Food Insecurity in Rural India: Examining the Role of Weather Shock and Variability

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Abstract: Food insecurity is one of the major causes of concern confronting the world today. The achievement of food security is made challenging by the fact that it not only requires availability of a sufficient quantity of food but it has to be accessible, nutritious and stable over time. This challenge has got exacerbated, among others, by the changes in climatic conditions. This paper is first in its kind to measure the extent and variations of food insecurity in rural India using household level data sourced from the India Human Development Survey for the year 2011-12. It further intends to identify the determinants of food insecurity with special focus on weather shock and weather variability. The results of analysis of a binary logistic regression show that poverty, drought, mean temperature, household size and dependency ratio increase the probability of a household of being food insecure. On the other hand, temperature variability, per capita income and cultivation as the main occupation reduce the probability of food insecurity.

Key words: Food Insecurity, Weather Shock, Weather Variability

I. INTRODUCTION

The major causes of concern which confront the today's world is food insecurity which is inherently interlinked with other current global challenges of the economy. Food security is said to exist when all people at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs for an active and healthy life [1]. Though India has made significant progress over the last 50 years, most of its populations or communities have had to deal with uncertainties of food security on a daily basis year after year, most often generation after generation. With a population of 1.21billion in 2011, India is likely to be the most densely inhabited country in the world by 2030 with 1.51 billion people. In recent times, the need for achieving food security is felt significantly in India due to the heavy pressure from the increasing population. India after 66th independence has not only achieved development and progress but also has become one of the rapidly growing economies of the world. In India, the attainment of food security is of prime importance where more than one third of its population is estimated to be absolute poor, and beyond one half of its children are suffered from malnourishment over the last three decades [2]. However after the green revolution in 1960s, initiated a notable watershed that transformed the agriculture sector in India, a closer look at the experience in the last two decades indicates a decline in both production and yield [3]. Though India is one of the largest producers of food grains in the world, according to the Global Hunger Index 2013 India ranked 63rd among 120 countries. Still India is not in the condition to meet the basic food requirements of people [4]. There are many people in India who strive hard even for the square meals.

Climate change has now become one of the most important issue which has adverse effects on the lives of human and assets across the world. IPCC defines climate change as a variation in the state of the climate that can be known by changes in the mean and/or the changeability of its properties, which continues for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural discrepancy or as a result of human action [5]. Despite unsettled controversies about the extent and causes of changes in climatic conditions there is now unanimity regarding the fact the global climate has changed noticeably during the last one century. Agricultural sector which is critically dependent on the climatic factors like temperature and rainfall would be worst hit, especially in the developing countries like India. This would affect not only food security or lack of it but also exacerbate vulnerability to food insecurity. Climate change can affect food security through its impact on food availability, food accessibility, food utilization and food stability [6]. It affects productivity by increasing the frequency and severity of extreme weather events such as heat waves, droughts and floods, which wipes out harvests. In some places, even where food is available, due to extreme weather events, food cannot reach markets and for this consumers availability is limited. Climate change also challenges people's access to food by increasing and destabilizing food prices. Climate change affects the utilization of food through impacts on the quality and safety of food itself which decline its nutritional benefit and affect people's health. The climatic variability produced by more frequent and intense weather

events can upset the stability of individual's and government's food security strategies, creating fluctuations in food availability, access and utilization [7]. The objective of this chapter is to examine and quantify the extent of food insecurity in rural India and its variations across states and union territories, and various social and religious groups. It further intends to examine the impact of weather shock and variability on food insecurity along with the determinants of it in rural India. In this study, household level food insecurity is measured by taking into account nutritional requirement of an individual on the basis of recommendation of the report of the Expert Group to the Planning Commission, Government of India [8]. The existing literatures are mainly deals with food security [9-12] and food insecurity in India [13-15]. But till date, no study has been carried out for examining the impact of weather shock and variability on household level food insecurity in rural India. The paper is organized in six sections. Section two outlines the materials and methods. Section three discusses the extent of food insecurity in India and its variations across space and various social and religious groups. Section four outlines the model with a brief explanation of the variables of interest. Section five discusses the regression results whereas section six deals with concluding remarks.

II. MATERIALS AND METHODS

2.1 Data Source and Methodology-

This analysis is totally focused on secondary data. The secondary data was obtained for 2011-12 from the second round of the India Human Development Survey (IHDS-II). The IHDS presents data on a variety of measurements and factors at the household level. The data has been extensively cleaned and a few variables specific to the present paper have been taken into account and a few others have been generated from the available data. Section IV includes a thorough overview of the factors used in the paper. The primary aim of this paper is to think about food insecurity at the household level. Food insecurity at the household level is then calculated based on the Expert Group's report[1] submitted to the Planning Commission of the Government of India. They have explained the normative criteria for food expenditure including calories, proteins and fats. To estimate food insecurity, we have taken this proposed spending (per capita per month) on calories, proteins and fats as the standard. National food insecurity lines have therefore been identified as monthly food expenditure per capita (calorie+protein+fat) of Rs. 554 in rural areas and Rs. 656 in urban areas and an aggregate food insecurity measure is obtained on the basis of these food insecurity lines These food insecurity lines are then calibrated to estimate state-specific food insecurity lines by price indices.

2.2 Binary Logistic Regression-

To examine the determinants of food insecurity, a binary logistic regression model is used. The model is ---

$$FI_i = \frac{1}{1 + e^{-(\alpha + \beta' W_i' + \gamma' X_i' + u_i)}} \dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where, w/ is a vector of weather related variables (e.g. flood, drought, mean daily average temperature etc.), x/ is a vector of other explanatory variables representing different socio-economic variables. β' and γ' are vector of coefficients of the weather variables (w) and other explanatory variables (x) respectively. Finally α represents the intercept, u refers to the disturbance term and i (i=1, 2, 3,…….., n) refers to the households. Here, the dependent variable FI_i indicates food insecurity status of the i^{th} household which takes on value 1 if a household is food insecure and 0 otherwise. The definitions of the explanatory variables are explained as: Dummy variable is used to capture the differential impact of the variable hill on food insecurity. Dummy takes the value '1' if the household resides in hilly region, '0' otherwise. Household size can be defined as number of persons living in one house. Larger sized households have more mouths to feed and hence have lesser availability of food consumption per capita. An increase in household size increases the probability of food insecurity. The per capita income of each household is obtained by dividing its total annual income by the number of household member. Higher the per capita income, higher will be the capacity of the household to consume food items. Thus, per capita income is expected to have a negative impact on food insecurity. Poverty is an important determinant of food insecurity. To capture the impact of poverty on food insecurity, dummy variable is used which takes the value '1' if household is poor, '0' otherwise. It is expected that the poor do not have enough resources to purchase the required amount of food items for their household which raises

[1] This Expert Group was constituted in June, 2012 by the Planning Commission under the Chairmanship of Dr. C. Rangarajan to suggest a methodology for measurement of poverty in India. It has re-computed the average requirements of calories, fats and proteins on the basis of the 2010 Indian Council of Medical Research norms (Government of India, 2014).

their probability of being food insecure. To capture the differential impact of different castes on household level food insecurity, dummy variables are used. The dummy variable takes the value of '1' if a household belong Other Backward Classes (OBC) category, '0' otherwise. Similarly, it takes the value '1' if the household belong to Schedule Caste (SC) category, '0' otherwise, takes the value '1' if the household belong to Schedule Tribe (ST) category, '0' otherwise and takes the value '1' if the household belong to Other Caste, '0' otherwise. Here General caste is taken as reference category. Generally it is expected that households belong to General caste are economically more stronger and hence they are food secure in comparison to other caste. Dummy variable is also used to capture the differential impact of religion on food insecurity. Dummy takes the value '1' if the household belongs to Hindu religion, '0' otherwise. Dependency ratio is defined as the number of young and old dependents as a percentage of working age group members of a household. If dependency ratio is high, there will be more pressure on a household to feed relatively more people by a smaller number of earners in a household. This will reduce the economic capacity of a household to buy enough food for its members. Thus dependency ratio is expected to increase food insecurity. Cultivation as the main occupation is also an important determinant of food insecurity. To capture this variable a dummy variable is used, which takes the value '1' if a household's main occupation is cultivation, '0' otherwise. This implies that the household whose main occupation is cultivation are less likely to be food insecure than others. This is quite intuitive. The cultivator households in India are primarily subsistence farmers, and hence allocate a considerable amount of farm produce on household consumption. To capture the impact of remittances on food insecurity, dummy variable is used which takes the value '1' if the households get remittances, '0' otherwise. It is expected that remittances into a household reduce its likelihood to be food insecure. This is because receipt of remittances enhances liquidity and hence the household can spend more on food.

III. RESULTS AND DISCUSSION

3.1 Food Insecurity in India: Extent and Variations-

A household whose monthly per capita spending on calories, proteins and fats is smaller than this benchmark as suggested by the Rangarajan Committee, is categorized as food insecure. Table 1 displays the national and state specific food insecurity lines along with poverty lines.

Table-1 National and State Specific Lines for Poverty and Food Insecurity

State/UTs	Poverty line		Food insecurity line		State/UTs/ Nation	Poverty line		Food insecurity line	
	Rural	Urban	Rural	Urban		Rural	Urban	Rural	Urban
Andhra Pradesh	**1031.74**	**1370.84**	**588.05**	**639.14**	**Mizoram**	**1231.03**	**1703.93**	**701.64**	**794.44**
Arunachal Pradesh	**1151.01**	**1482.94**	**656.03**	**691.41**	**Nagaland**	**1229.83**	**1615.78**	**700.95**	**753.34**
Assam	**1006.66**	**1420.12**	**573.75**	**662.12**	**Orissa**	**876.42**	**1205.37**	**499.52**	**561.99**
Bihar	**971.28**	**1229.3**	**553.59**	**573.15**	**Punjab**	**1127.48**	**1479.27**	**642.62**	**689.70**
Chhattisgarh	**911.8**	**1229.72**	**519.69**	**573.34**	**Rajasthan**	**1035.97**	**1406.15**	**590.46**	**655.60**
Delhi	**1492.46**	**1538.09**	**850.64**	**717.12**	**Sikkim**	**1126.25**	**1542.67**	**641.92**	**719.25**
Goa	**1200.6**	**1470.07**	**684.29**	**685.41**	**Tamil Nadu**	**1081.94**	**1380.36**	**616.66**	**643.58**
Gujarat	**1102.83**	**1507.06**	**628.57**	**702.65**	**Tripura**	**935.52**	**1376.55**	**533.21**	**641.80**
Haryana	**1127.82**	**1528.31**	**642.81**	**712.56**	**Uttar Pradesh**	**889.82**	**1329.55**	**507.16**	**619.89**
Himachal Pradesh	**1066.6**	**1411.59**	**607.92**	**658.14**	**Uttarakhand**	**1014.95**	**1408.12**	**578.48**	**656.52**
Jammu & Kashmir	**1044.48**	**1403.25**	**595.31**	**654.25**	**West Bengal**	**934.1**	**1372.68**	**532.40**	**640.00**
Jharkhand	**904.02**	**1272.06**	**515.25**	**593.09**	**Puducherry**	**1130.1**	**1382.31**	**644.11**	**644.49**
Karnataka	**975.43**	**1373.28**	**555.95**	**640.28**	**Andaman & Nicobar Islands**	**1314.98**	**1797.69**	**749.48**	**838.16**
Kerala	**1054.03**	**1353.68**	**600.75**	**631.14**	**Chandigarh**	**1303.17**	**1481.21**	**742.75**	**690.60**
Madhya Pradesh	**941.7**	**1340.28**	**536.73**	**624.89**	**Dadra & Nagar Haveli**	**1008.39**	**1540.81**	**574.74**	**718.39**
Maharashtra	**1078.34**	**1560.38**	**614.61**	**727.51**	**Daman & Diu**	**1200.6**	**1434.93**	**684.29**	**669.02**
Manipur	**1185.19**	**1561.77**	**675.51**	**728.16**	**Lakshadweep**	**1327.77**	**1458.69**	**756.77**	**680.10**
Meghalaya	**1110.67**	**1524.37**	**633.04**	**710.72**	**All India**	**972**	**1407**	**554**	**656**

Sources: a) Poverty lines – Government of India (2014); b) Food Insecurity Lines – Calculated by the author from IHDS-II

3.2 Food Insecurity across Social Classes and Religion-

The variations in food insecurity across different castes and religions are shown in Table 2. It is evident from the figures that there are wide variations in the prevalence of food insecurity across social and religious groups in rural India.

Table-2 Food Insecurity in Rural India across Social Classes and Religions

Caste		Religion	
Categories	**Percentage**	**Categories**	**Percentage**
General	**22.78**	**Hindu**	**32.30**
Other Backward Caste	**30.68**	**Muslim**	**28.12**
Scheduled Caste	**37.48**	**Christian**	**29.01**
Scheduled Tribe	**48.67**	**Sikh**	**13.10**
Others	**15.65**	**Others**	**27.14**

Source: Calculated by authors from IHDS-II

As far as the social groups are concerned, food insecurity is the highest for scheduled tribes with around 49% of its households are food insecure. In case of scheduled castes around 38% of the households are food insecure which is followed by other backward castes (30.68%). Food insecurity is the lowest in case of other caste people as percentage of insecure households belonging to this is only around 16%. Such differences in the extent of food insecurity reflect the economic inequalities among these classes. Table 2 also highlights the differences in the level of food insecurity across various religious groups in India. The point to be noted here is that for the convenience of our analysis we have grouped Buddhists, Jains, Tribal and other small religious groups into one group and named it as 'Other Religion' due to the fact each of its constituents represent a very small proportion of the sample households compared to other major religions. It is seen form Fig. 2 that food insecurity is highest among the Hindu religion people (32.3%) followed by Christians (29.01%). Food insecurity is lowest among the Sikhs (13.1%). It is interesting to note that there is not much variations across the other two major religions.

3.3 Spatial Variations in Food Insecurity-

The extent of food insecurity and its spatial variations are captured by Head Count Ratio (HCR) which has been shown in Table 3. As seen from the table 31.49% of the sample households covering the rural India are food insecure. No sample household in Goa and Tripura are found to be food insecure. The highest food insecurity is found to be in Chhattisgarh with 67.72% of its sample households being food insecure. This is followed by Meghalaya (63.21%). Other states with food insecurity higher than the national average are Uttar Pradesh (31.51%), Assam (33.02%) Maharashtra (38.64%), Tamil Nadu (41.92%), Uttarakhand (43.21%), Jharkhand (44.51%), Bihar (45.44%) and Odisha (54.25%).

Table-3 Spatial Variations in Food Insecurity in Rural India

State/UTs	Head Count Ratio	Food Insecurity Gap Index	State/UTs / Nation	Head Count Ratio	Food Insecurity Gap Index
Goa	**0**	**0**	**Rajasthan**	**24.26**	**0.059**
Tripura	**0**	**0**	**Manipur**	**26.19**	**0.025**
Jammu & Kashmir	**4.5**	**0.009**	**West Bengal**	**26.67**	**0.057**
Puducherry	**4.9**	**0.007**	**Uttar Pradesh**	**31.51**	**0.07**
Nagaland	**5.56**	**0.008**	**Assam**	**33.02**	**0.069**
Sikkim	**8.33**	**0.001**	**Dadra & Nagar Haveli**	**38.46**	**0.115**
Daman & Diu	**10.17**	**0.011**	**Maharashtra**	**38.64**	**0.096**
Punjab	**13.17**	**0.021**	**Madhya Pradesh**	**39.2**	**0.112**
Mizoram	**16.67**	**0.02**	**Tamil Nadu**	**41.92**	**0.125**
Arunachal Pradesh	**19.2**	**0.035**	**Uttarakhand**	**43.21**	**0.123**
Gujarat	**20.39**	**0.044**	**Jharkhand**	**44.51**	**0.124**
Andhra Pradesh	**20.75**	**0.041**	**Bihar**	**45.44**	**0.114**
Karnataka	**21.41**	**0.045**	**Orissa**	**54.25**	**0.144**
Kerala	**21.85**	**0.05**	**Meghalaya**	**63.21**	**0.201**
Himachal Pradesh	**22.09**	**0.049**	**Chhattisgarh**	**67.72**	**0.226**
Haryana	**23.11**	**0.04**	**India**	**31.49**	**-------**

Source: Calculated by authors

In this study the depth of food insecurity has been captured by the Food Insecurity Gap Index (FIGI). From the above table it is found that the depth of food insecurity is also highest in Chhattisgarh (0.226) followed by Meghalaya (0.201).In the states like Odisha (0.144), Tamil Nadu (0.125), Jharkhand (0.124), Bihar (0.114) and Madhya Pradesh (0.112), food insecurity is deeper as compared to other states. The district level analysis of spatial variations and depth of food insecurity is given in the appendix section.

3.4 Determinants of Food Insecurity-

The results of the binary logistic regression of food insecurity are shown in Table 4. It is to be noted that the odds ratio are reported here rather than the coefficient, and the results are interpreted accordingly.[2]

Table-4 Results of the Binary Logistic Regression

Variables	Odds Ratio	Std. Error
Drought_2011	1.291***	0.057
Flood_2011	0.951	0.040
Mean Temperature	1.128***	0.011
Hill	1.091***	0.041
Household Size	1.196***	.009
Per Capita Income	0.990***	1.35e-06
Poor	12.31***	0.530
Other Backward Classes	1.322***	0.063
Scheduled Castes	1.590***	0.086
Schedule Tribes	2.010***	0.120
Muslim	0.722***	0.048
Sikh	0.633***	0.086
Buddhist	1.508**	0.299
Dependency Ratio	1.158***	0.025
Main Cultivation	0.776***	0.028
Remittance	0.910**	0.045
Constant	0.008***	0.002
Pseudo R squared	28.83%	
LR chi2(15)	9073.25	
Prob > chi2	0.0000***	

Note: ***, ** and * represent significant at 1%, 5% and 10% respectively.
Source: Calculated by authors

It is necessary to remember that the appropriateness of the model is justified by various diagnostic tests, as stated in the final rows of Table 4. In the second and third columns, odd ratios and standard errors are reported. From the regression analysis the variable drought is found to have positive impact on food insecurity. This means that the probability of food insecurity increases with the increase in drought. Similarly mean temperature also effects food insecurity positively. This implies that when mean temperature rises, the likelihood of food insecurity also rises. The variable hill is found positive and significant. This implies that the people residing in hilly regions are more food insecure as compared to the plains. Household size is found to have a positive impact on food insecurity. This implies that the probability of food insecurity increases with increase in the size of households. Larger sized households have more mouths to feed and hence have lesser availability of food consumption per capita. Per capita income is found to have a negative impact on the probability of household level food insecurity. An increase in per capita income of the households reduces its probability of food insecurity. The odds ratio of poor is found to be as high as 12.31. This implies that the probability of food insecurity for the poor households is higher than others. Food insecurity of a poor household is 12.32 times of a non-poor household. This is quite intuitive. The poor do not have enough resources to purchase the required amount of food items for their household which raises their probability of being food insecure. As far as the differential impact of caste on food insecurity is concerned it is found that compared to general caste, food insecurity is more among Other Backward Classes (OBC), Scheduled Caste (SC) and Schedule Tribe (ST). The

[2]This is because there is a direct relationship between odds ratio and the coefficient. Odds ratios greater than 1 and less than 1 imply positive and negative coefficients respectively. Therefore, our analysis is carried out in terms of odds ratio as it is easier to interpret the impact of the explanatory variables in terms of odds ratio

odds of being food insecure for a household belonging to OBC, SC and ST are 1.32, 1.59 and 2.01 times, respectively, of a general category household. This is quite expected because usually the general category people are economically better-off than other social classes. The dummies used to capture differential impacts of religions are also found to have significant coefficients. The odds ratios of the Muslim and Sikh have turned out to be less than one, and the reverse is found to be true in case of Buddhist. This implies that households belonging to the former are less likely to be food insecure compared to Hindu. On the other hand, the Buddhist have a higher probability of being food insecure than the Hindus. Dependency ratio, showing the number of young and adult dependents as a percentage of number of economically active members in the households, is found to increase the probability of food insecurity. The odds ratio of cultivation is found to be 0.77. This implies that the households whose main occupation is cultivation are less likely to be food insecure than others. This is quite intuitive. The cultivator households in India are primarily subsistence farmers, and hence allocate a considerable amount of farm produce on household consumption. The odds ratio for remittances has turned out to be 0.91. This implies that remittances into a household reduce its likelihood to be food insecure. More precisely, the households receiving remittances are 9% less likely to be food insecure than others. This is because receipt of remittances enhances liquidity and hence the household can spend more on food. Finally, the Pseudo R squared is found to be reasonably high at 28.83%.

IV. CONCLUSION

This paper makes a novel attempt to examine food insecurity in rural India and its variations across space and different social and religious groups. Around 31.49% of the sample household in the country are found to be food insecure with large scale variations across the states and union territories. The percentage of food insecure sample households in the country is found to be varying between 0% in Goa and Tripura, and 68% in Chhattisgarh. There is prevalence of large scale inequality in food insecurity among various social and religious groups. Around 49% of the households belonging to scheduled tribes are food insecure and the corresponding figure for general category households is 23%. Likewise, around 13% of the Sikh households are food insecure and the same for religions Hindu is 32.3%. This paper further identifies the determinants of household level food insecurity. The variables like drought, mean temperature, hill, size of households and dependency ratio increase the probability of food insecurity. Likewise, poverty makes a household more likely to be food insecure. On the other hand, per capita income, remittances and cultivation as the main occupation reduce the probability of food insecurity.

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