The wellbeing of smallholder coffee farmers in Mount Elgon region-
a quantitative analysis of a rural community in Eastern Uganda

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Introduction

By producing more than 38 thousand tons of Arabica coffee (in 2017/18), Uganda is among the most important Arabica coffee producer in the world (UCDA 2018). As about 1.3 million rural households (HH) are engaged in coffee production, the coffee sector has a very high socioeconomic importance for Uganda (UBOS 2010). It is well-known that in most coffee cultivation areas smallholder coffee farmers often do not live under conditions that surpass the subsistence level. However, only a few research projects are investigating on the wellbeing of coffee farmers.

Those research studies implementing wellbeing of coffee farmers, do mainly measure the impacts of participation in specialty markets, or cooperatives and focus on certification programs on wellbeing aspects of coffee farmers (e.g. Ahmed and Mesfin 2017, Bacon et al. 2005, Reben and Fort 2011). In addition, recent research on the wellbeing of coffee producers is mainly indirectly accompanied by renounced explanation of what wellbeing means or equals wellbeing and welfare. Ahmed and Mesfin (2017), for example, use the equivalent of consumption per adult as a wellbeing indicator. The analysis of a sole wellbeing dimension, commonly income or expenditure, has been also critized by authors of other research fields, e.g. by Decancq and Lugo (2011) who investigated inequality of wellbeing in Russia. Even though some authors include direct questions about wellbeing in their questionnaire to get an idea of the farmers' wellbeing and its impacts (e.g. Frank et al. 2011), they do not clarify the farmers' understanding of wellbeing. Some other authors use related terms, as the "quality of life," cf. Bacon et al. (2005) in their research on the impacts of participation in certification programs of coffee farmers in Nicaragua. However, results like those of Bacon et al. (2005) show that most coffee farmers (74 % of the surveyed Nicaraguans) perceive their quality of life independently from being part of the conventional or an alternative trade network, because "sales to alternative markets is not enough to offset the many other conditions that influence the quality of one's life" (Bacon 2005). Other works on self-reported wellbeing, as those of Luttmer (2005), also state that individuals not only care about their economic situations, but also on their relative position with regard to other individuals. Estoque et al. (2018) claim that wellbeing is the prerequisite for the quality of life. Hence, wellbeing and related terms are of more complexity and there is a need for research on wellbeing structure for HHs engaged in coffee farming; Not only because a better understanding of wellbeing is required for comparison between individuals within a research area or between groups of different coffee cultivation areas, but also for better evaluation of development processes of certification programs or political programs.

However, the high importance of wellbeing has been widely accepted in other research fields and research on wellbeing has been globally growing in recent decades (e.g., Suh et al. 1996, Kahnemann 1999, Allen 2001, Decancq and Lugo 2011, Keyes et al. 2002, Beaumont 2011, Seligman, 2011, Dodge et al. 2012). Drawing from multiple disciplines (e.g. psychology, medicine, economics, and sociology) with different focuses, varying values for the measurement of wellbeing are presented in past and current research. One of the more recent and broader applicable definitions is the one of Dodge et al. (2012) who define wellbeing as "the balance point between an individual's resource pool and the challenges faced" in terms of physical, social and psychological sub-components. In other words: stable wellbeing exists "when individuals have the psychological, social and physical resources they need to meet a particular psychological, social and/or physical challenge" (Dodge et al. 2012). Hendry and Kloep (2002) developed this concept even further and added in their so-called *Lifespan model* the assumption that successful solving of challenges leads to development in the individual and/or environment, whereas failing challenges impedes the solution of future challenges. They also assume that the success of meeting challenges depends on the resources pool individuals have. Therefore, research on wellbeing is not only required to measure development it is also the prerequisite for development.

Adding the assumptions of the *Lifespan model* to the theory of subjective wellbeing of Headey and Waring (1992), who mentioned external force as the preconditional factor for change within the wellbeing balance, one could assume that development occurs when external forces appear. Humans could be faced with more challenging situations, regarding their ecosystem for example. Considering the estimated decrease in climatic suitability for most of Ugandans Arabica coffee cultivation area, the debate of climate change might be considered as a potential high impact factor (Damatta et al. 2012, Jassogne et al. 2012). Next to the more challenging conditions for coffee production the farmers are faced, such as higher occurrence of pests and diseases (UNDP 2012), and higher uncertainties with regard to temperature and irrigation, changing weather is also expected to reduce coffee quantity and coffee quality (e.g. Bartl unpublished, Jassogne et al. 2012, UNDP 2012, Läderach et al. 2012). This would also lead to a lower income from coffee selling, what thereby would also have a long-term impact on the farmers' resources for the balance of wellbeing. Considering the before-mentioned difficulties, the Uganda Coffee Development Authority (UCDA) developed a program to counteract the challenges the coffee farmers are facing. They state, quite ambitiously, the aim to quadruple Ugandan's coffee production by 2040 by stabilizing the coffee farmers' resource situation, e.g. by providing workshops on coffee management and by distributing coffee seedlings for free (UCDA 2019).

The present paper investigates the composition of wellbeing in order to provide ideas on the development of the living conditions of HHs engaged in coffee farming by using data from 431 quantitative interviews. A good specification of wellbeing is required to describe wellbeing from the coffee farmers' point of view in order to then draw policy recommendations that could help the smallholder farmers and their families to increase their wellbeing constitution. Inspired by the wellbeing definition of Dogde et al. (2012), a composite indicator (CI) for wellbeing is built based on the material wealth (physical), the fulfillment of social needs (social), and the fulfillment of basic psychological needs (psychological) to enable the measurement of wellbeing in one of the three most important Arabica coffee cultivation areas of Uganda.

Materials and methods

Study area

The study was conducted on the Western slopes of Mount Elgon region, which is one of the three main Arabica coffee producing regions in Uganda (Knutsdatter Formo and Padegimas 2012). For many smallholder farmers in the Mount Elgon region of Uganda, Arabica coffee cultivation is the main income-generator.

The data collection of this study took place in Bulambuli district which extends on a surface of about 809 km², reaches elevations of up to 1526 m.a.s.l. and is divided into two counties, Elgon and Bulambuli county (NPHC 2014). Surveys were administered in Elgon county because 60.5 % of its HHs were engaged in coffee growing, whereas coffee farmers in Bulambuli county were only represented by 2.2 % of the existing HHs (NPHC 2014). Within Elgon county, the three sub-counties Bulegeni, Simu, and Namisuni were chosen (Fig.1).

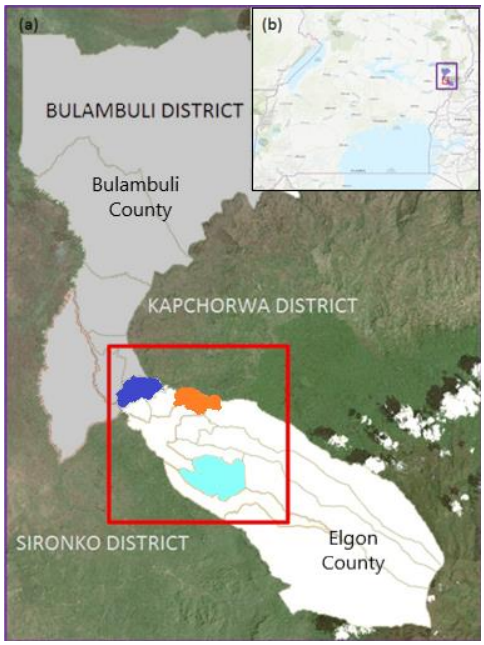


Figure 1. Map of (b) South Uganda and (a) details of Bulambuli district with Bulambuli County (grey) and Elgon County (white) with the sub-counties Bulegeni (blue highlighted), Simu (cyan highlighted), and Namisuni (orange highlighted)

For the data collection, 431 heads of coffee cultivating HHs were randomly chosen (Table 1).

Table 1: Number of HH participating in the study

Sub-county	Participants HH survey
Bulegeni	156 (36.2%)
Simu	90 (20.9%)
Namisuni	185 (42.9%)
Total	431 (100%)

Data collection

Within the project 'Potential improvements for the income situation of smallholder coffee farmers in Mount Elgon, Uganda' developed and implemented by the Georg-August University of Göttingen, Germany, and the National Agricultural Research Organization (NARO) of Uganda, quantitative data from 431 smallholder coffee

farmers were captured in the timeframe from July to December 2018. Pre-tests to evaluate the feasibility to conduct interviews were done during research preparations one year before the research program started.

The HH heads were interviewed at their homes. The instrument for the survey was divided into seven sections, including (i) general HH composition, including educational level of all HH members, (ii) farm management practices, (iii) access of information and extension material, (iv) general HH living conditions, (v) expectation of yield and income, (vi) socioeconomic infrastructure, and (vii) deficiencies and shocks experienced so far. In total, 78 closed questions were asked in about one hour.

Because of different language levels in English, five local assistants (four male and one female) were trained to conduct an average number of five interviews per day, using the local language Lugisu. For their expended time during answering our questionnaire, each farmer got compensation in the form of bookkeeping and management materials.

Composite Indicator for Wellbeing

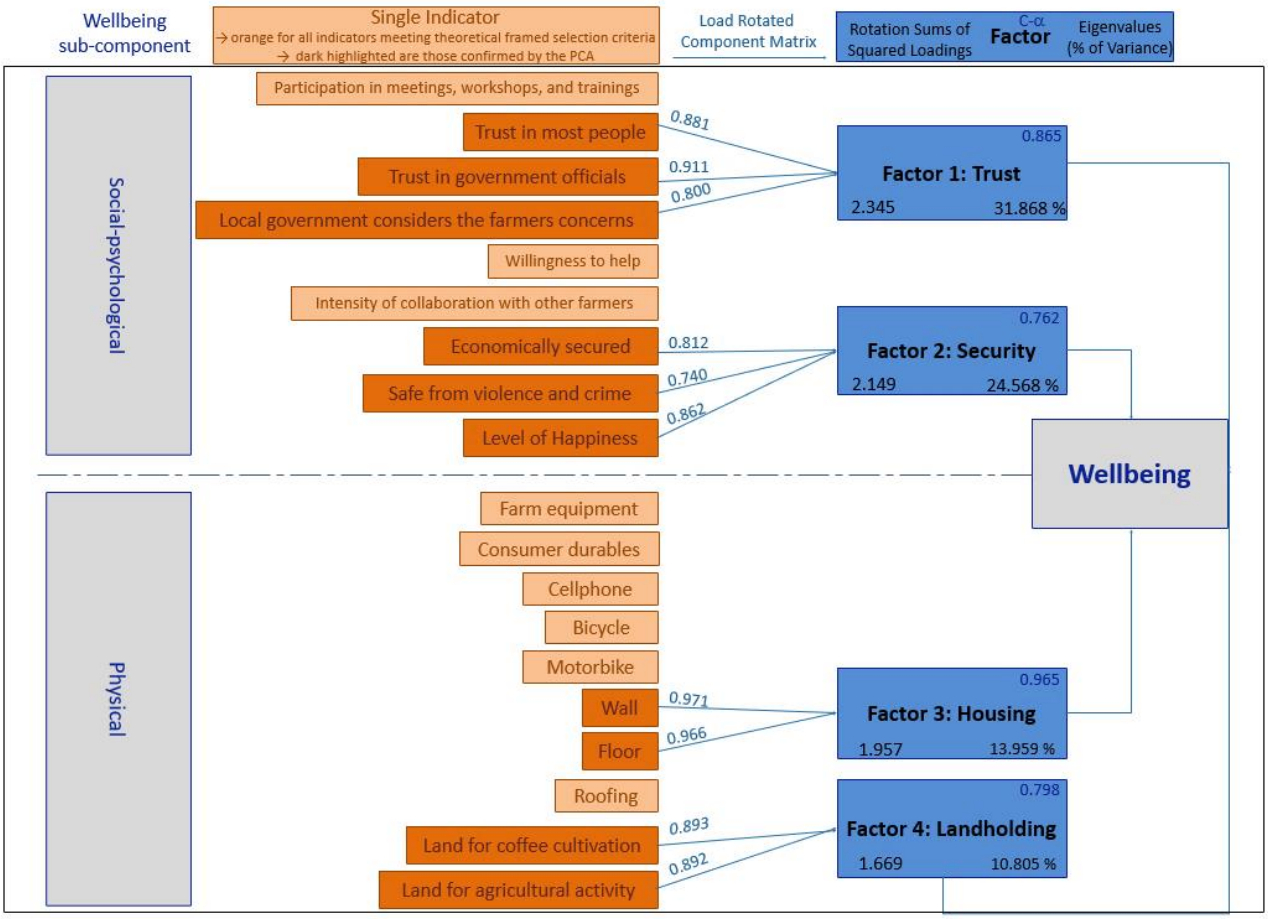
As deducted in the introduction section, a composite indicator (CI) was built for wellbeing-indicators based on the material wealth (physical), the fulfillment of social needs (social), and the fulfillment of basic psychological needs (psychological). Due to the high level of content-related overlap between social and psychological indicators in the here presented data set, I the social and psychological wellbeing indicators were merged and the "social-psychological" and the "physical" sub-component were used. The selection criteria for indicators of the data set describing wellbeing with regard to the physical and social-psychological sub-components are shown in Table 2.

Table 2: Selection criteria for variables to build the CI of wellbeing

Sub-components	Focus on	Selection criteria
Physical	Material wealth	Indicators that value the belongings of a HH used for living or as agents of production • HH level • objective
Social-psychological	Fulfillment of basic psychological and social needs	Indicators that value the sensations and social interactions of farmers • Individual • Subjective/objective

All indicators that meet the selection criteria, and can be exclusively categorized with regard to sub-components without showing missing values, are enumerated in Figure 2. *Safe from violence and crime* or *Willingness to help* can be clearly categorized to the social-psychological sub-component, whereas *Farm equipment* or *Bicycle* are defined to the physical sub-component.

The scales of all indicators are ranged from low to high levels of wellbeing. To enable comparison within and between single indicators with different scales, the indicators were standardized by building z-scores[1].



Extraction Method: Principal Component Analysis, Rotation Method: Varimax with Kaiser Normalization, Rotation converged in 5 iterations.
** highly significant P=0.01

Figure 2: Summarizing of wellbeing sub-components, investigated single indicators, and the results from the Principal Components Analysis (PCA)

To explore whether the theoretically developed indicators for wellbeing are statistically well-balanced and if the underlying structure of data is suitable for the wellbeing indicators, a Principal Components Analysis (PCA) was performed. A four factors solution can explain 81.20% of the total variance (Kaiser-Meyer-Olkin Measure (KMO) = 0.681, Bartlett's Test of Sphericity Sig. =0.000) by including ten of the previously derived indicators.

Factors that meet the prerequisite of being associated with eigenvalues larger than one and to contribute individually to the explanation of the overall variance by more than 10 %: Factor 1 *(Trust)* is explaining 31.868 %, Factor 2 *(Security)* is explaining 24.568 %, Factor 3 *(Housing)* is explaining 13.959 %, and Factor 4 *(Landholding)* is explaining 10.805 % of the total variance (Fig. 2). The factor *Trust* consists of the indicators *Trust in most people*, *Trust in Government officials*, *Local government considers the farmers' concerns*. *Security* compromises the indicators *Economically secured*, *Safe from violence and crime* and the *Level of Happiness*.

[1] For each individual indicator x_{qc}^{t}, the average $x_{qc=\bar{c}}^{t}$ and the standard deviation $\sigma_{qc=\bar{c}}^{t}$ are calculated. It comes to similar dispersion across indicators when implementing into the normalization formula: $I_{qc}^{t} = \frac{x_{qc}^{t} - x_{qc=\bar{c}}^{t}}{\sigma_{qc=\bar{c}}^{t}}$

The content related connection between happiness and security can be explained by citing one of the interviewed farmers: "[…] Well to me happiness is a state of life when one is contented with all the prevailing circumstances in life". For the physical sub-component, the factor *Housings* consists *Wall* and *Floor*, whereas the factor *Landholding* reflects the *Land for agricultural activity* and the *Land for coffee cultivation.*

Testing the combination of the variables of the four-factor solution for reliability, the Cronbach's Coefficient alpha (C-α) for the total internal consistency shows a value of 0.741, which is acceptable (Field 2009). Consequently, for the development of the CI of wellbeing, only the variables of the subsequent termed factors *Trust, Security, Housing,* and *Landholding* are further investigated.

The square of factor loadings represents the proportion of the total unit variance of the CI of wellbeing which is explained by the factor (JRCEC 2008). The calculation of the weights of single factors in the formula for CI of wellbeing is done by the intermediate approach of Nicoletti et al. (2000). Therefore, the variance explained by the factor after varimax rotation (Rotation Sums of Squared Loadings, Figure 2) is used to calculate the weight of each factor.

$$Weight\ of\ the\ factor\ for\ the\ CI\ of\ wellbeing\ (Wq) = \frac{Variance\ explained\ by\ the\ factor}{Total\ variance\ of\ the\ four\ factors}$$

$$CI\ of\ wellbeing\ = (W_{Trust} * Trust) + (W_{Security} * Security) + (W_{Housing} * Housing) + (W_{Landholding} * Landholding)$$

Implementing the weights of each factor into the formula of CI of wellbeing, the finally CI formula is:

$$CI\ of\ wellbeing = (0.2888 * Trust) + (0.2647 * Security) + (0.2410 * Housing) + (0.2055 * Landholding)$$

The z-standardized scores used for the PCA were regressed for each factor and the CI of wellbeing was calculated for each interviewed HH.

Data analysis

To build the CI of wellbeing, the methodology approaches guided in the 'Handbook on Constructing Composite Indicators' of the Joint Research Centre-European Commission was followed (JRCEC 2008). SPSS Version 25 was used inter alia to perform the required Principal Components Analysis (PCA) for the construction of the CI of wellbeing. To assess if there was an influence of sub-county on indicators, factors or CI of wellbeing, a one-factor ANOVA was performed. Pearson's correlation coefficient was used to check for correlations between single indicators by using the z-scores of the items.

Results

Sample description

Comparing the sample distribution with the average HH characteristics of the research area, a slight deviation of the socio-demographic parameters is present (Table 3). However, statistics of the research areas population was either captured in 2012 (see NPHC 2014) or, if more recent, only refers to the Mount Elgon region as a whole (UNHS 2016/17). Including the high fertility rates (5.4 children per women in 2016) in Uganda, those deviations of the sample characteristics can generally be accepted due to the socio-demographic trends being largely similar (SUPRE 2018). As cash crop production like coffee cultivation is usually male-dominated in rural

areas of Sub Saharan Africa, and only coffee farmers were included into the sample group, female-headed HHs are clearly underrepresented.[2] (e.g. Bolwig 2012, Doss 2002).

Table 3: Sample characteristics

Quantitative data set		Bulegeni	Simu	Namisuni	Total	Research area
Number of HHs		n= 156	n= 90	n= 185	n=431	21,244 [1]
Gender of HH head	Male	94.2%	95.6%	93.5%	94.2%	81.4% [1]
	Female	5.8%	4.4%	6.5%	5.8%	18.6% [1]
Age of HH head	<18	0.0%	0.0%	0.0%	0.0%	1.0% [1]
	18-30	7.1%	11.1%	16.1%	11.7%	25.9% [1]
	31-59	60.3%	62.2%	65.0%	62.7%	53.9% [1]
	>60	32.7%	26.7%	18.9%	25.6%	19.2% [1]
Highest level of education for head of HH	Illiterate	3.9%	4.4%	2.2%	3.3 %	9.3% [2]
	Primary school	45.8%	41.1%	59.7%	50.7%	58.7% [2, 3]
	High school	44.4%	47.8%	34.3%	40.8%	27.8% [2, 4]
	College	3.9%	3.3%	2.8%	3.3%	8.2% [2, 5]
	University	2.0%	3.3 %	1.1%	1.9%	
People per HH	MD/SD	6.31/2.338	6.41/2.238	5.21/2.170	5.86/2.312	4.638/0.135 [2]
Coffee production is the main source of income		83.2%	93.3%	88.6%	87.7%	83.0% major economic activity is crop farming [2]

[1]Data for Elgon County from NPHC 2014
[2]Data for Elgon Region from UNHS 2016/17
[3]Sum from category: some primary and completed primary for the whole HH
[4]Sum from category some secondary and completed secondary for the whole HH
[5]Post-secondary and above for the whole HH

Descriptive statistics

Indicator Level

In this section, descriptive statistic provides insights into absolute (not standardized) values of all indicators building the final CI of wellbeing. Table 4 shows the means and standard deviation for the single indicators of the social-psychological factors *Trust* and *Security*. All social-psychological indicators were measured by a five-level Likert Scale. Likert scale ranging from 1 (not at all) to 5 (very much). No outliers could be found for the indicators of social-psychological factors. For the total sample, the *Level of happiness* shows a mean of 3.76, for *Local government considers the farmers concerns* the mean is 3.70. *Trust in most people* indicates a mean of 3.10 and *Trust in government officials* shows a mean of 3.36. Trends between single indicators of the factor *Trust* and sub-county are not clearly visible: The mean for all indicators of *Trust* is the lowest for Bulegeni sub-county, Namisuni shows the highest mean for the indicators *Local government considers the farmers concerns* and *Trust in government officials*, whereas Simu sub-county has the highest mean for *Trust in most people*.

[2] Only 20.7 % of the female heads are married. The rest of the female heads are single (20.7%), divorced (10.3%) or widowed (48.3%), whereas only 1.5 % of the male headed HHs are widowed.

For the *Security* indicators *Safe from violence and crime* and *Economically secured* relations between sub-counties and emphasis of indicators could be assumed.

Table 4: Means and standard deviation for the single indicators of the social-psychological factors

Factor	Indicator		Bulegeni (n= 156)	Simu (n= 90)	Namisuni (n= 185)	Total (n=431)
Trust	Trust in most people	Mean	3.08	3.17	3.09	3.10
		SD	1.56	1.50	1.54	1.53
	Trust in government officials	Mean	3.26	3.36	3.44	3.36
		SD	1.57	1.34	1.44	1.47
	Local government considers the farmers concerns	Mean	3.61	3.71	3.77	3.70
		SD	1.38	1.38	1.30	1.35
Security	Economically secured	Mean	3.08	3.72	3.72	3.49
		SD	1.63	1.39	1.42	1.52
	Safe from violence and crime	Mean	3.87	3.27	3.32	3.51
		SD	1.16	1.60	1.69	1.52
	Level of happiness	Mean	3.85	3.77	3.68	3.76
		SD	1.20	1.45	1.40	1.34

The results of the one-factor ANOVA (shown in Table 5) confirm the previously mentioned assumptions with P=0.000*** regarding the influence of sub-county on *Economically secured* and with P=0.001*** for the influence of sub-county on *Safe from violence and crime*. For all other social-psychological indicators no significant influence of sub-county could be found. However, these results should be interpreted carefully for some indicators due to the significant findings of Levene's Test for *Safe from violence and crime* (P=0.000***), *Economically secured* (P=0.000***), *Level of happiness* (P=0.000***) and *Trust in local government officials* (P=0.011*). In addition, the requirement for normally distributed data is not met, according to Kolmogorov-Smirnov (KS) Test (P = 0.000***).

Table 5: One-factor ANOVA for the influence of sub-county on the indicators of the social-psychological wellbeing sub-component

Factor	Indicator	Source	Partial SS	df	MS	F	P(>F)
Trust	Trust in most people	Between groups	0.475	2	0.238	0.101	0.904
		Within groups	1011.033	428	2.362		
		Total	1011.508	430			
	Trust in government officials	Between groups	2.955	2	1.477	0.684	0.505
		Within groups	924.020	428	2.159		
		Total	926.974	430			
	Local government considers the farmers concerns	Between groups	2.289	2	1.144	0.631	0.533
		Within groups	776.101	428	1.813		
		Total	778.390	430			
Security	Economically secured	Between groups	41.164	2	20.582	9.229	0.000***
		Within groups	954.516	428	2.230		
		Total	995.680	430			
	Safe from violence and crime	Between groups	32.502	2	16.251	7.266	0.001***
		Within groups	957.220	428	2.236		
		Total	989.722	430			
	Level of happiness	Between groups	2.472	2	1.236	0.688	0.503
		Within Groups	768.948	428	1.797		
		Total	771.420	430			

Number of observations = 431

Table 6 shows the descriptive statics for the single indicators of the physical factors *Housing* and *Landholding*. The single indicators for the factor *Housing* physical sub-component show a very high percentage (84.4 % to 97.8 %) of HHs that floor and wall materials consist out of earth (floor) and mud/soil (wall) that indicate the lowest level, with regard to welfare. In consequence, percentages for mid and high valued emphasis of the indicators for *Housing* are low (0.0% to 15.6%) which could also explain the presence of extreme values. However, a trend for differences in *Housing* characteristics between the sub-counties are visible: Simu indicates for both, wall and floor material, a lower percentage of the low valued emphasis and a higher percentage of the high valued emphasis. After a greater interval, Bulegeni is showing lower *Housing* quality, directly followed by Namisuni. The same trend is visible for the mean of the indicators of the factor of *Landholding*. Extreme values are also present for the areas of hectares for agricultural activity and for coffee cultivation. To ensure that all levels of wellbeing are involved in the data analysis these extreme values were not excluded from the data analysis.

Table 6: Descriptive statistic for the single indicators of the physical factors

Factor	Indicator		Bulegeni (n= 156)	Simu (n= 90)	Namisuni (n= 185)	Total Sample (n=431)	Number of extreme values
Housing	Wall material	Mud/soil	93.6%	84.4%	96.2%	92.8%	31
		Plastered	3.2%	3.3%	1.6%	2.6%	
		Bricks	3.2%	12.2%	2.2%	4.6%	
	Floor material	Earth	92.9%	84.4%	97.8%	93.3%	31
		Wood	0.6%	0.0%	0.0%	0.2%	
		Cement	6.4%	15.6%	2.2%	6.5%	
Landholding	Land used for coffee cultivation (ha)	Mean	0.46	0.77	0.39	0.50	26
		SD	0.48	0.99	0.42	0.62	
		Range	3.03	5.26	2.83	5.26	
		Minimum	0.00	0.00	0.00	0.00	
		Maximum	2.83	5.26	2.83	5.26	
	Land used for agricultural activity (ha)	Mean	0.91	1.32	0.80	0.95	24
		SD	0.81	1.29	0.61	0.88	
		Range	5.97	7.99	2.95	8.04	
		Minimum	0.10	0.10	0.05	0.05	
		Maximum	6.07	8.09	3.00	8.09	

The results of the one-factor ANOVA (shown in Table 7) confirm the previously made assumptions with P=0.000*** for the influence of sub-county on all indicators of the physical sub-component. However, these results should be interpreted carefully due to the significant findings of Levene's Test for all indicators (P=0.000***). In addition, the requirement for normally distributed data is not met, according to Kolmogorov-Smirnov (KS) Test (P = 0.000***).

Table 7: One-factor ANOVA for the influence of sub-county on the physical wellbeing sub-component

Factor	Indicator	Source	Partial SS	df	MS	F	P(>F)
Housing	Wall	Between groups	3.006	2	1.503	7.849	0.000***
		Within groups	81.959	428	0.191		
		Total	84.965	430			
	Floor	Between groups	4.346	2	2.173	9.197	0.000***
		Within groups	101.116	428	0.236		
		Total	105.462	430			
Landholding	Total hectare of land used for coffee cultivation	Between groups	9.109	2	4.555	12.448	0.000***
		Within groups	155.868	426	0.366		
		Total	164.978	428			
	Total hectare of land used for agricultural activity	Between groups	16.614	2	8.307	11.146	0.000***
		Within Groups	318.993	428	0.745		
		Total	335.606	430			

As a last step, the relationship between single indicators is briefly examined, and depicted in Table 8, in order to inspect the single indicators and their values after standardization (z-scores). Correlation yields that there is a strong positive relationship between *Trust in most people* and *Trust in government officials* (corr=0.718**), between *Local government considers the farmers concerns* and *Trust in most people* (corr=0.587**), and between *Trust in government officials* and *Local government considers the farmers concerns* (corr=0.736**). For the indicators of the factor *Security* the positive relationship is not as strong: Between the *Level of happiness* and *Economically secured* (corr=0.589**), between *Safe from violence* and *Economically secured* (corr=0.402**), and between the *Level of happiness* and *Safe from violence and crime* (corr=0.559**). Then, there is a positive relationship between *Wall* and *Floor* material (corr=0.932**) and between *Land used for agricultural activity* and *Land used for coffee cultivation* (corr=0.480).

In addition, all physical indicators do have a positive relationship with each other. Pearson's correlation indicates a relationship between *Economically secured* and (a) *Land for coffee cultivation* (corr=0.129**), (b) *Land used for agricultural activity* (corr=-0.160**). Similar relationsships between the *Level of happiness* and the indicators of *Landholding* are visible. Furthermore, all indicators of the factor *Trust* show a highly significant (P≤0.01) positive correlation with the indicators of *Security* and the *Landholding* indicator *Land used for coffee cultivation*. The perception of being *Safe from violence and crime* correlates in a negative way with *Land used for agricultural activity* (corr=-0.257**). Relationships between indicators of different factors can also be found but their correlation is not that strong (corr<0.5).

Table 8: Pearson's correlation with z-scores of the ten single indicators

Factor	Indicator	1	2	3	4	5	6	7	8	9	10
Trust	1.Trust in most people	1	0.718**	0.587**	0.152**	0.242**	0.211**	n.s.	n.s.	0.137**	n.s.
	2.Trust in government officials	**0.718****	1	0.736**	0.236**	0.309**	0.288**	n.s.	n.s.	0.146**	n.s.
	3.Local goverm. considers the farmers concerns	**0.587****	**0.736****	1	0.363**	0.364**	0.389**	n.s.	n.s.	0.163**	n.s.
Security	4.Economically secured	0.152**	0.236**	0.363**	1	0.402**	0.589**	n.s.	n.s.	0.129**	-0.160**
	5.Safe from violence and crime	0.242**	0.309**	0.364**	0.402**	1	0.559**	n.s.	n.s.	n.s.	-0.257**
	6.Level of Happiness	0.211**	0.288**	0.389**	**0.589****	**0.559****	1	n.s.	n.s.	0.117*	-0.244**
Housing	7.Wall	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	1	0.932**	0.338**	0.101*
	8.Floor	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	**0.932****	1	0.360**	0.102*
Landholding	9.Land used for coffee cultiv.	0.137**	0.146**	0.163**	0.129**	n.s.	0.117*	0.338**	0.360**	1	0.480**
	10.Land used for agricultural activity	n.s.	n.s.	n.s.	-0.160**	-0.257**	-0.244**	0.101*	0.102*	0.480**	1

*Significance for two-tailed correlation is P≤0.05, **Significance for two-tailed correlation is P≤0.01, Correlations of 0.5 and above are shown in bold

Factor Level

In the following section, the emphasis of factors after standardisation (z-score transformation) is investigated. Following the descriptive results shown in Table 9, total range and the ranges per sub-county for z-scores of the social-psychological factors *Trust* and *Security* are < 4. The ranges of the z-scores of the factors *Housing* and *Landholding* of the physical sub-component show greater (5.132 to 8.629) differences between minimum and maximum emphasis of z-scores in total and for single sub-counties. Thereby, the physical sub-component indicates a greater extent of variations and also a higher diversity in the share of impact on wellbeing compared to the social-psychological component.

Table 9: Descriptive statistics for the four wellbeing factors

Sub-component	Factor	Sub-county	N Valid	Mean	Median	SD	Variance	Range	Min	Max
Social-psychological	Trust	Bulegeni	156	-0.026	0.350	1.071	1.148	3.718	-2.189	1.528
		Simu	90	-0.019	0.219	0.953	0.909	3.462	-1.828	1.634
		Namisuni	185	0.031	0.311	0.964	0.930	3.810	-2.182	1.628
		Total	431	0.000	0.285	1.000	1.000	3.823	-2.189	1.634
	Security	Bulegeni	156	0.006	0.144	0.904	0.817	3.653	-2.077	1.576
		Simu	90	0.007	0.380	1.036	1.074	3.673	-1.936	1.737
		Namisuni	185	-0.008	0.289	1.062	1.127	3.828	-2.249	1.579
		Total	431	0.000	0.273	1.000	1.000	3.987	-2.249	1.737
Physical	Housing	Bulegeni	156	-0.026	-0.210	0.911	0.831	5.132	-0.885	4.247
		Simu	90	0.300	-0.236	1.490	2.221	5.953	-1.523	4.430
		Namisuni	185	-0.125	-0.221	0.708	0.501	5.467	-0.901	4.566
		Total	431	0.000	-0.221	1.000	1.000	6.089	-1.524	4.566
	Landholding	Bulegeni	156	-0.069	-0.332	0.839	0.703	6.170	-1.230	4.940
		Simu	90	0.4358	0.102	1.563	2.442	8.626	-1.632	6.993
		Namisuni	185	-0.154	-0.350	0.663	0.439	5.154	-1.636	3.518
		Total	431	0.000	-0.270	1.000	1.000	8.629	-1.636	6.993

However, more detailed explanation for the impacts of the single factors on wellbeing with regard to sub-county is given in Figure 3 that depicts the means for all factors and the CI of wellbeing for the single sub-counties. Following Figure 3, it is obvious that *Landholding* provides the highest impact on wellbeing in all single sub-counties, even though in a negative way in the sub-counties of Bulegeni and Namisuni. The means of the social-psychological factors *Trust* and *Security* are clearly smaller for all single sub-counties, except Bulegeni, where *Trust* provides a negative impact on the mean wellbeing of the HHs. With regard to the mean of total wellbeing, Figure 3 could also lead to the assumption that in Simu, the wellbeing score is the highest, followed by Bulegeni and Namisuni.

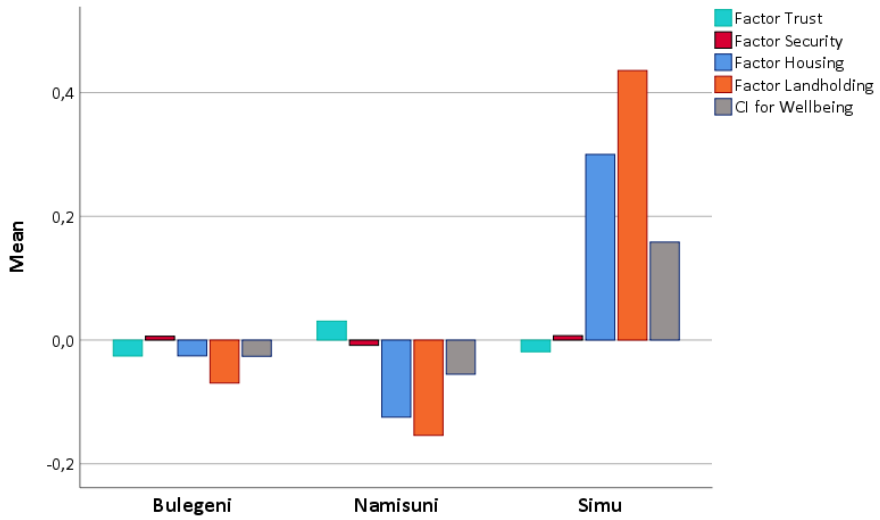


Figure 3. Means of 'Trust', 'Security', 'Housing', and 'Landholding', and the CI of wellbeing for the sub-counties Bulegeni, Namisuni, and Simu

The results of the one-factor ANOVA (shown in Table 10) show a significant influence of sub-county on *Housing* (P=0.004**) and on *Landholding* (P=0.000***). The influence of sub-county on *Trust* (P=0.858) and *Security* (P=0.988) is not significant. However, due to the significance of Levene's Test for *Housing* (P=0.000***), *Landholding* (P=0.000***) and *Security* (P=0.043*), these results should be interpreted carefully.

Table 10: One-factor ANOVA for the influence of sub-county on 'Trust', 'Security', 'Housing', and 'Landholding'

Factor	Source	Partial SS	df	MS	F	P(>F)
Trust	Between groups	0.307	2	0.153	0.153	0.858
	Within groups	427.693	426	1.004		
	Total	428.000	428			
Security	Between groups	0.023	2	0.012	0.012	0.988
	Within groups	427.977	426	1.005		
	Total	428.000	428			
Housing	Between groups	11.080	2	5.540	5.661	0.004**
	Within groups	416.920	426	0.979		
	Total	428.000	428			
Landholding	Between groups	22.228	2	11.114	11.668	0.000***
	Within Groups	405.772	426	0.953		
	Total	428.000	428			

Wellbeing CI

Using the previously specified formula of wellbeing, the wellbeing index shows a mean of 0.000 for the total group, despite having different means of wellbeing in various sub-counties (Table 11).

Table 11: Descriptive statistics for the CI of wellbeing and sub-county

Sub-county	Mean	SD	Median	Minimum	Maximum	Range
Bulegeni	-0.026	0.446	-0.028	-0.885	1.856	2.742
Simu	0.158	0.661	0.131	-0.912	2.266	3.178
Namisuni	-0.055	0.445	0.093	-1.088	1.150	2.238
Total	0.000	0.504	0.068	-1.088	2.266	3.355

In pursuit of a better illustration of wellbeing distribution, wellbeing levels are defined. A HH refers to the group with a low wellbeing level if indicating a value of < 0, to the groups with a mid-wellbeing level by having a wellbeing value of 0-1, and to the group with a high wellbeing level if indicating a wellbeing index of >1.

Figure 4 depicts the proportions of the different wellbeing levels in the single sub-counties, and across all sub-counties. It can be seen that, for the whole sample, more than half of the total HHs (52.45%) belong to the group with mid wellbeing level. About 44% of the total HHs show a low wellbeing level, and only about 4 % indicate a high wellbeing level. Regarding the wellbeing distribution between the sub-counties, it can be seen that Simu indicates the lowest percentage of HHs with low wellbeing level (33.33%) and at the same time also the highest percentage (11.11%) of the HHs with high wellbeing level. Bulegeni indicates the highest percentage (52.60%) of HHs having low wellbeing level but at the same time a higher percentage of high wellbeing HHs (3.25%) then Namisuni (1.08%). The highest percentage (57.84%) of mid wellbeing level is given in Namisuni.

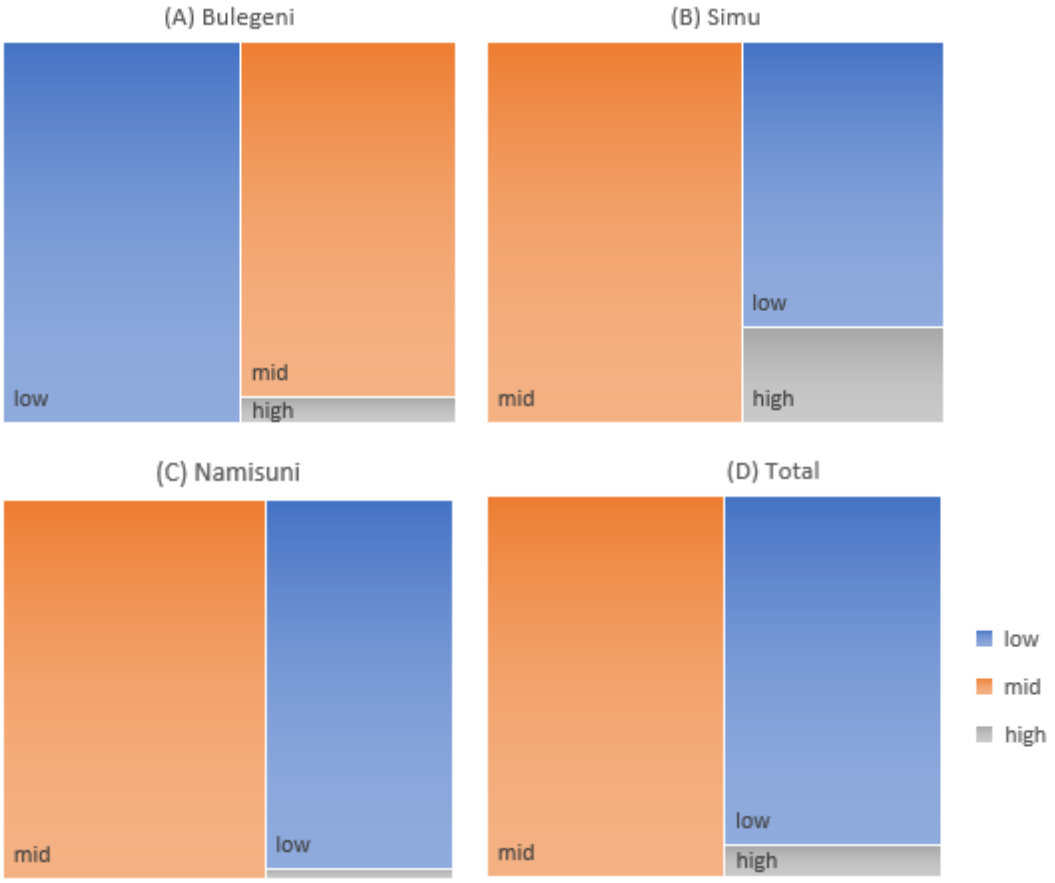


Figure 4. Hierarchical tree-structured maps depicting the proportions of the different wellbeing levels (low CI<0, mid CI= 0-1, high CI>1) in (A) Bulegeni, (B) Simu, (C) Namisuni, and (D) across all sub-county

Based on the ANOVA (Table 12), the influence of sub-counties on wellbeing index is highly significant (P = 0.003**), but again, Levene's Test is significant (P=0.006**) which should result in a careful interpretation of this result.

Table 12: One-factor ANOVA for the influence of sub-county on wellbeing index

Source	Partial SS	df	MS	F	P(>F)
Between groups	2.923	2	1.462	5.891	0.003**
Within groups	105.696	426	0.248		
Total	108.619	428			

Discussion and conclusions

This paper presents the construction of a composite indicator of wellbeing to summarize the complex and multidimensional realities, and to enable easier understanding or comparison of complex data sets without dropping the underlying information base (Decancq and Lugo 2011, JRCEC 2008). Based on the wellbeing definition of Dodge et al. (2012), who defined wellbeing with regard to physical, social, and psychological dimensions, selection criteria including indicators were established. Due to the inconclusive distinction between social and psychological sub-components in our data set, both groups are combined. The theoretically framed selection of nineteen potential indicators for the resulting physical and social-psychological sub-components of wellbeing was further eliminated by statistical relevance. The results of the explorative PCA show that *Trust*, *Security*, *Housing*, and *Landholding*, containing in total ten of the previously selected indicators, provide the most comprehensive assembling for wellbeing, by explaining 81.20% of the total variance. The construction of a CI has the advantage of indirect measurement of wellbeing. Indirectly answered questions can lead to a lower impact of social desirability of given answers by the farmers. It can further prevent low answering quality due to different understanding of what complex terms like wellbeing mean. However, there are many different ways for the construction of a CI and thereby, the choice does influence how good the CI reflects wellbeing.

The weighting was also calculated by the variance of the PCA, and resulted in higher weighting for *Trust* and *Security* than for *Landholding* and *Housing*. Using results from (male) expert interviews would have led to higher weighting for Landholding because "land comes first for farmers"[3], but for reasons of objectivity the results of the PCA were used.

However, the investigation of the values for the indicators of the social-psychological factors shows the highest ranking (five-stage Likert Scale) for the *Level of happiness* (3.76) and the lowest mean value for the indicator *Trust in most people* (3.10). Nevertheless, the farmers believe more in the consideration of their concerns by the local government (3.70) than they have *Trust in government officials* (3.36). Therefore, it can be assumed that the trust in institutions is higher than the *Trust in most people* the farmers work with directly. This assumption can be confirmed by the observed high frequency of political gatherings and demonstrations in the sub-counties and very cautious behavior of individuals when it came to an interaction with unknown people during our fieldwork. However, the perception of being *Economically secured* and the perception of being *Safe from violence and crime* show a mean of about 3.5. The physical conditions of the investigated HHs show that a very high percentage of the *Walls* for the main houses are built out of soil (total mean 92.8%) and *Floors* are mainly out of earth (total mean 93.3%). Only a few houses consist of plastered or bricked wall material, or wood or cement floor material. This finding confirms those of the NPHC (2014), where only 6.6% of the interviewed HHs answered to live in dwelling units constructed using permanent floor and 6.9% used permanent wall material construction. The total mean for *Land used for agricultural activity* is 0.95 ha, whereas the total mean for *Land used for coffee cultivation* is about half (0.5 ha). For both, *Land used for*

[3] Next to the here presented quantitative interviews, qualitative interviews and expert interviews were done by the research team.

agricultural activity in general and *Land used for coffee cultivation*, the ranges of values for the area are up to ten times higher than the mean which indicates wide disparity with regard to the *Landholding* in the community.

Pearson's correlations of normalized indicators show highly significant (P≤0.01**) positive correlations between all indicators that belong to one factor. Then, the positive relationship between the indicators of *Housing* and *Landholding* indicates that by increasing property of land, the main house constitution improves. Interestingly, there is a positive relationship between the perception of being *Economically secured* and *Land used for coffee cultivation* (corr=0.129**), but a negative correlation between *Economically secured* and *Land used for agricultural activity* (corr=-0.160**). Consequently, it can be assumed that an increase in *Land used for coffee cultivation* is associated with higher income, whereas *Land used for other agricultural activities* might be associated with higher costs. The latter could be explained by the commonly practiced cultivation of crops for self-sufficiency that does not directly provide cash income for the HH. Similar relationships between the *Level of happiness* and *Landholding* indicators are visible: The *Level of happiness* and the *Land used for coffee cultivation* correlate positively (corr=0.117*) whereas the *Level of happiness* and the *Land used for agricultural activities* correlate in a negative way (corr=-0.244**). The positive relationship between the *Level of happiness* and the area for coffee cultivation could be explained by greater business activities and greater freedom on spending money for the cultivation of cash crops. Self-sufficiency crops are usually used for home-consumption and could increase the nutritional status of the HH. Sometimes, leftovers are sold at the local market which yields some small money. However, other costs for meeting existential needs, as for health care, education, or shelter could only be covered by the incomes from cash crop selling.

The *Level of happiness* does also increase by higher valuing of *Trust in most people* (corr=0.211**), the *Trust in government officials* (corr=0.288**), and the consideration of the farmers' concerns by the local government (corr=0.389**) (and the other way around). The same direction is visible for the relationship between all other indicators of *Security* with the indicators of the factor *Trust*. A well-known issue in the research area are explorative businessmen, as e. g. middlemen for coffee selling (Baffes 2006). Thus, a positive relationship between *Trust in most people* and the perception of being *Economically secured* (corr=0.152**) could be explained. Another interesting finding is the relationship between the perception of being *Safe from violence and crime* and (a) the *Trust in government officials* (corr=0.309**) and the emphasis of (b) *Local government considers the farmers' concerns* (corr=0.364**). The positive relationship leads to the assumption that farmers who trust in the institutions feel more protected. In contrast, larger *Land used for agricultural activity* decreases the farmers' perception of being *Safe from violence and crime* (corr=-0.257**).

However, results of the one-factor ANOVA indicate an influence of the sub-county on the farmers' perception of being *Economically secured* (P=0.000***) and being *Safe from violence and crime* (P=0.001***). For the physical sub-component, the one-factor ANOVA indicate an influence of the sub-county on all physical indicators (P=0.000***).

The investigation of factor levels using the normalized z-scores, indicates that the total range and the ranges per sub-county for z-scores of the social-psychological factors *Trust* and *Security* are < 4. The ranges of the z-scores of the factors *Housing* and *Landholding* of the physical sub-component show greater differences (5.132

to 8.629). Considering the before found results of the influence of sub-county on single indicators, a closer investigation of the means per factor and sub-county was done. Interestingly, *Landholding* was identified to be the highest impacting factor for all sub-counties, even after the lowest weighting within the CI formula. *Landholding* shows a negative mean for Bulegeni and Namisuni and a positive z-score for Simu sub-county. However, the smaller means (without considering the positive or negative swing) for the social-psychological factors could inter alia be explained by the transformation into z-scores: Indicators with extreme values, as those of *Landholding,* have a greater effect on the CI, because indicators are converted to a common scale with a mean of zero and standard deviation of one. Here, extreme values were not excluded, because differences in hectares of land could not be ignored in cases where the main economic activity is farming.

However, going back to the impact of sub-county on wellbeing factors, a significant influence on *Housing* (P=0.004**) and *Landholding* (P=0.000***) was found and no influence of sub-counties on *Trust* (P=0.858) or *Security* (P=0.988) was present.

With regard to the proportions, results indicate that about 44 % of the HHs have a low wellbeing index (CI<0), more than a half (52.45%) of the HHs are indicating mid-wellbeing index (CI 0-1) and only 3.90% have a high wellbeing index (CI>1). The means for the final calculated CI of wellbeing indicate the highest wellbeing for Simu sub-county (0.158), followed by Bulegeni (-0.026), and Namisuni (-0.055). The same order can be mentioned for the value of wellbeing range within the sub-counties, which is the highest in Simu sub-county (3.178), followed by Bulegeni (2.742) and Namisuni (2.238). The lower range of wellbeing in Namisuni indicated by the range of z-score can be confirmed by the low percentage of HHs having a low wellbeing CI (1.10%) and the highest percentage of HHs having mid wellbeing (57.84%). Besides, many HHs in Bulegeni (51.90%) indicate a low wellbeing index, about 44% show a wellbeing index of mid-level, and 3.2% of the HHs indicate high wellbeing index. Those percentages vary widely from the results found in Simu where the group of low wellbeing reaches one-third of all interviewed HHs, two thirds of the HHs show mid (55.60%) and high (11.10%) wellbeing indices. The assumption that the sub-county influences the wellbeing can be confirmed by the results of the one-factor ANOVA (P=0.003**). In short, different emphasis on wellbeing within and even higher differences of wellbeing between sub-counties were found. Although there has been no direct research on wellbeing for the here investigated area, the findings of the NPHC (2014) also indicate different situations of life for different sub-counties; The percentage of 6-12-year-old children not attending school is 17.6% in Bulegeni, 13.6% in Namisuni, and 12.9% in Simu. In addition, the percentage of 18-30-year-old people that are not in school and not working differs considerably: Bulegeni is showing the lowest percentage (8.7%), followed by Simu with 12.5%, and Namisuni where 27.1% of this age group do not work or attend school. Looking at the percentage of people eating less than two times a day, Simu has the highest rate with 9.3%, followed by Namisuni with 7.2% and Bulegeni with 5.3% (NPHC 2014). In contrast to the results of the present paper, the findings of the NPHC (2014) could not clearly indicate distinct trends for the individual single sub-counties.

The here presented influence of the sub-county on wellbeing can be mainly explained by significant differences found for the physical factors *Housing* and *Landholding*. The ranking of the sub-counties with regard to wellbeing is the same as for the single indicators of *Housing* and *Landholding*. However, even if the whole social-psychological sub-component does not significantly differ between sub-counties, the results from

ANOVA have also indicated significant influence of the sub-county on the single indicators *Economically secured* (P=0.000***) and *Safe from violence and crime* (P=0.001***). Both indicators show a significant negative correlation with *Land used for agricultural activity*, but there is also a positive relationship between *Economically secured* and *Land used for coffee cultivation*. For the indicators of Housing and *Economically secured* or *Safe from violence and crime,* no significant relationship could be found.

Investigated sub-counties do not border with each other. Considering the map with the sub-counties, it becomes clear that Namisuni and Bulegeni have less distance to each other than to Simu. The geographical distances between the sub-counties indicate similarities in the results of the wellbeing index. Further research should investigate if geographical location really matters for wellbeing and if there are other reasons that could explain the differences in physical wellbeing in different sub-counties. However, a possible explanation for the higher emphasis on welfare in Simu could be the better access to roads that enable faster and safer transport to the next town and could also lead to economic advantages. Another possible explanation could be better ecological conditions. It could be assumed that the presence of the Sissyi waterfalls, which pass through Simu, could provide more constant water for crop cultivation or less impact of droughts. This could lead to higher income from coffee selling or lower expenditures for food that has to be bought on top of self-providing agriculture. But there could be several other reasons for better physical wellbeing in Simu that should be included in further analyses. It further might be interesting to find reasons explaining the higher *Trust* levels and the lower *Security* perception in Namisuni, compared to the other sub-counties. The results of the here presented data set were only suitable for a static specification of the current wellbeing at the time of data collection. To enable the measurement of dynamic changes in wellbeing over time, further data collection could acquire repeated evaluation and could also include medical or nutritional status or other aspects of the housing quality to increase the number of potential physical indicators.

In addition, a detailed investigation of influencing factors for wellbeing (e.g. income, education, number of children) and the relationship between the perceptions of deficiencies and wellbeing should be done in further research.

Here, the HH heads, which are mainly men, were interviewed. Considering that the role of the women within the HH is more likely to consider the wellbeing of the whole family, there might be differences in the indicators impacting the wellbeing. A female perspective could be a little more representative for the wellbeing of the whole HH. Due to the widespread gendered division of labor, and the thereto connected varying responsibilities of the spouses in coffee related issues in Uganda (Nakabuga 2015), it might be difficult to collect good quality data from the HH heads' wives that include inter alia questions on the economic or security level of the HH as those realms belong to the husbands' responsibilities.

The here presented results show the current balance point of wellbeing (see Dodge et al. 2012) and outline the starting position for single sub-counties with regard to the development of their life quality. For sure, further research is required on how the farmers cope with external forces with regard to climate change or other challenges faced. But for the current situation, some recommendations from the here found results can be mentioned. It might have a positive impact on the wellbeing level of the farmer's HH to increase the percentage of land used for coffee cultivation of their total land used for agricultural land. From the results of

Pearson's correlation, it can be assumed that the *Level of happiness* and the perception of being *Economically secured* could be improved by a higher percentage of *Land used for coffee cultivation*. At the same time, the consequently following reduction of land used for other agricultural activities could also lead to a positive impact of larger land on being *Economically secured*, *Safe from violence and crime* and the *Level of happiness*. It seems like a larger area for the cultivation of coffee could also increase other social-psychological indicators, as those of *Trust*. However, investigations on suitability of given land for Arabica coffee cultivation and potential other influencing factors should be made before recommending switching from self-sufficient crop production to coffee cultivation. From previously mentioned results, we may conclude that the farmers are intrinsically motivated to increase their coffee cultivation activities to improve their own wellbeing. That, in turn, could help UCDA to reach their goal of a quadruple increase of Uganda's coffee production (see UCDA 2019), if they provide a better resource situation for the farmers that helps extend their coffee cultivation. Research on the required basic conditions for this purpose could not only help to rise the tendency of coffee production; it could also prevent or slow down the assumed reduction of coffee production due to expected reduction in suitable areas for Arabica coffee cultivation in Uganda induced by climate change (Jassogne et al. 2012). However, it cannot be assumed that farmers are willing to switch the complete area used for self-sufficient crop production to coffee cultivation area due to significantly changes in market prices for the anyway common low prices they get per kilo of coffee. Sometimes, the prices even do not cover the production costs (Sayer 2002). If, in those cases, farmers would only cultivate coffee and do not have any self-sufficient crop production, a reduction in wellbeing could be assumed.

Results also indicate that development activities can focus on improving housing quality, especially in Namisuni and Bulegeni. The same could be assumed for landholding. The reduction in land per changing generation is a well-known problem in the investigated area and could not be easily prevented. This issue will become even more critical due to the high fertility rates and further splitting of land in the line of succession (SUPRE 2018). What could be recommended is the official registration of land to prevent potential land-grabbing motivated by the nutrient-rich volcanic soils given in the Mount Elgon region (UNDP 2012). The official land registration should try to establish equal land rights in a married couple. At the moment, it is common that the man is having the land rights (even if not officially). In cases of the male HH head's death, male relatives of the man inherit those rights. The loss of land often increases the economic vulnerability of the remaining HH members. This is especially important, considering that 48.3 % of the female-headed HHs of the here presented HHs are widowed.

With regard to other planned development activities in the here investigated area, one could use the here presented results to check on the farmers' wellbeing level. Based on that, one could create programs that help in terms of strengthening the individually required resource level or in terms of reducing the level of challenges (Dodge et al. 2012). Only a level of resources that is sufficient to meet the farmers current and future challenges, could lead to the development and improvements of the life quality of the economic vulnerable group of coffee farmers in Uganda. The here presented results could further be used to investigate the success of given development approaches in the Bulambuli district.

However, the HHs of the sample group are representing similar socio-demographic trends as the average HH in the research area of Mount Elgon, Uganda (NPHC 2014, UNHS 2016/17). Slight differences can be accepted because of the high fertility rates in Uganda (SUPRE 2018). Due to the high percentage of HHs engaged in coffee production and the representative data set, one could (carefully) figurate results from the present paper to HHs of other coffee cultivation areas in the Mount Elgon region.

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List of abbreviations

CI	Composite Indicator
HH	Household
JRCEC	Joint Research Centre-European Commission
KS	Kolmogorov-Smirnov
NARO	National Agricultural Research Organization
PCA	Principals Component Analysis
UBOS	Uganda Bureau of Statistics
UCDA	Uganda Coffee Development Authority
UNHS	Uganda National Household Survey