Resilience of Households Graduated from Productive Safety Net Program Pursuing Different Livelihood Strategies in Rural Konso, Ethiopia

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ABSTRACT

This study attempts to address resilience of households graduated from productive safety net program (PSNP) who pursued different livelihood strategies in rural Konso. The objective of the study is to measure the level of resilience of households to food insecurity by using the resilience approach. The study employed cross-sectional survey design for 298 PSNP graduated households drawn from sampling frame of graduated households through systematic random sampling. Factor analysis using principal component factor is employed to examine the components of resilience and the percentage variance explained by each of the components. The study results indicate that households are resilient at different levels. The relative sizes of factor loadings of each observed variables and latent dimensions of resilience have important policy implications. The study also indicate that resilience indices across different livelihood strategies have shown significant differences, implying households who diversified their livelihoods are relatively resilient. Therefore, to enhance households resilience, enabling environment that support smallholder livelihood diversification should be facilitated.

Key words,

Resilience, food insecurity, household, livelihood strategy, factor loadings, Konso

1. INTRODUCTION

Ethiopia is one of the fastest growing economies in Sub-Saharan Africa (SSA) with growth rates averaging 11 percent over the last decade which is about double of the average growth rate for SSA (UNDP, 2014). Alemayehu and Addis (2014) have also confirmed this inspiring achievement in their economic appraisal that the growth of the economy was in fact quite impressive with an average growth rate of about 9 percent per annum since 2000. While the economy continues to grow impressively, poverty and food insecurity still remains to be a major challenge in rural areas (MoA, 2012). To address the underlying causes of chronic food insecurity in the rural communities, as a resilience strategy, the government has established Productive Safety Net Program (PSNP) in 2005.

Drought and food insecurity coupled with poverty in most fragile rural communities of Ethiopia in general and Konso in particular, appear to be very frequent. Frequent drought that has characterized the study area coupled with land fragmentation jeopardized agricultural production. As result, farming has increasingly been unable to provide sufficient means of survival for poor households. In his recent empirical study, Geremew (2017) reveals that the dwarf productivity growth of agriculture and the ever-continuing population growth push smallholder farm households to diversify their livelihood strategies. This compels the smallholder households to look for alternative livelihood strategies. Thus, in this study, it is hypothesized that PSNP graduated households who diversified their livelihood strategies are resilient.

Due to these apparent problems mentioned above the government declared the study area as one of the drought prone and food insecure areas. Since 2005 the chronically food insecure rural households of study area have been getting predicted transfer from the PSNP (WoA, 2015).
PSNP is the main focus of the country. Several assessments and studies have been carried out To list a few, Gilligan *et al*. (2008), Anderson *et al*.(2009). Klaus *et al*.(2013) and Hermela (2015). These studies more focused on the general impact of the program by comparing beneficiaries and non-beneficiaries of the program. In fact, Klaus *et al*. (2013) and Hermela (2015) questioned the resilience aspects of PSNP. None of these authors have rigorously studied

the underlying dimensions of resilience that determine the level of resilience of households graduated from PSNP.

Social Safety Net Program is an international concern for countries like Ethiopia. There are several studies on social safety net like PSNP in different developing countries. To mention a few of these works carried out in Nigeria and Pakistan by Olarinde and Kuponiyi (2005) and Khan *et al.* (2013) respectively. None of these studies said anything about resilience aspect of their respective safety net programs. All lacks the quantitative measurement of resilience employed by Alinovi *et al.* (2008 ; 2010). Thus, this study is to bring up what is lacking in the previous studies that failed to rigorously present quantitative assessment of households resilience to food insecurity.

2. RESEARCH METHODOLOGY

2.1 Description of the Study Area

Konso woreda is located in the Segen Area Peoples Zone (structure above district) in Southern Nations Nationalities and Peoples Region, and is situated about 600km south of the nation's capital, Addis Ababa. Ninety six percent of the population are rural dwellers and the settlement is concentrated in mid altitude. Seventy percent of the area fall under hot low land agro-ecological zone whereas the remaining thirty percent fall under mid altitude (WoA, 2015). Topographically, it has rugged landscape which is predominantly composed of many hills and is part of volcanic-sedimentary region characterized by a relief of medium mountains, between 1400 - 2000m above sea level.

Konso is known for its industrious people who are endowed with extraordinary skill and knowledge especially, in soil and water conservation practices. Pleasantly, the terraces are unique and have striking features which have almost covered the whole middle altitude areas of the district. They managed to survive in the marginal environment using indigenous knowledge and skills that enabled them to make optimal use of unfavorable terrain and climatic conditions in innovative manner as a survival strategy over centuries. This creative and noble work culture has qualified Konso people in 1995 for UN prize among the best fifty communities all over the globe and surprisingly, they deservingly won the award.

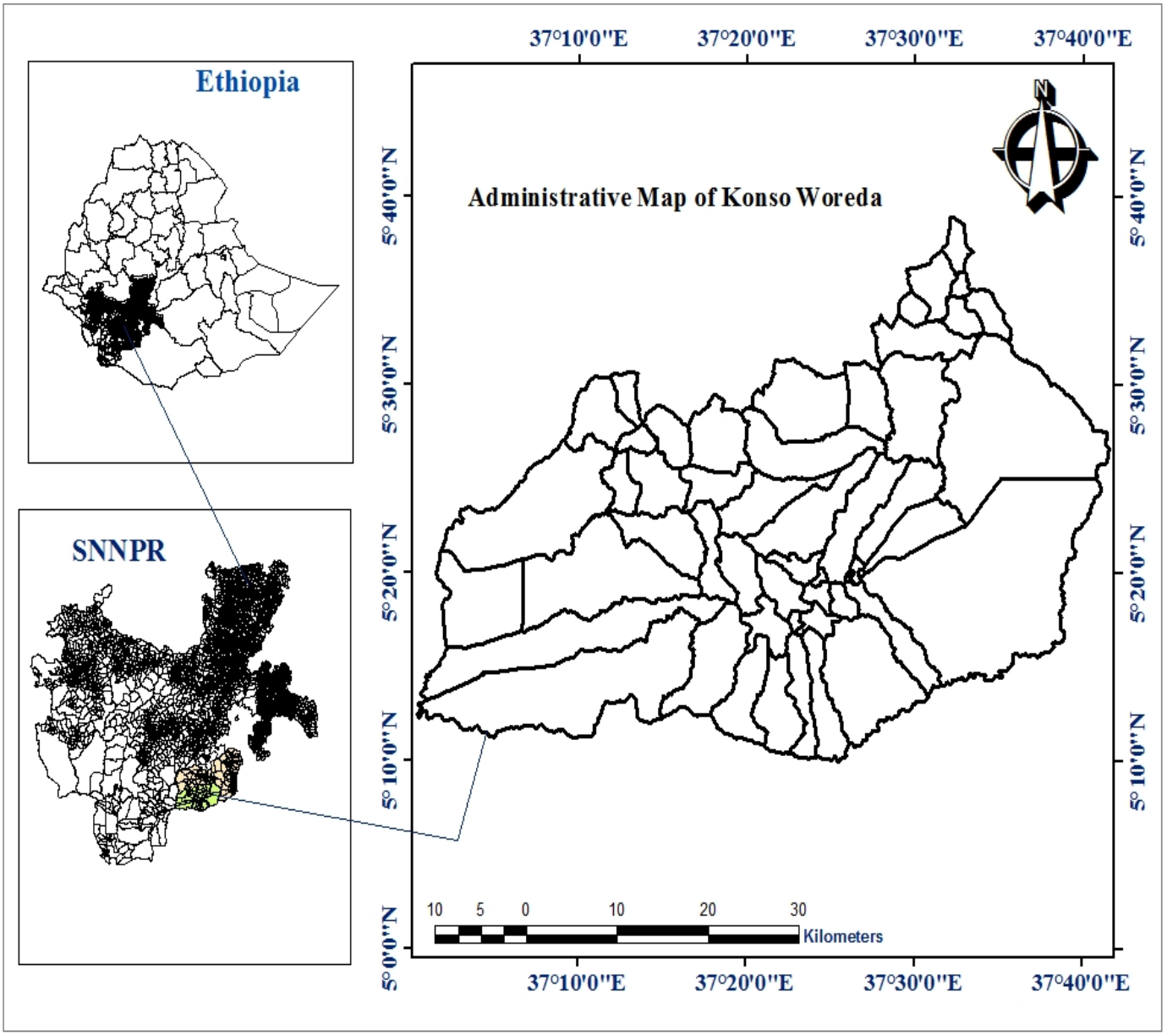

Figure 1. Map of the study area

Source: CSA, 2007

2.2 Sampling and Data Description

In this study, both primary and secondary data are collected. Primary data collection is mainly based on a survey. Probability and non-probability sampling is employed to select respondents for qualitative data collection.

A multi-stage sampling technique is employed with clear description for purposive sampling of the study area. At the first stage, Segen Area Peoples Zone is purposely selected from the existing zones of the region. At the second stage, Konso district is purposely selected for the study for the following main reasons. Firstly, it is known for its drought proneness among the existing other districts of the zone and officially disclosed by the government as the chronically food insecure district. Secondly, PSNP beneficiary concentration is very high (50.3% of total zone share) as compared with other districts in the zone.

At third stage, six PSNP targeted kebeles (smallest unit of government structure) are randomly selected, which are distributed over the existing agro-ecologies of the district. The district has two agro-ecological zones, seventy percent is low land and the remaining thirty percent is mid altitude. Accordingly, four PSNP targeted kebeles are selected from low land and the remaining two PSNP targeted kebeles are selected from mid altitude. For each selected kebele, sampling frame of PSNP graduated households is prepared by their respective kebele agriculture office upon the request from the researcher. Finally, at the fourth stage, systematic random sampling technique is employed to select PSNP graduated households by assuming that the livelihood strategies that PSNP graduated households pursued in each kebele is heterogeneous. As result, Proportionate Probability Sampling (PPS) technique is employed to get proportionate samples from each kebele as per their population size for both male and female headed households graduated from PSNP.

2.3 Data Analysis

In this study household resilience to food insecurity is assessed. Resilience is not observable per se and hence considered as latent variable. Its latent dimensions are also latent, cannot be directly observed in a given survey. It is possible to estimate them through multivariate techniques. The data collected from each observed variables of each latent dimension of the resilience is analyzed by using factor analysis. For this purpose, two steps of analysis are undertaken. At first stage,

relevant multivariate analysis is run using available indicators of each latent dimension separately as done in Alinovi *et al* (2008 and 2010). Then, relevant observed variables are selected based on the factor loadings and other statistical criteria such as KMO-statistics of sampling adequacy, Bartlett's test of sphericity, communalities, and variance explained by the factor generated. At the second stage, these selected variables are used to estimate the respective final latent dimensions that are later used to estimate the overall resilience index.

Hence, the resilience index for a household i is expressed as follows:

$$RI_i = f\,(IFA_i\,,\ AP_i\,,\ ABS_i\,,APT_i\,,AC_i\,)$$

Where: RI = Resilience Index; IFA = Income and Food Access; AP = Asset Possession;
ABS = Access to Basic Services; APT = Agricultural Practices and Technologies;
AC = Adaptive Capacity;

A PCA was used to examine the components of resilience and the percentage variance explained by each of the components. According to the approach proposed by Alinovi *et al*. (2010), the factor variance obtained for each factor from the PCA is multiplied by the generated factor to develop the RI of each household. The formula is described as follows:

$RI = V_1*F_1 + V_2*F_2 + V_n*F_n$

3. RESULTS AND DISCUSSION

3.1 Income and Food Access

The result of this dimension is presented hereunder.

Table 1. Eigen values of each factor

Factor	Eigen value	Difference	Proportion	Cumulative
Factor 1	3.38250	2.59259	0.6765	0.6765
Factor 2	0.78991	0.45966	0.1580	0.8345
Factor 3	0.33025	0.02642	0.0660	0.9005
Factor 4	0.30383	0.11030	0.0608	0.9613
Factor 5	0.19352		0.0387	1.0000

LR test: independent vs. saturated: chi2(10) = 874.32 Prob>chi2 = 0.0000, source: factor analysis result (2017)

Kaiser criterion suggests to retain those factors with Eigen values equal or higher than 1. Accordingly, for this dimension factor one is retained which explains about 67.7% of the total variance. The factor produced is quite meaningful and can be considered as the underlying latent variable for food and income access (Table 1). This factor which accounted for 67.7 % of the total variation indicates high representation of the income and food access status of household in resilience to food insecurity. It means that better income and food access is associated with income, expenditure, calorie intake, household food insecurity access scale and coping strategy index. Due to its high factor loading, income has contributed for high variation of the total variation, confirming households access to food due to income. The KMO measure of sampling adequacy is 0.8124 indicating that the sample size was adequate for running factor analysis and indicating a reliable first principal component representing IFA. This well fits the suggestion of Field (2005) that KMO statistics should be greater than 0.5 if sample size and the proportion of variance in variables that might be caused by underlying factors are adequate for running factor analysis. The result of this study shows that Bartlett's test is significant (p = 0.000) and Chi-square = 588.92) suggesting that the factor analysis is appropriate with the data available for this study (Table 2)

Table 2. KMO and Bartlett's test of sphericity for each resilience dimensions

Resilience dimensions	Bartlett's test[a]	Values	KMO value
Income and food access	Approx. Chi-Square	588.92	0.8124
	Degree of freedom (df)	10	
	Significance level (p)	0.000	
Asset possession	Approx. Chi-Square	35.09	0.4979
	Degree of freedom (df)	3	
	Significance level (p)	0.000	
Adaptive capacity	Approx. Chi-Square	160.69	0.5874
	Degree of freedom (df)	6	
	Significance level (p)	0.000	
Access to basic services	Approx. Chi-Square	93.29	0.5139
	Degree of freedom (df)	21	
	Significance level (p)	0.000	
Agricultural practices and technologies	Approx. Chi-Square	70.70	0.5876
	Degree of freedom (df)	8	
	Significance level (p)	0.000	

Note: a based on correlations

These indicators play important role in estimating the IFA dimension although they differ in their correlation coefficients. As expected, the factor loadings and correlation coefficients of income (INC), expenditure (EXP) and calorie intake (CAL) are positive while of household food insecurity access scale (HFIAS) and coping strategy index (CSI) are negative. All the five observed variables have high correlation and play almost the same role in estimating the IFA, because the magnitude of their factor loadings and correlation coefficients are similar. As expected, HFIAS and CSI have a negative correlations since their respective score increases when food security declines (Table 3). The correlation coefficient takes on a value between zero and one and is reflective of how much the indicator and the factor move with respect to one another. For instance, if the correlation coefficient between income and food access (IFA) and income (INC) is 0.83, then for a 1% increase in the IFA, the score on INC will increase by 0.83%. Since correlation coefficients have no causal relationship inherent in their value, it is also equally valid to say that if an income score increases by 1%, then we would expect income and food access to be 0.83% higher. The relative size of factor loading of each variable has therefore important policy implication

Table 3. Factor loadings, uniqueness and correlation with income and food access (IFA)

Variables	**Factor 1**	**Uniqueness**	**IFA**
Income (INC)	0.8119	0.3408	0.8308
Expenditure (EXP)	0.7034	0.5053	0.7304
Calorie intake (CAL)	0.8668	0.2487	0.7735
Household Food Insecurity Access Scale (HFIAS)	-0.8673	0.2477	-0.8561
Coping Strategy Index (CSI)	-0.8515	0.2750	-0.8454

Source: factor analysis result (2017)

3.2 Asset Possession

This dimension is a crucial aspect of household resilience because the more a household possess asset such as land and livestock, the more that household copes with a shock and becomes more resilient. For this study, three observed variables are used to estimate the AP component as they are very essential for a farm household. These are farm land, livestock ownership and farm implements. These components measure the impact on resilience of assets important for agricultural production. It has been computed by adding all the farm plots the PSNP graduated household possesses at different sites in hectare, animals owned by the PSNP graduated

household in tropical livestock unit (TLU) and farm implements computed as the sum of the monetary values for the farm implements the PSNP graduated household owns.

Table 4. Eigen values of each factor

Factor	Eigen value	Difference	Proportion	Cumulative
Factor 1	1.33731	0.34114	0.4458	0.4458
Factor 2	0.99617	0.32966	0.3321	0.7778
Factor 3	0.66651		0.2222	1.0000

LR test: independent vs. saturated: chi2(3) = 35.20 Prob>chi2 = 0.0000, source: factor analysis result (2017)

According to the Kaiser criterion, for this dimension the factor retained has Eigen value of 1.337 that accounted for about 44.6% of the variation. The factor produced is quite meaningful and can be considered as the underlying latent variable for asset possession (Table 4). The KMO measure of sampling adequacy is 0.4979, indicating that the sample size is nearly adequate for running factor analysis and indicating a reliable first principal component representing AP. Bartlett's test is significant (p = 0.000) and Chi-square = 35.09 suggesting that the factor analysis is appropriate with the data available for this study (Table 2)

Table 5. Factor loadings, uniqueness and correlation with Asset Possession(AP)

Variables	Factor 1	Uniqueness	AP
Farm land (FLAND)	0.2172	0.9528	0.2172
Farm implements (FIM)	0.8152	0.3355	0.8152
Tropical Livestock Unit (TLU)	0.7909	0.3744	0.7909

Source: factor analysis result (2017)

These indicators play important role in estimating the AP dimension although they differ in their correlation coefficients. As expected, the factor loadings and correlation coefficients of indicators are positive. Except farm land other two indicators have high correlation and play almost similar important role in estimating the AP, because the magnitude of their correlation coefficients are similar (Table 5). The relative size of factor loadings of each variable has therefore important policy implication. As it can be seen from the Table 5, the factor loading of farm land is very small (0.217). However, this does not mean that the land has less importance for the rural livelihood resilience rather indicates less farm land ownership of PSNP graduated households confirming that there is fair selection of the beneficiaries as landownership used to be

one of the selection criteria for the program. Livestock ownership (TLU) has high correlation (0.79) with asset possession. For a 1% increase in the AP , the score on TLU will increase by 0.79%. Since correlation coefficients have no causal relationship inherent in their value, it is also equally valid to say that if livestock ownership score increases by 1%, then we would expect asset possession to be 0.79% higher.

3.3 Adaptive Capacity

This is another important dimension of resilience, which measures the household's ability to adapt and react to shocks. Adaptive capacity refers to the level of access to and exploits benefit therein from resources in order to deal with shocks (Frankenberger *et al*., 2012). Education average as one of the observed indicator is used in the estimation of adaptive capacity, which is the average of years of education completed by PSNP graduated household members. The other variable included to estimate this latent variable is diversified sources of income. It is based on the premises that a diversified sources of income leads to a greater adaptive capacity. Furthermore, based on the flexibility principle of resilience, periodic maintenance of conservation structure is also addressed as one of the observed variables in this study, since the study area, Konso is known for its conservation practices.

Table 6. Eigen values of each factor

Factor	**Eigen value**	**Difference**	**Proportion**	**Cumulative**
Factor 1	1.82428	0.76355	0.4561	0.4561
Factor 2	1.06074	0.39760	0.2652	0.7213
Factor 3	0.66314	0.21130	0.1658	0.8870
Factor 4	0.45184		0.1130	1.0000

LR test: independent vs. saturated: chi2(6) = 161.24 Prob>chi2 = 0.0000, source: factor analysis result (2017)

Two factors, factor 1 and factor 2 are retained with Eigen values of 1.824 and 1.060 respectively that accounted for about 72.3% of the variation. The factor produced is quite meaningful and can be considered as the underlying latent variable for adaptive capacity (Table 6). This factor which accounted for 72.3 % of the total variation indicates high representation of the adaptive capacity

status of household in resilience to food insecurity. It means that better adaptive capacity is associated with income diversity, education average, employment ratio and periodic maintenance of conservation structure. In particular, due to their high factor loadings, income diversity and education average have contributed for high variation of the total variation.. The empirical findings of Fabusoro *et al*. (2010) reveal households with better level of education would have high tendency to gain better skill, experience, knowledge that could help them to engage in diversified livelihood strategies. The KMO measure of sampling adequacy is 0.5874 indicating that the sample size was adequate for running factor analysis and indicating a reliable first principal component representing adaptive capacity. Moreover, Bartlett's test is significant (p = 0.000) and Chi-square = 160.69 suggesting that the factor analysis is appropriate with the data available for this study (Table 2)

Table 7. Factor loadings, uniqueness and correlation with Adaptive capacity (AC)

Variables	**Factor 1**	**Factor 2**	**Uniqueness**	**AC**
Income diversity (ID)	0.7424	-0.4446	0.2511	0.8057
Employment ratio (ERP	0.7129	0.1964	0.4532	0.6707
Education average (EDU)	0.8350	-0.0546	0.2997	0.8326
Periodic maintenance of conservation measure	0.2600	0.9064	0.1109	0.1067

Source: factor analysis result (2017)

The three observed variables on the first factor have high factor loadings while periodic maintenance of conservation structure has high factor loading on the second factor. The income diversity and education average on the second factor loading have negative values while the factor loading for the education average is very low (-0.055). As expected, all variables are positively correlated to the AC. For example, education has high correlation (0.83) with adaptive capacity. For a 1% increase in the AC, the score on EDU will increase by 0.83%. Since correlation coefficients have no causal relationship inherent in their value, it is also equally valid to say that if education average score increases by 1%, then we would expect adaptive capacity to be 0.83% higher. Empirical findings of Liu *et al* (2013) and Dingde *et al*. (2015) reveal household heads with better education level are more competitive in the labor market and find it easier to access short-term non-agricultural work. Other empirical evidences also reveal better level of education often help rural households to be engaged in better remunerated occupations than their counterparts (Fekadu and Gebrehiwot, 2012; Aababbo and Sawore, 2016).

Periodic maintenance of conservation structure has low (0.107) correlation with adaptive capacity, confirming the finding of Tesfaye (2003) which says conservation based farming system in Konso community is degrading due to some internal and external factors. According to this author, poor farmers are now unable to carry out the periodic maintenance due to a shortage of food. Farmers who do have the capacity prepare food and local beer called 'cheka' and call for indigenous labor organizations called 'parka'. This situation has forced farmers to migrate to other places in search of alternative survival strategies. As a result, their indigenous labor organization, which is the backbone of the soil and water conservation efforts, has failed to operate as usual.

3.4 Access to Basic Services

Though it is beyond the control of sample households, access to basic services is a key factor for enhancing households' resilience by improving their access to assets (Alinovi *et al*, 2009). It is true that better access to basic services (ABS) affects the capacity of households to manage risks and respond to crisis. The observable variables addressed in this latent component are telecommunication, distance to water, distance to work, school dropout, credit access, market distance and health station distance. The average distance to reach the nearest available services is taken as a proxy for representing ABS .

Table 8. Eigen values of each factor

Factor	Eigen value	Difference	Proportion	Cumulative
Factor 1	1.45841	0.10023	0.2083	0.2083
Factor 2	1.35818	0.34735	0.1940	0.4024
Factor 3	1.01083	0.01633	0.1444	0.2468
Factor 4	0.99450	0.13054	0.1421	0.6888
Factor 5	0.86396	0.14759	0.1234	0.8123
Factor 6	0.71638	0.11864	0.1023	0.9146
Factor 7	0.59774		0.0854	1.0000

LR test: independent vs. saturated: chi2(21) = 90.11 Prob>chi2 = 0.0000, source: factor analysis result (2017)

In this component three factors, factor 1, factor 2 and factor 3 are retained with Eigen values of 1. 458, 1.358 and 1.011 respectively that accounted for about 54.67% of the total variation. The factors produced are quite meaningful and can be considered as the underlying latent variable for access to basic services (Table 8). This factor which accounted for 54.67 % of the total variation indicates optimum representation of the access to basic services status of household in resilience to food insecurity. It means that better access to basic services is associated with telecommunication, access to credit, access to market, access to health services, access to school, access to work place and water services. The KMO measure of sampling adequacy is 0.5139 indicating that the sample size is adequate for running factor analysis and indicating a reliable first principal component representing ABS. Furthermore, Bartlett's test is significant (p = 0.000) and Chi-square = 93.29 suggesting that the factor analysis is appropriate with the data available for this study (Table 2)

Table 9. Factor loadings, uniqueness and correlation with Access to basic Services (ABS)

Variables	Factor 1	Factor 2	Factor 3	Uniqueness	ABS
Telecommunication (TEL)	-0.0018	0.7795	-0.1230	0.3772	-0.0061
Distance to water (WAT)	0.8069	-0.0702	0.1449	0.3229	0.8151
Distance to work (DTW)	0.7580	0.1579	-0.1153	0.3872	0.7482
School dropout (SDO)	-0.1139	0.2601	0.2603	0.8516	-0.0925
Credit access (CRE)	0.0582	0.7872	0.0525	0.3742	0.0669
Market distance (MKTD)	-0.0605	-0.0255	0.8004	0.3551	-0.0771
Health station distance (HSTD)	0.3544	-0.0735	0.6039	0.5043	0.3981

Source: factor analysis result (2017)

Except access to health station, each of observed variables loaded to different components/factors but only one factor with high loadings while the rest are with low loadings below the suggestion of Peterson (2000). Access to health station loaded to both factor one (0.35) and factor three (0.63). Distance to water and work have loaded to factor one where as access to phone network and access to credit have loaded to factor two and access to market loaded to factor three (Table 9). As it is expected access to credit is positively correlated with the estimated ABS while its correlation is so weak indicating that sample households had less access to credit. This is also confirmed by the qualitative aspect of this study. In PSNP program, household asset building program is meant to deliver credit service that would facilitate and speed up households exit from the program For a 1% increase in the ABS, the score on CRE will increase by 0.07%. Since correlation coefficients have no causal relationship inherent in

their value, it is also equally valid to say that if credit access score increases by 1%, then we would expect access to basic services to be 0.07% higher which is very less. With such less access of the households to credit services, it seems very difficult to attain the expected sustainable gradution as per the plan of the program.

Access to phone network by PSNP graduated household head or any members in the household enable farmers to obtain updated information on their crop and livestock prices, agricultural input prices such as price of fertilizer and improved seeds, insecticides and pesticides. This helps farmers to make aware of where to sell their products and livestock. Contrary to the expectation access to telecommunication correlated negatively with access to basic services. This can be explained by less access to phone network due to the capacity limitation of the PSNP graduated households that they could not afford to buy mobile phones like other better-off farmers.

3.5 Agricultural Practices and Technologies

This resilience component is directly related to the household's degree of production capacity. The observable variables that are expected to generate this latent variable are organic fertilizer, inorganic fertilizer, veterinary services and artificial insemination. In fact, there are also other factors such as pesticides and extension contact that could generate this variable but for this study based on the context of the study area the researcher focused on the first four observable variables. Farmers of the study area often use organic fertilizers such as cattle manure to boost up their crop production and hence included to check for the regular use of it to maintain their soil fertility

Table 10. Eigen values of each factor

Factor	Eigen value	Difference	Proportion	Cumulative
Factor 1	1.57360	0.56757	0.3934	0.3934
Factor 2	1.00603	0.20998	0.2515	0.6449
Factor 3	0.79605	0.17173	0.1990	0.8439
Factor 4	0.62433		0.1561	1.0000

LR test: independent vs. saturated: chi2(6) = 70.94 Prob>chi2 = 0.0000, source: factor analysis result (2017)

For this component two factors, factor 1 and factor 2 were retained with Eigen values of 1. 574, and 1.006 respectively that accounted for about 64.49% of the total variation. The factor produced is quite meaningful and can be considered as the underlying latent variable for agricultural practices and technologies (Table 10). This factor which accounted for 64.4 % of the total variation indicates high representation of the agricultural practices and technologies status of household in resilience to food insecurity. It means that better agricultural practices and technologies is associated with organic fertilizer, inorganic fertilizer, veterinary service and artificial insemination services. Due to its high factor loading, organic fertilizer has contributed for high variation of the total variation.. Farming households who often use organic fertilizer such as cow manure get more produce that help them to avail food at household level. The KMO measure of sampling adequacy is 0.5876 indicating that the sample size is adequate for running factor analysis and indicating a reliable first principal component representing APT. This well fits the suggestion of Field (2005) that says KMO statistics should be greater than 0.5, if sample size and the proportion of variance in variables that might be caused by underlying factors are adequate for running factor analysis. Furthermore, Bartlett's test is significant (p = 0.000) and Chi-square = 70.70 suggesting that the factor analysis is appropriate with the data available for this study (Table 2).

Table 11. Factor loadings and correlation with Agricultural Practices and Technologies (APT)

Variables	**Factor 1**	**Factor 2**	**Uniqueness**	**APT**
Organic fertilizer (ORG)	0.7215	0.2571	0.4133	0.7568
Inorganic fertilizer (INO)	0.5536	0.5404	0.4016	0.6447
Veterinary services (VET)	0.7606	-0.2527	0.3576	0.7001
Artificial insemination services (INS)	-0.0392	0.8663	0.2479	0.1231

Source: factor analysis result (2017)

Use of both organic and inorganic fertilizers and having more access to veterinary services play significant role in estimation of APT. As it is expected all the observed variables have positive correlation with APT and correlations between each variable and APT is higher whereas artificial insemination is less important (Table 11). These variables are the most import inputs for boosting agricultural production whereby food is available at household level. Often use of these agricultural inputs enables PSNP graduated households to produce more and as the result

households would have more options and enhance their capability to escape from food insecurity and relatively become more resilient to food insecurity.

3.6 Estimation Result of Resilience

The variables estimated in the previous sub-sections become co-variates in the estimation of the resilience index by assuming that all the estimated components are normally distributed with zero mean and variance equal to 1, where by a factor analysis is run using principal component factor method. In this factor analysis the first two factors, factor 1 and factor 2, are retained with an Eigen values of 2.219 and 1.071 explaining about 71.24% of the total variation (Table 12). The KMO measure of sampling adequacy for resilience is 0.707 indicating that the sample size is adequate for running factor analysis and indicating a reliable first principal component representing resilience index

Table 12. Eigen values of each factor for resilience index

Factor	Eigen value	Difference	Proportion	Cumulative
Factor 1	2.21959	1.14810	0.3699	0.3699
Factor 2	1.07149	0.08785	0.1786	0.5485
Factor 3	0.98364	0.22147	0.1639	0.7125
Factor 4	0.76217	0.17134	0.1270	0.8395
Factor 5	0.59083	0.21855	0.0985	0.9380

LR test: independent vs. saturated: chi2(15) = 276.29 Prob>chi2 = 0.0000, source: factor analysis result (2017)

As expected all the latent dimensions have positive correlation with resilience index and except access to basic services all the remaining four latent dimensions have high correlation with the resilience index (Table 13). Accordingly, income and food access, asset possession, agricultural practices and technologies and adaptive capacity are very important components in enhancing resilience. In particular, asset holding is the most important component in resilience of smallholder farmers, which represent household's level of wellbeing. Among the dimensions of resilience, APT is negatively related to the second factor implying that farmers with poor agricultural practices and technologies are less resilient to food insecurity. For instance, income

and food access has high correlation (0.85) with resilience index. For a 1% increase in the RI, the score on IFA will increase by 0.85%. Since correlation coefficients have no causal relationship inherent in their value, it is also equally valid to say that if income and food access score increases by 1%, then we would expect resilience index to be 0.85% higher. This indicates that income and food access has contributed more for the household resilience to food insecurity

Table 13. Factor loadings and their respective correlation with resilience index (RI)

Resilience dimensions	**Factor 1**	**Factor 2**	**Uniqueness**	**RI**
Income and Food Access (IFA)	0.8538	0.0298	0.2701	0.8529
Asset Possession (AP)	0.7435	0.0039	0.4472	0.7432
Agricultural Practices and Technologies (APT)	0.5160	-0.2324	0.6797	0.5212
Adaptive Capacity (AC)	0.8017	0.1082	0.3456	0.7990
Access to Basic Services (ABS)	0.0989	0.8307	0.6662	0.0800

Source: factor analysis result (2017)

3.7 Status of Resilience Across Livelihood Strategies

The analysis of resilience and its components by livelihood strategy has generated insightful results. When we compute the difference between each livelihood strategy index and the overall resilience index for the PSNP graduated households (Table 14), those households pursued both combination, farm plus off-farm plus non-farm are relatively tending to be resilient (2.436), followed by farm plus non-farm combination (0.081) while for the farm plus off-farm (-0.524) and farm alone (-0.590) is the worst. Similarly, the indices of resilience dimensions for the first two livelihood options (farm alone and farm plus off farm) are negative for the second livelihood strategy. For the livelihood option (farm plus non-farm), income and food access, adaptive capacity and access to basic services have positive indices whereas asset possession, and agricultural practices and technologies have negative indices while all the five latent components have positive indices for fourth livelihood option, combining both farm, off farm and non-farm livelihood activities.

Table 14. Resilience latent dimensions and resilience indexes for different livelihood strategies

Resilience dimensions & resilience indexes	**Y = 0**	**Y = 1**	**Y = 2**	**Y = 3**
Income and Food Access (IFA)	-0.686	-0.537	0.368	2.228
Asset Possession (AP)	-0.064	-0.308	-0.164	1.058
Agricultural Practices and Technologies (APT)	0.117	-0.341	-0.165	0.656
Adaptive Capacity (AC)	-0.888	-0.308	0.243	2.502
Access to Basic Services (ABS)	-0.124	-0.118	0.270	0.102
Resilience Index	-0.590	-0.524	0.081	2.436

Source: factor analysis result (2017)

As shown in Table 14 resilience index across livelihood strategies is different. This finding is supported by growing number of empirical evidence in the field of household resilience to food insecurity. Though, studies applying the concept of resilience to the assessment of rural livelihoods strategies in Ethiopia are limited, Frankenberger *et al*. (2007), using qualitative information obtained through rapid rural appraisal, showed that households who are able to cope with shocks that regularly plague their communities are characterized by several factors, including diversification of income sources. A similar resilience study in Tigray region (Vaitla *et al*., 2012) also found a strong and positive association between diversified income sources and household resilience. Congruent to this findings, Tesfahun (2017) found that diversified income sources as well as crop varieties have significant positive contribution to resilience has indicated that a unit increase in Shannon's income diversification index increases probability of households being resilient. Hence, households with diversified income sources are relatively more resilient than those with less diversification of income sources.

When analyzing resilience by sex of the household head, the study found that male-headed households are relatively tended to be more resilient than female-headed ones. The chi-square test shows that there is a statistically significant difference at less than 1% probability level between male and female headed households in their tendency to be resilient to food insecurity. Significant proportion of male headed households are tended to be resilient to food insecurity than their counterparts (Table 15)

Table 15 Summary of resilience category by sex

Category description	Proportion	Sex of household head			χ2-value
		Male	Female	Total	
Resilience category					
Non resilient	Frequency	93	73	166	
	Percent	56.02	43.98	100	30.15***
Resilient	Frequency	113	19	132	
	Percent	85.61	14.39	100	

4. CONCLUSSION AND POLICY PRIORITIES

Food insecurity is a main problem in the study area, one of the less favored areas of protracted crisis in Ethiopia. Climate related shocks and stressors are the major causes of rural households' food insecurity. The way a household withstands and copes with these climate related shocks and stressors depends on the preconditions and options available to them in terms of capabilities, assets and activities. The best option to address the effects of these prevailing climate related shocks and stressors is through resilience approach. Using resilience analysis framework, resilience index of this study is the function of five latent dimensions, namely, income and food access, asset possession, access to basic services, agricultural practices and technologies and adaptive capacity.

For the analysis of the resilience and its dimensions, factor analysis is run using principal component factor method and factors with Eigen values higher than 1 are retained. For income and food access (IFA) one factor is retained that explains more than 67% of the variation. Among its observed variables income, expenditure and calorie intake are positively correlated with IFA while household food insecurity access scale and coping strategy index are negatively correlated with IFA. For asset possession (AP) one factor is retained which explains more than 44% of variation and all its observed variables are positively correlated with AP. For adaptive capacity (AC) two factors are retained which explains more than 72% of variation and all its observed variables are positively correlated with AC. For access to basic services (ABS) three factors are retained which explains more than 54% of variation and all its observed variables are

positively correlated with ABS. For agricultural practices and technologies (APT) two factors are retained which explains more than 64% of variation and all its observed variables are positively correlated with APT.

The results obtained in resilience analysis are meaningful and the resilience index estimates across livelihood groups show significant differences. The resilience structure of each group is distinct, and depends on how the different components contribute to household resilience according to the options available for household livelihoods. PSNP graduated households who pursued combination of farm plus off-farm plus non-farm livelihood strategy tended to be more resilient followed by farm plus non-farm livelihood group.. Whereas the worst off are farm plus off-farm and farm alone. For graduated households who pursued the combination of farm plus off-farm plus non-farm livelihood strategy, all the latent dimensions of resilience showed positive indices, implying that diversifying income sources via the engagement in different livelihood strategies would greatly contribute and enhance household resilience to food insecurity. Therefore, enabling policy environment should be created for the promotion of income generating activities that households could have get access to off/non-farm activities to earn more income so that smallholder households would get easy access to food and ensure food security at household level.

The study also found there is the differences in level of resilience by sex of household heads. When analyzing resilience by sex of the household head, we noticed that male-headed households are more resilient than their counterparts. This is mainly associated with female-headed households' low adaptive capacity, lack of assets, lack of access to new agricultural technologies due to cultural barrier in extension services (majority of agricultural extension agents are male) and their more vulnerability to shocks and stressors. In this regard, appropriate policy intervention that should address this differences should be established based on research that aims to identify the causes of such differences.

This study employed cross-sectional household-based survey data. Accordingly, based on this data, prediction is impossible; whether a resilient household today will be less vulnerable tomorrow. For this kind of analysis, we need panel data, which our data does not allow us to do.

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