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The Livelihood Vulnerability Analysis: A Pragmatic Approach to Assessing Risks from Climate Variability and Change—a Case Study Of Livestock Farming In Karnataka, India

Letha Devi G[1], Dhirendra Varma[2], Mukund A Kataktalware[3]
[1]*ICAR-National Institute of Animal Nutrition and Physiology, Bangalore, India- 560 030.*
[2] *PhD Scholar, Indian Institute of Science, Bangalore, India.,*
[3] *Southern Regional Station, ICAR- National Dairy Research Institute, Bangalore, India - 560 030*

Abstract : *Vulnerability is often reflected in the condition of the economic system as well as the socioeconomic characteristics of the population living in that system. Assessment of current vulnerability can be done using a variety of socioeconomic indicators that capture the exposure of the population in concern. The socioeconomic status of a group is closely linked to the adaptive capacity of that particular group. Many factors contribute to social and economic vulnerability including rapid population growth, poverty and hunger, poor health, low levels of educations, gender inequality, social exclusion, fragile, marginal and/or hazardous location, resource degradation, and lack of access to infrastructure, resources and services, including knowledge and technological means. The exposed population has a limited capacity to protect themselves from natural hazards, especially from extreme events such as storms, droughts and floods. They bear the brunt of the consequences of large-scale environmental change, including land degradation, biodiversity loss, and climate change, which affect the welfare of the most vulnerable populations. Over the long term vulnerable populations have to learn to cope with the effects of climate change on their production systems. The Livelihood Vulnerability Index (LVI) was developed to estimate climate vulnerability of livestock farming in Chitradurga and Kolar Districts of Karnataka, India. One hundred and twenty households were surveyed in each district to collect data on socio-demographics, livelihoods, social networks, health, food and water security, natural disasters and climate variability. Data were aggregated using a composite index and differential vulnerabilities were compared. Results suggest that Chitradurga district may be more vulnerable in terms of water resources while Kolar district may be more vulnerable in terms of socio-demographic structure.*

Keywords: *Livelihood, livestock farming, vulnerability, climate variability, India*

I. Introduction

Fallout of climate change on environment, social ecology and livelihood need serious attention. It threatens to deepen vulnerabilities, erode hard own gains and seriously undermine prospects of sustainable development. Vulnerability to climate change varies across regions, sectors, and social groups. Understanding the regional and local dimensions of vulnerability is essential to develop appropriate and targeted adaptation efforts. We must recognize that climate change impacts will not be felt in isolation, but in context of multiple stresses.

The Intergovernmental Panel on Climate Change (IPCC) in its fourth assessment report (2007) indicated that many of the developing countries tend to be especially vulnerable to extreme climatic events and adverse impacts of a gradual climate change as they largely depend on climate sensitive sectors like agriculture and forestry. India has a geographic disadvantage as it is already in the warmer part of the world. Nearly two thirds of the Indian population is rural mostly living in harsh climatic regions of mountains, deserts and river deltas, which are more susceptible to climate change.

In the case of livestock, global warming and climate change are likely to impact negatively on production and health. Increase in physiological reactions at high temperatures will elevate heat loads of animals resulting into a decline in productivity of meat, wool, milk and draught power (Upadhyay, Singh and Ashutosh, 2008).

Livestock is an essential component of the dry land ecosystem. Grazing animals in dry lands contribute to a healthy soil through manure and seeding. It improves the soil's physical properties (porosity, water holding capacity, drainage) and its fertility (dung has high carbon : nitrogen ratio and urine is rich in 'nitrogen' and 'potassium' . Small ruminants spread the manure and urine very evenly. It is reported that a flock of 1000 sheep and goats, when spent five nights in the field can very well manure 1.32 acres of land. Almost eighty percent of milk in India is produced in integrated mixed crop-livestock farming systems. A well managed integrated crop livestock system has the potential to create a win-win situation for both farmers and the environment. However, there are two areas where livestock in India has likely negative contributions on the environment. They are: (a)

methane emission and (b) degradation of common lands. These are issues that need to be addressed through technical and policy interventions. But valuing livestock only from one perspective (environmental) in a context where it plays many roles might lead to making expensive mistakes. This is because a preponderant number of farmers in the marginal lands in countries like India are surviving only because of livestock. In these countries livestock is kept by people not just for production but because of its multiple (livelihood, social, environmental) contributions. When there was agrarian distress in India, farmers committed suicide. But no suicides were reported in areas where livestock was prominent as there was something to fall back. Livestock is found to be positively egalitarian. Therefore a more detailed and holistic assessment is required before drawing conclusions (Pasha, 2001).

The poor livestock keepers depend heavily on common property resources for their survival. At the same time there are few organised efforts for the development of common lands and its sustainable management. This is likely to have a negative impact on the land. This scenario is not inevitable, provided the poor are offered alternative options that will reduce their dependency on the common resources and that will regulate the use, enhance the regeneration and raises the productivity of common property resources. Therefore, any change in the status and productivity of common property resources directly influences the economy of the rural poor. Jodha (1992) rightly suggested certain key elements of such an approach. Some of them are: (1) introduction of technological investments and creation of economic incentives to conserve such resources while raising their productivity and (2) regulation of common resource use with the involvement of user groups and mobilization of a community strategy that complements state interventions with the essential participation of local people.

An effort was made to analyse the impact of climate change on livestock farming, in Chitradurga and Kolar districts of Karnataka state, through a combination of quantitative and qualitative methods, with the objective to assess the vulnerability of Indian livestock farming to climate variability and socio-economic impact of climate variability and to study the coping strategies of Indian livestock farmers to impacts of climate vulnerability.

II. Methodology

The Sustainable Livelihoods Approach, which looks at five types of household assets—natural, social, financial, physical, and human capital (Chambers and Conway, 1992), is an approach used to design development programming at the community level. The approach has proven useful for assessing the ability of households to withstand shocks such as epidemics or civil conflict. Climate change adds complexity to household livelihood security. The Sustainable Livelihoods Approach to a limited extent addresses the issues of sensitivity and adaptive capacity to climate change, but a new approach for vulnerability assessment that integrates climate exposures and accounts for household adaptation practices is needed in order to comprehensively evaluate livelihood risks resulting from climate change. We combined previous methods to construct a Livelihood Vulnerability Index (LVI) to estimate the differential impacts of climate change on communities in Chitradurga and Kolar Districts of Karnataka, India.

2.1 Livelihood Vulnerability Index

Livelihood Vulnerability index was developed which includes social vulnerability, infrastructure development, biophysical conditions, climate, agriculture and livestock, and transportation (Fig 1). These were combined into vulnerability indices and mapped as vulnerability profiles. Five case studies were undertaken in depth to understand their coping strategies to impacts of climate vulnerability. It was observed that there is a shift in cropping pattern and farmers themselves evolve their strategies to minimize the economic losses due to changes in climate and market changes.

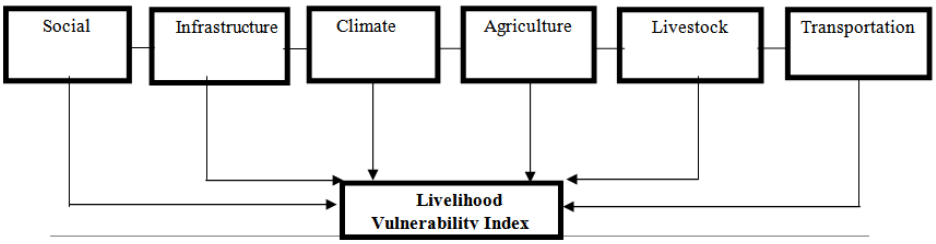

Figure1: Construction of Livelihood Vulnerability Index

2.2 Components Of Livelihood Vulnerability Index

The following components were selected for composite index, after consulting literature and experts in the field.

- Social vulnerability (social participation, access to common facilities)
- Infrastructure development (roads, health care, common facilities),

- Climate (rainfall, temperature, humidity),
- Agriculture (crops, pattern of cropping),
- Livestock
- Transportation

2.3 Development Of Livelihood Vulnerability Index

There were three major steps involved in the development of LVI, as described in detail below

(a) Determination of scale values
(b) Selection of items/ indicators of components of Index
(c) Computing the composite Livelihood Vulnerability Index

2.3.1 Determination Of Scale Values

Normalized rank method by Guilford (1954) was used for determining scale values. Different components of VI were ranked by a group of judges according to their perceived significance in determining the Vulnerability to climate change. Rankings were obtained from 36 judges who were experts in the fields of social science and climate change research. The rankings were then tabulated and a frequency distribution denoted by 'fji' was worked out for each component. For different numbers of stimuli ranked 'n' corresponding 'c' values were made available from the statistical table. Then 'fji' multiplied by the corresponding 'c' value and summated over all the ranks gave a total score '$\sum$fji ci' for each component, which was further divided by the total number of judges and the consequent value 'Ri' was subjected to linear transformation to arrive the scale value 'Rc' using the formula $Rc = 2.357\ Rj - 7.01$

Table 1: Scale values of components of Vulnerability Index

Components	Scale Value
Climate	11.53
Infrastructure development	11.44
Social/ financial vulnerability	10.16
Agriculture	9.45
Livestock	9.36
Transportation	8.13

2.3.2 Selection Of Items/ Indicators Of Components Of Livelihood Vulnerability Index

Items under each component of Livelihood Vulnerability Index were selected through expert consultation and literature scan. Content validity of items ascertained. Thirty eight items covering the different components were selected initially. The selected items were pre-tested on a sample of thirty farmers in a non-sampling area. The items, which were found irrelevant, were dropped. Thirty two items covering the different components constituted the final indicators for Livelihood Vulnerability Index

2.3.4 Computing The Composite Livelihood Vulnerability Index

Each component of Index consisted of different number of items/indicators and hence their range of scores was different. Therefore, the scores of all the seven components were converted into unit scores by using simple range and variance as given underneath.

$$Uij = \frac{Yij - Min\ yi}{Max.\ yj - Min\ yj}$$

Where,

Uij = Unit score of the ith respondent on jth component
Yij = Value of the ith respondent on the jth component
Max yj = Maximum score on the jth component
Min yj = Minimum score on the jth component

The score of each component ranged from 0 to 1 i.e. when yij is minimum, the score is 0 and when yij is maximum the score is 1. The unit scores of each respondent were multiplied by respective component scale values and summed up. The scores thus obtained were divided by the total scale value and multiplied by 100 to get the Vulnerability Index for each respondent

Different components were combined into vulnerability index

$$VIi = \frac{\sum Uij.\ Sj\ i = 1\text{-}240,\ j = 1\text{-}6}{\sum Sj} \times 100$$

Where,

VIi = Vulnerability Index of ith respondent

Uij =Unit score of the ith respondent on jth component

Sj =Scale value of the jth component

Subsequently, mean index for each group of respondents was calculated. Reliability of the index was tested using 'test- retest' method and the 'r' value 0.813 was found to be highly significant

III. Results

3.1 Vulnerability To Climatic Variability In Karnataka

Vulnerability is often reflected in the condition of the economic system as well as the socioeconomic characteristics of the population living in that system. Assessment of current vulnerability can be done using a variety of socioeconomic indicators that capture the exposure of the population in concern. The socioeconomic status of a group is closely linked to the adaptive capacity of that particular group. Many factors contribute to social and economic vulnerability including rapid population growth, poverty and hunger, poor health, low levels of educations, gender inequality, social exclusion, fragile, marginal and/or hazardous location. resource degradation, and lack of access to infrastructure, resources and services, including knowledge and technological means. The exposed population has a limited capacity to protect themselves from natural hazards, especially from extreme events such as storms, droughts and floods. They bear the brunt of the consequences of large-scale environmental change, including land degradation, biodiversity loss, and climate change, which affect the welfare of the most vulnerable populations. Over the long term vulnerable populations have to learn to cope with the effects of climate change on their production systems.

Table: Comparison of livelihood vulnerability among groups (n=240)

Village	LVI (Crop farming)	LVI (Livestock rearing)	LVI (Integrated farming)	F-value
Adilaur	58.10	57.50	56.74	0.57
Bharamapura	55.70	54.64	53.65	1.04*
Kumbarakatte	56.96	55.28	54.58	1.01*
Shahpur	56.12	54.98	54.73	0.81
Nanadanahalli	56.91	53.21	54.74	2.07**
Yaranghatta	57.12	55.58	54.64	1.99**

* Significant at 5 % level and ** Significant at 1 % level

The sample was stratified into three groups viz., crop farming, livestock rearing and integrated farming system based on the crop or livestock enterprise which they were practicing. It was observed that all the villages were vulnerable to the climate change and in general it was observed that the district Chitradurga was much vulnerable as compared to Kolar. Further, it was found that groups with single livestock species (Cattle) were highly vulnerable to climate vagaries. Integrated farming system with a few cattle, sheep/goat and livestock was found to be the least vulnerable system. Significant difference was found among integrated farming system and livestock farming system.

Most of the households reported that they suffered crop loss and loss of animals due to extreme climatic conditions. The major loss was due to field crops, which are much sensitive to climatic conditions. Vegetable crops also faced the similar issues. The most vulnerable livestock species was found to be cross bred cattle as compared to sheep and goat, which can withstand extreme weather conditions.

Animal Feeding and management were the worst affected in case of climate vagaries. In extreme climate affected situations, livestock was the first option to encash, followed by cash crops and trees. Shelter, food and basic sustenance were the most essential needs in case of climate vagaries, both for human and animal. 95% of respondents reported that meeting out the water requirement of animals was challenge during drought periods. There is very little compensation received for the loss of livestock, due to natural disasters, as is the case of crops. 98% were not able to repay the agricultural loans during climate disasters. 79% of the total respondents changed their livelihood pattern, as coping strategy to climate changes (species of crops and livestock, management practices, housing of animals etc).

The areas which were vulnerable in the earlier time continued to be more vulnerable. But the study focused changes during the past 5 years only, as collecting information through recall method is difficult for beyond 5 years period. Majority of households were affected by climate extremes and most of them carved out their own adaptation strategies, especially in case of livestock rearing. The trend in crop-livestock production shows that milk production is less susceptible to draft conditions, compared to crop production. Farmers have developed their own adaptation strategies to vagaries of nature by shifting from field crops to cash crops, adoption of scientific management practices for crops and livestock. It was observed that milk production can be sustained even under stress if population is optimized along with proper management of available feed-fodder resources. This is more important for feed-fodder deficit states like Karnataka in India.

3.2 Case Studies

Five case studies were conducted in the study area, to find out the micro level adaptation strategies for coping the impact of climate variability. In general, six measures were zeroed in as coping behaviour by the households to hedge against the shocks. They were: (i)interest free loans from friends and relatives, (ii) relief from government (iii) selling of land iv) additional loans v) selling household assets and (vi) selling livestock.

The findings are summarized in the following points:

- Households belonging to Below Poverty Line, households which own the land and those receiving medical or any other kind of aid are least likely to opt for selling of livestock.
- Most of women headed households opted for sale of household assets, whereas male headed households were not opting it as coping strategies.
- Female headed households were not opting for additional loans to cop up with losses due to climate vagaries. Similar is the case with that receiving government relief for natural disasters.
- Respondents belonging to OBC and above middle class were not receiving government relief for natural disasters, and had to resort to other coping strategies.
- Money received from friends and relatives were used mainly to cover up short fall in supply of food and other necessary items.

IV. Conclusion

The study brings out a few suggestions for helping to cop up the vulnerability of climate variability for the farmers. It requires efforts at various levels of stakeholders such as farmers, line department officials, scientists, policy makers etc. There is still lack of initiatives in the climate adaptation policies from the government agencies and most of the households believe that there has to be intervention from the government, especially in natural disasters, with respect to crops and livestock. Insurance sector also can play a vital role in this regard.

Farmers need to be trained in various aspects of coping with climate variability. Awareness has to be developed at the level of line department officials working closely with the farmers. Modern Information and communication tools should be utilized appropriately, for timely and proper dissemination of climate related information. Research organizations should work in close participation with farmers so that technologies can be developed for coping the climate challenges. Policies need to be framed, keeping emphasis on challenges posed by the changing climate.

Policy makers face a multiple issues like poverty, illiteracy, infant mortality, malnutrition, environmental pollution, provision of basic amenities, etc., so that broader issues such as climate vagaries and natural disasters get sidelined. It can be concluded that poor population find it challenging to cop up with impacts of climate vagaries. The study results may help in policy decisions in formulating effective strategies for coping up climate variability, especially in livestock sector, which contributes to more than 60% of livelihoods of rural population in India.

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