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Analysis of gender differences in resilience to drought in rural households of lay Gayint district, Ethiopia

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Abstract
The occurrence of climate induced shocks such as drought has increased its severity and affects the livelihood security of people indiscriminately. However, there are certain groups of people who are more vulnerable and less resilient to withstand shocks. The aim of this study is to examine gender differences in resilience to drought among male and female headed rural households in Lay Gayint district, Ethiopia. Primary data were collected from 422 sample household heads through questionnaire. The study employed the FAO's econometric model to measure resilience and principal component analysis was employed to derive the resilience index. Chi-square test was used to assess the presence of statistically significant difference among different categories. P value less than 0.05 was considered statistically significant for all tests. Overall households that are non-resilient to drought in the study area were 227 (53.8%). In this study, we have found disproportion in resilience status among male headed and female headed households. Female headed households have disproportionally high non-resilient level 40 (69%) to drought compared to male headed counter parts 187(51.4%). Hence, the result revealed that resilience to drought between male and female headed households was statistically significant (p= 0.016) in which, female headed households are less resilient than male headed households in the study area. Any intervention aiming at resilience building of households in the study area should prioritize and address the vulnerability of women.

Keywords: resilience, drought, Ethiopia, Lay Gayint district, RIMA model, gender differences

1. Introduction
Climate induced disasters like drought affected millions of people. Evidences show that climate sensitive sectors like agriculture will face serious challenge due to the increase of drought risk in most parts of the Eastern Africa by 2050 [1]. Drought is one of the major climatic shocks in Ethiopia that pose a challenge on people who depend on rain-fed agriculture (about 85% of the population) for livelihood [2].

Lay Gayint district, is one of the most vulnerable areas where recurrent drought, environmental degradation, population pressure and food insecurity put all 31 rural lower administration structures *("Kebeles"*) in the district as target for Productive Safety Net Program (Lay Gayint District food security office, 2017). Moreover, there is a decreasing trend in annual rainfall in the study area [3], which is another future risk because people in the study area are dependent on rain-fed agriculture.

Resilience is a multi-dimensional concept that began to gain a growing recognition in the area of environmental hazards [4]. This is because resilience approach helps to strengthen the capacity of people who are vulnerable to environmental disasters through absorbing and adapting to changing circumstances [5].

In terms of measuring resilience, it was first applied by the Food and Agriculture Organization (FAO) in the issue of food security. There are some studies that assessed resilience in relation with food insecurity [4, 6, 7] and particularly in Ethiopia [5, 8, 11]. However, gender based analysis on resilience to drought has not been studied so far in the study area.

Thus, this study measure resilience of households to drought following FAO's econometric model. And it is particularly aiming at analyzing the gender differences in resilience to drought among male and female headed rural households in Lay Gayint district of Amhara Regional State, Ethiopia. Studies proved that in many developing countries rural women are among the most vulnerable groups [12, 13]. This is because women have limited access to information, land and other resources, than men [14]. They are also responsible for most of the unpaid tasks in the house and many of their activities are sensitive to climate such as, agriculture, collecting firewood and fetching water [15].This holds true for the study area where drought is recurrent.

As per the nature of the data the gender differences are assessed among households not within the household. It should also be noted that the male-female comparison is done only based on the data from the heads of the household, not other members of the household. Hence, identifying which categories of households are resilient to drought is crucial in providing up to date and context specific information which is vital for policy makers and development interventions to properly target and address vulnerable groups.

2. Materials and Methods
This section presents an overview of the study's research design in terms of the main datasets used, as well as their sources, types, and approaches for data analysis.

Description of the study area

Lay Gayint district is located in South Gondar Administrative Zone of Amhara Regional State, Ethiopia. It lies within 11^0 04' to 12^0 10' N latitude and 38^0 12' to 38^0 37'E and covers a total area of 1,320.31 km2 with a total population of 242,306. The topography of Lay Gayint district comprises dissected plateaus, peaked mountains, mountain ridges and deep gorges. It has wide variations of altitude ranging from less than 1500 to more than 4000 m above sea level (Lay Gayint District Agriculture Office, 2017).

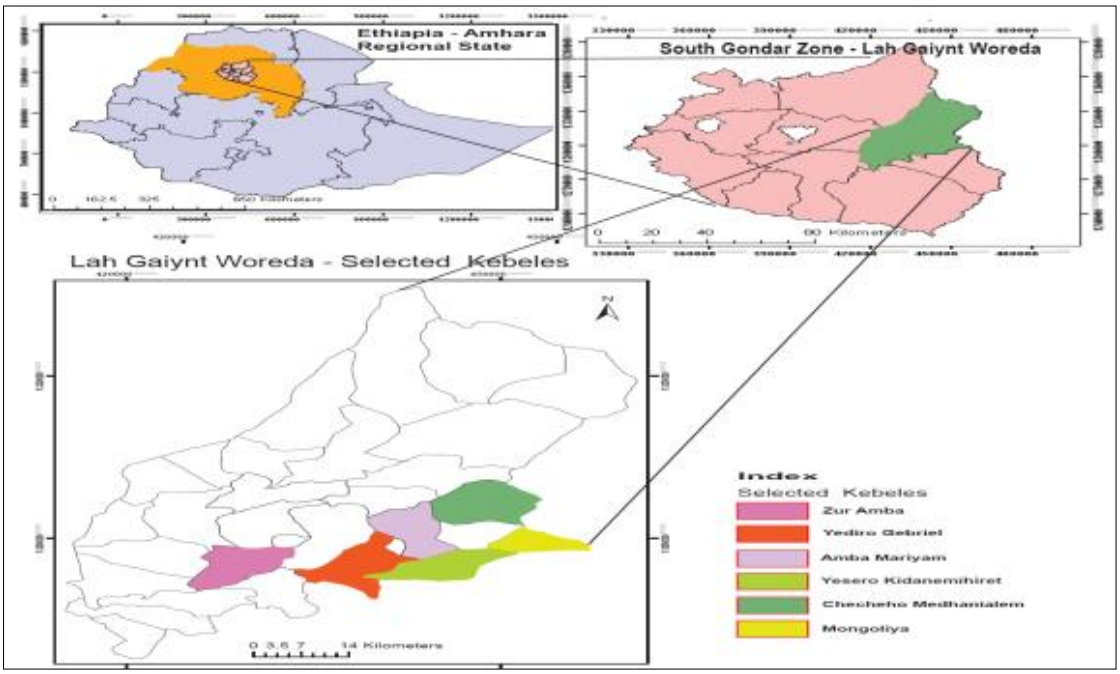

Fig 1: Map of Lay Gayint district

Sampling

The combination of stratified sampling and simple random sampling techniques are used in the selection of study site and sample households. First, all *kebeles* (lower administration unit) in the district were stratified into major agro-ecological zones (*Kolla* /lowland; *Woina-Dega* /mid-highland and *Dega* /highland. Six *kebeles* were selected: two from each agro-ecological zone, in a random sampling procedure. The assumption here is, in an agro-ecological zone, households share similar opportunities to secure livelihoods.

Then, 422 households were selected from those *kebeles* based on stratified random sampling technique for structured household survey. The sample size for this study is determined using single population proportion statistical formula:

$$n = Z^2 \frac{P(1-P)}{d^2}$$

$$n = \frac{0.5(1-0.5)1.96^2}{0.0025}$$

$$n = 384$$

Where: n=the sample size required; Z = Standard normal deviation at which corresponds to 95% confidence interval; p = estimated proportion of households resilient to drought (50%) and d=margin of error (5%). The total household in the six selected *kebeles* is 10510. Considering 10% non-response rate, the final sample size is calculated to be 422.

The data were collected from both primary and secondary data sources. Primary data were collected using structured questionnaire from household heads. Secondary data were also collected from agricultural office and other relevant government offices in the district and from books, published documents, reports and other sources.

The data generated by the structured questionnaire were entered into the statistical package SPSS (Statistical Package for Social Scientists) and analyzed using inferential and descriptive statistics. The econometric model used to determine households' level of resilience is discussed below.

Modeling resilience to drought

According to [15] resilience refers to the capacity of households to withstand the adverse impacts of climate induced shocks and econometric model called Resilience Index Measurement and Analysis (RIMA) is applied to measure resilience of each household. As stated by [6] resilience of a given household is determined by the options available to make a living. In this study, the indicators used to estimate resilience were access to public services, assets, social safety nets and adaptive capacity. 1) Access to Public Services (APS): this pillar indicates the capacity of a household to rely on suitable infrastructural needs. Access to public service is believed to be a major enabling factor for a household's capacity to manage risks and respond to disaster. In this study, the observed variables that are used to measure the household's access to public services are water, electricity, road and health center (both physical access and the availability of the service are considered for measurement indicator). 2) Assets (AST):

are main elements of a livelihood because their availability is an important means of coping in times of hardship. It includes both agricultural assets and non-agricultural assets given the rural context in study area. This pillar indicates the household's ownership of goods intended for agricultural activities and ownership of other tradable assets. The observed variables used to build this indicator are agricultural land (measured in hectares) and livestock owned by the household (TLU- a measure used in the tropics equivalent to an animal of 250 kilograms). 3) Social Safety Nets (SSN): are important pillars for resilience because they enable the household to mitigate crisis. In this pillar observed variable on access of any assistance received in the form of loan or borrowed (in kind and in cash) from local associations and international non-governmental organizations are included. 4) Adaptive Capacity (AC): this shows the capacity of a household to cope with and to adapt to a new situation and develop new sources of livelihood. Measures the ability of the household to diversify or change their main income generation source in the short term. The observed variables used to measure this dimension include: educational level, professional skills and income diversification, new practices adopted.

Estimation Procedure

Resilience as a latent variable is estimated through indicators using principal component analysis. First, each indicator is estimated separately and then resilience index is computed from the aggregated results of those indicators. The conceptual model is based on the following equation:

$$R_I = f\ (APS, AST, SSN, AC)$$

Where: R_I = Resilience Index; APS = access to public services; AST = assets; SSN = social safety nets; AC= adaptive capacity. Thus, resilience index is the weighted sum of the values generated from each indicator.

Ethical Consideration

The study was approved by the Institutional Review Board of University of Gondar. Hence, all the relevant offices at different levels were consulted for permission, and verbal consent was secured from each respondent prior to administering the questionnaire.

3. Results and Discussion

In this section, descriptive and inferential statistics as well as econometric results are presented. Descriptive statistics includes demographic characteristics of households and agricultural production system in the study area. Then, the econometric model outputs are presented to show the resilience index of households.

Socio-demographic characteristics

The mean age of the respondents was 46.6±13 years. The majorities (86.3%) of the respondents were male, because respondents in this study were household heads and in the study area male is the head of the house. With respect to educational status, more than half (58.5%) of the respondents were illiterate and only 3.3% are attending high school, indicating that inadequate literacy status among the sampled population.

Econometric model result of households resilience index

After conducting the principal components analysis, overall, the results indicate that more than half of the sampled households (both male and female headed) in the study area are non-resilient to drought.

Table 1: Summery statistics of resilience status of household head by sex in Lay Gayint District, Ethiopia, 2017.

Household head	Resilient Count	Non-Resilient Count	N	*p* Value
Male	177 (48.6%)	187 (51.4%)	364	0.016
Female	18 (31.0%)	40 (69.0%)	58	
Total	195 (46.2%)	227 (53.8%)	422	χ^2 =6.229

Table 1 shows the resilience level by the sex of household head and the results are in line with the hypothesis given in the introduction part that female-headed households are less resilient to drought compared to male-headed households. This is evidenced by the chi-square test that the difference in resilience to drought between male and female headed households was statistically significant at *p* value of 0.016. This finding is in line with the works of [4, 16, 17, 18] where female headed households are less resilient. However, studies in Sub-Saharan African context [19] and in Latin American countries [20, 22] have showed the contrary, attributing it to better income level of female headed households.

Many reasons could be listed for the low level of resilience in female-headed households in the study area. As shown by [4, 5, 18, 20] age, educational status and income diversification were factors accounting for the resilience of households. In this study as there is no statistical difference between the mean ages of male and female respondents (mean age of female household heads is 46.93±11.2 years while mean age among males is 46.5 ±13.38 years), age could not be taken as a factor in explaining the differences among the sampled households. However, there is a great variation in terms of educational status.

Low level of education among female household heads than male heads in the study area could be one of the possible explanation for the less resilient to drought status of female household heads. Table 2 shows that 74.1% of female heads are illiterate, while this is the case for 56.0% of male heads. The difference is also statistically significant with *p* value of 0.01.

Table 2: Summery statistics of the Educational status of household head by sex in Lay Gayint District, Ethiopia, 2017

Household head	Educational status		N	*p* Value
	Illiterate Count	Literate Count		
Male	204 (56.0%)	160 (44.0%)	364	*0.01*
Female	43 (74.1%)	15 (25.9%)	58	
Total	247 (58.5%)	175 (41.5%)	422	χ^2 =6.748

Education helps the household to diversify their livelihoods [14]. But high level of illiteracy in the study area may hinder the engagement of female headed households, which in turn affects their resilience to drought. This is confirmed by the findings of [23]. However, the findings of [22] revealed that high level of income among female headed households contributed

for better resilience than male heads, despite their low level of education.

On the other hand, one of the reasons that could explain lesser level of resilience of female headed households than male heads is related with diversification of income sources. Non-farm and off-farm income has a significant importance in the households' total incomes [24] which in turn contribute for the resilience of a household. This is particularly important in the study area where low agricultural productivity is the main challenge.

Table 3: Summery statistics of household head non-farm activities by sex in Lay Gayint District, Ethiopia, 2017

Household head	Participation in non-farm activities		N	*p* Value
	Yes Count	No Count		
Male	79 (21.7%)	285 (78.3%)	364	0.131
Female	18 (31.0%)	40 (69.0%)	58	χ^2=2.461
Total	97 (23.0%)	325 (77.0%)	422	

As shown in table 3, the overall engagement of households in non-farm activities is very minimal (23%). Participation of female-headed households was found better than male-headed households in the study area, although the difference between male and female is not statistically significant (p=0.131).

In addition, looking at the overall participation of the households in off-farm activities in the study area, there is even very low (10.9%) participation in both male and female households.

Table 4: Summery statistics of household head off-farm activities by sex in Lay Gayint District, Ethiopia, 2017

Household head	Participation in off-farm activities			*p* Value
	Yes Count	No Count	N	
Male	44 (12.1%)	320 (87.9%)	364	0.06
Female	2 (3.4%)	56 (96.6%)	58	χ^2=3.845
Total	46 (10.9%)	376 (89.1%)	422	

Table 4 shows that female headed households participate less in off-farm activities compared to the male-headed households. However, there is no statistically significant (p=0.06) difference between male and female household heads in off-farm activity participation. The less engagement of female headed households in off-farm activities could be attributed with their high level of illiteracy as well as limited activity of women to care for children and other household chores, which impedes them from doing productive activities. In addition, given the area is drought-prone, male tend to migrate in search of additional source of off-farm income which could also be the reason for their better participation.

Generally, about (10.9%) and (23.0%) of the households were engaged in off-farm and non-farm activities, respectively, which was very low based on the standards of Sub-Saharan Africa average at 42% [25]. This could be explained by the low level of illiteracy rate in the study area which is confirmed by the findings of [23] who found that an increase in the levels of education of the household head increases the probability of diversifying livelihood.

In summary, looking at the variation in resilience level, the proportion of male-headed non-resilient households is undeniable. As the study area is prone to drought, it affected the livelihood of all people indiscriminately. For instance, households that are able to feed their family up to next harvest with their own agricultural production are only about 17.8% from which male headed households account for 19.5% while 6.9% are female headed households. Although, this helps explain the overall vulnerability of the community in general and female headed households in particular, prioritizing only female headed households may result misrepresenting many other non-resilient groups of people in the study area.

4. Conclusion

It is concluded that there is a clear difference in resilience to drought between female and male headed households in Lay Gayint District, Ethiopia. The result revealed that resilience to drought between male and female headed households was statistically significant in which, female headed households are less resilient than male headed households in the study area. Any intervention aiming at sustainability and resilience building of households in the study area should prioritize the empowerment of women.

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