sustainability

MDPI

Article

Do Biomass Technology Innovations Improve Subjective Well-Being? Traditional versus Improved Cookstoves in Uganda

Irene Namugenyi [1,2,*], Ståle Navrud [1], Joachim Scholderer [1] and Sarah Ephrida Tione [1]

[1] School of Economics and Business, Norwegian University of Life Sciences, Chr. Magnus Falsens Vei 18, NO-1433 Ås, Norway
[2] Faculty of Energy Economics and Management Science, Makerere University Business School, Plot 21 A, Port Bell Rd, Kampala P.O. Box 1337, Uganda
* Correspondence: irene.namugenyi@nmbu.no; Tel.: +47-67232865

Abstract: This study investigates the dark side of biomass technology innovations on households' subjective well-being (SWB) in Uganda. The dark side of biomass technology innovations concerns households moving away from the intangible cultural cooking heritages that they have preserved for a long time. These intangible cultural cooking heritages are important to understand as they contribute to policy decisions on sustainable society transformation (sustainability transitions) in the clean cooking energy sector. This study adds to the scarce literature on innovation for well-being and innovation for transformative change, addressing grand societal challenges while considering the well-being of technology users. Principal component analysis was used to generate the subjective well-being variable from the captured traditional household cooking considerations, perceptions, and practices. Linear regression was used to analyze the effect of improved cookstoves (ICSs) and other factors on the subjective well-being of households in Uganda. The results show that using ICSs moves Ugandan households away from traditional ways of cooking, which reduces the well-being they attach to the intangible cultural heritage of traditional cooking. Thus, innovators, entrepreneurs and promoters of clean cooking technologies should consider the well-being of users along with the benefits of bioenergy innovation to accelerate society transformation (sustainability transitions) in Uganda.

Keywords: dark side of innovation; subjective well-being; innovation for well-being; improved cookstoves; intangible cultural cooking heritages; sustainability transitions

check for updates

Citation: Namugenyi, I.; Navrud, S.; Scholderer, J.; Tione, S.E. Do Biomass Technology Innovations Improve Subjective Well-Being? Traditional versus Improved Cookstoves in Uganda. *Sustainability* **2023**, *15*, 3487. https://doi.org/10.3390/su15043487

Academic Editor: Ying Sheng

Received: 12 December 2022
Revised: 26 January 2023
Accepted: 7 February 2023
Published: 14 February 2023

Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Research on improved biomass technologies has positioned these technologies as the main socio-technical strategy for reducing emissions caused by indoor air pollution, which are associated with the household use of solid biomass in developing countries [1,2]. Consequently, providing access to improved biomass technologies continues to be a priority for development actors such as the United Nations [3,4]. Since the inception of these technologies in developing countries in the 1950s, several studies have been undertaken to understand their association with user uptake in society. For example, Jan and Lohano [5] found that the uptake of improved biomass technologies is significantly associated with high education and income levels and that the technologies reduce indoor air pollution, which improves the health of households. Misra [6] and Kishore and Ramana [7] found that improved cookstoves (ICSs) reduce biomass usage, which contributes to nature conservation and environmental sustainability. Ray [8] and Rwiza [9] found that using ICSs improves economic growth, which contributes to the creation of social and economic well-being by reducing cooking and firewood gathering time, as well as to the good health to households.

Whilst previous studies have explored several factors and contributions of biomass cooking technologies on society, it could be argued that they have ignored the empirical analysis and documentation of the dark side of improved cookstove technologies on the household subjective well-being [10,11]. Martin [12] and Spanakis [11] asserted that the possibility of innovations having a negative impact on household subjective well-being cannot be ruled out. This may concern intra-personal subjective well-being related to health beliefs, knowledge, attitudes or values, and inter-personal well-being among individuals and in societies. The dark side of the ICS could be related to the changes in household subjective well-being as the households move away from traditional to improved cooking practices. Traditional cooking practices are intangible cultural cooking heritages that households have practiced and preserved for a long time [13]. These practices are passed on from one generation to another with a symbolic meaning and special significance that has origins in the past. Any threat to erode such traditions threatens the households' subjective well-being of using and preserving them [14].

In Uganda, traditional cooking practices are associated with cultural values and keeping our traditions alive, such as cooking on open fires, and we are strong because of the way we cook our millet bread [15]. While cooking and gathering around the open fire, parents tell stories and riddles to children that carry the knowledge concerning acceptable behavior in society and responsible living [16]. Although changing from traditional to improved cooking practices reveals positive societal and environmental impacts [1,17,18], moving away from intangible cultural heritages associated with traditional cooking practices can be considered a dark side of clean cooking technologies. In a review paper, Lindgren [1] found that studies on technology adoption in Asia and sub-Saharan Africa have not accounted for the cultural and social needs of users, such as recognizing that cooking practices often serve specific traditional purposes for communities and families. In Ugandan societies, cooking traditional foods on an open fire has a symbolic connection to a strong cultural heritage that represents specific norms, beliefs, and values related to different foods. The qualitative (anecdotal) findings of this research indicate that Ugandan households consider food cooked on open fires to have a unique, natural taste and distinct aroma caused by the smoke that perforates into the food during cooking. Similarly, Masera [18] found that households in rural Mexico reported that tortillas cooked on open fire tasted better than the ones prepared over improved stoves. This indicates that the taste and aroma attributes are considered absent in food prepared over improved cookstove technologies. However, no empirical study has been assessed to support or explore the validity of such evidence, which this study does.

According to Bielecki and Wingenbach [19], traditions are nested under three interlinked domains on which the dark side of the ICS may be assessed. These include the social, cultural, and functional domains. The social domain relates to family size and meal occasions, which concerns cooking for large family gatherings and important occasions, for which an ICS may not serve this purpose. The cultural domain concerns the local norms, customs, traditions and views on aesthetics and well-being that are likely to be affected when using ICS technologies. The functional domain concerns the ability to provide space, heat, and ambient light. For instance, improved cookstoves have no burning flames that could enable households to sit around the fire, especially at night. Additionally, elders often pass on discipline, tell stories, and talk to their children about life at cooking time, as the flames of the fire provide warmth and light [16]. These domains and values of traditional cooking are associated with food satisfaction and social well-being, which can be eroded by ICS innovations. Therefore, understanding the dark side of innovation is important for a comprehensive evaluation of people's subjective well-being beyond the common assessment of the bright side of innovation. In this regard, the purpose of this study is to investigate whether improved biomass technologies (improved cookstoves) have a negative impact on households' subjective well-being regarding the practicing of traditional cooking methods. To investigate this dark side, we hypothesize that:

H1. *Using improved cookstoves reduces the household's subjective well-being regarding the practicing of traditional cooking methods*.

This investigation is important for informing policymakers as well as producers and promoters of clean technologies about the importance of considering society's values and traditions when addressing societal challenges, as this can accelerate sustainability transformations.

Kweyunga [16] found that in central Uganda, cooking traditions relating to Uganda's signature cuisine "matooke" (plantain) are highly valued and practiced. In this region "matooke" defines food. This food is thus prepared in a special way that requires high precision and careful handling relating to traditions. Additionally, traditional cooking is one of the main values taught to girls in Ugandan homesteads and is treated as a prerequisite for marriage. Marriage in Buganda (central region) is locally known as "obufumbo", which comes from an act of cooking (okufumba). Therefore, the values of traditional cooking in Uganda are rooted in culture and are valued as a cultural and national heritage that affects subjective well-being. Away from Uganda, Loo [20] found that most of the women in western Kenya prefer to use the traditional three-stone technologies when cooking traditional dishes such as "nyoya", with the view that it turns out well when cooked traditionally. Lang and Caraher [14] found that traditional cooking has a place in people's everyday life, and cooking heritage contributes to national pride. Lang and Caraher also reported that in Scotland and Northern Ireland, traditional cooking is retained on the curriculum as a symbol of national pride that must be passed on to young generations. Masera [18] asserted that traditional cooking practices are still considered important and are prevalent in most Mexican rural and peri-urban areas. Furthermore, in Mexico, households continue to keep their traditional socializing spaces and their most important traditional cooking practices.

The consideration of cultural heritages in technological innovation is thus part of the paradigm shift from innovation for wealth creation to innovation for transformative change that accounts for households' subjective well-being [21,22]. This implores policymakers to look beyond improving only the economic well-being of using clean technology and consider other intangible well-being factors that might delay sustainability transitions such as cultural cooking heritages. The concept of innovation for well-being has in this case emerged as a central notion in science, technology, and innovation research [12,23]. This research contributes to such knowledge by comprehensively exploring the specific cultural attributes that the use of ICS technologies might cause households to move away from. Furthermore, this can inform innovators, entrepreneurs, and policymakers to develop technologies that are inclusive of economic, social, and cultural factors. The rest of the paper is structured as follows: Section 2 discusses the theoretical framework concepts used in framing the study. Section 3 explains the methodology used in the study. Section 4 presents the results. Section 5 presents the discussions and limitations of the study and Section 6 provides conclusions and recommendations.

2. Theoretical Framework

Developing countries continue to promote clean energy technologies through innovation policies to improve the well-being of households [21]. However, it can be argued that many of the societal challenges facing the world today are caused by both the direct and indirect effects of innovations (Diercks [22]). A new paradigm has thus emerged arguing for innovative research and policy to focus on addressing broader societal challenges such as resource depletion, climate change, cultural dynamics, and demographic change [21]. This implies that clean innovations influence all societal domains, and to create societal transformation, innovation policy needs to promote all societal goals and values, including cultural heritage preservation. This paradigm thus considers innovation for societal and/or subjective well-being, which is rarely discussed in the literature [24].

Subjective well-being (SWB) corresponds to individuals' perceptions of what makes a good life [23,25]. Subjective well-being includes aspects such as cognitive evaluations of one's life, happiness, life satisfaction, positive emotions such as joy and pride, and

negative emotions such as pain and worry [26]. With SWB, Kahneman and Krueger [27] denoted that people idiosyncratically develop perceptions that enable them to think of life in terms of lived experiences. Individuals have different subjective perceptions that they rely on to evaluate their past and current life concerning the conditions in which they live [26,28]. This evaluation of one's life allows people to determine whether they are living a good, satisfied, or dissatisfied life. Kahneman and Krueger [27] found that SWB is measured based on a bottom-up approach to life satisfaction where a combination of life-lived experiences informs people's reported feelings of happiness or unhappiness. Fujiwara [29] stated that to comprehensively understand the effects of innovations on subjective well-being, several variables should be considered and measured separately in surveys. Diener [28] and Pavot and Diener [30] used the satisfaction-with-life scale (SWLS) to extensively assess and measure different domains of life in terms of SWB. This tool includes measures such as economic value, happiness, satisfaction with life, culture, pride, pain, and worry [11]. These measures have, however, not been applied in assessing the individual use of innovations, particularly cooking technologies.

Measuring Subjective Well-Being (SWB)

Although the construct of subjective well-being is complex to conceptualize, operationalize and measure [31], Diener's satisfaction-with-life scale proposes a cognitive measure that uses individual self-reported measures to assess the quality of life. Dolan and White [32], Krueger and Schkade [33], and Martin [12] found that self-reported subjective well-being is considered the best estimate of overall utility; thus, it is well applicable for evaluating subjective well-being concerning the use of technologies. Kahneman and Krueger [27] asserted that self-reported subjective well-being encompasses a cocktail of life domains that are closest to people's personal lives and can influence their subjective well-being. However, according to Diener [26] and Sagiv and Schwartz [34], self-reporting is not the only way to measure subjective well-being. Other specific components of subjective well-being exist, although the decision on which measures to use depends on the goals of a particular study. In this regard, Castellacci and Tveito [23] asserted that exploring the potential bright- and dark-side effects of innovations on subjective well-being requires assessing the economic and social value creation and destruction of technologies.

Economic value creation concerns preference satisfaction and how policies can be crafted concerning subjective well-being. The economic view further contends that individuals work to earn an income from economic activities to spend it on the consumption of items that fulfil their basic needs, which allows them to live a socially competitive and satisfying life [31]. Income influences household decisions on technology use, and technology can improve the subjective well-being of individuals [23,35]. However, Diener and Seligman [36] and Diener [37] reported that the economic view does not fully account for subjective well-being since economic growth may not definitively create higher subjective well-being, and people may be unhappy even with rising incomes. Therefore, there are other indicators such as social capital and a clean and healthy environment in societies that could explain well-being beyond economics. These indicators are related to perceptions of lived experiences, and not utility as economists state. Krueger and Stone [38] found that perceptions are a more exact measure of how people feel, especially if they are reported in real time or if they recall the experience.

Perceptions are defined by the social construct, and they help to evaluate explicit domains and activities such as cooking, working life and health; they also involve an assessment of one's social status or societal living standards [23,38]. These social domains are explained by physical and environmental factors such as location, health, and existing social regimes (trust, governance, crime, social amenities, social and national artefacts, religion, values, politics, cultural heritages, time, education, motivations, age, gender, technology, and self-status). A combination of these factors can negatively or positively influence one's subjective well-being [11,23]. For instance, realizing and respecting one's traditional values, and an acceptance of people's customs and beliefs that

traditional culture offers may be fulfilling, life-satisfying, and associated with individual well-being [33,34,39]. Diener [39] further found that people are happier if they have attributes that are consistent with cultural norms, beliefs, and values because cultures hold traditions that inspire what people consider to be most important to their social well-being. Nevertheless, the social construct follows the social, cultural, and functional domains of Bielecki and Wingenbach [19], as discussed above. Therefore, using the methods outlined in the next section, in the cultural dimension, we empirically investigate whether improved cookstoves have a negative impact by moving households away from the intangible cultural heritage preservations.

3. Materials and Methods

3.1. Sampling and Data Collection Survey

Innovation for well-being can either be measured in the whole population or a specific group of people using longitudinal or cross-sectional survey data [10,40]. Using cross-sectional survey data collected between July–October 2019, we investigated the dark side of improved cookstove technologies regarding the subjective well-being of households in central Uganda. Uganda is a country in sub-Saharan Africa, specifically in the east African region. The country is divided into four regions: central, eastern, northern, and western as shown in Figure 1. The four regions are further subdivided into a total of 134 districts. From the 134 districts, we sampled four districts in the central region, namely Kampala, Wakiso, Mukono and Luweero. The sampled districts are marked with a red star in Figure 1. These districts were purposively selected because they have a higher adoption rate of improved cookstove technologies [41,42]. The high adoption rate was thus important in studying the energy use efficiency of improved cookstoves. However, the data on energy use and cost are considered in another study. Considering the inequality gap that influences the decision of a household on whether to have an improved cookstove or not, data were collected from both rural and urban areas. In Kampala and Wakiso, data were gathered from the urban areas, while in the Luweero and Mukono districts, the data were collected from the remote or rural areas away from the urban centers.

Before the data collection, we developed a survey instrument to capture data on household cooking perceptions, considerations, and practices of using improved cookstoves (ICSs) vs. traditional cooking methods (TCMs) with related questions on traditional cooking heritages and subjective well-being. The data were collected using computer-assisted personal face-to-face interviews (CAPIs). After a thorough review of the data instrument, we transformed it into a digital format using the open data kit (ODK) that is installed on android tablets. Our unit of analysis was the household. We targeted the decision makers (household heads), the person(s) with the main responsibility for purchasing and using cooking technology. In households where the husband and the wife were both present, one of them was interviewed. There was no situation where we interviewed both. However, in many cases we interviewed the wife at the permission of the husband. In households headed by single parents or an "older child", we interviewed the elder, who in this case was the main decision maker in the home. Households that used both improved and traditional stoves were categorized among those using improved cookstoves. The data were collected from three (3) different categories of respondents (households, institutions (schools), and restaurants). The selected categories are the main users of biomass fuel and technologies in Uganda [43]. Each category was subjected to a different data collection instrument. Unlike objective well-being, SWB cannot be assessed in a group of individuals, such as in the case of institutions (schools) and restaurants [23]. Therefore, borrowing from the dominant satisfaction-with-life scale [28,33], we developed a set of perceptions to measure and understand the effect of ICS innovations, compared to traditional cookstove (TCS) technologies, on households' subjective well-being in central Uganda. We anchored the perceptions on a 7-point Likert scale with 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neither agree nor disagree, 5 = slightly agree, 6 = agree, and 7 = strongly agree.

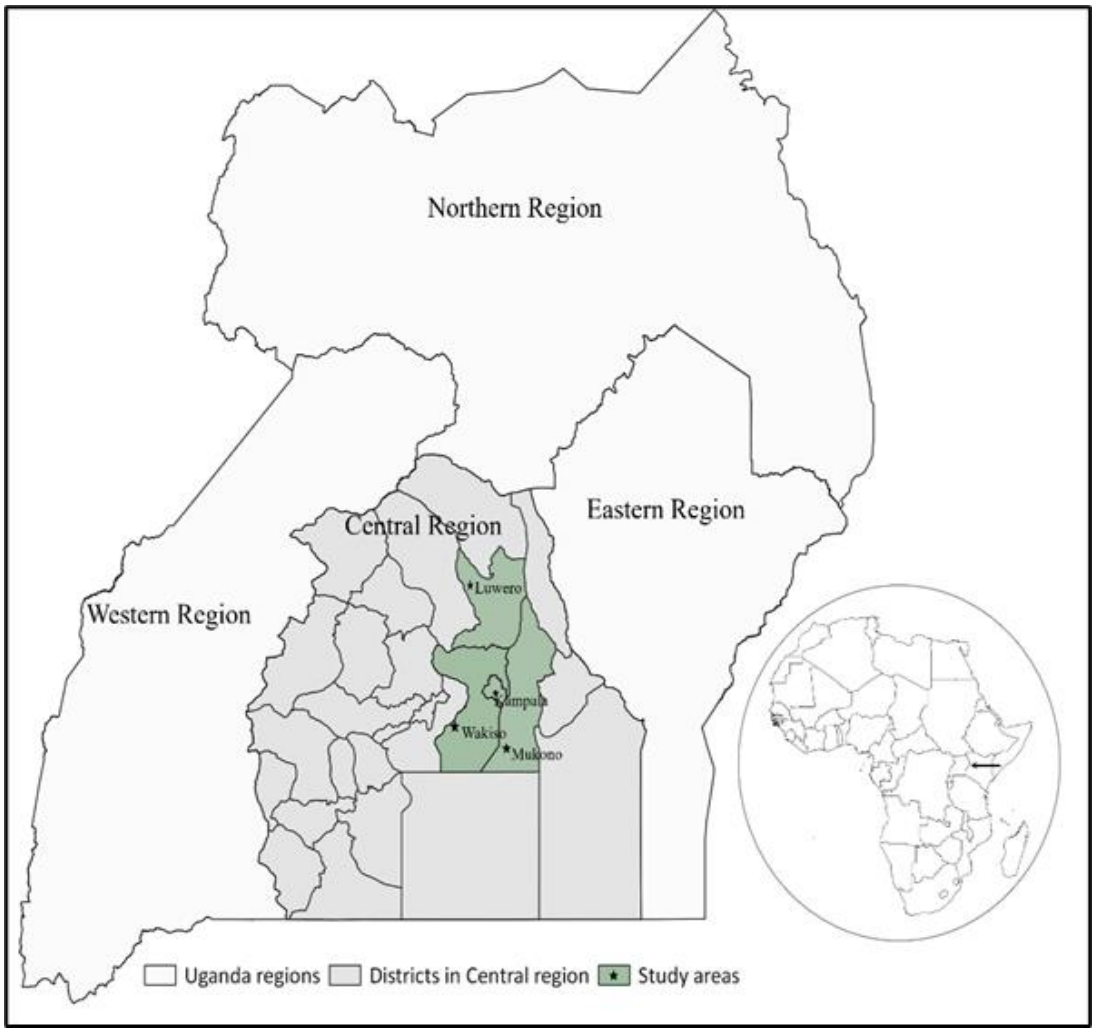

Figure 1. Map of Uganda showing survey areas.

3.2. Analytical Model

To measure the subjective well-being of households, we used nine (9) Likert scale questions (following the Likert measures specified in Section 3.1). The questions were related to traditional cooking considerations, practices, and perceptions. Out of the nine (9) Likert scale questions, we obtained a linear variable that combined all the responses using principal component analysis (PCA) [43]. This is because subjective well-being is a latent variable, and several variables can define well-being. The goal of using PCA was to identify the most meaningful basis to re-express and reveal the hidden structure of the nine questions. The stated questions were: (1) Cooking with open fires keeps my tradition alive; (2) I like my food cooked with open fire; (3) I eat from home (here) because the food has a distinct aroma; (4) Food cooked on an open fire has a distinct taste; (5) The way I cook is very important for my tradition; (6) I have more confidence when cooking traditional foods on an open fire; (7) A traditionally cooked meal gives me a sense of security; (8) I feel proud when eating food cooked on an open fire; (9) To me, cooking on improved stoves connects with happiness and a feeling of well-being. The PCA weights of these questions are presented in Table A1 Appendix A. In determining the score for the subjective well-being of households, the three questions with higher eigenvalues were (1) cooking with an open fire keeps our traditions alive, (2) I like my food cooked with an open fire, and (3) I eat from home (here) because the food has a distinct aroma.

Using the SWB score generated from the PCA as the dependent variable, we tested H_1 using a linear regression model. We express the linear regression model as

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon_i \quad (1)$$

where the dependent variable Y is the SWB score as a continuous variable generated from the principal component analysis (PCA). The independent variables are gender (1 = female), education (1 = above primary), health (1 = long life is important), fuel used (1 = firewood and charcoal), not having an ICS (1 = yes), ICS advantages (1 = cost savings), household size, monthly income (Ugandan shillings; at the time of the study, 1 Ugx = 0.00027064 USD), changed cooking practices (1 = yes), and confidence with open-fire cooking (1 = yes).

4. Results

4.1. Descriptive Statistics

Table 1 presents the descriptive statistics of the variables used in the model. The number of sampled households was 169, spread across the four districts marked in Figure 1. From the sampled households, education was captured as binary, one (1) representing household heads who have attained at least primary education, and zero otherwise. From Table 1, approximately 70% had attained at least a primary education. We also observed that the gender of the household heads in our sample represented 72% males in an average household size of five members. In the economic domain, we captured household monthly income. On average, the households reported having a monthly income of 469,550 UGX. The data had income outliers from a minimum of zero (0) to a maximum of fifty million Ugandan shillings (50,000,000 UGX). A box plot showing the income distribution is presented in Appendix B. We captured the health variable as binary, one (1) indicating that having a long life is important and zero (0) otherwise. The question in the health domain was "To me, a long life and being in good health are important factors, so I carefully consider the technology I use to cook". On average, about 65% of the sampled households perceived it important to have a long life. Regarding cooking fuel, a larger sample (93%) of the households reported using firewood and charcoal as the main fuel, leaving the smallest sample to other fuel sources like electricity, biogas, liquified petroleum gas (LPG), and kerosene. For households using improved cookstoves, the main advantage reported was cost savings. The dependent variable SWB, captured as a continuous variable, had an average score of 3.45 with a standard deviation of 1.74. A detailed description of the variables used in the model is presented in Table 1.

Table 1. Description of independent and dependent variables used in the model to explain and measure subjective well-being of practicing traditional cooking in Uganda.

Variable	Frequency	Percent	Definition
Education (1 = above primary)	115	69.70	The education level of the household head (dummy, 0 = below primary and 1 = Above primary)
Health (1 = long life is important)	110	65.09	The healthy cooking technology is important = 1; 0 = otherwise. Dummy variable constructed from the question: "To me, a long life and being in good health are important factors, so I carefully consider the technology I use to cook"; Likert scale (1–7) 1 = completely disagree and 7 = completely agree, where 5–7 is defined as 1 = important and 1–4 as 0 = not important.
Gender (1 = female)	47	28.14	Gender of household head (0 = male and 1 = female)

Table 1. *Cont.*

Variable	Frequency	Percent	Definition
Fuel used (1 = firewood and charcoal)	158	93.49	The main fuel used to cook in a household (dummy variable, 0 = LPG gas, electricity, and kerosene, and 1 = firewood and charcoal
Do not have ICS (1 = yes)	55	32.54	Dummy: 1 = household without ICS, 0 = household with ICS
ICS advantages (1 = cost savings)	124	73.37	Dummy: 1 = cost savings, 0 = time savings
Changed cooking practice (1 = yes)	120	71.01	Perception, "We can change our cooking practices from traditional technologies to improved ones" Likert scale variable (1–7; 1 = completely disagree and 7 = completely agree) converted to dummy $\leq$4 = completely disagree and >4= completely agree)
Confidence with open-fire cooking (1 = yes)	85	50.30	Dummy variable generated from perception "I have more confidence when cooking traditional foods on an open fire" Likert (1–7) 1 = completely disagree and 7 = completely agree (dummy, 1–4 = 0 "disagree" and 5–7 = 1 "agree"
	Mean	***SD***	
Household size	5.28	3.38	Number of people that live and eat in the household (including the respondent)
Monthly income (UGX)	469,553.6	712,134.7	In the analysis we used the log of average household monthly income, in millions of Uganda shillings (UGX), I UGX = 0.00027 US $. The maximum income was 5 million UGX
Well-being (SWB score)	3.46	1.74	Principal component score generated using principal component analysis (PCA)

4.2. Regression Results

Table 2 shows the results from the regression model. The overall model was significant at 5% with 38% of the independent variables explaining household subjective well-being regarding traditional cooking methods.

In the model, variables that statistically explain the change in well-being are (1) not having an ICS, (2) open fire saving cooking time, (3) ICSs saving fuel, and (4) changed cooking practices. We noted a significant positive effect on the households that reported not having an ICS on subjective well-being at a 10% significance level. Not having an ICS increases the subjective well-being of households by 29.7 percentage points, ceteris paribus. We observed a significant positive effect (at the 1% level) on the households who reported that an open fire reduces their cooking time. This implies that open fires saving cooking time contributes to subjective well-being by 18 percentage points. We further observed a significant negative effect on subjective well-being from improved cookstoves saving fuel and from changing cooking practices. Among the households who reported that an ICS saves cooking fuel and can change cooking practices from traditional to improved ones, their subjective well-being was reduced by 28 and 32 percentage points, respectively. In the analysis, we controlled for education, healthy cooking technology, household size, gender, and income. We considered these variables to be key in determining the household cooking technology choice, and hence important control variables for assessing whether improved cookstoves have a negative impact on the subjective well-being of households in Uganda. However, in the regression model, these control variables had no significant effect on households' subjective well-being associated with traditional cooking methods.

Table 2. Linear regression analysis.

Y = Well-Being	Coefficient	*p*
Do not have ICS (1 = Yes)	0.297 * (0.157)	0.061
Education (Category)	−0.125 (0.155)	0.42
Health	−0.099 (0.146)	0.5
Household size	−0.016 (0.018)	0.367
Average monthly income (log)	−0.156 (0.095)	0.102
Gender (1 = female)	0.049 (0.147)	0.74
Fuel (1 = firewood)	−0.093 (0.223)	0.678
Open fire saves cooking time	0.18 *** (0.033)	0.00
ICS saves fuel (1 = yes)	−0.278 * (0.144)	0.056
Changed cooking practice (1 = yes)	−0.318 ** (0.146)	0.031
Confidence with open-fire cooking (1 = yes)	0.153 (0.129)	0.238
Number of observations = 163 F (11, 152) = 8.51 Prob > F = 0.0000 R-squared = 0.3810		

Notes: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$ denote significance at the 1%, 5% and 10% levels, respectively.

5. Discussion

In H_1, we test whether using improved cookstoves reduces households' subjective well-being from practicing traditional cooking methods. Our key indicator for assessing the subjective well-being of using traditional cooking practices was the change in cooking practices from traditional to improved. We found a strong and negatively significant association between the change in cooking practices and the subjective well-being associated with traditional cooking methods. This implies that changing from traditional to improved cooking practices reduces the subjective well-being associated with traditional methods related to cultural cooking values, and that households in Uganda are less likely to change from such cooking practices. The findings from our study relate to the findings of Loo [20], Lang and Caraher [14], and Masera [18] where households stuck to using traditional methods, claiming the improved cooking technologies would not allow them to practice cultural cooking, which affected their well-being. Particularly, Masera [18] found that traditional cooking considerations can influence household decisions of switching to improved fuels and technologies. Based on these findings we cannot reject $H_{1,}$ and we conclude that using an ICS has a dark side by moving households away from the intangible cultural cooking heritages that they have preserved for a long time in Uganda. Therefore, households that do not have ICSs cannot change their cooking practices from traditional to improved ones.

Furthermore, Bielecki and Wingenbach [19] and Masera [18] indicate that the ICS has limited cultural and social attributes. They cook for a small number of households with an average of six (6) family members. The stoves are not able to meet the cooking demands of large family gatherings or occasions, which denies households enough family time to socialize. From our qualitative findings, the household indicated that ICSs do not have smoke directly perforating into the food, which denies the food a good aroma and natural taste. Households also indicated that many ICSs use charcoal, which does not produce

smoke. The ICSs that use firewood are expensive to construct and for this reason, firewood is used on an open fire. Using firewood on an open fire enables women to confidently practice their traditional cooking and helps them to serve their husbands tasty meals. The tradition of serving tasty meals to husbands was also discovered in rural Mexico as one of the reasons women preferred to use traditional stoves and declined the use of an ICS [2]. Aside from moving households away from their intangible cultural cooking heritages, our qualitative findings revealed that the ICS cannot accommodate large pots and cannot cook for extended families. This finding was also reported by Bielecki and Wingenbach [19]. ICSs were also indicated to be slow-cooking stoves compared to the three-stone open fire that starts cooking right away when the fire is made. Additionally, the ICS stove has a strong ceramic liner that takes time to heat up and the fire needs to first spread over all the charcoal for the stove to start cooking.

However, transition actors may find our results a challenge for a sustainable transition to cleaner energy sources. Many scholars have found that open fires have significant negative health, climate, and environmental effects resulting from indoor air pollution and emissions [2,17]. Recommendations to overcome these negative effects of open-fire cooking in the past have been to switch to the use of improved cookstoves to save lives, the environment, and the ecosystem [20,44]. Contrary to this recommendation, Kishore and Ramana [7] and Nepal [45] found that the improved cookstoves are neither energy- nor cost-efficient, which causes continuous resource depletion and environmental damage. The latter authors thus recommended moving away from the ICS to cleaner and energy-efficient technologies such as liquid bioenergy. IRENA [46], Clemens [47] and Zhang [4] support the transition from the ICS as a clean technology to biogas as a better alternative to clean cooking. Therefore, although we cannot reject the null hypothesis in this study, we agree with the above-mentioned scholars that have recommended a transition to cleaner and sustainable energy sources such as biogas. However, as sustainability actors consider moving away from ICSs, and other technologies that are not clean, they should also consider incorporating cultural characteristics in the technologies they introduce to society. The findings and discussions in this study should thus inform policy actors and clean technology producers on the direction of regimes. For instance, the regimes should be fairer to the cleaner energy sources and unfair to the open fire and improved cooking technologies. This way, regimes will not directly attack the intangible cultural cooking heritages but will improve cleaner energy developments, and this may attract users of traditional technologies to move away from wasteful energy sources while still practicing their cooking cultures.

Limitations and Future Research

Although this study makes promising contributions, it also has some limitations that cannot be ignored. First, the literature on innovation for well-being particularly concerning intangible cultural heritages is very limited. Second, the theory applied in this study used literature from divergent disciplines including psychology, economics, innovation, and sustainability studies; thus, caution should be taken when applying the results to one discipline. Third, this study assessed the dark side of biomass innovations but did not show how this could increase or limit the uptake of improved biomass technologies for sustainability transitions. Fourth, the survey variables explained 38% of the variation in e subjective well-being of traditional cooking. This means there might be other variables that this study did not consider that can explain the subject matter. Thus, future research assessing the effects of biomass technologies on subjective well-being should seek to address these limitations. Particularly, the use of a larger sample based on longitudinal and/or ethnographic methods such as those used in Matinga [48] could help to explore more subjective well-being indicators to widely study the phenomena for more informed policy conclusions. Additionally, more research on user preferences for clean cooking and preservation of the intangible cultural heritage of traditional cooking is needed for clean innovations to maximize subjective well-being and social welfare. This could accelerate

a sustainable transition to clean energy in developing countries. Finally, future studies could also explore how the dark side of biomass technologies could inhibit sustainability transitions and sustainable development in Uganda, and how governments could embrace this challenge.

6. Conclusions and Recommendations

This study contributes to research on innovation for well-being. The article uses household survey data to explore the dark side of improved cookstoves on the subjective well-being of users, a concept that has been ignored by many clean cooking scholars. We find that using improved cookstove innovations is likely to have a negative impact on households' subjective well-being due to improved cookstoves moving households away from their intangible cultural cooking heritages (social, cultural, and functional traditions). This movement away from traditions implies that households could drop their traditional ways of cooking that form an important sense of belonging and cultural heritage, which they have preserved for a long time. Therefore, innovators, entrepreneurs and policymakers need to avoid the dark side of clean cooking innovations that affect households' subjective well-being. However, this dark side should not stop the actors from promoting cleaner energy sources, as they will help to reduce the wasteful use of biomass and improve the health of users in Uganda. Households should be informed about how to continue practicing their important traditional cooking methods in food preparation, but with cleaner energy resources. This will accelerate the transition to clean energy in Uganda.

Author Contributions: Conceptualization, I.N.; Methodology, I.N., S.N. and S.E.T.; Software, I.N and S.N.; Validation, I.N., S.N. and J.S.; Formal analysis, I.N., S.N., J.S. and S.E.T.; Investigation, I.N.; Writing—original draft, I.N.; Writing—review & editing, I.N., S.N., J.S. and S.E.T.; Visualization, I.N. and S.N.; Project administration, I.N. and J.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

Data Availability Statement: Data can be availed on request from the corresponding author.

Acknowledgments: I would like to thank the NORAD/NOHED program for supporting the Energy Economics project which this study part. the editor and the two anonymous reviewers for their very constructive comments which have helped us improve this work. Any remaining errors are of course the sole responsibility of the authors.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in the manuscript:

SWB	Subjective well-being
PCA	Principal component analysis
TCM	Traditional cooking methods
ICS	Improved cookstove
CAPI	Computer-assisted personal face-to-face interviews
ODK	Open data kit
LPG	Liquified petroleum gas
SWLS	Satisfaction-with-life scale
TCS	Traditional cookstove

Appendix A

Table A1. Principal Component Analysis (PCA).

Variable	Loading on Principal Component 1
Cooking with open fires keeps our traditions alive	0.40
I like my food cooked with an open fire	0.39
I eat from home (here) because the food has a distinct aroma,	0.49
Food cooked with open fire has a distinct test	0.21
The way I cook is very important for my tradition	0.13
I have more confidence when cooking traditional foods on an open fire	0.10
A traditionally cooked meal gives me a sense of security	0.49
I feel proud when eating food cooked on an open fire	−0.25
To me, cooking on improved stoves connects with happiness and a feeling of well-being	−0.27

Note: The eigenvalue associated with the first principal component was 2.99, indicating that the first principal component accounted for 33% of the total variation.

Appendix B

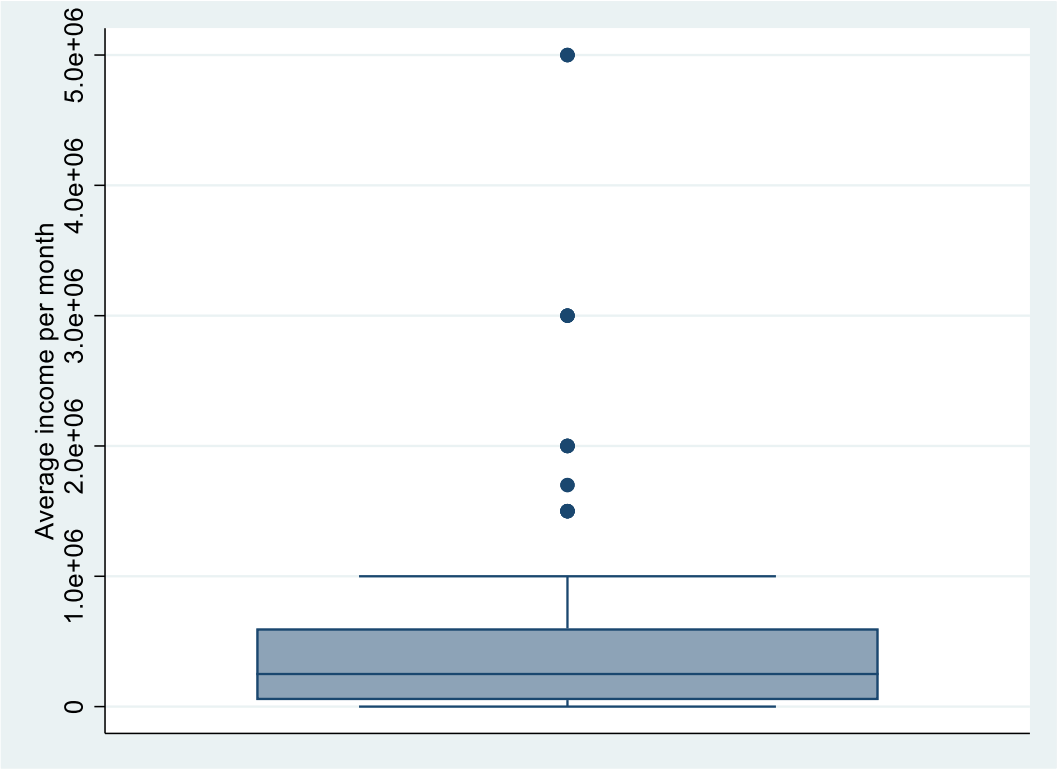

Figure A1. Income distribution.

References

1. Lindgren, S.A. Clean cooking for all? A critical review of behavior, stakeholder engagement, and adoption for the global diffusion of improved cookstoves. *Energy Res. Soc. Sci.* **2020**, *68*, 101539. [CrossRef]
2. Catalán-Vázquez, M.; Fernández-Plata, R.; Martínez-Briseño, D.; Pelcastre-Villafuerte, B.; Riojas-Rodríguez, H.; Suárez-González, L.; Pérez-Padilla, R.; Schilmann, A. Factors that enable or limit the sustained use of improved firewood cookstoves: Qualitative findings eight years after an intervention in rural Mexico. *PLoS ONE* **2018**, *13*, e0193238. [CrossRef] [PubMed]
3. UN General Assembly. *Transforming Our World: The 2030 Agenda for Sustainable Development, Resolution Adopted by the General Assembly*; UN General Assembly: New York, NY, USA, 2015.

4. Zhang, Y. Accelerating access to clean cooking will require a heart-head-and-hands approach. *Development* **2022**, *65*, 59–62. [CrossRef]
5. Jan, I.; Lohano, H.D. Uptake of energy efficient cookstoves in Pakistan. *Renew. Sustain. Energy Rev.* **2020**, *137*, 110466. [CrossRef]
6. Misra, K.B. *Clean Production: Environmental and Economic Perspectives*; Springer Science & Business Media: Berlin, Germany, 2012.
7. Kishore, V.; Ramana, P. Improved cookstoves in rural India: How improved are they?: A critique of the perceived benefits from the National Programme on Improved Chulhas (NPIC). *Energy* **2002**, *27*, 47–63. [CrossRef]
8. Ray, N.; Mohanty, M.; Mohanty, R. Biogas compression and storage system for cooking applications in rural households. *Int. J. Renew. Energy Res. IJRER* **2016**, *6*, 593–598.
9. Rwiza, M. *Innovations and Sustainability: The Case of Improved Biomass Stoves' Adoption and Use in Tanzania*; Spring: Lund, Sweden, 2009.
10. Engelbrecht, H.-J. The (social) innovation–subjective well-being nexus: Subjective well-being impacts as an additional assessment metric of technological and social innovations. *Innov. Eur. J. Soc. Sci. Res.* **2018**, *31*, 317–332. [CrossRef]
11. Spanakis, E.G.; Silvina, S.; Tsiknakis, M.; Marias, K.; Sakkalis, V.; Teixeira, A.; Janssen, J.H.; de Jong, H.; Tziraki, C. Technology-based innovations to foster personalized healthy lifestyles and well-being: A targeted review. *J. Med. Internet Res.* **2016**, *18*, 128. [CrossRef] [PubMed]
12. Martin, B.R. Twenty challenges for innovation studies. *Sci. Public Policy* **2016**, *43*, 432–450. [CrossRef]
13. Wirth, S.; Markard, J.; Truffer, B.; Rohracher, H. Informal institutions matter: Professional culture and the development of biogas technology. *Environ. Innov. Soc. Transit.* **2013**, *8*, 20–41. [CrossRef]
14. Lang, T.; Caraher, M. Is there a culinary skills transition? Data and debate from the UK about changes in cooking culture. *J. HEIA* **2001**, *8*, 2–14.
15. Amone, C. We are strong because of our millet bread: Staple foods and the growth of ethnic identities in Uganda. *Trames A J. Humanit. Soc. Sci.* **2014**, *18*, 159. [CrossRef]
16. Kweyunga, S. Tradition and Modernity in the Domestic Urban Kitchen Design in Uganda: A Case of Kampala. Ph.D. Dissertation, KTH Royal Institute of Technology, Stockholm, Sweden, 2013.
17. Singh, A.; Tuladhar, B.; Bajracharya, K.; Pillarisetti, A. Assessment of effectiveness of improved cook stoves in reducing indoor air pollution and improving health in Nepal. *Energy Sustain. Dev.* **2012**, *16*, 406–414. [CrossRef]
18. Masera, O.R.; Saatkamp, B.D.; Kammen, D.M. From linear fuel switching to multiple cooking strategies: A critique and alternative to the energy ladder model. *World Dev.* **2000**, *28*, 2083–2103. [CrossRef]
19. Bielecki, C.; Wingenbach, G. Rethinking improved cookstove diffusion programs: A case study of social perceptions and cooking choices in rural Guatemala. *Energy Policy* **2014**, *66*, 350–358. [CrossRef]
20. Loo, J.D.; Hyseni, L.; Ouda, R.; Koske, S.; Nyagol, R.; Sadumah, I.; Bashin, M.; Sage, M.; Bruce, N.; Pilishvili, T. User perspectives of characteristics of improved cookstoves from a field evaluation in Western Kenya. *Int. J. Environ. Res. Public Health* **2016**, *13*, 167. [CrossRef] [PubMed]
21. Schot, J.; Steinmueller, W.E. Three frames for innovation policy: R&D, systems of innovation and transformative change. *Res. Policy* **2018**, *47*, 1554–1567.
22. Diercks, G.; Larsen, H.; Steward, F. Transformative innovation policy: Addressing variety in an emerging policy paradigm. *Res. Policy* **2019**, *48*, 880–894. [CrossRef]
23. Castellacci, F.; Tveito, V. Internet use and well-being: A survey and a theoretical framework. *Res. Policy* **2018**, *47*, 308–325. [CrossRef]
24. Tura, N.; Keränen, J.; Patala, S. The darker side of sustainability: Tensions from sustainable business practices in business networks. *Ind. Mark. Manag.* **2019**, *77*, 221–231. [CrossRef]
25. Dolan, P.; Metcalfe, R. The relationship between innovation and subjective wellbeing. *Res. Policy* **2012**, *41*, 1489–1498. [CrossRef]
26. Diener, E. Subjective well-being. In *The Science of Well-Being*; Springer: Berlin/Heidelberg, Germany, 2009; pp. 11–58.
27. Kahneman, D.; Krueger, A.B. Developments in the measurement of subjective well-being. *J. Econ. Perspect.* **2006**, *20*, 3–24. [CrossRef]
28. Diener, E.; Emmons, R.A.; Larsen, R.J.; Griffin, S. The satisfaction with life scale. *J. Personal. Assess.* **1985**, *49*, 71–75. [CrossRef] [PubMed]
29. Fujiwara, D.; Kudrna, L.; Dolan, P. *Quantifying and Valuing the Wellbeing Impacts of Culture and Sport*; Research Paper; Department for Culture Media and Sport: London, UK, 2014.
30. Pavot, W.; Diener, E. The satisfaction with life scale and the emerging construct of life satisfaction. *J. Posit. Psychol.* **2008**, *3*, 137–152. [CrossRef]
31. Dolan, P.; Peasgood, T.; White, M. Do we really know what makes us happy? A review of the economic literature on the factors associated with subjective well-being. *J. Econ. Psychol.* **2008**, *29*, 94–122. [CrossRef]
32. Dolan, P.; White, M.P. How can measures of subjective well-being be used to inform public policy? *Perspect. Psychol. Sci.* **2007**, *2*, 71–85. [CrossRef]
33. Krueger, A.B.; Schkade, D.A. The reliability of subjective well-being measures. *J. Public Econ.* **2008**, *92*, 1833–1845. [CrossRef] [PubMed]
34. Sagiv, L.; Schwartz, S.H. Value priorities and subjective well-being: Direct relations and congruity effects. *Eur. J. Soc. Psychol.* **2000**, *30*, 177–198. [CrossRef]

35. Chesley, N. Blurring boundaries? Linking technology use, spillover, individual distress, and family satisfaction. *J. Marriage Fam.* **2005**, *67*, 1237–1248. [CrossRef]
36. Diener, E.; Seligman, M.E. Beyond money: Toward an economy of well-being. *Psychol. Sci. Public Interest* **2004**, *5*, 1–31. [CrossRef]
37. Diener, E. The remarkable changes in the science of subjective well-being. *Perspect. Psychol. Sci.* **2013**, *8*, 663–666. [CrossRef] [PubMed]
38. Krueger, A.B.; Stone, A.A. Progress in measuring subjective well-being. *Science* **2014**, *346*, 42–43. [CrossRef] [PubMed]
39. Diener, E.; Suh, E.M.; Lucas, R.E.; Smith, H.L. Subjective well-being: Three decades of progress. *Psychol. Bull.* **1999**, *125*, 276. [CrossRef]
40. Dolan, P.; Metcalfe, R. Measuring subjective wellbeing: Recommendations on measures for use by national governments. *J. Soc. Policy* **2012**, *41*, 409–427. [CrossRef]
41. Uganda Bureau of Statistics (Ed.) *The Uganda National Household Survey Report 2019/2020*; Uganda Bureau of Statistics (UBOS): Kampala, Uganda, 2021; p. 387.
42. Uganda Bureau of Statistics (Ed.) *National Population and Housing Census*; Uganda Bureau of Statistics: Kampala, Uganda, 2014.
43. Kurita, T. Principal component analysis (PCA). In *Computer Vision: A Reference Guide*; Springer: Berlin/Heidelberg, Germany, 2014; pp. 1–4.
44. Urmee, T.; Gyamfi, S. A review of improved Cookstove technologies and programs. *Renew. Sustain. Energy Rev.* **2014**, *33*, 625–635. [CrossRef]
45. Nepal, M.; Nepal, A.; Grimsrud, K. Unbelievable but improved cookstoves are not helpful in reducing firewood demand in Nepal. *Environ. Dev. Econ.* **2011**, *16*, 1–23. [CrossRef]
46. International Renewable Energy Agency. *Accelerating the Energy Transition through Innovation*; International Renewable Energy Agency: Masdar City, United Arab Emirates, 2017; p. 128.
47. Clemens, H.; Bailis, R.; Nyambane, A.; Ndung'u, V. Africa Biogas Partnership Program: A review of clean cooking implementation through market development in East Africa. *Energy Sustain. Dev.* **2018**, *46*, 23–31. [CrossRef]
48. Matinga, M.N. "WE GROW UP WITH IT". An Ethnographic Study of the Experiences, Perceptions and Responses to the Health Impacts of Energy Acquisition and Use in Rural South Africa. Ph.D. Thesis, University of Twente, Enschede, The Netherlands, 2010; 317p.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.