Multidimensional Livelihoods Security Analysis in Rural Areas of Western Ethiopia

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Abstract

Previous studies narrowly analysed food and nutritional securities. We argue such studies contributed limited information for policymakers and development planners. This paper aims to analyse the multidimensional livelihood security of rural households in Ethiopia. The livelihood security model guided it. November 2019 and January 2020 were our fieldwork. Cross-sectional, descriptive, and explanatory were our designs. Multiple stage sampling techniques were employed. A survey questionnaire was used to collect primary data. Multidimensional livelihood security index, multiple correspondence analysis, OLS, and logit models were employed to analyse the data. Key findings show while four livelihood securities were found under low/serious, environmental security was found under middle/fragile and food security under high/well-protected categories. Composite multidimensional livelihood security of samples was found at low/fragile equilibrium. Inter-household inequality in terms of the seven multidimensional livelihood security indices was found. OLS results show literacy, dependency ratio, and landholding has negatively and significantly affected rural heads' multidimensional livelihood security. Logit model identified agro-ecology/farming system, livestock holding, and credit service having a significant effect. Both models suggest a member of cooperative significantly (at 1% significance level) impacted households' multidimensional livelihood security. Theoretically, the study implies narrow considerations (household-level food and nutritional security studies alone) couldn't comprehensively understand their multidimensional issues. Hence, effective rural development policies and strategies aiming to ensure household-level well protected multidimensional livelihood security need to base on such study than mere considerations of food and nutritional securities alone. The former has the long-term benefit of household-level sustainable development in general and poverty reduction in particular.

Keywords: Rural households, multidimensional livelihood security, multiple correspondence analyses, OLS/Logit models

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1. Introduction

According to International Fund for Agricultural Development/IFAD (2010) at least 70 % of the world's very poor population lives in rural areas. Their food, income, and livelihood prospects depend on smallholder agriculture (Ferris *et al.* 2014; Mumuni and Oladel 2016). Nevertheless, because the agricultural sector is highly characterized by decreasing farm sizes, low levels of output per farm, a high degree of subsistence farming, and several other bottleneck issues of rural households relying upon smallholder agricultural-based rural livelihood alone couldn't guarantee their multidimensional livelihood security (Jirstrom *et al*. 2011; Arega, *et al*. 2013). Food security is one of the elements of rural households' multidimensional livelihood security. FAO (2009) refers to food security as "food for all people all times". However, the state of rural chronically undernourished people in the world is estimated to have increased (FAO 2017). Besides, compared to the year 2016 the number of undernourished, stunting, wasting, and overweight people worldwide has increased in 2017 (FAO *et al*. 2018). In Ethiopia, well-established household-level food and nutritional studies (Degefa 1996; 2002; 2005; Asfaw *et al*. 2005; Million 2007; Mesay 2008; Tsegaye 2008; Aurino and Cafiero 2012; Carletto *et al*.2012; Arega 2012; Cintron *et al*.2016; Souza and Jolffiee 2016; Alemeseged 2016) have been conducted. However, rather than their narrow analysis (food and nutritional security alone) none of them has conducted their study from the wider livelihood security perspectives/issues of rural households, astonishingly; there exists a dramatic increase in the number of rural household's food insecurity and nutritional insecurity (Abduselam 2017; Federal Disaster and Risk Management Commission 2018).

This paper aims to analysed the multidimensional livelihood security issues (food security, habitat security, empowerment security, occupational security, environmental security, water security, and community participation security) of rural households in Jimma Geneti woreda, Oromia National Regional State of Ethiopia. The main justification is that in the study area the overall livelihood securities of the households have been threatened by the rise in the water level of the artificial Fincha'a Lake constructed for hydro-electric power during the Imperial period. For example, vast areas of land farms are converted to swampy areas. Grazing lands are covered by water bodies. Rural-urban migration is increasing. As a result, food, habitat, economic, environmental, and other security issues are under threat unless otherwise scientifically study the state and determinants of households’ multidimensional security issues than merely focusing on their food and nutritional security issues.

2. Objectives and Basic Questions of the study

The objectives of the study are to:

1. compute the separate livelihood security indices of seven livelihood security domains;
2. construct composite multidimensional livelihood security index of the woreda; and
3. examine determinants of the rural households’ multidimensional livelihood security.

The study attempts to answer two basic questions:

1. When decomposed, which of the seven livelihood securities are found at the state of low/serious, medium/fragile, and high/well-protected multidimensional livelihood security equilibrium? What about the current state of the composite multidimensional livelihood security of the woreda?
2. Are there any significant determinants of rural households’ multidimensional livelihood security? If yes, what are they?

Furthermore, many of the definitions of the concept of multidimensional livelihood security derive from the work of Chambers & Conway (1992). That is, it emerges from the three strategic shifts[1] in understanding causes of household-level food and nutritional insecurities throughout the 1970s to 1990s. It focuses on the enhancement of people's capacities to secure the security of their livelihoods (Maxwell 1996; Maxwell & Smith 1992). However, this study adopts the definition given by Baby (2005) that it refers to rural households' adequate access to income, food, nutrition, health facilities, clean environment, habitat facilities, educational opportunities, community participation, and social integration, thereby; meet basic needs

(Baby 2005). However, this study denotes the seven multidimensional livelihood security domains operationalized under section (6.1). Moreover, since the third strategic shift, the theoretical foundation of analysing rural households' multidimensional livelihood security was integrated into the CARE (2004) livelihood security model that constitutes multidimensional livelihood security dimensions and assessment indicators. Hence, it guides this study because it is a participatory and rapid community assessment technique that helps to use the village profiles as baselines to learn about the lag between macro policy reforms, trickle-down benefits, and grassroots impacts.

Based on livelihood security model, a few but critical analyses of rural household's multidimensional livelihood security have been conducted in different places. For example, CARE India (1997) has done a study in 15 villages of Bastar (India). The study identified seven multidimensional livelihood security domains. Each separate index shows the community participation security index (1.25), education security index (2.7), income security (2), primary health care security index (3.125), reproductive health security index (1.125), sanitation security index (1.125), and water security index (2.25). However, the overall composite multidimensional livelihood security index in 15 villages of Bastar (India) was found as (1.9): the village is on the fragile end of the household livelihood security index. Furthermore, Baby (2005) has computed the overall livelihood security index for two rural communities in India from seven livelihood security domains and corresponding indicators such as food, occupation, habitat, education, social, health, and environmental security indices. Her study implies that household food security emerged as the most important dimension (highest index) compared to the rest of the remaining six livelihood security dimensions. Singh & Hiremath (2010) conducted similar research on the sustainable livelihood index in India/Gujarat district. Results show that the eastern districts dominated by scheduled tribes' have a high ecological security index/ESI but a very low economic efficiency index/EEI and social equality index/SEI. In turn, based on seven livelihood security dimensions (food security, economic security, health security, social security, infrastructural security, educational security, and institutional security) Barela *et al*. (2018) assessed the livelihood security of tribal farmers of Madhya Pradesh/India and found overall livelihood security status as 48.33% of the respondents come under the low category. In Bangladesh, Rahman and Akter (2012; 2014) have studied the livelihood security in poor urban settlements in Jessore and Tongi, too.

The above descriptive results were generated by CARE India (1997), Baby (2005), Singh and Hiremath (2010), Akter (2012), Rahman and Akter (2012; 2014) and Barela *et al*. (2018) revealed that rural households'' multidimensional livelihood security was low. Several determinants contributed. For example, Akter (2012) reported an insignificant effect of age and sex on multidimensional livelihood security. Rahman and Akter (2014) reported that family size has positively and significantly increased the probability of being food secure and empowered. Family size of the household head is another demographic determinant factor of rural households' multidimensional livelihood security, *ceteris paribus.* More family size means more labour that can produce more food. On contrary, Akter (2012) reported that family size reduces the probability of rural households' multidimensional livelihood security because the larger the family size the more they are demand basic needs, thereby, affect it negatively.

Akter (2012) reported an insignificant effect of marital status dependency ratio variable negatively affected rural households' composite livelihood security because the more the dependents the more their demand for basic needs. Besides, Rahman and Akter (2012; 2014) reported a consistent finding that the dependence burden has a significant negative effect on rural households' state of multidimensional livelihood security. Concerning the influence of the household heads' landholding, Akter (2012) found a positive and significant effect of landholding on rural households' composite livelihood security. Moreover, results show that all livelihood security indices (economic, food, health, education, and empowerment) are significant determinants of overall household livelihood security (Rahman and Aakter, 2012; 2014).

In synthesis, one of the prime gaps of the previous studies was the methodological gap. For example, Barela *et al*. (2018) assessed the livelihood security of rural households using a simple percentage. However, this study computed both the separate livelihood security indices of seven livelihood security dimensions and the overall/composite livelihood security index of the woreda implying that apart from the empirical, knowledge, and literature wise contribution of this study, it has also merit in terms of methodological contribution, too. Furthermore, we conjecture that this paper will bridge the existing gap in the current literature on multidimensional livelihood security. All instigated this study.

Context of the Research: This article is based on the quantitative study of rural household heads in Jimma Geneti woreda of Oromia National Regional State (Ethiopia). This study was conducted in the woreda located 287 Km away from Addis Ababa on the way to Nekemte asphalt road and 27Km away from *Shambu* town (zone capital). Furthermore, the study was conducted in the woreda having a projected total rural population of 78, 981 (Male = 39,183 and Female= 39,798) (Woreda Finance and Economic Development office, 2017). The study was conducted in the woreda, which has a total area of 410.068 km2 /41,006.8 hectares, 193.12 km2 /19, 312 hectares of land use, 11.205 km2 /11,205 hectares of cultivable land, 39.655 km2 /39,655 hectares of forest land, and 166.0268 km2 /16,602.7 hectares grazing land in 2010 EC (Woreda land administration office, 2010EC).

3. Methods

3.1 Data Types and Sources

The quantitative data type is used in the current study. Both primary and secondary data sources were used. That is, while the **p**rimary household-level data was collected from sample heads related to government, international organizations, multidimensional livelihood security researchers, and thesis were used.

3.2. Sampling Techniques and Sample Size

Except, the two towns Hareto and kidame Gebeya, all the twelve rural kebeles and the total household heads in all the 12 rural kebeles (N= 8,075) were considered as the study population from which respondents were selected randomly. Multi-stage sampling techniques were employed. The sample wereda was stratified into three strata by farming systems: Highland area (Wheat and Barley producers), Plain area (Maize and Teff producers), and Coastal area (Maize, Teff & Fish producers) using a stratified sampling technique. Then, the sample size from each cluster was determined depending on proportional sampling to population size. However, the availability sampling technique was used to include all the twelve kebeles in the study. Furthermore, Krejcie and Morgan's (1970) formula was used to determine the sample size of 387 household heads'.

$$S = \frac{X2NP(1-P)}{d2(N-1)+X2P(1-P)} \quad \text{......(1)}$$

Where, *s=sample size,* ***X2****=the table value of chi-square for 1 degree of freedom at the desired confidence level:* ***1.96****, when squared equals to (3.841),* ***N*** *=the population size=* ***11,021****(DAO, 2006/07EC),* ***P*** *=the population proportion (assumed to be* ***.50*** *since this would provide the maximum sample size), and* ***d****=the degree of accuracy expressed as a proportion (****.05****) (Krejcie& Morgan, 1970:1).*

A systematic random sampling technique was used to include sample heads in this study. However, 30 experts/ judges were purposively selected.

3.3. Instruments of Data Collection

This study was organized based on the data captured through a household survey questionnaire (closed-ended and open-ended). Before the actual collection of the data, both content validity and reliability analysis were made. While content validity of the survey questionnaire was made with relevant experts' judgment, its reliability analysis was checked using Cronbach's alpha having a value of 0.77. Direct observation of the housing condition, water sources, and environmental overview was used.

3.4 Methods of Data Analysis

According to Parris and Kates (2003) and Bohringer and Jackem (2007), there are twenty-one different methodologies of analysing sustainable development of which the sustainable multidimensional livelihood security index is the one. In response to describe the state of sample households' in terms of their fragile, medium and well-protected multidimensional livelihood security equilibrium, both separate and composite multidimensional livelihood security index was computed because the index helps to identify the state of rural households' multidimensional livelihood security problems. Besides, most previous scholars like Baby (2005), Rhman and Akter (2012), and Barela *et al*. (2018) used the same methodology. The composite multidimensional livelihood security index formula is given by:

$$HLSIi = \frac{\Sigma Uij * Rc}{Total\ scale\ value(RC)} * 100 \quad \text{……………………………………..…} \quad (2)$$

Where; *HLSi= Livelihood security index of I household, i= 1-387, J=1-7,* U_{ij}*=Unit score of the* i^{th} *respondent on the* j^{th} *dimension, and Rc= Scale value/weight of the ith respondent on the jth dimension*

Following a series of steps (selection/characterization of livelihood security dimensions, indicators, and modalities/categories, determination of scale value/weighting livelihood security dimensions using the formula (Guilford 1954; Mathew 1989; Baby 2005; Letha *et al*. 2016; Niketha *et al*. 2017), non-arbitrary attachments of weights to each indicator and their corresponding categories (Asselin 2002; 2009, Desawi 2019), and finally computing the overall multidimensional livelihood security index) multiple correspondence analysis (MCA) was used to identify key livelihood security indicators and attach non-arbitrary weights to each indicator and their corresponding categories. To analyse the determinants of rural households' multidimensional livelihood security two models were comparatively used. These were:

First, ordinary least square/OLS model. Following Rahman and Akter (2014) and Chinangwa *et al*. (2016) OLS method was used to estimate the parameter of a linear regression model, thereby, minimize the sum of the squared errors (a difference between observed values and predicted values). The general description of OLS is:

$$Y^* = X_i\beta + \varepsilon_i, \quad \varepsilon_i \approx N\left(0, \sigma^2\right) \qquad \text{……………………………………………(3)}$$

Where, Y^* is the dependent variable (livelihood security index). OLS regression assumes that the dependent variable (Y^*) is linear and continuous. Xs are characteristics of the household heads βs are parameters to be estimated. The error term ε is assumed to be normally distributed with mean zero and variance σ^2.

Second, logistic regression or logit model. Although one can estimate the linear probability model by the standard Ordinary List Square Methods as a mechanical routine, the result will be beset by several estimation problems and hence logit model was alternatively employed for the same purpose. That is, the logistic distribution has an advantage over others in the analysis of dichotomous dependent variables. The cumulative logistic probability function is computationally extremely flexible, relatively simple from a mathematical point of view, and lends itself to meaningful interpretation. Hence, following Abbey and Admassie (2004) logit model was used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval, or ratio-level independent variables where the log odds of the outcome was modelled as a linear combination of the predictor variables. Logit model was specified as follows:

Probability functions

$$Y_i^* = \beta_0 + \sum_{j=1}^{k} \beta_j X_{ij} + \varepsilon_i$$,………………….(4) Latent variable [not observable]

Where;

Y_i^* = Latent variable (not observable)

Yi = Dummy variable (observable) defined as

$$\begin{cases} 1 \text{ if } y_i^* > 0 \\ 0 \text{ otherwise} \end{cases}$$ …..(5) dummy variable [observable]

Logit model estimating the probability of a household to be either in a state of low and medium multidimensional livelihood security (0) otherwise high (1). The logistic regression model is specified as:

$$P_i = F(Z_i) = F\left[\alpha + \sum_{i=1}^{m} \beta_i X_i\right] = \left[\frac{1}{1+e^{-[\alpha+\sum \beta_i X_i]}}\right] \quad \text{.....................................(6)}$$

Where,

e = represents the base of natural logarithms (2.718…)

X_i= represents the ith explanatory variable

P_i=the probability that an individual makes a certain choice (in this study saying yes or no)

α and β_i= are parameters to be estimated.

It should be noted that the estimated coefficients do not directly indicate the effect of change in the corresponding explanatory variables on the probability (P) of the outcome occurring. Rather the coefficients reflect the effect of individual explanatory variables on its log of odds. The positive coefficient means that the log-odds increase as the corresponding independent variable increases. The coefficients in the logistic regression are estimated using the maximum likelihood estimation method. The logistic distribution function for the determinants of households' multidimensional livelihood security can be specified as:

$$[1 - P_i] = \left[\frac{1}{1+e^{Z_i}}\right] \quad \text{..(7)}$$

Where, $Z_i=\beta_0+\beta_i X_i$, Z_i represents Logistic Distribution Function

The odds ratio becomes:

$$\left[\frac{P_i}{1-P_i}\right] = \left[\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right] = e^{Z_i} \quad \text{..(8)}$$

Alternatively,

$$\left[\frac{P_i}{1-P_i}\right] = \left[\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right] = e^{\left[\alpha+\sum_{i=1}^{m} \beta_i X_{ii}\right]} \quad \text{..(9)}$$

Taking the natural logarithms of equation (9) will give the logit model as indicated below:

$$Z_i = \ln\left[\frac{P_i}{1-P_i}\right] = \alpha + \beta_1 X_{1i} + \beta_{2i} X_{2i} + ----+\beta_m X_{mi}$$
……………..……………..….(10)

If we consider a disturbance term, u_i, the logit model

$$Z_i = \alpha + \sum_{t=1}^{m} \beta_t X_{ti} + U_i$$
………………………………………………….(11)

OR

$$Log\left(\frac{P_i}{1-P_i}\right) = \sum \beta_j X_{ij} + \varepsilon_i$$

Where;

- P = P [Y = 1] denotes, the probability that a household has high livelihood security
- P = P [Y = 0] denotes, the probability that a household has low/medium livelihood security
- Pi =represents the conditional probability that a household has high livelihood security
- (1 −Pi) =denotes the conditional probability that a household has low/medium livelihood security
- β_j's=are vectors of coefficients to be estimated
- X_j's =are vectors of explanatory variables
- $\varepsilon_{i=}$ the error term.

In general, the logistic regression model including the disturbance term can be expressed as:

$Z_i = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_{3+}\beta_4X_{4+}\beta_5X_5…+\beta_nX_n+ \mathcal{E}_i$....................................(12)

Where: Z_i=is a function of explanatory variables (X), β_0=is an intercept; $\beta_1, \beta_2...\beta_n,$ =are the slopes of the function; Or, $\beta_0, \beta_1 X_1, \beta_2 X_2, \beta_3 X_3, \beta_4 X_4, \beta_5 X_{5,...,} \beta_n X_n)$= coefficient parameters; X_i= is the vector of explanatory variables (predictors); and $X_i...X_n$ represents major factors influencing household participation in agricultural extension services in the last 12months considered as independent variables; $\mathcal{E}_{i\,=}$error term.

Therefore, the above econometric model was used to analyse the data in this study. The parameter of the model was estimated using the iterative maximum likelihood estimation procedure. This yields unbiased and asymptotically efficient and consistent parameter estimates. For both the OLS and logit regression models, the dependent variable is the livelihood security index in binary form.

The following are the list of the eleven explanatory variables and their descriptions:

X1: Agroecology/farming system: agroecology/farming type of sample heads was assumed to have a positive and significant effect on their multidimensional livelihood security status.

X2: Age/proxy of the overall experience of the household head was expected to significantly increase the probability of the respondents being health and educationally secure and empowered, thereby, well-protected multidimensional livelihood security. Akter (2012) reported an insignificant effect of age on multidimensional livelihood security.

X3: Sex of the household heads was expected to have a positive and significant effect on the multidimensional livelihood security of rural households. This was so because in rural areas of the study area man has more access to seven multidimensional livelihood security domains than a woman. Akter (2012) reported an insignificant effect of sex on multidimensional livelihood security.

X4: The family size of the household head. Rahman and Akter (2014) reported that family size has positively and significantly increased the probability of being food secure and empowered. On contrary, Akter (2012) reported that family size reduces the probability of rural households' multidimensional livelihood security because the larger the family size the more they are demand basic needs, thereby, affect it negatively. However, this study assumed that family size has a positive and significant effect because the bigger availability of family labour means, more members bring more resources to the households, for example, produce more food due to the availability of family labour.

X5: Marital status of the household head was expected to improve the probability of the rural households' multidimensional livelihood security than single or unmarried heads. The potential reason may be the more the household head gets married there is high the probability of couples' participation in different multidimensional livelihood security domains. Akter (2012) reported an insignificant effect of marital status on multidimensional livelihood security.

X6: Literacy status was expected to improve the probability of the rural households' multidimensional livelihood security than illiterate.

X7: Dependency ratio of household heads variable was assumed negatively affected rural households' composite livelihood security because the more the dependents the more their demand for basic needs. This assumption was consistent with Akter (2012) and Rahman and Akter (2012; 2014).

X8: Landholding (hectare). Consistent with Akter (2012) it was assumed that the landholding variable was assumed positive and significant effect on rural households' composite livelihood security. The potential reason is that land is the main source of the wealth of the rural households (i.e. food security).

X9: Livestock holding (TLU) was expected to have a positive and significant effect on rural households' multidimensional livelihood security than those household heads with a fewer number of livestock holdings.

X10: Credit services were assumed to have a positive and significant effect on sample heads' composite livelihood security.

X11: Member of cooperatives was also expected to have a positive and significant effect on rural households' state of multidimensional livelihood security. The potential reason maybe being a member of cooperatives; household heads get the opportunity to work jointly with other heads. This could enable to improve his/her state of food security and occupational security, thereby, significantly enhances the probability of rural households' well-protected multidimensional livelihood security.

4. Results and Discussions

4.1 Livelihood Security Dimensions

1. As per Guilford (1954) Normalized Rank Order Method, the seven livelihood security dimensions were ranked by 30 purposively sampled judges who are the experts in the field of social science, food security, agricultural extension, environment, women and children affairs/gender, economics, cooperatives, rural development, and related fields. A format containing the seven livelihood security dimensions was handed over personally to them for ranking (1 to 7) dimensions according to their relevance to rural households. Then, rankings were tabulated, frequency distribution (f_{ji}) worked out, mean of each livelihood dimension computed, and finally, scale value/weights of each dimension computed (row 16 of annex 1/Table 1, below). The Table shows that weight of 9.42, 4.94, 8.00, 9.45, 4.70, 4.78, and 6.12 was attached to food security, habitat security, empowerment security, occupational security, environmental security, water security, and community participation security dimensions, respectively implying that the relative weights of each livelihood security dimensions attached.

Livelihood security key indicators, categories, and weights

2. The seven livelihood security dimensions have a total of 92 potential indicators and 224 categories that all of them couldn't be key variables used to construct separate and composite livelihood security indices. Hence, to identify the major livelihood security indicators and their categories used to compute the separate and multidimensional rural households' livelihood security indices multiple correspondence analyses were followed to reduce the numbers of livelihood security indicators in general and non- arbitrarily attach weights to each of their corresponding categories. Thus, following Hair *et al*. (1995), Asselin (2002; 2009), Ezzrari and Verme (2012), and Desawi (2019) the following key livelihood security indicators and corresponding categories were used to construct livelihood security indices of each seven operationalized as follows:

3. ***Food security*** key variables include food items (13 different food baskets) and frequencies consumed in the last seven days. Thus, a total of

(9) indicators and 36 modalities/categories having discriminating power/standard deviation greater than or equal to 1.11 was used to construct rural household's food security induces in general and the composite index in particular. Previous studies by Twigg (2001), Baby (2005), and Barela *et al*. (2018) identified several related food security indicators consistent with the current study,

4. *Habitat security* key indicators operationalized as sample heads ownership of house/dwelling, transport facilities, and its means. Despite the cut-off point was 0.69, the researcher decided to include all three variables with 6 categories as key indicators of habitat security indices and that of the composite index. Scholars like Twigg (2001) and Baby (2005) were also used habitat security as in their composite index,

5. *Empowerment security* key indicators for this study denotes rural households' participation in community services, access to service giving institution, and their participation in local planning, implying 3 indicators and 6 modalities/categories were identified to construct habitat security indices of the sample household in the general and composite index of the woreda. Previous studies (Wickramsinghe 1999; IFAD 2001; Singh & Hiremath 2010) identified several related habitat security indicators consistent with the current study;

6. *Occupational security* key indicators include employment status, job according to education, and satisfaction with the present work environment and have 3 indicators and 8 modalities/categories. Previous studies (Twigg 2001; Baby 2005) identified several related occupational security indicators consistent with the current study;

7. *Environmental security* key indicators were operationally focused on the extent of environmental pollution issues [water and air pollution, soil erosion groundwater shortage, and flood/drought on the farm] in the sample household's respective kebele having 5 key indicators and 15 modalities/categories. Previous studies (Wickramsinghe 1999; Dahl 1995; Singh and Hiremath 2010; Baby 2005) identified several related environmental security indicators consistent with the current study;

8. *Water security* key indicators include access to pipe water, public water, and distance from safe drinking water, rainwater, and spring water, implying that 5 key indicators and 10 modalities/categories were used to develop the water security indices and the overall multidimensional security index. Previous scholars (Dahl 1995; CARE India 1997; Twigg 2001) used water security consistent with the present study as one of the livelihood security dimensions; and

9. *Community participation security* key indicator was operationally defined as the involvement of sample households in government organizations, land management practices, and soil conservation practices on their farmland having 7 key indicators and 16 modalities/categories. CARE India (1997) and Lendernberg (2002) used as another dimension of multidimensional livelihood security index development. Overall, a total of 35 key livelihood security indicators and 110 corresponding categories were used to construct livelihood security indices of each seven dimensions and composite multidimensional livelihood security index of the study area as follows:

4.2. Construction of Livelihood Security Indices

This section aimed to construct the separate livelihood security indices for the seven dimensions (Table 2 and Fig 1) that reveal sample households were found in different livelihood security indices. For example, UNDP (2016) Goal 6 states that ensuring availability and sustainable management of water and sanitation for all. In the current study area data was collected for non-arbitrarily selected five water security indicators and 10 corresponding categories having Egen value greater than or equal to 0.47: access to pipe water (Egen value=0.47) and access to public water (Egen value= 0.50), distance from safe drinking water /30 minutes round (Egen value=0.50), sources of drinking water like rainwater (Egen value=0.48) and spring water (Egen value=0.50). The mean *water security index* of the study area was found as 0.468.

The result was triangulated with other water security figures. For example, out of the total 387 respondents, safe and improved drinking water sources (pipe water) at least a 30-minute walk from home (round trip). That is, instead of a piped water source, rural household heads of the study area were mostly using rainwater (35%) and spring water (56.6%) sources. Besides, secondary data sources from Woreda Water Office (2017; 2018) also confirmed that the major sources of potable drinking water in the study area include 1st spring, 2nd Tope water, 3rd River, 4th Well, and 5th Pond. Both primary and secondary data sources revealed that access to a potable water source to the rural household heads and their families in the study area was very difficult. As a result of lack of clean drinking water sources in the short distance have multifaceted problems on the health status of rural household heads and their families in the current study area. For example, a secondary data source from Jimma Geneti Woreda Health Office (2017; 2018) reported that water-borne diseases like diarrhoea 15% in 2017 and 15.82 in 2018, infection of skin 9% in 2017, and 13.83% in 2018.

A study by Jabeen *et al*. (2011) also revealed health hazards due to lack of potable water like diseases such as typhoid, cholera, hepatitis, worm infestation, diarrhoea, skin infection, eye infection, stomach problems, and allergies. Added with water-borne diseases, lack of clean water by rural households also could result in a long-distance walk of women, especially, girls at the expense of their education could have a deterring role on their future capabilities. Above all, it increased the workload of women. Deprivation in drinking water was not exceptional to the current study area. Alemseged (2016) found a total of 48.7% of rural household heads deprived of drinking water. Similarly, Desawi (2019) found also 43% of rural household heads deprived of drinking water indicators. The *empowerment security index* of the sample households of the study area was constructed from three indicators and 96 categories each having different Egen values: participation in community service (Egen value= 0.43), access to service giving institutions (Egen value= 0.45), and participation in local planning (Egen value= 0.47). It was the second (mean index=0.755) implying that the status of sample households concerning empowerment security dimension was found not as it ought to be. The mean *occupational security index* was computed as 0.823. It was developed from three indicators and eight categories: employment status (Egen value= 0.1.30), job according to education (Egen value= 49) and satisfaction with the present working condition (Egen value= 0.50). The consistent result from descriptive statistics also shows that out of the total 358 respondents, the majority of them (71.23%) owned regular employment. Other sample households owned seasonal employment (15.64%), not able to work due to handicaps (1.40%), daily labourer (11.45%), and salaried worker (28%). However, the majority of them (60.22%) don't have a job according to their education. This resulted in the dissatisfaction of 144.44% of sample households with their present working environment. Furthermore, the current study, used the occupational security dimension to develop households' livelihood security index (HLHSI) and composite multidimensional livelihood security index (MLHSI) as did Twigg (2001) and Baby (2005)

Furthermore, following Lendernberg's (2002), the study used *community participation security* (mean index=0.960) in the analysis of the rural households' extent of multidimensional livelihood security. The index was developed from 7 indicators and 16 categories having egen value greater than 0.47: participation in government organization (egen value=1.45), participation in land management practices like (fallowing/field rotation egen value=0.49), manure (egen value =0.50), and use of chemical fertilizer (egen value=0.49), and participation in soil conservation practices like terracing (egen value= 0.50), tree planting (egen value =0.50) and strip cultivation (egen value= 0.49). Descriptive results also found consistent results. For examples, out of the total 387 sample households who responded to this item it was found that only 9.52% of them participated in government organizations, and did not participated in fallowing/field rotation (59.43%), manure (45.99%), terracing (52.71%), and tree planting (52.45%) and used chemical fertilizer (39.53%) and practiced strip cultivation (40.31%).

Habitat security (mean index=1.137) was constructed from three indicators and nine categories: ownership of housing/dwelling (egen value= 0.43), transport facilities (egen value= 0.48) and means of transportation (egen value= 1.14). Previous scholars like Twigg (2001) and Baby (2005) also used the habitat security dimension to construct households' composite livelihood security index in general and their habitat security indices in particular. Both indicators were about sample households' housing and basic amenities. Descriptive results also revealed consistent results. For example, out of the total 387 sample households who responded to this item it was found that 92.13% owned their own house, 36.39% responded that basic amenities like transport facilities to their house are available and most sample households 65.54% used the house as their major mode of transport facilities.

Environmental security (mean index=1.852) was constructed from five indicators and 15 categories having egen values greater than or equal to 0.71: extent of environmental pollution related indicators (water pollution (egen value= 0.71), air pollution (egen value= 0.71), and soil erosion (egen value= 0.73)), groundwater storage (egen value= 0.71) and flood or drought-prone condition (egen value= 0.75). Descriptive statistics show that out of the 387 total sample households 144.79% and 49.97% respond to the extent of water pollution and air pollution, respectively "somewhat" as opposed to the "very much" problem. However, 45.19%, 48.48%, and 42.56% of sample households responded "very much" to environmental problems related to soil erosion, groundwater shortage, and the seriousness of the flood or drought condition on farmland, respectively. Each response was below the 50% number of samples. Previous studies (Wickramasinghe 1999; Dahl 1995; Singh & Hiremath 2010; Baby 2005) identified several related environmental security indicators consistent with the current study.

The dominant livelihood security component, *food security* (mean index=3.01) was constructed from sample head data on food consumed baskets on seven days recall bases and divided into 9 indicators and 36 categories, having egen value greater than or equal to 1.11. These types of food baskets include bread/grain (egen value=1.35), meat including chicken (egen value=1.16), milk (egen value=1.17), butter (egen value=1.23), egg (egen value=1.18), potato (egen value=1.33), vegetables/tomato, carrot & "kosta" (egen=1.20), spices/ salt and "zinjibil" (egen value=1.11), and beverages/*tella*, "*areke*" and soft drinks (egen value=1.31). Out of the total, 387 sample households consumed bread once/day (51.94%), twice/day (13.16%), and three times/day (2.84%). However, 32.04% consumed never at all in the last seven days before this study. The later sample household's missed eating food item (bread) full of carbohydrate in the last seven days preceding the current study. Different results were also revealed in the other eight food security indicators.

Furthermore, concerning the monthly households' food insecurity, primary data was collected on the twelve months (January- December). Most sample households responded that they are food insecure during July (61.50%) and August (66.15%), implying that households are highly food insecure during August. The potential reasons for sample households' food insecurity during lean periods (July and August) is due to stock clearance for seed during the harvesting year. In the study area, July and August months are known for a non-harvesting times. It also implies that sample households of the study are failed to produce sufficient food for households. That is, sample households grain stock is full during the harvesting seasons such as December to February).

In the above paragraphs, 62.53% of households responded to food insecurity to families throughout the year. The main reasons for food insecurity include the inability to produce sufficient grains (82.12%, inability to rear sufficient livestock (65.03%), meagre financial income (59.07%), drought/shortage of rainfall (38.34%), shortage of farmland (68.91%) and shortage of oxen (44.04%) as the major reasons being food insured status. They identified a limited amount of food consumed (40.05%), no food at all (3.10%), skip a meal (16.28%), sleeping hungry (19.12%), children first (41.86%), meal size reduction (17.05%), borrowing from neighbour/relatives (12.14%), working on other farms (15.255), livestock disposal/de-stocking (189/48.84%), change cropping pattern (12.14%), migration to nearby towns for labour (20.67%) and sell off small animals (27.65%) as coping strategies for mitigating family’s food poverty.

Table 2. Inter-household inequality of livelihood security indices of each dimension

LHS indices	Mean index	St. Dev
Water security indices	0.468	0.238
Empowerment security indices	0.755	0.332
Occupational security indices	0.823	0.467
Comm. participation security indices	0.960	0.359
Habitat security indices	1.137	0.457
Environmental security indices	1.852	0.553
Food security indices	3.01	0.689
Mean composite index	**2.406**	**0.907**

Composite Livelihood Security Index

To compute the overall multidimensional livelihood security index (MLHSI) of the sample households of the current study area, major procedures of the previous studies (Baby 2005; Singh and Hiremanth 2010; Rahman and Akter 2010; 2014; Akter 2012) have adhered. Fig 2, below shows the overall livelihood security index of the current study area, which was 2.406. When compared to the finding of CARE India (1997) it implies the result was greater than that of Baster/India (1.9). The same table further revealed that the sample kebeles were on the fragile end of the rural households' multidimensional livelihood security index equilibrium.

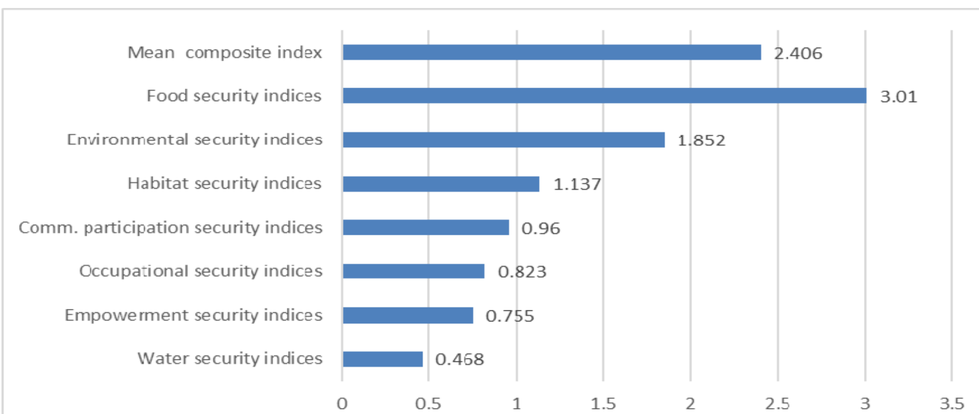

Fig 2. Livelihood security indices of each dimension

4.3 Decomposition of Livelihood Security Indices by Equilibrium Scale Ranging from 0 to 5

Lower/serious separate livelihood security equilibrium scale (LHSI <1.137) denotes livelihood security index/LHSI <1.137 and located at the end of the equilibrium mainly characterized by serious livelihood security indices. Accordingly, looking at Fig 2, above, the water security index (0.468) was found at the end of the livelihood security equilibrium implying serious livelihood security of sample heads. When compared, the result was less than that of the Basar/Index reported by CARE India (1997). The result was found against Goal 6 of the UNDP (2016). The empowerment security index (0.755) was another separate livelihood security found at the lower end of the livelihood security equilibrium implying that the study area empowerment livelihood security index higher than that of Bangladesh with the mean index of 0.108 reported by Rahman and Akter (2014). Both results imply serious empowerment security conditions. Besides, the occupational security index (0.823) shows sample heads were found in a state of serious livelihood security condition. Compared to the findings of Baby (2005), current study area occupational security index was higher than the three farmers' categories' occupational security index in India (/ 0.44 mean index), marginal farmers (0.49 mean index), and small farmers (0.75 mean index). Besides, the community participation security index (0.960 mean index) of the study area was found at the end of the livelihood security equilibrium. The result was by far less than the community participation security mean index (1.25) Bastar of India computed by CARE India (1997).

Middle/fragile separate livelihood security equilibrium scale (1.37<LHSI<3.0) also denotes livelihood security index/LHSI greater than or equal to 1.137 and less than 3.0 located in the middle of the equilibrium mainly characterized by fragile livelihood security indices. For example, based on the results of Fig 2, the habitat security index (1.137 mean index) of the study area was found in the middle of the livelihood security equilibrium. Also, the environmental security index (1.852 mean index) was found in the same category. The state of the environmental security index of the current study was found higher than that in India reported by Baby

(2005) labourers (0.80 mean index), marginal farmers (0.69 mean index), and small farmers (0.78 mean index). Mean indices of both habitat security and environmental security imply that the two livelihood security dimensions were found in a fragile condition in the current study area. The potential reasons may be due to sampling heads' lack of quality houses and their contributions to existing environmental threats like deforestation for wood, house construction, and farmland expansion.

Higher/well protected separate livelihood security equilibrium scale (LHSI >3.0) denotes that livelihood security index/LHSI greater than 3.0 located at the upper/highest equilibrium mainly characterized by well-protected livelihood security indices. For example, based on the results of Fig 2, the food security index (3.01 mean index) was the only livelihood security indices found in the well-protected livelihood security equilibrium in terms of availability of food baskets at the household level throughout the year except for the three lean periods. The potential reason is that the woreda is well known in its crop and animal production (Woreda Agriculture office, 2017;2018) and hence found not in the list of the Oromia Food insecure woreda (Oromia Bureau of Agriculture, 2017). The result was found higher than that of food security dimension index of developing countries, for example, India computed by Baby (2005): labourers (0.43) and marginal farmers (0.65), Rahman and Akter (2014) (0.555) in Bangladesh, and Bareta *et al*. (2018) (0.407) in India. But lower than small farmers of India (0.88) computed by Baby (2005) and CARE India (1997) who computed food security index as 2.3 on a scale of 1-5 point.

These classifications of livelihood security domains show that irrespective of location/kebele differences in opportunities, sample households of the study area appear equally insecure in terms of potable water supply, empowerment, occupational and community participation securities. This does not mean that call for the same intervention strategy is equally applicable everywhere in kebeles. There are location/ kebele differences in the component indicators. Access to assets/capital endowment should be taken into consideration to design program intervention to improve the water, empowerment, occupational, and community participation securities of the sample heads. Areas, where springs, farmlands, livestock, and fishing activities are more accessible, should take as an opportunity to improve the current status. More specifically, water enhancing policies are equally suitable for everywhere.

Furthermore, Fig 2., above show that the composite multidimensional livelihood security index (2.406) of the study area was found in the middle/fragile state of the multidimensional livelihood security equilibrium. The major potential reasons could emanate from the joint contributions of some livelihood security dimensions like water security, empowerment security, occupational security, and community participation security being found in the lower/serious separate livelihood security condition. Besides, the middle/fragile state of habitat security and environmental security also might contribute to the fragile state of the overall multidimensional livelihood security in the study area. Besides, the other econometric significant determinants were analysed under section (5.4).

4.4 Determinants of Rural Households' Composite Multidimensional Livelihood Security

Diagnosis Tests for Ordinary Least Square Model

There were two separate OLS tests made. First, the heteroskedasticity test was made using Breusch-Pagan / Cook-Weisberg test. It tests whether the null hypothesis that the error variances are all equal/constant variance. The *hettestt command* (a test for linear forms of heteroskedasticity) was used to test the heteroskedasticity assumption. A large chi-square would indicate that heteroskedasticity was present (Williams 2020). In this study, the chi-square value was small, indicating heteroskedasticity was probably not a problem. Second, multicollinearity test. Diagnosis test of multicollinearity assumptions for six discrete variables using *pwcorr command* (Table 3). This was done using coefficients of contingency [chi-square /χ^2 based measure of association]. If it varies the degree of associations among dummy explanatory variables (greater than 0.75), the parameter estimate would seriously be affected by the presence of multicollinearity among variables. However, in the case of the current study there was no value 0.75 or above that indicates a stronger relationship between dummy or explanatory variables, no serious multicollinearity problem.

Table 3. Diagnosis test (**c**ontingency coefficients of categorical independent variables)

Variables	AE	Sex	MSB	LS	CS	CM
Agro-ecology (AE)	1					
Sex of HH head (	0.0315	1				
Marital status-binary (MSB)	0.088	0.181	1			
Literacy status (LS)	0.0918	-0.1155	0.0415	1		
Credit service (CS)	0.1512	0.042	-0.1099	-0.1036	1	
Cooperative member (CM)	0.0371	0.0317	-0.042	0.2056	0.0641	1

Besides, no multicollinearity assumption test among five continuous explanatory variables (Table 4). A rule of thumb of VIF>10 detects serious multicollinearity problems, otherwise, no multicollinearity problem. In this study, no multicollinearity (VIFs <10) was observed, implying that the assumption of the OLS model was met and possible to trust coefficients and P-value in the analysis of the determinants of rural households multidimensional livelihood security. That is, the OLS model is fitted to the current data.

Table 4. Diagnosis test (continuous variables (no multicollinearity) using VIF)

Variable	**VIF**	**Tolerance=1/VIF**
Livestock holding in (TLU)	1.14	0.880471
Landholding in hectare	1.11	0.897747
Family size of the HH head	1.07	0.934229
Age of the HH head	1.06	0.945266
Dependency Ratio	1.01	0.986380
Mean VIF	**1.08**	

Furthermore, diagnosis tests for logit model show that the pairwise correlation matrix of six discrete variables and VIF of five continuous variables revealed no multicollinearity problem) and the logit model can be used.

Determinants of rural households' multidimensional livelihood security

Table 5, below suggests seven out of eleven independent variables affecting sample heads multidimensional poverty in the study area. Based on the results presented in Table 5, as hypothesized agro-ecology/farming system of sample heads was found positively and statistically significant at 5% has effect (logit model) on sample heads multidimensional livelihood security status but insignificant in the case of OLS model. Furthermore, contrary to our assumptions, literacy status was found negatively and statistically significant (5% significance level) in impacting sample heads multidimensional livelihood security when OLS model employed but insignificant when logit model was employed.

The dependency ratio of household heads variable was assumed negatively affects rural households' composite livelihood security. A similar result was exhibited under Table 5 when OLS model was employed but not when logit model was employed. With OLS model the current result was consistent with Akter (2012) who employed Tobit model and Rahman & Akter (2012; 2014) who employed 2SLS (two stages least square framework) and multivariate Tobit model, respectively in different years in the case of Bangladesh.

Landholding (hectare) was assumed positive and significant effect on rural households' composite livelihood security. Except, the sign of coefficient, consistent OLS finding was witnessed landholding has significant effect at 5% significance level on sample households' multidimensional livelihood security. The potential reason is that land is the main source of the wealth of the rural households (i.e. food security). OLS result was consistent with Akter (2012) Tobit result the variable has a significant effect. But Logit model witnessed an insignificant effect.

Concerning the effect of livestock holding (TLU), OLS model found an insignificant effect. However, contrary to our assumption, logit model result revealed a negative and significant (5% significance level) effect of sample heads' livestock holding (TLU) on their multidimensional livelihood security status, *citrus paribus*. Credit services were assumed to have a positive and significant effect on sample heads' composite livelihood security. While OLS model results show insignificant effect, logit model result shows negative and significant (5% significant level) effect of rural households' access to credit on their status of multidimensional livelihood security.

An interesting result of Table 5 is the significant effect of the variable member of cooperatives on sample heads multidimensional livelihood security (both OLS and logit models) but differ in the sign of coefficients (OLS model, negative and logit model, positive). The potential reason maybe being a member of cooperatives; household heads get the opportunity to work jointly with other heads. This could enable to improve his/her state of food security and occupational security, thereby, significantly enhances the probability of rural households' well-protected multidimensional livelihood security.

Table 5. Determinants of multidimensional livelihood security /OLS vis-à-vis logit models

Variables	**OLS model**		**LOGI model**		
	Coef.	**P>t**	**Coef**	**Odds ratio**	**p>/z|**
Lsi-binary but ordered					
Agro-eco/farming system	.0620987	0.103	0.3569037	1.428898	0.045**
Age of the HH head	-.0818601	0.253	-0.4506181	0.6372342	0.152
Sex of the HH head	-.0100155	0.920	0.1886741	1.207647	0.633
Family size of HH head	-.047175	0.336	-0.2551727	0.7747827	0.243
Marital status of HH head	.0114493	0.913	-0.2428034	0.7844257	0.562
Literacy of the HH head	-.0838671	0.047**	-0.0591085	0.9426044	0.865
Dependency ratio	-.2794563	0.043**	-0.9022435	0.4056586	0.126
Landing holding	-.0129909	0.034**	-0.0691608	0.9331766	0.43
Livestock holding	-.0170854	0.398	-0.0554541	0.9460555	0.048**
Credit service	-.0998148	0.122	-0.7333498	0.4802974	0.01**
Member of cooperative	-.1667898	0.033**	-1.187349	0.3050287	0.002***
__cons_	1.369799	0.000	3.526304	33.99808	0.001

Note: ***, ** significant at 1% (for significant p-value<0.01), and 5% (for significant 0.01<p-value<0.05).

5. Conclusion and implications

Descriptive findings show that four out of seven multidimensional livelihood security dimensions were found in serious livelihood security conditions in the woreda. Also, the composite multidimensional livelihood security of sample heads was found at the fragile end of the multidimensional livelihood security equilibrium ranges 0 to 5 scale. Hence, it is possible to conclude that there exists inter-household inequality in terms of the seven multidimensional livelihood security indices. Given, a major emphasis on water security, empowerment, occupational security, and community participation security, results in calls for urgent integrated program responses by the government in general and the local community in particular. For example, a pro-active rural development policy that increases the number and quality of livestock and similar policies that enhance the food, habitat, occupational, and community participation securities of sample heads should be in place, monitored, and evaluated. Theoretically, the study implies narrow considerations (household-level food and nutritional security studies alone) couldn't comprehensively understand their multidimensional issues. Therefore, the strategic focus of studying rural households' food and nutritional security studies (narrow) has to be shifted to their multidimensional livelihood security analysis (wider). The latter has the long-term benefit of household-level sustainable development in general and poverty reduction in particular.

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Notes

[1] Strategic shift one is a shift from a concern for regional and national food security to a concern for the food security and nutritional status of households and individuals (1970s to 1974)(Davies *et al.*1991).

[2] A rule of thumb is a broadly accurate guide or principle, based on practice rather than theory.

[3] Egen value is in linear algebra is a nonzero vector that changes by a scalar factor when a linear transformation is applied to it. The corresponding eigenvalue, often denoted by \lambda, is the factor by which the eigenvector is scaled. Sometimes also known as characteristic roots, characteristic values (Hoffman and Kunze 1971), proper values, or latent roots (Marcus and Minc 1988:144).

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Annex 1/Table 1. Frequencies, p-values, C values, mean (Rj), and scale values/weights (Rc) of each livelihood security dimensions

(A)	**(B)**	**Product of frequencies and C values of the seven Dimensions of samples Multidimensional LHSAI**							**(J)**	**(K)**	**(L)**
r_i	**Ri**	**(C)** ***FoSD***	**(D)** ***HaSD***	**(E)** ***EmSD***	***(F)*** ***OcSD***	**(G)** ***EnSD***	**(H** ***WaSD***	**(I)** ***CoPD***	**∑fji**	**Proportion (P values)**	**C value Correct rank**
1	7	11x8=88	0x8=0	7x8=56	12x8=96	0x8=0	0x8=0	0x8=0	30	92.86	8
2	6	8x7=56	3x7=21	6x7=42	7x7=49	2x7=14	0x7=0	4x7=28	30	78.57	7
3	5	7x6=42	5x6=30	3x6=18	6x6=36	2x6=12	3x6=18	4x6=24	30	64.29	6
4	4	3x6=18	3x6=18	5x6=30	4x6=24	2x6=12	3x6=18	10x6=60	30	50.00	6
5	3	1x5=5	6x5=30	7x5=35	0x5=0	5x5=25	4x5=20	7x5=35	30	35.71	5
6	2	0x5=0	1x5=5	2x5=10	1x5=5	10x5=50	14x5=70	2x5=10	30	21.43	5
7	1	0x4=0	12x4=48	0x4=0	0x4=0	9x4=36	6x4=24	3x4=12	30	7.14	4
	∑fji	30	30	30	30	30	30	30	210	350	41
P-values		92.286	78.57	64.29	50	35.71	21.43	7.14			
∑ (fji *C)		209	152	191	210	149	150	169			
$R_j = \frac{\sum(f_{ji} * C)}{\sum(f_{ji})}$		6.97	5.07	6.37	7.00	4.97	5.00	5.57			
Judges Rank of Rj		2nd	5th	3rd	1st	6th	7th	4th			
Rc=2.357Rj-7.01		9.42	4.94	8.00	9.45	4.70	4.78	6.12		∑Rc	47.41
		Food security dimension	Habitat security dimension	Empower't Security dimension	Occup. l security dimension	Envir. l Security dimension	Water security dimension	Com. p Security dimension			

Where: **R_c**= Scale value of weighting of each livelihood dimension, **R_j**= mean of each livelihood dimension