



# Information System Better-iS

## ZALF - Output

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### Summary:

This Factsheet presents the results of the analysis of all of the Better-iS surveys focussing on three issues: (i) energy, (ii) pressure on land and (iii) agroforestry. Results were derived in the four case-study villages (Laela, Mpanda, Kigoma and Tandai) and are compared to contribute to the development of a monitoring system to assess the sustainability of energy usage as well as a potentially bioenergy production through small-scale farmers.

Results are highlighting the possibility to produce bioenergy crops at farm level. Applicable indicators were derived through a participatory approach on local level to be implemented in village surveys.

### Title:

**Analysis of energy usage, pressure on land and agroforestry to contribute to the development of a sustainability impact assessment of bioenergy production in rural Tanzania.**

### Problem and Objective:

The energy consumption of villagers mainly depends on firewood. The availability of woody biomass from forests will significantly decrease in the near future due to population growth. This will, as its best, prolonge the walking distances but will furthermore also lead to resource conflicts within the villages. One main focus of the four Better-iS village surveys was the energy situation and the respective share of energy consumption per source. This could generate the basic to evaluate the level of dependency towards one or several energy sources. To gather insights of the future trends in competition for land between several uses (food production, natural spaces, energy crops

production, etc.) different pressures on land were analysed in the studied villages. Agroforestry, as one of them, does in this context refer to the implementation of trees on farmland whereby a significant interaction between woody and non-woody components is assumed. Trees may generate various products such as timber wood, firewood, income, food and others. On the one hand, tree planting can be regarded as alternative for wood collection in forests, reducing consequently the pressure on forest. On the other hand, the use of land for cash crops and trees might be in direct competition with food crops for local consumption.

### Method:

To get an overview of energy production and consumption in rural villages, three energy uses are considered: Cooking, lighting and production of electricity. Energy sources for cooking are firewood, charcoal and crop residues. For lighting, kerosene and palm oil are used. Finally, electricity can be produced with generators using either fossil diesel or fossil petrol. To specify the indicator “*pressure on land*” it was necessary to a) collect data about the future population growths. Thus information was derived from the proportion of children in each village. Subsequently b) the acreage of arable land per head was evaluated. Finally c) aspects concerning the quality of arable land were analysed: its fertility status as well as its fertility development over time. The extension or implementation of agroforestry in the land use systems of small-scale farmers was indicated by the number of cultivated trees in the four case-study villages. The presented numbers of trees are sample specific for on farm trees. Trees have been analysed taking into account that in the sample group oil palm and Jatropha could be separated from the other species because they are potential biofuel crops.

### Results:

Results for each indicator and each case-study village are summarised in tables in annex.

### Energy:

In all four villages, cooking is by far the activity consuming the major share of energy. On average, it amounts to 7.997 MJ per head and year (2.221 kWh), which represents 92.3 % of the total energy consumption. As firewood is the major energy carrier used for cooking, it is also the by far most consumed energy source. Per year, an average of 4.740 MJ (54.7 % of the total energy consumption, or 59.7 % of the energy used for cooking) is used per head, ranging from about 3.100 MJ in Kigoma to 5.900 MJ in Tandai. Generally does the share of use represent respective firewood availability as well as access to other sources. The range of firewood share between 43.9 % (in Kigoma) and 60.0 % (in Mpanda) can be explained by the different availability of crop residues. With an average yearly consumption of 2.000 MJ/head (23.3 % of the total consumed energy) crop residues are the second biggest energy source. It ranges from 930 MJ in Mpanda to 2.600 MJ per head and year in Tandai. Both sources indicate the importance of the cooking device of a “three stone stove” as a very simple way of cooking. The use of charcoal, which optimised indoor cooking and different types of stoves, has an average of 1.240 MJ/head (14.3%).

Energy for lighting represents a comparable small share of the energy consumption (in average 310 MJ per head per year, representing 3.5 % of the total energy consumption). Consumption varies from 210 to 430 MJ/head (from 2.6 % to 6.2 % of the total energy consumption).

In three villages (Mpanda, Kigoma and Tandai), the annual energy consumption of petrol and diesel for electricity production is lower than energy consumption for lighting. In Laela, electricity production gains 14.7 % of the total energy (1.400 MJ/head). One of the reasons why Laela has been selected as a case-study village was the presence of electricity generators using diesel. As Laela is located to a main road of the region, transport may explain the particularly high use of energy for electricity production compared to the three other villages. The demand of electricity consuming services from passing customers led to the supply e. g. of repair shops or cooled drinks.

Results for energy consumption per head per year according to the energy source and the village are presented in Table 1 and Figures 1 and 2 of Annex.

### Pressure on land:

This section aims at analysing expected trends in demographic development as well as quantity (area) and quality (fertility) of arable land in order to gather insights about the pressure on land in the four case-study villages. In the four case-study villages, household size varies between an average of 5.82 members in Kigoma ,7.95 in Tandai, 6.63 in Laela and 6.55 in Mpanda. In Laela, Kigoma and Tandai, the proportion of “children” (here defined as being younger than 15) in the population is about 42 %, which is higher compared to Mpanda where it reaches 49 % of the population. By comparing information about arable land and their percentages children future household trends as well as land distribution patterns become obvious. For the four case-study villages, the average area per head has been calculated. The area per head strongly varies according to the village and ranges from 0.3 ha/head in Kigoma (or 2.36 ha/household) to 0.85 ha/head (5.54 ha/household) in Mpanda. In Laela and Tandai, acreage per head is respectively 0.49 and 0.45 ha/head.

### Fertility:

The term ‘fertility’ does not refer to a quantifiable property of soils although villagers were requested to estimate the fertility of each plot at time of acquisition in comparison to the respective status today. In all case-study study villages, the assessment of the villagers about the fertility of their plots is low. The best average could be recorded in Tandai but even there, the status ‘fertile’ could not be reached. In Laela and Mpanda, estimated levels of fertility are quite similar and are slightly, lower than the status ‘somewhat fertile’.. In Kigoma, villagers the assessment of the fertility of their plots revealed on average very low fertility rates as figure 3 shows. Generally does, according to the villagers, fertility decreased in every village. The decline of fertility is worst in Laela, followed by Kigoma and Mpanda. In Tandai, villagers do not estimate the fertility decreased as being comparably severe compared to the other villages but fertility decreased nevertheless. Results for household size, the proportion of children, acreage and fertility are presented in Tables of Annex.

### Agroforestry:

Number of trees: In Laela, about 69 % of the households do own at least one tree. This is very few compared with the proportion in the other three villages where it ranges between 91 % in Tandai and 97 % in Mpanda (94 % in Kigoma). Furthermore, the number of trees per head in Laela is lowest (only 4 trees per head in average) while it is the highest in Mpanda (97 trees per head). In Kigoma and Tandai, it reaches respectively 30 and 53 trees per head.

Even explicitly excluding biofuel crops (palm trees and Jatropha), the highest number of trees is found in Tandai (43 trees per head). In Mpanda, on average 30 trees do exist per head on farms whereas in Kigoma it reaches 11 trees per head. **In Laela, this number is only 4 trees per head..**

## Lessons learnt:

### *For practitioners:*

Reasons for the decrease of fertility have been identified in the overcultivation of land (ca. 75 % of the answers, depending on the village). A bit less than 10 % of the answers identified poor farming methods as a cause of fertility decline (lack of fertilizer, no techniques for the improvement of soils, etc.). Another 10 % identified causes such as soil erosion or water lodging. Less than 5 % of the villagers named poor environmental conditions (poor soil, bad climate, etc.) as the responsible criteria. Experiences of good practices (mainly the use of fertilizers or of mulching) associated with an increase of the fertility concern only less than 5 % of the answers. In Kigoma, where cultivation of oil palms is important, those trees are highlighted as being responsible of the decrease of the fertility of 20 % of the plots.

### *For research:*

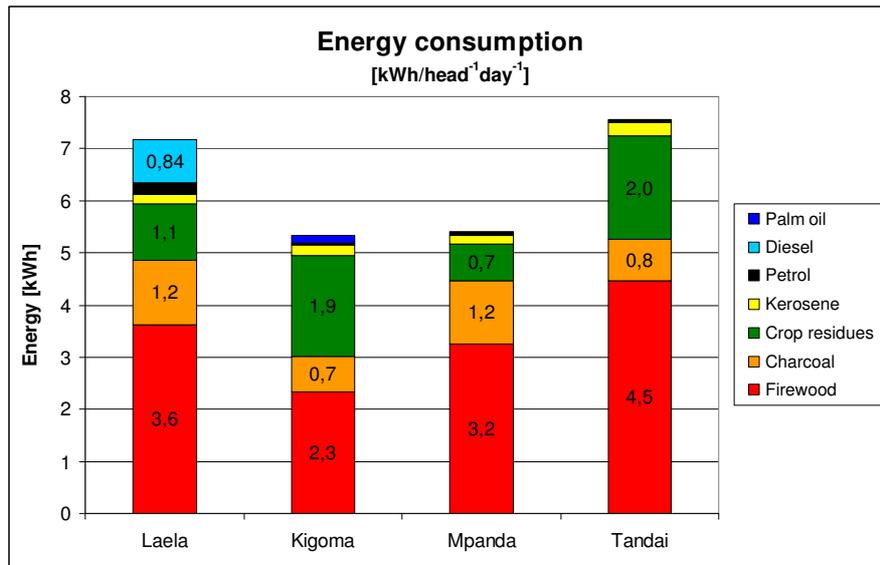
Questionnaire implementation of population, energy and farmland issues are able to indicate the sustainability of energy consumption and its development.

## Documentation

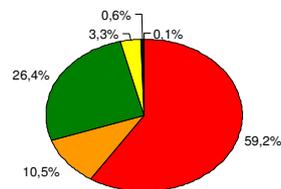
Table 1 and figures 1 and 2: Energy consumption per head and per year in the four case-study villages. (Source: Better-iS surveys 2010-2011).

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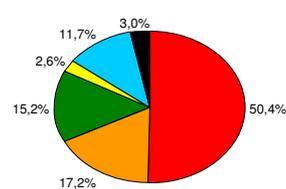
Energy (source/head) [MJ]				
	Laela	Kigoma	Mpanda	Tandai
<b>Firewood</b>	4739	3065	4255	5853
<b>Charcoal</b>	1615	890	1594	1037
<b>Crop residues</b>	1428	2531	932	2615
<b>Kerosene</b>	241	255	210	323
<b>Petrol</b>	285	59	106	60
<b>Diesel</b>	1101	0	0	6
<b>Palm oil</b>	0	177	0	0
<b>Total</b>	<b>9407</b>	<b>6978</b>	<b>7097</b>	<b>9893</b>



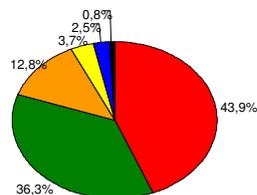
Energy share in Tandai



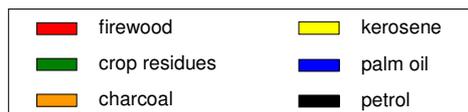
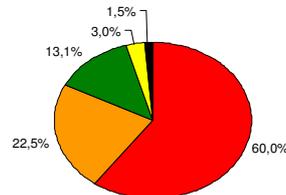
Energy share in Laela



Energy share in Kigoma



Energy share in Mpanda



**Table 2: Population characteristics in four case-study villages according to the household survey carried out within the Better-iS project 2010 and 2011.**

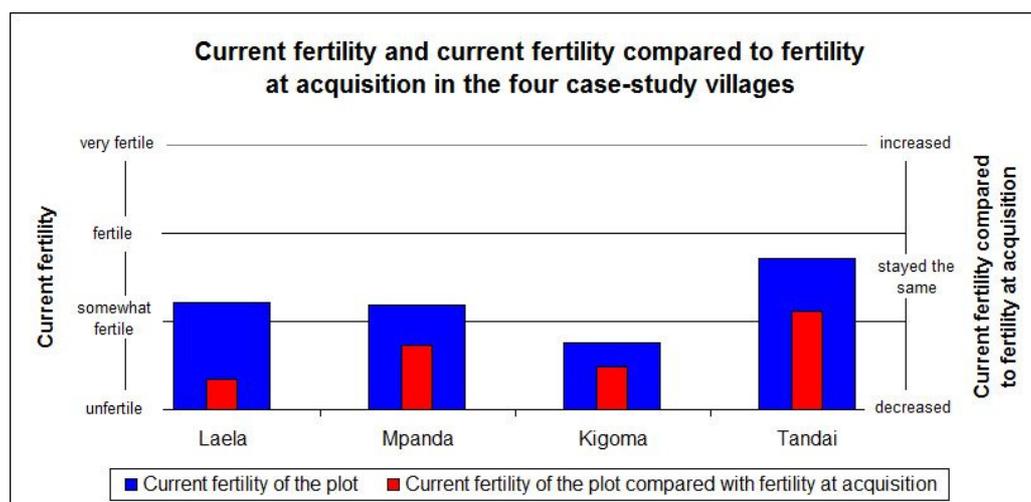
Better-iS survey	Laela	Mpanda	Kigoma	Tandai
	Children < 15 years old	441	439	399
Adults > 14 years old	620	458	563	1061
Total population	1061	897	962	1840
Proportion of children	42%	49%	41%	42%
Number of households	160	137	121	316
Average household size	6,63	6,55	7,95	5,82

**Table 1: Population characteristics in the four case-study regions according to the household survey carried out within the microcensus 2003.**

Microsensus 2003	Rukwa	Rukwa	Kigoma	Morogoro	Tanzania
	Children < 15 years old	549 944	549 944	828 122	729 786
Adults > 14 years old	586 410	586 410	845 925	1 023 576	19 204 991
Total population	1 136 354	1 136 354	1 674 047	1 753 362	34 443 603
Proportion of children	48%	48%	49%	42%	44%
Average household size	5	5	5,4	4,4	4,7

**Table 4: Average area per household and per head in acres and hectares in the four case-study villages.**

	Laela	Mpanda	Kigoma	Tandai
Area per household [acres]	8,21	13,68	5,82	6,57
Area per household [ha]	3,32	5,54	2,36	2,66
Minimum	0,40	0,30	0,08	0,10
Maximum	20,23	40,47	15,38	13,35
Area per head [acres]	1,22	2,09	0,73	1,11
Area per head [ha]	0,49	0,85	0,30	0,45



**Figure 1: Current fertility and current fertility compared to fertility at acquisition in the four case-study villages**

**Table 2: Number of trees per head in the four case-study villages**

	<b>Laela</b>	<b>Mpanda</b>	<b>Kigoma</b>	<b>Tandai</b>
<b>Average number of trees per HH</b>	<b>29,74</b>	<b>633,31</b>	<b>237,04</b>	<b>311,06</b>
Number of HH with at least one tree	111	133	114	289
Total number of HH	160	137	121	316
Proportion of HH with at least one tree	69%	97%	94%	91%
Average size of the HH	6,63	6,55	7,95	5,82
<b>Number of heads in HH with at least one tree</b>	<b>736</b>	<b>871</b>	<b>906</b>	<b>1683</b>
<b>Total number of trees</b>	<b>3 301</b>	<b>84 230</b>	<b>27 022</b>	<b>89 896</b>
Number of oil palm	0	0	16 847	0
Number of Jatropha	0	58 454	0	17 952
<b>Number of biofuel trees</b>	<b>0</b>	<b>58 454</b>	<b>16 847</b>	<b>17 952</b>
<b>Number of trees excluding biofuel trees</b>	<b>3 301</b>	<b>25 776</b>	<b>10 175</b>	<b>71 944</b>
<b>Proportion of biofuel trees</b>	<b>0%</b>	<b>69%</b>	<b>62%</b>	<b>20%</b>
<b>Number of trees per head</b>	<b>4</b>	<b>97</b>	<b>30</b>	<b>53</b>
<b>Number of biofuel trees per head</b>	<b>0</b>	<b>67</b>	<b>19</b>	<b>11</b>
<b>Number of trees per head (excluding biofuel trees)</b>	<b>4</b>	<b>30</b>	<b>11</b>	<b>43</b>

Further information on Better-iS sustainability indicator development:

[http://www.better-is.com/files/Hoffmann\\_et\\_al\\_2010\\_Sustainability\\_indicators.pdf](http://www.better-is.com/files/Hoffmann_et_al_2010_Sustainability_indicators.pdf)

Participating institutions: International Food and Policy Research Institute (IFPRI), Institute for Environmental Economics and World Trade IUW, World Agroforestry Centre ICRAF, Wuppertal Institute for Climate, Environment and Energy, Leibniz-Centre for Agricultural Landscape Research (ZALF e.V.), Association for Strengthening Agricultural Research in Eastern and Central Africa. Associated partners: SOKOINE University of Agriculture, Ministry of agriculture, food security and cooperatives Tanzania