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MEASURING FARM HOUSEHOLDS' RESILIENCE CAPACITY IN TIMES OF PANDEMIC CRISIS: EVIDENCE FROM NIGERIA

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ABSTRACT
Literature documents a correspondence between production of risk and the management of risk in a local context. Quantifying the relative importance of resilience indicators is therefore at a premium in policy circles. We propose a practical methodology for estimating the ex-ante resilience capacity of farm households. We propose an index of resilience capacity that can be estimated at the household level. The composite index is constructed from indicators sourced from Nigeria's COVID-19 National Longitudinal Phone Survey (NLPS) data set. 3,000 households were selected from the frame of 4,934 households with contact details. Various household welfare indicators were analyzed using the factor component analysis and the generalized family of distance measures used for household ranking. The estimated Resilience Capacity Index (RCI) of a mean distance of 5 points and a +-1.5 standard deviation revealed a moderate farm households resilience capacity. Taken as a whole, the results from this study show that programs that build on absorptive, adaptive and transformation capacities will go a long way to strengthen the ability of agricultural households to recover from a pandemic shock. Based on these findings, the research highlights the need for development actors interested in promoting resilience in Nigeria to increase investments in strengthening access to essential services and functions like electricity, quality housing and livelihood strategies. Notwithstanding some of the analytical limitation, the essentials of resilience capacity framework have been advanced to motivate further research.

Keywords: Resilience, Pandemic, Welfare, Food security, Vulnerability, shock

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INTRODUCTION
COVID-19 Pandemic presents an unprecedented socio-economic challenge. Despite the importance, the analysis of a farm household's vulnerability and resilience to COVID-19 shock remains unexplored empirically. The aim of the paper is to develop an analytical tool (of indicators) that can be used to evaluate the resilience capacity of agricultural households using Nigeria's National data collected during the Pandemic. The farm sector plays a significant role in Nigeria's economy and many households both in rural and urban areas participate in the sector (Odozi and Uwaifo-Oyelere, 2021).

The vulnerability of farm households as well as their resilience during a pandemic has attracted increasing public and academic interest. Even though the activities of the sector were not stopped by government's containment measures, the inter- and intra-state movement restrictions impacted on farm

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inputs flow and access as well as the inability of farmers to sell their output (Adeniyi, Adetunji, Olumoyegun, Fanifosi, & Odozi, 2022). The notion of vulnerability since the time of Adger, (2006) "has become influential for defining the condition of susceptibility to risk, inadequacy, and marginality of both physical and social institutions, and for influencing normative study of behavior to increase quality of life through risk mitigation". Although, the concept of resilience has been used extensively in the climate and natural disaster literature, "there is scant literature within the sphere of economics on the measurement of individual resilience" (Asheim, 2019).

This paper is justified because, Pandemics present an unprecedented governance challenge pre and post. Prior to the Pandemic between late December 2019 and March 2020, the country experienced oil price shock characterized by a substantial decline in oil prices (Obayelu, Obayelu, Bolarinwa, & Oyeyinka, 2021). In an economy where much of government revenue is built on oil, meant a severe shock on budgetary spending on agriculture, farm input subsidy and spending on safety nets. Together with the high inflation, the effects on farm and rural households have been catastrophic. Building the resilience of households and reducing vulnerabilities will in large part be determined by how households, communities and governments are able to manage the current processes of social and economic changes.

Unlike previous papers (Josephson, Kilic, and Michler (2021); Tan, Song, and Liu (2021); Amare, Abay, Tiberti, and Chamberlin (2021);Rahman, Jian, Junrong, and Shafi (2021)), our approach to conceptualizing household resilience capacity is multidimensional and also contrast with cross country level analysis since larger scale analysis hide heterogeneous pattern of spatial and social differential. The paper is structured as follows: immediately following the introduction in section 1 is the methodology described in section 2. Results are presented in section 3 and in section 4 the discussion is presented while section 5 concludes.

MATERIALS AND METHODS

Conceptual framework and Data source

The concept of resilience is complex and difficult to measure (Bene, 2020). Several authors document operationalization perspectives namely, resilience capacity, resilience per se, resilience as normative condition and resilience as return to equilibrium (Barrett (2020);Bene (2020)

The Food and Agriculture Organization (FAO) defines resilience as the ability of individuals, households, communities, cities, institutions, systems and societies to prevent, resist, absorb, adapt, respond and recover positively, efficiently and effectively when faced with a wide range of risks, while maintaining an acceptable level of functioning and without compromising long-term prospects for sustainable development, peace and security, human rights and well-being for all(FAO, 2018). We focused on resilience capacity at the micro level viewed as a combination of attributes both observable and unobservable employed by households to mitigate the adverse effects of stressors and the consequences both short- and long-term. This analytical perspective is closely related to the view of "Social vulnerability" in Adger(1999) and Sen's notion of endowments, entilements, and rights. Several studies have used this view to guide the selection of indicators (Smith and Frankenberger (2018); Brück, d'Errico, and Pietrelli (2019)). Figure 1 presents the hypothesized correspondence between pandemic crisis and the management of risk

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via three broad resilience capacity categories of absorptive, adaptive and transformative capacities at a local level. On the basis of the available data, the absorptive capacity consists of: (1) housing quality (2) household assets (3) household farm assets. The adaptive capacity consists of: (1) safety nets, (2) household size, (3) household composition. The transformative capacity consists of: (1) access to farm inputs and labour (2) access to output market.

We relied on the Nigeria COVID-19 National Longitudinal Phone Survey (NLPS) 2020 data set in the selection of the variables (NLPS/NBS/WB, 2020). Details of the data set can be found in Josephson et al. (2021) and Amare et al. (2021). Most of the variables in our data set are binary variables except for a few that are continuous variables. These variables were normalized for the construction of household level resilience capacities. Table 1 presents the summary statistics of the selected indicators. The table also shows the Cronbach's Alpha reliability test that the results are satisfactory with an alpha of 0.75. Using the factor component analysis, key indicators and their factors were selected based on Kaiser Criterion conventional practice of Eigen value greater than one (Filmer & Pritchett, 2001), having Eigen weight greater than four (W>0.4) and together accounting for 71% variability of the original indicators.

Analytical framework

Formally, given a household i characterized by j indicators of resilience capacity potential, then r_{ij} is the value of the j^{th} indicator of the i^{th} household. Using the [1]expression:

$$\hat{r}_{ij} = \frac{r_{ij} - Minr_{ij}}{Maxr_{ij} - Minr_{ij}} \qquad \text{(eq1)}$$

$\hat{r}_{ij}$ is the normalized resilience indicator using the range approach function. r_{ij} is the original value of the variable, $Maxr_{ij}$ and $Minr_{ij}$ are the maximum and minimum values of the variables. The normalized values range from 0 to 1. Most of the indicators in our data set are binary variables except for a few indicators that were continuous variables. We sum the normalized value of the jth indicator over n households using the expression:

$$M_j = \sum_{i=1}^{n} \hat{r}_{ij} \qquad \text{(eq2)}$$

Indexing of Resilience Capacity indicators and Dimensions

In the first step, we validate the reliability and internal consistency of the normalized indicators for constructing the various sub-dimensions and dimensions of resilience capacity using Cronbach's Alpha reliability test. In the second step we generate indicator weights using the Factor Component analysis. We used the loadings of the first factor having the highest variance as weights in the construction of sub-dimensions. As noted in (Greco, Ishizaka, Tasiou, & Torrisi, 2018), the standard procedure in using FCA or PCA as a weight elicitation technique is to use the factor loadings of the first component to serve as weights for the indicators. The weights are important for ranking and aggregating indicators. As documented in Gbetibouo, Ringler, and Hassan (2010), three approaches are commonly used to assign weights namely, expert judgment, arbitrary choice of equal weight; and statistical methods such as principal component analysis or factor analysis. The development of weights via expert judgment is often constrained by the

[1] The aim of the normalization is to guarantee adequate comparison and aggregation between the resilience indicators by transforming the values of the original variables into 0 to 1 scale.

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availability of expert knowledge and the difficulties in reaching a consensus on the weights among expert panel members. Hence the choice of FCA as our weighting technique. Further we used the regression equation:

$$RCI_{ik} = \beta_0 + \sum_{i=1}^{n} \beta_1 X_i + \sum_{i=1}^{n} \beta_2 Z_i + \varepsilon$$

(eq3), where RCI_{ij} is a household i resilience capacity in dimensions k, to test the statistical significance of the identified indicators in explaining our hypothesize Resilience Capacity dimensions. The results are not presented in this paper.

Construction of the Composite Index (RCI) and ranking of agricultural households

We used the generalized family of distance measures in Zelany (1974) and as applied in Reig-Martínez, Gómez-Limón, and Picazo-Tadeo (2011) to construct Resilience Capacity Index (RCI) expressed as:

$$d_i = \left[\sum_j^J w_j^p (\hat{r}_j^* - \hat{r}_j)^p\right]^{1/p}$$

(eq4)

Where d_i is the distance to a reference score of the i^{th} household. w_j is the weight of the j^{th} indicator while $\hat{r}_j$ is the normalized value of the j^{th} indicator. $(\hat{r}_j^* - \hat{r}_{ij})$ is the deviation from the reference score. p the distance metric parameter (a constant). Eakin and Bojórquez-Tapia (2008) applied the ‘‘compensatory mode,’’ whereby the parameter p=1 was applied. This means a reduction in the distance to the reference point in one indicator can be compensated by an equivalent increase in another indicator. Thus, the extent of capacity of any household is defined in terms of the distance from the reference point (the greater the distance, the higher the capacity) and therefore used as a ranking index. We analyzed the estimates using graphs.

RESULTS

Figure 2 shows the distribution and ranking of agricultural households on the basis of the RCI using the box and whisker plot. Agricultural households are classified across three categories of low, moderate and high resilience capacity. Each category consists of the lower (p25), median (p50) and upper (p75) quartiles of the distribution. Each category has minimum and maximum values linked by whiskers extending respectively from the lower and upper quartiles to the values. From Figure 3, the distribution of the moderate capacity group is symmetrical while the low and high-capacity groups are positively and negatively skewed respectively. The Low resilience capacity category is characterized by a distance of less than four (RCI < 4), the moderate capacity (Distance < 6) and high capacity (Distance 6+). The estimated mean RCI across households is a distance of 5 points with a +-1.5 standard deviation. The result suggests an average moderate farm households’ resilience capacity. Figure 3 shows the distribution of agricultural households by key resilience capacity indicators and the composite RCI. The idea is to show how the indicators are linked to the index as a robustness check.

DISCUSSION

Capacities to manage Pandemic crisis at local levels depend on local conditions and farm households’ endowments. Institutions influence local conditions and also shape the extent agricultural households are able to deploy their resources in the event of shock and vulnerability. The selected indicators for the construction of the resilience capacity index reflect key functionality of farm

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households and the growth of the agricultural sector in Nigeria. These key indicators are employment diversification, quality housing, ownership of land, financial inclusiveness, ownership of farm productive assets, human capital, non-farm employment opportunities, access to input and output markets, access to information and electricity infrastructure and safety nets. From Figure 2, while 29% of agricultural households are ranked in the low-capacity category, 44% of agricultural households fall into moderate resilience capacity while 27% into high resilience capacity. It becomes important to strengthen the resilience capacities of agricultural households to move from low and moderate to high resilience capacity. Results from figure 3 showing the variation of the three categories of resilience capacity across agricultural household resilience indicators revealed that households with diversified income such as rental income and remittances have relatively moderate to high resilience capacity. Households who received assistance have low to moderate resilience capacity. Large percentage of households with large and small ruminants have relatively low resilience capacity.

Households that have diversified income sources and livelihood arrangements are more likely to bounce back quickly against shock impacts. Furthermore, the livestock holding of farm households serves as wealth and as a means of transportation and therefore a predictor of a household resilience. Asset holding, including land and livestock holding help farm households to diversify income sources, critical for enhancing a household resilience capacity. It has been shown that households who have access to basic public services are more resilient than their counterparts. Underdeveloped infrastructure is a driving cause for insufficient access to public services, minimal market integration and little returns on investments Bird, Higgins and Harris(2010) . The limitation of the data used for this paper did not allow the evaluation of other elements of infrastructure except for electricity connectivity. Having said that, geographically isolated communities who live distant from the main road and local market experience minimal access to inputs, market exchange, information as well as livelihood diversification opportunities Tesso, Emana, and Ketema (2012). As noted in the paper in Asmamaw, Mereta, and Ambelu (2019) land asset for farming and the amount owned is a predictor of a household' resilience to shock impacts. Brück et al. (2019) and other authors have evidenced the association between access to basic services before a shock and the rate of recovery after the shock and how access to basic services can contribute to the reduction of illness risk. Productive assets contribute to the income-generating process; they can also be sold to protect consumption in the case of shocks. Social safety nets whether formal or informal, cash or in-kind - can act as insurance mechanisms before the occurrence of a shock, or can be activated after a shock has taken place. Taken as a whole, the results from this study show that programs that build on absorptive, adaptive and transformation capacities will go a long way to strengthen the resilience of farm households. Based on these findings, the research highlights the need for development actors interested in promoting resilience in Nigeria to increase investments in strengthening access to essential services and functions like electricity, quality housing and livelihood strategies.

CONCLUSION

The correspondence between risk production and the management of risk in a household is well acknowledged (Eakin, 2005). Capacities to manage Pandemic crisis at local levels

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depend on local conditions and farm households' endowments. Institutions influence local conditions and also help to shape the extent agricultural households are able to deployed their resources and endowments in the event of vulnerability and shock. We propose an index of resilience capacity that can be estimated at the household level. This composite index comprises three dimensions, absorptive, adaptive and transformative capacities which attempt to capture comprehensively the nature of a farm household Resilience Capacity. Each dimension is constructed from indicators, whose estimation is based on Nigeria COVID-19 National Longitudinal Phone Survey (NLPS) data set collected by the National Bureau of Statistics in 2020. We find the Absorptive Capacity (APC) of a household as the key driver of Resilience Capacity Index (RCI). From the results the estimated mean RCI across households is a distance of 5 points and a +-1.5 standard deviation. The result suggests on average a moderate farm household's resilience capacity. While 29% of households are in the low-capacity category, those in moderate and high capacity are respectively 44% and 27% in high resilience capacity category.

Our results shed light on important indicators for local level vulnerability programming in times of COVID-19 Pandemic. This study is however limited in a number of ways. First our approach is often fraught with controversies of over simplifying the underlying conditions. Secondly, since indicators of resilience are dynamic there is the problem of how to capture the drivers of adaptive capacity accurately. Also, some of these indicators may change over time. For example governance creates other dimensions of uncertainty. It is often impossible to precisely project change in resilience capacity over time since it depends on a range of socio-economic variables for which there are specific uncertainties.

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APPENDICES

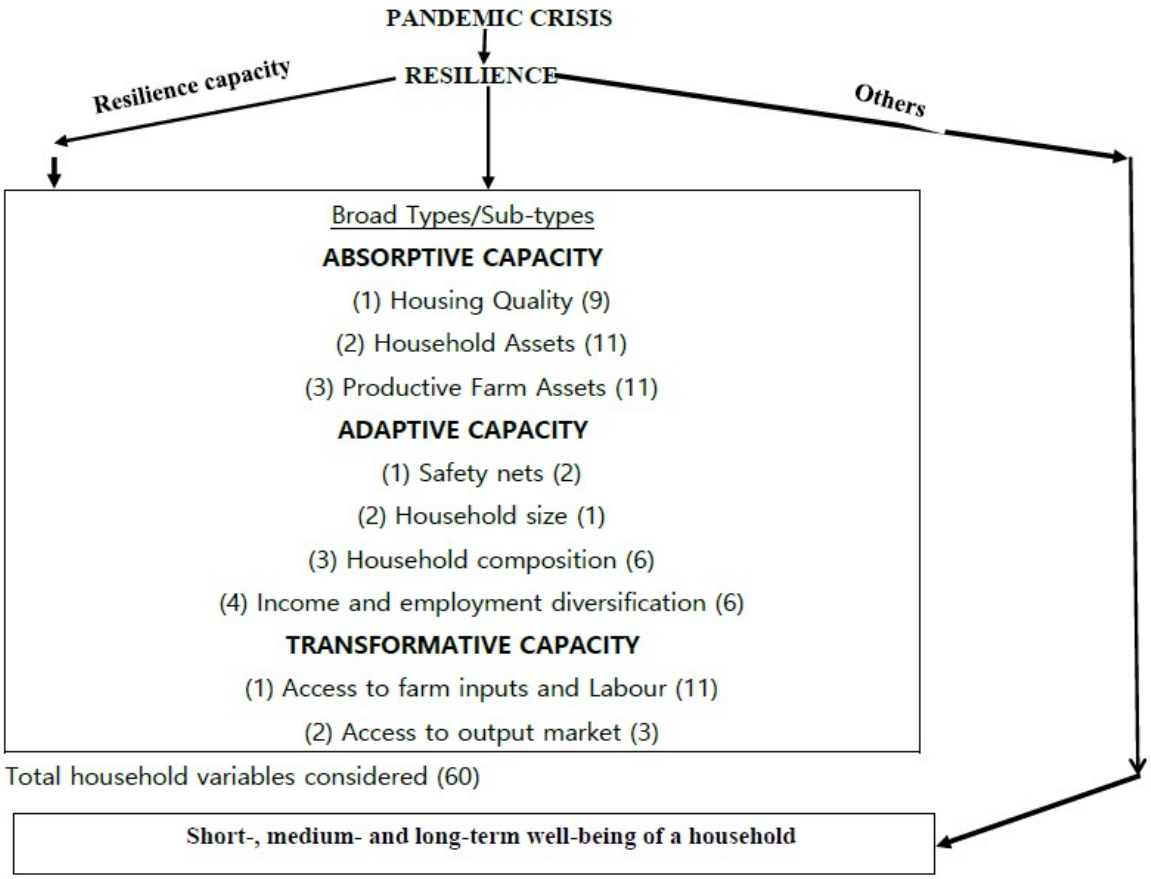

Figure 1 Conceptual framework of resilience capacity

Source: Authors conceptualization

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Table 1. Summary statistics

Resilience Indicators	Original Values		Normalized values		FCA	Alpha Test	
	Mean	Sd.	Mean	Sd.	Weights	Alpha	Signs
Ownership of Dwelling	0.607	0.489	0.607	0.489	0.399	0.752	+
Modern exterior wall	0.636	0.481	0.636	0.481	-0.671	0.740	-
Connection of Electricity	0.642	0.48	0.642	0.48	-0.537	0.744	-
Ownership of Television	0.553	0.497	0.553	0.497	-0.605	0.747	-
Total land size owned	0.677	1.245	0.06	0.11	0.564	0.764	+
Total land size cultivated	0.784	1.323	0.058	0.099	0.548	0.765	+
Consumption quintile	3.154	1.404	0.539	0.351	-0.583	0.750	-
Account from Fin. Institution	0.609	0.488	0.609	0.488	0.426	0.757	-
% working adults	65.037	33.389	0.65	0.334	0.541	0.767	-
% working adults in agric	27.601	36.6	0.276	0.366	0.447	0.797	-
% working adults in Non farm	30.868	34.477	0.309	0.345	0.695	0.767	-
Ownership of Non farm Ent	0.607	0.489	0.607	0.489	0.55	0.780	-
Sale of Crop	0.637	0.481	0.637	0.481	0.758	0.770	+
Sale of unprocessed crop	0.064	0.245	0.064	0.245	0.748	0.769	+
Ownership of Livestock	0.441	0.497	0.441	0.497	0.512	0.737	+
Ownership of large ruminant	0.089	0.285	0.089	0.285	0.498	0.757	+
Ownership of small ruminant	0.322	0.467	0.322	0.467	0.509	0.744	+
Ownership of poultry	0.273	0.446	0.273	0.446	0.408	0.758	+
Household size	5.52	3.357	0.161	0.12	0.719	0.766	+
Number of males 15 to 64yr	1.384	1.127	0.173	0.141	0.56	0.770	+
Number of females 15 to 64	1.542	1.109	0.154	0.111	0.556	0.769	+

Source: Authors' estimates

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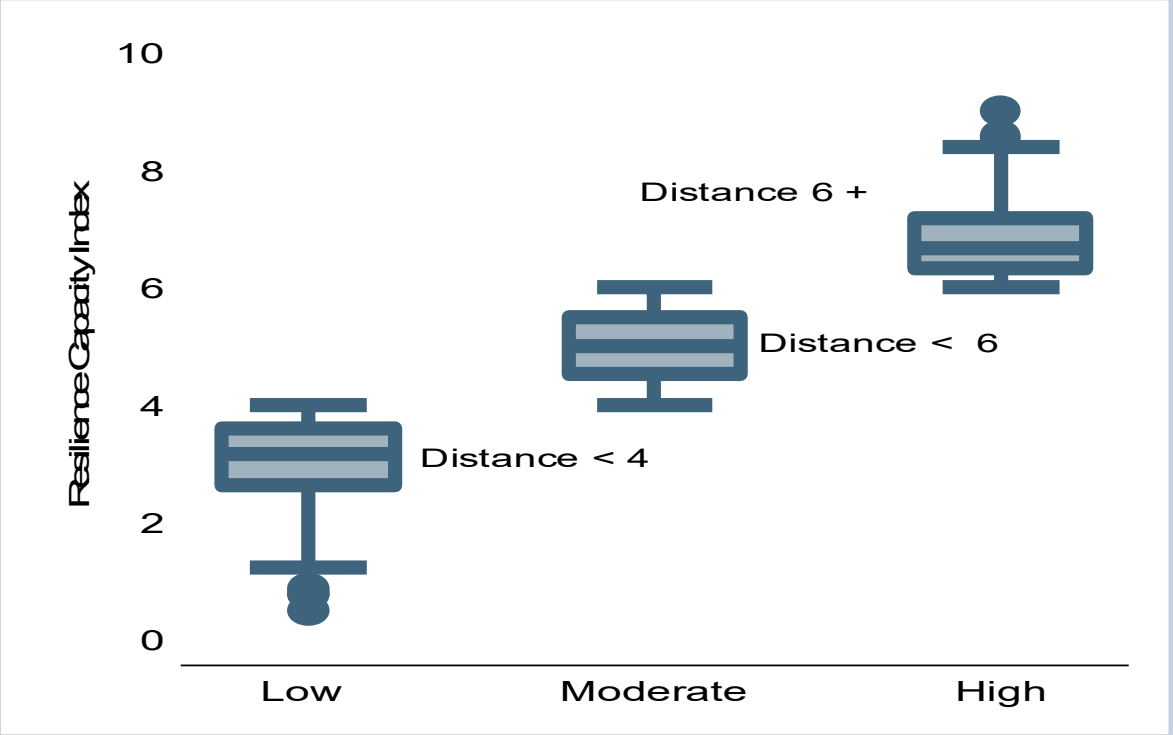

Figure 2 Box plot of resilience capacity categories

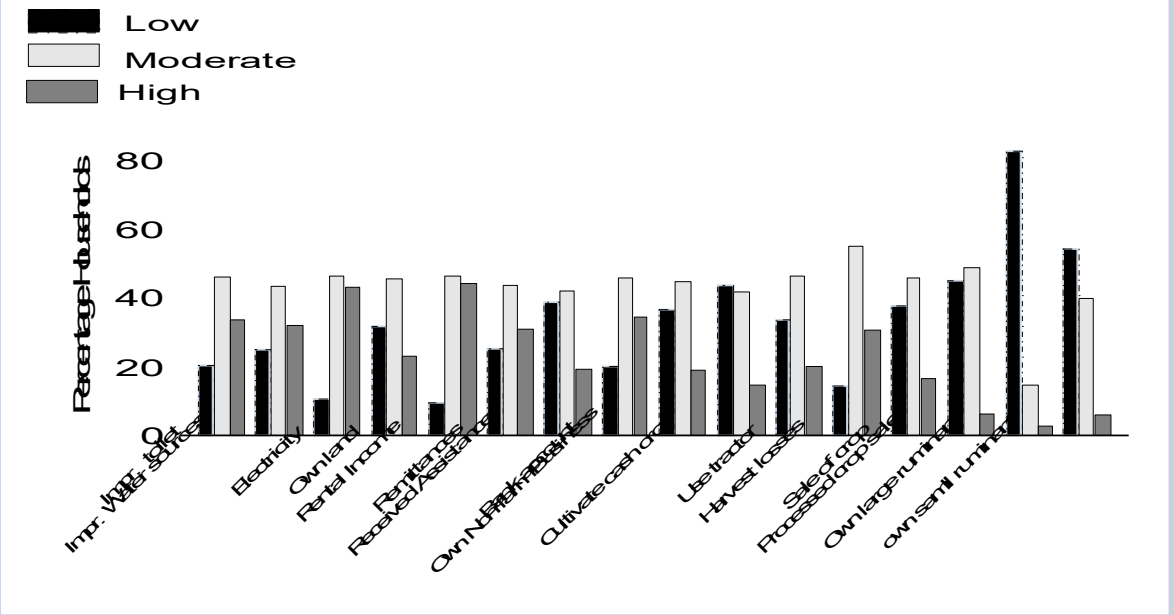

Figure 3 characterization of classes of resilience capacity across farm household characteristics