Determinants of economic vulnerability among female-headed households in central Kerala

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Abstract
Women constitute a disproportionate share of the poor and hence are likely to be extremely vulnerable to the effects of climate change. This study aims to analyse the economic vulnerability of women to extreme weather events and its determinants. It was carried out in the agricultural households of Mala and Vellangallur blocks of Thrissur district in Kerala, which were heavily flooded during the Kerala floods of 2018. Economic Vulnerability Index (EVI) of male and female-headed households were estimated by modifying the ASPIRES Economic Vulnerability Tool. It was found that female-headed households had a greater economic vulnerability compared to male-headed households. Logistic regression analysis was carried out to study the determinants of economic vulnerability. The results suggested that while natural disasters and dependency ratio positively influenced the economic vulnerability, high school education, assistance from local government, family size and agricultural diversification index were found to negatively influence the vulnerability.

Keywords: Climate change, Economic vulnerability index, Extreme weather events, Female-headed households, Kerala floods.

Introduction

Disaster induced economic damage has been increasing in the past few decades and is likely to continue growing because of population growth, urban development and changing land use pattern(IPCC, 2012).Women constitute a disproportionate share of the poor and hence are likely to be extremely vulnerable to the effects of climate change (Hemmati and Rohr, 2007). Around 70 per cent of the 1.3 billion people in developing countries living below the poverty threshold are women. Globally, more than 400 million women engage in farm work in more than 90 countries. Agriculture being a climate sensitive sector, climate change takes a huge toll on this area. Women are usually engaged in subsistence agriculture and labor-intensive works which worsens their susceptibility to climate change (Lambrou and Piana, 2006). Hence during extreme weather events, women experience greater impacts and higher vulnerability than men. They also become economically insecure after a disaster.

Vulnerability is 'the characteristics of a person or group and the situation that influence their capacity to anticipate, resist, cope with and recover from the impact of a natural hazard'(Blaikie et al., 2003). The effects of extreme weather-related disasters are gender-biased and women experience higher

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vulnerability and greater impacts than men (Rahman, 2003). A substantial body of literature on gendered nature of vulnerability to past climate change induced disasters throws light on how women and men are differently affected.

There are four types of impacts of disaster which affect women participation in economic life. First, women become economically insecure after a disaster. Second, the working conditions of women deteriorate. Third, increase in the responsibility and workload of women. Fourth, women take considerably more time to compensate for the economic losses caused by the disaster than men. Also compared to men, women are poorer, have less ability to buy and own land and access financial resources like credit, savings or pensions. They have less access to developing entrepreneurial skills, and are paid less if at all paid. Hence, their income is less secure (Enarson, 2000).

According to Parida et al. (2018), floods are the most common natural hazards in the state and Kerala stands fourth in the country in state-wise vulnerability to floods. The floods witnessed by Kerala in August 2018 which affected millions of people and caused 400 or more deaths is also an example of extreme weather event caused by climate variability.

About 16 per cent of families in Kerala, are female-headed as there is large outmigration from Kerala to Middle East countries not all of which are high-income groups. In such situations, women must manage the household and homestead matters single handedly. According to 2010-11 Agricultural Census, the total area of female operational holdings in Kerala is 2, 29,426.75 hectares accounting to 12.7 per cent of the total operational holdings(GOK, 2019). Hence, this study tries to relate gender and economic vulnerability of agricultural households on behalf of the Kerala floods of 2018. It was carried out in Mala and Vellangallur blocks of Chalakudy River Basin which was one of the most heavily flooded regions of Thrissur district.

Materials and Methods

Two blocks of Thrissur district, Mala and Vellangallur which are located in the Chalakudy river basin and that were heavily flooded during the Kerala floods of 2018 were selected for the study. The study was conducted among those agricultural households which were relatively poor i.e, BPL (Below Poverty Line) card holders. It was required that at least 20 per cent of their total income was from agriculture and allied sectors. The extent of agricultural losses due to floods from each panchayat of the selected blocks were found from the respective Krishi Bhavans and accordingly the number of agricultural households to be surveyed from each panchayat was decided. Sample size of the survey was 150 with 75 households each from the two blocks. The households were selected through simple random sampling method from the lists provided from the Krishi Bhavan and the Panchayat. Those samples in which men were involved in agriculture and were the head of the household were taken as male-headed households (MHH). Those samples in which men were away or bedridden or the women were either a widow or separated, were considered as female-headed households (FHH). The primary data was collected by a household survey and the secondary data was collected from various government departments.

Economic vulnerability is a complicated concept to measure (Kamanou & Morduch, 2002). It requires estimating a future state of economic status based on measuring known risks as well as known protective factors, or sources of resilience. Although there is a robust literature on the sources of economic or livelihood vulnerability emerging from the sustainable livelihood tradition, there are too many individual sources of risk for a single measure to quantify them all. It is therefore unlikely that a single vulnerability scale can be developed to capture a broad definition of economic vulnerability (Burke et al., 2016). The best we can do is to assess the aspects of vulnerability most relevant to project objectives.

Rather than attempting to develop an economic vulnerability scale for cross-contextual use, the Accelerating Strategies for Practical Innovation and Research in Economic Strengthening (ASPIRES) project of World Health Organisation, aimed at addressing the needs of vulnerable populations, conducted an analysis to identify five main domains that can be used to develop a construct for assessing economic status. These include: ability to pay for basic needs, consistency or volatility of income, availability of liquid assets and savings, food security, and availability of protective/productive assets. Thereby, ASPIRES developed a standardized, rapid monitoring tool for assessing economic vulnerability at the household level. The primary goal of the project is to support gender-sensitive programming, research and learning to improve the economic security of highly vulnerable individuals, families and children. ASPIRES focuses on efficiently providing technical assistance to scale up high-quality interventions in consumption support, money management and income promotion. The project also focuses on the design and implementation of rigorous research to evaluate programs and inform a new understanding of best practices in economic strengthening. The tool developed by ASPIRES ensures local validity and cross-contextual comparability, and is based on the perceptions of the heads of household or adult caregivers using the local context as a reference point. A household according to this concept consists of a person or group of persons, related or unrelated, who live together in the same dwelling unit, who acknowledge one adult male or female as the head of household, who share the same living arrangements, and are considered as one unit.

The ASPIRES tool has to be analyzed individually to identify economic strengths and needs among beneficiary households. This tool was developed for and piloted in South Africa. This tool was modified to study the Economic Vulnerability Index (EVI) of male and female-headed agricultural households of Thrissur district.

The focus of EVI approach is on quantifying the strength of current livelihood systems of agricultural households as well as their capacity to alter these strategies in response to climate-related exposures. A total of 15 components were used in the tool which are given in Table 1.

The values of components were taken in such a way that a higher value indicates higher vulnerability (For example, we considered the households solely dependent on agriculture for their livelihood as more economically vulnerable and hence assigned them a value '1', while others '0'. Those households with

Table 1. Economic vulnerability index – components

Sl. No.	Components	Source	Values
1	Agriculture as the sole source of income	Modified from LVI of Hahn et al. (2009)	Binary digits
2	Average agricultural livelihood diversification index	Hahn et al. (2009)	1/1+no. of agricultural activities
3	Proportion of agricultural income to annual income	Hahn et al. (2009)	Ratio
4	Household's ability to meet its basic needs	ASPIRES economic vulnerability tool	Range (0.1-0.4)
5	Income diversity	ASPIRES	1/no. of income sources
6	Household's perception about its economic status	ASPIRES	Range (0.1-0.4)
7	Frequency of income availability	ASPIRES	Range (0.1-0.4)
8	Ability to handle financial stress	ASPIRES	Range (0.1-0.5)
9	Debt	Anderloni et al. (2012)	Debt in rupees/10,00,000
10	Liquid assets	ASPIRES	Range (0.1-0.4)
11	Savings	ASPIRES	Range (0.1-0.4)
12	Productive assets	ASPIRES	Range (0.1-0.3)
13	Last time the household experienced a shock	ASPIRES	Range (0.1-0.5)
14	What was the shock	ASPIRES	Range (0.1-0.3)
15	Household recovery status from shock	ASPIRES	Range (0.1-0.4)

greater income diversity were considered less economically vulnerable. By taking the inverse of this component, we created a number that assigns higher values to households with a lower number of livelihood activities). As each of the components was measured on a different scale, it was first required to standardize each as an index. For this conversion, the following equation was adopted:

$$Index_{S_g} = \frac{S_g - S_{min}}{S_{max} - S_{min}} \qquad (1)$$

where, S_g is the original component for gender g and S_{min} and S_{max} are the minimum and maximum values, respectively, for each component determined using data from both male and female-headed households.The samples of data for male and female-headed households were tested for their significance using Mann-Whitney U test before estimating the index. The Mann-Whitney U test, which is also known as the Wilcoxon rank sum test, tests for differences between two groups on a single, ordinal variable with no specific distribution. It is conceptually similar to the t-test for determining whether two sampled groups are from a single population. When data do not meet the parametric assumptions of the t-test, the Mann-Whitney U test tends to be more appropriate.

The standardized components were averaged using Eq. (2) to calculate the Economic Vulnerability Index.

$$EVI_g = \frac{\Sigma_{i=1}^{n} = index\ S_g i}{n} \qquad (2)$$

The factors contributing to the economic vulnerability of male and female-headed households were found using logit model. The prediction is based on the use of one or several predictors which may be numerical or categorical. The equation of the model is explained below-

$$P_i = E(Y=1/X_i) = \frac{1}{1+e^{(\alpha+\beta i\, Xi)}}$$

Where,

P_i → probability
X_i → vector of independent variables
$\beta_i s$ → coefficients to be estimated

$$P_i = \frac{1}{1+ e^{-zi}} = \frac{e^{Zi}}{1+ e^{Zi}}$$

Where,
$Zi \rightarrow \alpha+\beta X_i$

$$1 - P_i = \frac{1}{1+ e^{zi}}$$

This is the probability of respondent to be categorized as less vulnerable for a given set of independent variables. Rearranging,

$$\frac{P_i}{1 - P_i} = e^{zi}$$

Taking logarithm on both sides,
$Li = \text{In}\ (Pi/1\text{-}Pi) = Zi$
$= \alpha + \beta iXi$

L is called the logit.
In the present study, the model is
$Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6$

Where,
α → the intercept
β → coefficient of subsequent variables
The dependent and independent variables used in the model and their units are given in Table II.

Among the independent variables, Dependency ratio gives an idea about the dependent population in the household. It is the ratio between the number of members in the household of the age group below 15 and above 65 years and those between 15 to 65 years.

The analysis was done in R 3.6.3 package.

Results and Discussion

The components which showed significant differences within MHH and FHH in Mann-Whitney U test were only chosen for estimating the

Table 2. Dependent and independent variables used in logit model

Sl No.	Variables	Unit
1	High school education (X1)	1- Head has at least high school education 0- Head doesn't even have high school education
2	Dependency ratio (X2)	Range: 0-3
3	Local govt. assistance (X3)	1-The household has received help from the local govt. at least once in the past 12 months 0-The household has not received any help from the local govt. in the past 12 months
4	No. of family members (X4)	Number
5	Households solely dependent on agricultural income for livelihood (X5)	1- Solely dependent 0- Not solely dependent
6	Average agricultural livelihood diversification index (X6)	Range: 0.2-0.5
7	Number of natural disasters that have occurred in the area in the past 6 years (X7)	Number
8	Economic vulnerability (Y)	1-High vulnerability 0-Low vulnerability

Economic Vulnerability Index as indicated in Table 3.

Female-headed households were found to have a greater Economic Vulnerability Index (0.47) compared to male-headed households (0.40) which implies that women were more economically vulnerable to extreme weather events. This is because except for three components, FHH were more vulnerable than MHH in all other components. The values of each component used in the calculation of EVI are given in the Figure I. In the figure, higher value means higher vulnerability.

The overall debt, larger share being agricultural loans, was also higher among the MHH (0.18 versus 0.12 in FHH). However, in all the remaining components, FHH were found to be more vulnerable.

Female-headed households had lower agricultural diversification which is attributed to their limited land holding size and lack of time to handle multiple sectors along with household chores which would prevent them from ensuring a fixed income all the time. This makes them more vulnerable (0.48) in this component compared to men (0.46). The overall income diversity was also lower among the FHH (1.46 versus 1.44 in MHH). This was because many of the male farmers had alternative jobs and most

Table 3. Results of Mann Whitney U test

Sl No.	Component	P-value
1	Average agricultural livelihood diversification index	0.0497
2	Proportion of agricultural income to annual income	0.0009
3	Household's ability to meet its basic needs	0.00029
4	Income diversity	0.047
5	Household's perception about its economic status	0.0057
6	Frequency of income availability	0.003
7	Ability to handle financial stress	0.00527
8	Debt	0.029
9	Liquid assets	0.049
10	Savings	0.0277
11	Productive assets	0.0384
12	What was the shock	0.044
13	Household recovery status from shock	0.0473
14	EVI	0.041

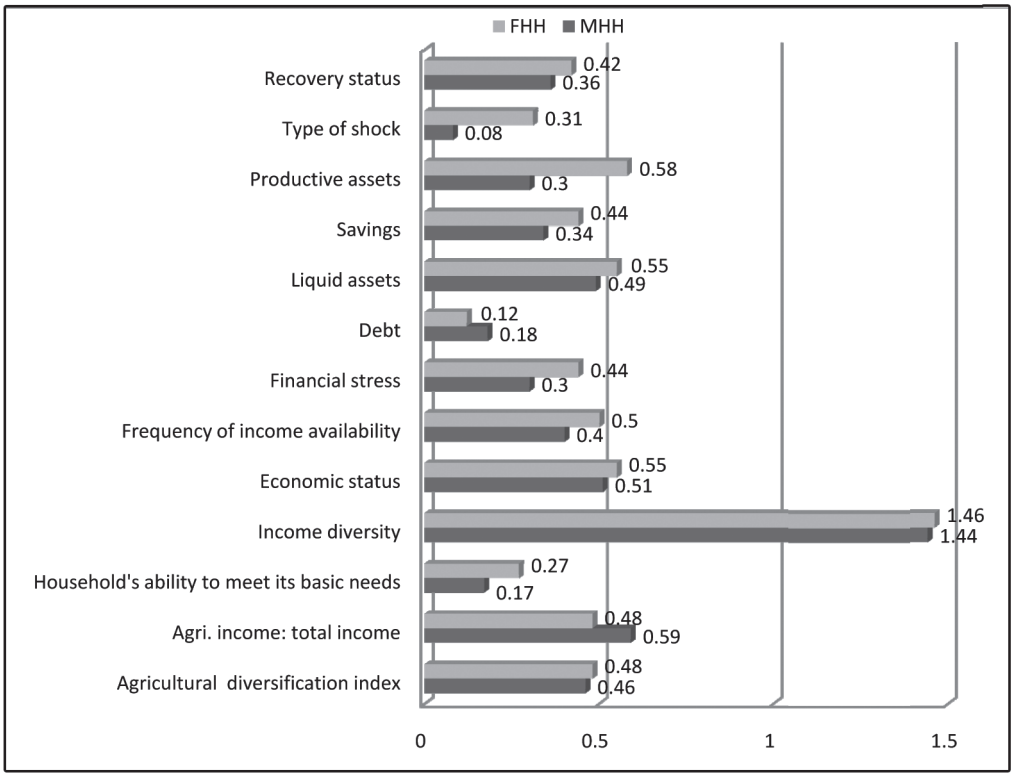

Figure 1. Bar graph showing values of components inEVI. In the diagram, higher the value of the component, higher is the vulnerability. It can be seen that out of the 13 components, female-headed households (FHH) were more vulnerable in most of them.

of them possessed larger assets compared to female farmers whose livelihood activities were mostly restricted to farming alone.

When asked about the household's ability to meet their basic needs, most of the FHH responded that they were only able to pay for food and shelter and struggled to make lump sum payments for health and education expenses whereas it was better among the MHH (0.27 versus 0.17 in MHH).

While both MHH and FHH admitted that their farm income changed dramatically depending on the season, FHH were found to be more vulnerable in their frequency of income availability because of less diversified agriculture (0.50 versus 0.40 in MHH). It was also found that the ability of FHH to handle financial stress was lower compared to their male counterparts (0.44 versus 0.30 in MHH). Many of them reported that if their primary source of living was lost, they had to rely on family for support.

Liquid assets include cash savings and assets used as savings instruments. These types of assets are critical for covering sudden or emergency expenses. Liquid assets in FHH were much lower compared to MHH which has also contributed to their greater economic vulnerability (0.55 versus 0.49 in MHH). Most of the households also lost their major liquid assets during the floods. When asked about their cash savings, most of the respondents told that they were struggling to make ends meet and hence could not afford to save money. Some MHH told about savings in chit funds. Most of the FHH had lower land holding size and lesser diversification in agriculture and therefore their productive assets were also lower compared to that of their male counterparts (0.58 versus 0.30 in MHH).

For most of the households, the flood of 2018 was the last major shock that they experienced which resulted in largescale economic loss. Some households even experienced floods in 2019 but it wasn't as severe as the previous one. However, among FHH, there were widows and also women looking after ill or bedridden husbands and they narrated those incidents as the major shock that have ever happened in their life. The current crisis caused by Covid-19 (Coronavirus disease 2019), in job sectors and economy has also created uneasiness in the livelihood of most of the respondents. MHH complained about their inability to sell products in local markets during times of country-wide lockdown. A female head reported about her son loosing job from abroad (a Gulf country) due to the economic crisis brought in by the pandemic. Cases of job loss from Middle East countries due to the pandemic have severely affected FHH as they were their main sources of economic support during times of extreme weather events. Hence, FHH were found to be more vulnerable with respect to this component (0.31 versus 0.08) contributing to their greater economic vulnerability.

However, MHH showed greater vulnerability on the debt component. While only 75 per cent of the FHH had loans, it was 86.4 per cent among MHH. Average credit per farmer was 2.67 lakhs in MHH compared to 2.04 lakhs in FHH. Most of the male heads also took possible loans in their wives' name from their social groups like Kudumbashree for general household purposes. For instance, truss work was done on the upper storey in a house after the 2018 floods by availing loan from Kudumbashree. On the other hand, FHH were found to be hesitant to take loans of large sums.

Altogether, FHH were found to be having a greater economic vulnerability compared to MHH due to the reasons discussed above.

The determinants of economic vulnerability of FHH are given in Table 4. 'High school education' was found to negatively influence the economic vulnerability i.e., those farmers who had at least high school education were less economically vulnerable compared to those without high school education. 'Assistance from local government' was also found to influence the economic vulnerability negatively which means that support from the local government during times of a natural disaster can reduce the economic vulnerability. 'Natural disasters' also influenced the economic vulnerability of the households positively which means greater the number of natural disasters, greater the economic vulnerability. 'Dependency ratio' may be significant because of the presence of some widows among the FHH. It was found to positively influence the economic vulnerability of FHH which means greater the dependency ratio of the household, greater is their economic vulnerability. 'Family size' was found to negatively influence the economic vulnerability of FHH. It can be interpreted that a larger family size means larger number of earning members for the family which would reduce their economic vulnerability. 'Agricultural diversification index' also negatively influenced the economic vulnerability of FHH owing to their lower agricultural diversification.

Table 4. Logit estimates for Economic Vulnerability in female-headed households

Variable	Coefficient	Standard error	Wald statistic	Odds ratio
High school education	3.60*	1.77	2.04	9.98
Dependency ratio	1.46*	0.80	1.81	4.30
Local government	-3.21*	1.43	-2.25	4.04
Family size	-1.35*	0.57	-2.37	2.60
Agriculture as the sole source of income	37.37	9147.50	0.004	1.70
Agricultural diversification index	-14.28*	7.36	-1.94	6.28
Natural disasters	2.52**	0.89	2.84	1.24
McFadden's Pseudo R-square	0.66			

***Significance at 1% level, **Significance at 5% level, *Significance at 10% level

Table 5. Logit estimates for Economic Vulnerability in male-headed households

Variable	Coefficient	Standard error	Wald statistic	Odds ratio
High school education	1.93*	0.94	2.05	6.92
Dependency ratio	0.53	0.48	1.10	1.70
Assistance from local government	-1.60*	0.82	-1.94	0.20
Family size	-0.32	0.42	-0.76	0.73
Agriculture as the sole source of income	4.58*	2.07	2.22	97.48
Agricultural diversification index	-0.07	3.88	-0.02	0.94
Natural disasters	2.48**	0.80	3.10	11.91
McFadden's Pseudo R-square	0.52			

***Significance at 1% level, **Significance at 5% level, *Significance at 10% level

The determinants of economic vulnerability of MHH are given in Table 5. Apart from 'high school education', 'assistance from local government' and 'natural disasters', the economic vulnerability of MHH is also determined by 'agriculture as the sole source of income.' This is because, agriculture being a climate sensitive sector, greater reliance on it will increase the economic vulnerability of the household.

Kerala encountered the most disastrous floods in its history since 1924, between June 1st and August 19th of 2018. As the torrential rainfall and associated storm thrashed the state, the entire state got buried under water with only few areas remaining above water. The combined precipitation received by the state during this period was 42 per cent in excess of the typical normal. The exceptional spell of rainfall inflicted heavy damage on the life and properties of thousands of people in the state. A large number of agriculture dependent rural households, most of which are involved in subsistence agriculture, were found to have borne the brunt of the unprecedented deluge as it vandalized the agricultural fields. It is in this context that the present study was undertaken. It was carried out in the BPL agricultural households of Mala and Vellangallur blocks in Thrissur district.

The objectives of the study were to analyze the economic aspects of women's vulnerability to extreme weather events and the components which contribute to the vulnerability as well as to study the adaptation strategies undertaken by the rural households. Both primary as well as secondary data were used for the study, however, the study was based mostly on primary data. Primary data was collected from the respondents using pretested structured interview schedule through personal interview method for studying the economic vulnerability of male and female-headed households as well as the adaptation strategies undertaken by them. The secondary data regarding the list of BPL farmers in the selected panchayats were obtained from the respective Panchayats and Krishi bhavans. A Mann-Whitney U test was done to find out whether there is significant difference between the male and female-headed households.

The economic vulnerability of male and female-headed households were estimated by slightly modifying the ASPIRES Economic Vulnerability tool. The results showed that female-headed households were more economically vulnerable with a value of 0.46 compared to 0.40 in male-headed households.

Logistic regression analysis was carried out to study the determinants of economic vulnerability. High school education, dependency ratio, assistance from local government, family size, agriculture as the sole source of income, agricultural diversification index and natural disasters were found to have significant influence on the male and female-headed households becoming economically vulnerable. The results suggested that while natural disasters and dependency ratio positively influenced the economic vulnerability of female-headed households, high school education, assistance from

local government, family size and agricultural diversification index were found to negatively influence the vulnerability.

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