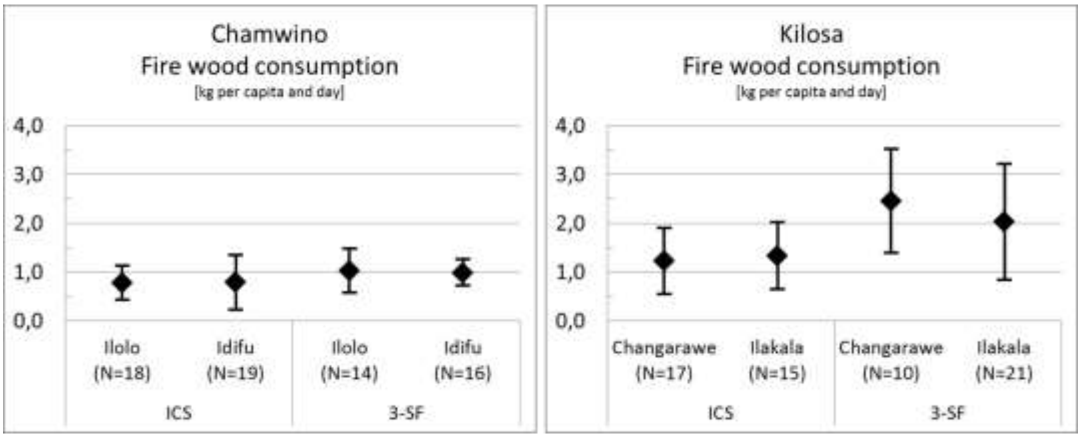

Figure 16: Monitoring results of firewood consumption in both case study sites (CSS)

Time of firewood collection and ICS implementation

In the following figure 17 we display results from the monitoring task in the two regions. The distances to firewood collection sites for villages can be proxied by the time to reach the forest or wooded areas as well as by the apparent time of collection. Here additional analyses may help to describe heterogeneity concerning household´s specifics and different degradation states of forest sites. We found that one third of the household members dedicated to firewood collection is male. This additionally indicates an increase of pressure as this work is traditionally done by woman and men are casually supposed to take over when work becomes physically strenous.

The observations within FGD (above) were covered through analyses of distances to FW sources out of the baseline survey (figure 2). In the monitoring report results from October to December 2015 in the following figure we specify answers by splitting into question on time efforts for walking and collecting:

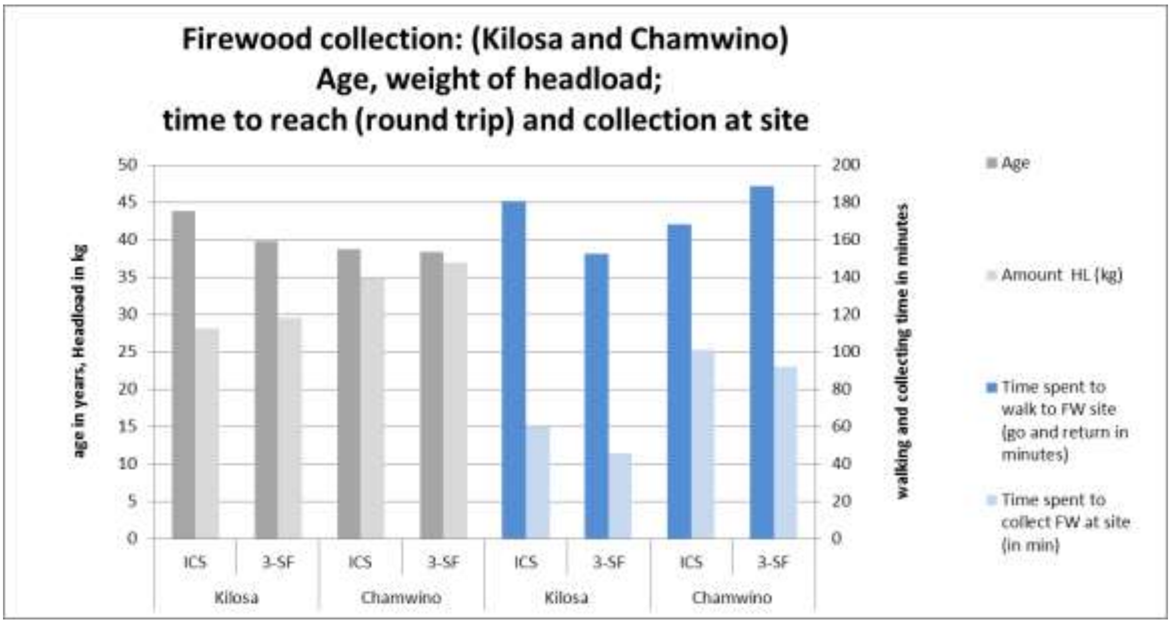

Figure 17: Monitoring results from survey (ARI) among ICS group members (18 to 33 households per village). Age of collectors, weight of headload and, time spent for FW collection (round trip and collection at sites in minutes)

First results on feasibility and income potentials of using complementary biomass production in agricultural crop production systems

The UPS of tree planting is focusing on building the capacity of farmers to produce tree seedlings and plant trees to provide an alternative source of wood biomass for the supply of cooking energy (especially firewood), fodder, other wood products (e.g., poles), and for provision of other environmental services (e.g. improving soil fertility, carbon sequestration and soil erosion). One of the main challenges to tree planting is the availability of high quality tree seedlings of sufficient amount to meet the demand. In order to address this challenge during and after the Trans-SEC project phases out, community-based tree nurseries were established. This activity started by mobilizing farmers into groups (Mazengo and Jamhuri) to fascilitate training. These groups have a total of 31 members with women forming 74% of the group. Training was conducted for three days per group and covered the following topics: site selection, seed source, selection and collection; potting mixture and pot filling, nursery management and silvicultural treatments of seeds and seedlings at the nursery. Group members were also trained on tree planting techniques.

Monitoring of the implementation of the UPS “tree planting”

After training, the farmers were involved in the nursery establishment activities including pot filling and seeding. Tree seedlings were planted in various niches in the fields, including farm boundaries, within the farm intercropped for suitable species like Gliricidia sepium, in highly degredared? Degraded? Disgregarded? sites not suitable for crops production as woodlots or pure stands. ARI Hombolo and ICRAF staff conducted regular monitoring of trees in the nusery and farmers fields to get feedback from farmers on progress and challenges encountered and assessed survival and growth of the seedlings. Data collected was used to estimate preliminary estimates of biomass yields to demonstrate the extent to which agroforestry technologies may meet household cooking energy demand, improve crops production and reduce land degradation.

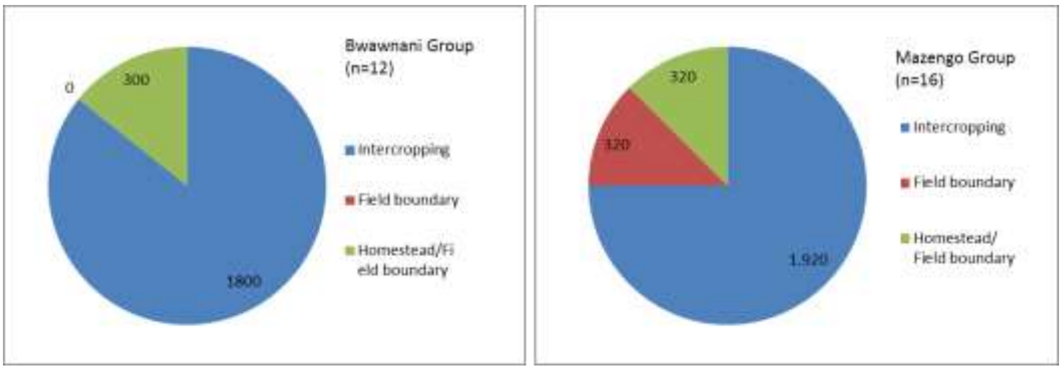

Figure 18: Monitoring of number and location of newly planted trees at farms derived at own tree nursery in Ilolo village in early 2016.

The potential for On-farm wood supply to meet household energy demand

Tree nursery groups produced about 12,000 seedlings of different species during the 2015 and 2016 growing seasons (Table 7). Over 94% of these seedlings were planted in farm boundaries, woodlots, as shelterbelts and intercropped with cereals. The types of tree species produced were based on farmers preference for fodder and soil fertility improvement (Gliricidia sepium and Melea azedirachta), fuelwood (Cardia sinensis and Senna siamea) and timber (Afzelia quanzesis) supply. These species also recorded the higest survival rates (67-100%) according to the assessment conducted in May 2016. The high survival rates reflect high adaptation to harsh and dry conditions in the village and hence the potetial for supply of fuelwood and addressing land degradation challenges.

Table 7: Number of tree seedlings produced and planted and survived (%) at Ilolo Village during the 2015 and 2016 growing seasons

Tree species	2015			2016		
	Produced	Planted	Survival	Produced	Planted	Survival
Afzelia quanzesis	30	30	23.3	640	460	68.7
Gliricidia sepium	1539	1539	56.2	4500	4342	66.5
Senna siamea	167	167	38.9	1646	1775	75.1
Acacia nilotica	49	49	79.6	340	274	55.8
Albizia labbeck	-	-	-	132	132	54.5
Leucaena diversifolia	-	-	-	120	260	22.3
Cardia sinensis	-	-	-	36	36	100
Carica papaya	-	-	-	226	58	41.4
Melea azedirachta	-	-	-	2448	2040	75.6
Delonix regia	-	-	-	80	80	0
Eucalyptus camadulensis	-	-	-	3	-	-
Total	**1,785**	**1,785**	**54.7**	**10,171**	**9,457**	**67.9**

After 2 years tree species planted produced 1 – 16 t/ha of wood depending on growth rates (Table 8). This amount of wood was sufficient to satisfy a 5-member household for up to 29 and 88 months when using three stone fires and improved firewood cooking stove, respectively (Table 8) based on the per capita daily consumption rates of 9.7 kg and 4.7 kg (Sererya, 2016).

Table 8: Potential for meeting household energy demand in Dodoma using Agroforestry

Agroforestry Practice	On-farm Wood Production		Duration (Months)*	
	Tree species	Biomass (t/ha)	With ICS	Without ICS
Boundary	*Acacia polyacantha*	0.98	4	1
	Eucalyptus camadulensis	2.03	9	3
Woodlots	*Grevillea robusta*	18.6	83	28
	Senna siamea	19.7	88	29
	Melia azadarachta	15.9	71	24
Shelterbelt	*Grevillea robusta*	5.6	25	8
Intercropping	*Gliricidia sepium*	3.3	15	5

*Duration of time it will take for a household of 5 members to complete the amount of wood produced on-farm. The estimate is based on the household consumption rates of 2.7t/yr when using ICS and of 8.1 t/yr for a three stone fire stove as determined by the on-going M.Sc. research in the Trans-SEC project (Sererya, 2016)

The planting, establishment as well as performance of trees is affected by many factors like a) Inadequate water supply for irrigating at the nursery stage can be a challenge in areas without reliable water supply; b) Low capacity and motivation to plant trees by farmers due to low awareness, the length of time need to realize benefits, constant maintenance efforts; c) Reduced crop yield due to failure to control competition and prolonged drought d) Risk of vandalism of planted trees by livestock owners; and e) Insecure land tenure can affect tree planting as trees are associated with land ownership in most societies.

Trans-SEC studies revealed that Ilolo farmers spend over 6 hrs to collect a headload of firewood (approx. 25 kg), which is often spent in 3 days when cooking using a 3 stone firewood stove (Kahimba et al., 2015; Sererya, 2016). Based on this estimate, the amount of firewood collection time saved as a result of on-farm wood supply is 1.4 and 2.8 months when cooking with the three stone fires and improved firewood cooking stove, respectively. Thus, substantial amount of the productive time spent in fuelwood collection could be diverted to other income generating activities such as farming, livestock keeping and agro-business to address food insecurity and poverty.

Outlook on dissemination, up- and out-scaling of UPS

Dissemination strategy

The designed dissemination strategy is aiming at a household adoption rate of at least 50% to enable substantial impacts (= benefits) on environmental, economical or social level. This goal could be seen as ambitious as in the past many ICS intervention programs faced low adoption rates (Johnson et al. 2009, Ruiz-Mercado et al. 2011, Bielecki and Wingenbach 2014). Accordingly, these ambitions are a prerequisite when scooping at sustaining the technical and theoretical knowledge of trainers via practicing a lot. Permanent ongoing construction activities of the trained trainers will not only guarantee the spread of the knowledge. They will also contribute on the aim of perpetuate improvements of the ICS technology in design and functioning according to the user needs. In case of a very high speed of dissemination at least each trained trainer has to build one stove per week. By this we would achieve about 500 ICS after a 6 month period. As we experienced in the time after implementation, various obstacles against this target occurred. The mismatching could not be traced back to the performance of single trainers because surprisingly all newly build stoves were constructed from the entire sub-group of the UPS group of ICS. This procedure might be reasonable in some sub-villages were ICS subgroups consist mainly of elderly woman, but it is not reasonable for the groups with the best trainers. Here we recommend to encourage the trainers to act independently. To adjust the acting at UPS group interests level by-laws and a structured registration processes are needed.

Within the strategy it is conceptualized to attend the process from acceptance to sustained usage. A careful monitoring after reaching a saturation of 30% seeks for reasons for dis-adoption especially when dissemination speed slowed down.

Determinants for dissemination speed

Pressure on natural resources (population growth, urbanisation, exceeded agricultural area, livestock keeping, etc.) led to unsustainable wood extraction or forest degradation. As a result, the household members assigned for firewood collection (mostly woman) need to walk to more distant places which takes more time.

We indicate this context by surveying the walking distance for firewood collection as estimate for the time needed for energy purposes. Assuming that in forest areas under high pressure more time for collection is needed we asked for both, walking distance as well as collection

time. To achieve a more decent picture we asked for the return separately where woman carrying a headload of 35 kg have to rest often. As most villagers are not holding a watch estimations of time spent walking/working were sometimes difficult.
A precondition to persuade the customer of the advantages of the improved stoves is needed. This awareness arose from constant or frequent usage of the stoves. We found a higher dissemination rate in those 3 villages where all the stove are used in a daily base (2-3 times a day). In Changarawe where according to interviews with the group and subgroup secretaries only a half of the stove owner is using the stove frequently no additional adopters had appeared.
Group performance:
Through the assessment of MWIVATA it was found that most of the group meet once per month to discuss different agendas. An important issue was to complete the constitution to contribute for the group registration though all the groups want to be registered at the district level. For instance since implementation of the UPS the UPS group for improved cooking stoves in Ilolo have met eleven times at every Sunday to influence construction of new stoves. In Idifu they have met eight times around the 20th to 25th every month to find new member and influence stove constructions.
MWIVATA group monitoring had identified that poor participation of members on internal meetings, poor geographical location of group members, and delay in contribution and poor leadership were the challenges facing most of the groups.
It was identified that the groups of improved stoves in Ilakala managed to train non group members on UPS implementation, the farmers trained are 13.

The adoption rates were higher during the dry season between September 2015 and January 2016. More stoves were built when no field work is possible. From January up to September the villagers are mostly occupied by farm works (planting, harvesting, processing of harvest). Especially during the cropping season from January up to June the speed of ICS dissemination is reduced.

Business models for ICS

Every business model developed for ICS dissemination has to incorporate concepts of ownership. Background is given by the observation of many other projects and approaches where the absence of eternal input is seen as source of benefitting self-help capacities. Additionally the concept of educating new trainers on how to build and as well improve the ICS will support knowledge ownership of the ICS construction technology among the villagers.

The trainer (together with other group members) will act as entrepreneurs. According to the special needs and request of new ICS technology users, they will offer variable services:

- Basic ICS model according to pro-poor approach of Trans-SEC project will be sold at the same price as before. Request of labour participation at time of construction and materials will be provided from new costumers
- Additional features, improved design => extra charge, make advantages visible, advertising is needed. Trans-SEC will provide items for attracting new customers (caps with Trans-SEC type of Salama-Stove logo, posters, t-shirts, etc.).

- Construction materials will be provided by trainers or the ICS group: Calculation and feed- in costs for bricks, proper mud (sand with clay), iron sheets for the chimney, water, etc.
- Each kind of change respectively the creation of new versions of ICS tailored to user needs and ideas are leading to extend of time spent on construction of ICS. Fair and proper wages per hour for trainers and auxiliary labourer forces should be calculated based on opportunity costs in the villages.

Outscaling of nursery management and tree planting activities

The firewood scarcity in a given community and self-motivated on tree planting. The supply of adequate firewood to meet the household energy demand will provide extra time to the community to perform other economic activities and reduce the expenditure on wood fuel.
It is very important to make sure that the essential requirements of tree planting such as loamy-sandy soil for nursery preparation, polyethane bags and reliable water supply are available to minimize the costs of out scaling. The distance to collection point is highly contributing to the time wastage that if not addressed, the community will be affected economically as they will be consuming a lot of time in collecting firewood rather than engaging on other economic activities.

On-farm wood supply holds high potential to meet household fuelwood demand. This approach also reduces substantial amount of productive time that is spent on firewood collection. This productive time can be diverted to other economic activities to improve rural livelihoods and environmental sustainability.

Evaluation data sheet for ICS

MONITORING of Improved Cook Stoves (ICS) implementation and performance							
	Please insert text or mark						
1	Name of household						***insert GPS coordinates***
2	HH no. "Baseline Survey"						
3	Trainers and builders						
4	Date of training on ICS						
5	Date of installment of ICS						
6	Kind of constructed stove		2 hole	3 hole	with chimney	without chimney	***insert picture***
7	Place of ICS in kitchen		indoor	outdoor	seperated room	living room	other: please specify
8	Share of ICS usage in %						
9	ICS usage experiences *(after 3 month)*	Performance of ICS compared to "3-stone-fire" (-) worse, (=) same, (+) better)	*a*	*b*	*c*	*d*	***assessment and txt for different dimensions (a: smoke, b: time for cooking, c: time for handling, d: comfort)***
		how often the "improved stove" is in use	*day*	*week*	*month*		***times per day or per week or per month***
10		how often the "3-stone-fire" is still in use	*day*	*week*	*month*		***times per day or per week or per month***
11	Meals and nutrition	kind of prepared food with ICS					
12		for which kind of meals the "3-stone-fire" is still in use					
13	Firewood savings	how many 25 kg headloads per week were used BEFORE installment of ICS					
			report after 1 week	***report after 1 month***	***report after 2 month***	***report after 3 month***	
14		how many 25 kg headloads per week were used AFTER installment of ICS					
15		number of days a 25 kg headload will last for cooking					
16		how often the "improved stove" is in use	*times / day*	*times / day*	*times / day*		
17		how often the "3-stone-fire" is still in use	*times / day*	*times / day*	*times / day*		

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