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REGIONAL SENSITIVITY OF RURAL HOUSEHOLD FOOD SECURITY: THE CASE OF PUNJAB, PAKISTAN

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ABSTRACT

This study aims to examine the regional sensitivity of rural household food security in three regions (South, Central and North) of the Punjab province of Pakistan. We used primary data from 1152 households located in 12 districts of these regions. It was found that food insecurity was highest in the Central region where about 31% of the sample households were measured to be food insecure compared to 13.5% and 15% households in South and North regions, respectively. Econometric analysis revealed that livestock assets have a positive impact on food security across all the three regions while family size has a negative impact. Intermediate and graduation levels of education improve food security in North and Central regions, respectively. In the North region, total number of income earners in the household also positively impacted food security while household heads' age has an inverse relationship with food security. Results suggest that targeted but region specific policies are needed to improve food security in Punjab.

Key words: food security, regional differences, logistic regression, rural households, Punjab, Pakistan.

INTRODUCTION

Food security is an important issue for both the developed and developing countries. However, the situation in developing countries is severe as illustrated in Figure 1. Out of the total 925 million undernourished people, 906 million live in developing countries (FAO, 2010) where the situation is getting worse especially in Africa and Asia.

The enormity of food security differs from nation to nation and time to time (Timmer, 2004). Food security is a multifaceted experience that takes in a range of demographic, social and economic factors and can vary in significance across, countries, regions, social groups as well as over time (Riely, 1999). The diverse nature of these factors causes a path-dependency characterised by the coexistence of various livelihood strategies and resource management systems. This implies that the 'blanket policy' strategy will not suffice to generate required development goal of food secure populations (Pender *et al.*, 1999).

Food self-sufficient countries at the national level can have food insecure households because of unequal distribution of food within the country (Stevens, 2000). Pakistan, for example, gained food self sufficiency in the 1980s (Gera, 2004) and maintains this status (Bashir *et al.*, 2007; and 2012), but has a seriously high proportion (26%) of undernourished population (FAO, 2010). Against the backdrop of food security trends in Pakistan, this study aims to examine the regional sensitivity of food security in rural areas of three regions in the Punjab province of Pakistan. Specifically it attempts to answer three key research questions:

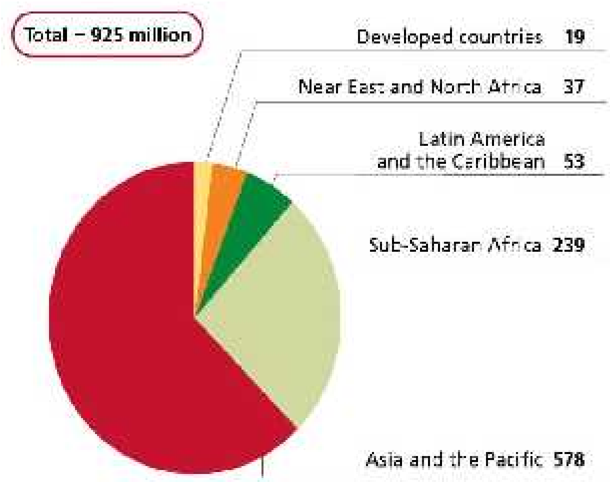

Figure 1: People affected by undernourishment across the world by region

Source: FAO, 2010

1. What levels of food insecurity have been experienced by the rural households in three different regions of the province? and
2. Which socio-economic factors best explain the levels of food security in each region?

METERIALS AND METHODS

Data Collection and Analysis: Primary data were collected using stratified sampling technique from the Punjab province acknowledging that the problem of food insecurity does exist in other regions and provinces. The province was divided into 3 regions (strata) based on geographical heterogeneity of districts within the province. The districts having desert, and mixed characters of both desert and plains formed the third stratum (South Punjab); those having mostly plain areas (<350 m above sea level) and similar typologies formed the second stratum (Central Punjab); and those that were situated at 350 to 900 meters above sea level were kept in first stratum (Northern Punjab).

Figure 2: Districts and three regions (strata) within Punjab Province

Figure 2 shows that out of 36 districts, 8 were in North Punjab, 17 were in Central Punjab and 11 were in South Punjab. One third of the districts (12) were considered to be a good representative sample for the study. Because the strata were not identical in terms of district numbers, a proportionate sample was drawn from each stratum. Three districts each from South and North Punjab and six districts from Central Punjab were selected to represent each stratum. Selection of districts was based on the homogeneity of different attributes of the districts including population, number of villages, irrigated and non irrigated land, per capita and per acre wheat production. In each selected district, 6 villages were randomly selected. On average, each village consists of about 200 households in which the majority of the households (> 80%) are either small land holders or landless households (GOP, 2010). Survey data were collected from 10% (1152) of those households (i.e. 5% small farmers and 5% landless households).

A comprehensive interview schedule was designed to document various aspects of household food security. The information was gathered in three major categories. The *first category* was about the general and demographic information of the household; the *second category* was related to the consumption of different food items on weekly basis; and the *third category* was about the income from different sources e.g. crops, livestock, labor etc.

Empirical Model: Following the conceptual and empirical models of Bashir *et al.* (2012a), the analytical technique follows a two stage approach to ensure the meaningfulness and accuracy of the empirical analysis. In stage one, food security status of the farming households was measured by calculating their per capita calorie intakes[1] using 7 days recall method for food consumption information. Calories thus calculated were adjusted for adult equivalents to ensure equal distribution of age and gender in a household[2]. Despite criticism on this method, the selection is justified because the sample households in our study belong to the lowest income group that is vulnerable to food insecurity (Yasin, 2000). For such households, it is more important to fill their stomachs than to choose a tastier food. Despite lack of consensus among researchers on threshold level of dietary intake, we followed Government of Pakistan's threshold definition for rural food security (GOP, 2003) to minimize error created due to ambiguity on threshold levels.

Mathematically, the food security status of a household can be written as:

$$FS_{ij} = \sum_{j=3}^{i=n} FS' - L \geq 0 \qquad (1)$$

Where: FS_{ij} is the rural household food security status of i^{th} household (i = 1 to 1152) of j^{th} region (j = north, central, south); 1 for food secure and 0 for food insecure; and L is the GOP's threshold level for rural areas i.e. 2450 Kcal/person/day (GOP, 2003).

To indentify the determinants of food security in three different regions, binary logistic regression was chosen because the dependent variable 'food security' was in the binary form. The logistic regression directly estimates the probability of an event occurring for more than one independent variable (Hailu and Nigatu, 2007).

Assuming that socio-economic characteristics are linearly related to food security, rural household food security can be written as:

$$FS_{ij} = \sum_{j=3}^{i=n} {}_{i}\mathbf{S_i} + £_i \qquad (2)$$

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[1] The calorie table of Allama Iqbal Open University is used to calculate calorie intake (AIOU, 2001)

[2] Adult equivalent units suggested by NSSO (1995) are used to adjust for gender and age differences in a household

Where: $_{i}$ represent the coefficients; S_i represents the vector of socio-economic factors; and $£_i$ represents the error term.

The model can be re-written in terms of the probability of a household becoming food secure as:

$$¢_{ij} = ¢(FS_{ij} = 1 \mid \mathbf{S_i} = \mathbf{s_i}) \quad (3)$$

Where: $¢_{ij}$ is the probability of the i[th] household from the j[th] region to become food secure; and $\mathbf{s_i}$ is the vector of socio-economic factors.

The logit expression for equation 3 can be re-written as:

$$\log it(¢_{ij}) = {}_0 + {}_i s_i \quad (4)$$

By incorporating socio-economic variables identified by Bashir *et al.* (2012b) in equation 4, the model can be expressed as:

$$¢(FS_{ij}) = {}_0 + {}_1 MI + {}_2 HHHA + {}_3 THM + {}_4 TE + {}_5 FSt + {}_6 Orp + {}_7 LSA + {}_8 Edu_P + {}_9 Edu_M + {}_{10} Edu_I + {}_{11} Edu_G + μ_i \quad (5)$$

Where

$¢(FS_{ij})$ = the probability of i[th] household to become food secure in j[th] region (food secure =1 or insecure = 0)

$_0$ = the constant term

$_{1–11}$ = the coefficients of socio-economic variables

MI = monthly earnings of the households both from farm and off-farm sources, in Pakistan Rupees (PKR)

$HHHA$ = household head's age, in years

THM = family size i.e. total number of individuals in the household

TE = total number of family members who earn monthly income from farm or off farm labour

FSt = the family type nuclear family (i.e. Husband, wife and children: '0') or joint family (more than one nuclear family under a common household head: '1')

LSA_L = number of large animals (buffalos and cows) owned by the households

LSA_S = number of small animals (goats and sheep) owned by the households

Edu_P = educational level (primary), number of five schooling years = grade 5, dummy

Edu_M = educational level (middle), number of eight schooling years = grade 8, dummy

Edu_I = educational level (Intermediate), number of twelve schooling years = grade 12, dummy

Edu_G = educational level (graduation and above), number of 14 schooling years = graduation or above, dummy

RESULTS AND DISCUSSION

Rural Household Food Security: The food security status of households was calculated using the calorie intake method for each region. Table 1 shows the comparative results for the food security situation among regions. This result indicates the Central Punjab region was the most food insecure region having more than 31% of the sample households measured as food insecure. On the other hand, situation was better in the South and North Punjab regions where 13.5% and 15% of the sample households were measured as food insecure.

Table 1. Food Security Status of Households by region.

	Food Insecure	
	Frequency	%
South Punjab (S) n = 288	39	13.5
Central Punjab (C) n = 576	182	31.6
North Punjab (N) n = 288	43	14.9
Total (n = 1152)	264	22.9

Determinants of Rural Household Food Security: This section presents the results of the binary logistic regression models that explain the influence of socio-economic characteristics on rural household food security among three regions of the Punjab province. The estimates of relative risk in binary logistic models are computed using odds-ratios (OR)[3]. It was revealed that out of eleven variables in all three models, two (family size and livestock (large animals)), five (monthly income, family size, total income earning members in a household, livestock (small animals) and household heads' education level of up to intermediate) and six (monthly income, household head's age, family size, livestock assets (large), livestock assets (small) and

[3] This is the ratio of the odds of an event occurring in one group to the odds of it occurring in another group (Grimes and Schulz, 2008).

household heads' education level of graduation and above) variables were statistically significant for South, North and Central Punjab regions, respectively (Table 2). Only the results of the statistically significant variables are explained below:

Monthly Income (*MI*) has a positive impact on households' food security in Central and North Punjab regions but with comparatively smaller impact in the Central Punjab. The results indicate that an increase of one rupee in monthly income will increase the chances of a household becoming food secure in both the regions by a factor of the associated odds-ratios. The odds ratios based on Rs. 1000 ($11) increase ($\exp^{0.00005*1000}$ and $\exp^{0.0001*1000}$) are 1.051 and 1.105 for Central and North Punjab regions, respectively which are converted into percentages (% = (OR-1)*100). An increase of Rs 1,000 ($11) in monthly income increases the chances of a household to become food secure by 5.1% and 10.5% in Central and North Punjab, respectively. The coefficient of monthly income is statistically non-significant for South Punjab. In an earlier study, Bashir *et al.* (2012) found for rural households of Punjab that an increase of Rs 1000 ($11) in monthly income increases the chances of a household to become food secure by 5%. Bashir *et al.* (2010) found that the households who belonged to a higher income group (Rs 5,001–10,000) had substantially high chances of becoming food secure compared to households belonging to a lower income group. Similarly, in India, Sindhu *et al.* (2008) found that chances of becoming food insecure are reduced by 30% with an increase of Indian Rupees (IR) 1,000 in the monthly income of households. And in the USA, Onianwa and Wheelock (2006) found that an increase in the annual income of household by $1,000 with and without children reduces the chances of food insecurity by 6% and 5%, respectively.

Table 2. Results of binary-logistic regression by regions.

Variables	South Punjab		Central Punjab		North Punjab	
	B	**OR**	**β**	**OR**	**β**	**OR**
MI	0.00001 (0.000)	1.00001	0.00005^{**} (0.000)	1.00005	0.0001^{*} (0.000)	1.0001
HHHA	0.011 (0.026)	1.011	-0.030^{***} (0.011)	0.971	-0.017 (0.020)	0.983
THM	-0.459^{***} (0.124)	0.632	-0.364^{***} (0.057)	0.695	-0.610^{***} (0.125)	0.544
TE	0.041 (0.305)	1.042	-0.003 (0.153)	0.997	0.662^{*} (0.363)	1.938
FSt	-0.555 (0.740)	0.574	-0.202 (0.272)	0.817	-0.373 (0.526)	0.689
LSA_L	0.152^{**} (0.068)	1.164	0.066^{*} (0.038)	1.068	0.011 (0.095)	1.011
LSA_S	0.329 (0.214)	1.389	0.232^{***} (0.079)	1.262	0.688^{***} (0.257)	1.990
Edu_P	-0.312 (0.508)	0.732	0.194 (0.259)	1.214	0.238 (0.478)	1.268
Edu_M	0.929 (0.971)	2.532	0.417 (0.367)	1.517	1.195 (0.888)	3.304
Edu_I	0.732 (0.707)	2.080	0.415 (0.333)	1.515	1.541^{**} (0.709)	4.670
Edu_G	18.717 (8062)	N/A	0.892^{**} (0.449)	2.440	-0.327 (0.871)	0.721
Constant	4.020^{***} (1.292)	N/A	3.368^{***} (0.640)	N/A	4.086^{***} (1.296)	N/A
MPS	88.2%		75.9%		89.2%	
Log-likelihood ratio	151.49		565.19		161.10	
H-L model (df = 8) significance test results	6.038 (p-value = 0.64)		9.89 (p-value = 0.27)		6.47 (p-value = 0.59)	
Cox & Snell R^2	0.234		0.234		0.247	
Nagelkerke R^2	0.428		0.328		0.434	

*** significant at < 1 %; ** significant at < 5 %; * significant at <10%
MPS = Model Prediction Success | Figures in parenthesis are standard errors.

The coefficient of household head's age (*HHHA*) is statistically significant only for Central Punjab with a negative sign. This implies that chances of a household becoming food secure are reduced by 3% with one year increase in the household head's age. It may be the case that the older people are weaker compared to the young men due to which their performance is poor in filed. Earlier, Bashir *et al.* (2012) found similar results for rural households of Punjab. Bashir *et al.* (2010) found that the chances of food insecurity increases with increase in household head's age. On the other hand, contradicting results were found in the USA indicating that increasing age of household head by one year reduces the chances of food insecurity by 2% (Onianwa and Wheelock, 2006).

Family Size (*THM*) is statistically significant across all three regions with a negative sign suggesting an inverse relationship between family size and food security. The coefficients of this variable for South, Central and North Punjab explain that an increase in family size by one member decreases the chances of household food security by 36.8%, 30.5% and 45.6%, respectively. Earlier, Bashir *et al.* (2012) found that an additional member in the household decreases the chances of a household to become food secure by 31%. Bashir *et al.* (2010) found that large families having household members up to 9 were about half as food secure compared to families with 4 to 6 members. Similarly in India, an increase of one member in the family size increases the probability of food insecurity by 49% (Sindhu *et al.*, 2008).

Total Earners (*TE*) in the household is statistically significant only for the North Punjab region. The results imply that an increase of one earning member increases the chances of food security by about double. Bashir *et al.* (2010) found that households with three earning members had substantially high chances of becoming food secure than the households having only one earning member.

The ownership of large livestock assets (LSA_L) i.e. buffalos and cows is statistically significant for South and Central Punjab regions while the ownership of small livestock assets (LSA_S) i.e. goats and sheep is statistically significant for Central and North Punjab regions. It implies that for the sample households in Central Punjab, an increase of one each of large and small animals increases the chances of the household to become food secure by 6.8% and 26.1% respectively. On the other hand having an additional large animal in South Punjab and an additional small animal in North Punjab increase the chances of food security by 16.4% and 98.9% in these regions, respectively. Earlier, Bashir *et al.* (2012) found that an additional small animal increases household food security by about 31%. Similarly, Bashir *et al.* (2010), found that the household who owned two milking animals had substantially high chances of becoming food secure than those had no animals. In Ethiopia, Haile *et al.* (2005) found that an additional ox (large livestock) increases the probability of household food security by 40%.

The impact of all educational levels for the South region is statistically non-significant while up to intermediate (Edu_I) and graduation and above (Edu_G) are statistically significant for the North and Central regions, respectively. The coefficients of these variables explain that having these educational levels increases the chances of household food security by 366% and 144%, respectively. This implies that education level is the lowest in South, up to intermediate (secondary and higher secondary) in the North and highest in Central Punjab. Similarly, intermediate level of education of household head doubles the chances of a household to become food secure (Bashir *et al.*, 2012). In Faisalabad district of the same province, Bashir *et al.* (2010) found a similar relationship of education with household food security. Amaza *et al.* (2006) found that due high education level the chances of a household to become food insecure were reduced by 59% in Nigeria. Similarly, in the USA, Kaiser *et al.* (2003) found that due to higher education level of mothers within households, the chances of household food insecurity were reduced by 29%.

Model Significance: The predictive power of all three region specific models is relatively high -- 88% for South, 76% for Central and 89% for North Punjab. The goodness of fit of the logistic regression model can be tested by: the Hosmer and Lemeshow (H-L) Test and pseudo R^2s (Peng *et al.*, 2002). For good model prediction, the Hosmer and Lemeshow (H-L) Test results must be non-significant. In case of all three models, H-L test results were statistically non-significant, implying that all these models are a good fit. On the other hand, the pseudo R^2s are the descriptive measures that cannot be tested in an inferential framework (Menard 2000). The values of the descriptive measures are 0.234, 0.234 and 0.247 for Cox & Snell and 0.428, 0328 and 0.434 for Nagelkerke R^2, respectively for South, Central and North Punjab. For example the models explained 25% to 43% of the variation in the data for North Punjab by these two measures separately. The descriptive measures, however, are not considered good representatives of goodness of fit (Hosmer and Lemeshow, 2000).

Relative importance of the determinants: Table 3 presents the comparison of the determinants for their relative importance to rural household food security within and across the regions. The variables can be ranked for their relative importance to food security in each region as to identify the most important areas for policy interventions.

Table 3. Comparison of the rank of significant factors by regions.

Ranks	South Punjab		Central Punjab		North Punjab	
	Factors	Impacts	Factors	Impacts	Factors	Impacts
Positive impacts						
1	LSA_L	16%	Edu_G	144%	Edu_I	366%
2	--	--	LSA_S	26%	LSA_L	99%
3	--	--	LSA_L	7%	TE	94%
4	--	--	MI	4%	MI	10%
Negative impacts						
1	THM	37%	THM	30%	THM	46%
2	--	--	--	--	HHHA	3%

There were only two variables identified for South Punjab that have opposing effects on food security. On the other hand, in Central and North Punjab, education levels (graduation and intermediate) were at the top of the lists followed in order by livestock assets (small and large for the Central Punjab and large for the North Punjab). The ranks are not similar across all three regions because of differences in socio-economic characteristics at households' level.

Conclusions: Our findings indicate that food insecurity is sensitive to regional differences and the situation is alarming in the Central region of the Punjab province of Pakistan. Statistically, it is proven that all the three regions are different from each other in terms of food security trends[4]. In addition, a significant difference in the determinants of food security was observed when we ranked the determinants for their relative importance to food security across all the three regions. These results suggest that a blanket policy approach, which is a case in Pakistan (Bashir and Schilizzi, 2012), is not a good idea to tackle food insecurity.

[4] The results of restricted (whole data set) and non restricted (regional data sets) with same explanatory variables $(2(LL_W – (LL_S + LL_C + LL_N)) = \chi^2_{(0.05, k)})$ pointed out that the regions are statistically different.

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