Food Security and Its Determinants at the Crossroads in Punjab, Pakistan

Muhammad Khalid Bashir[ab*], Steven Schilizzi[a], and Ram Pandit[a]

[a]School of Agricultural and Resource Economics, The University of Western Australia, Crawley, WA 6009, Australia
[b]University of Agriculture, Faisalabad, Pakistan

*E-mail address: khalid450@uaf.edu.pk

June 2012
Working Paper 1206
School of Agricultural and Resource Economics
http://www.are.uwa.edu.au

THE UNIVERSITY OF WESTERN AUSTRALIA
Achieve International Excellence

Citation: Bashir, M.K., Schilizzi, S. and Pandit, R. (2012) *Food security and its determinants at the cross roads in Punjab Pakistan*, Working Paper 1206, School of Agricultural and Resource Economics, University of Western Australia, Crawley, Australia.

Food security and its determinants at the cross roads in Punjab Pakistan

Abstract:

This paper investigates the factors affecting rural household food security in three different regions of the Punjab Province of Pakistan. For this it used Binary Logistic regression modelling based on primary data source from 3 districts each of South and North and 6 districts of Central Punjab. According to the results, Central Punjab was found to be the most food insecure region where about 31% of the sample households were measured to be food insecure. In South and North Punjab, 13.5% and 15% of the sample households were measured as food insecure, respectively. It was found that monthly income and livestock assets improve and family size deteriorates household food security across all the three regions. In Central Punjab, education level of graduation and above had a positive impact on food security while in North Punjab both middle and intermediate levels had positive impacts. Additionally, household heads' increasing age deteriorated food security in Central Punjab. On the other hand, total number of earners in the household improved food security in the North Punjab. Food security can be improved by targeting the neediest households.

Keywords: Logistic regression, rural food security, regional food security, Punjab, Pakistan

JEL Classification: I30, Q18 and R20.

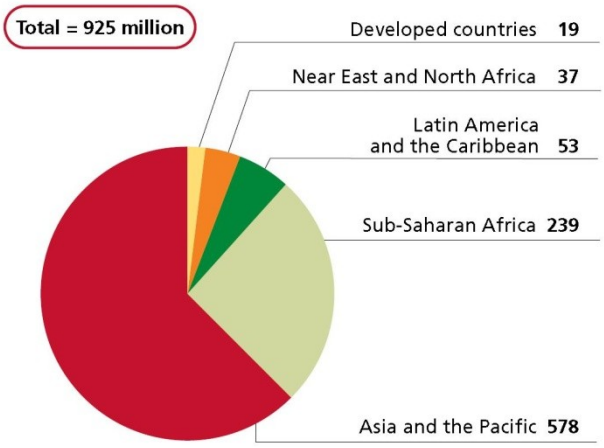
1 Introduction

Despite the fact that world food production has doubled during the past three decades (FAO, 2009), the numbers of malnourished people are soaring above 900 million around the world. Malnourishment exists when households' caloric intake goes below the minimum dietary energy requirement (FAO, 2010). It may be regarded as an indication of food insecurity that is defined, in literature, differently by different authors (see for reference Maxwell and Frankenberger, 1992). The most comprehensive definition, however, comes from FAO (2010). According to which *"food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern"*. Food insecurity, on the contrary, is known to be the absence of any of the conditions stated in the definition of food security at any level i.e. household, regional and national level. It is considered as severe food insecurity when individuals continuously take insufficient amounts of food to meet their daily dietary energy requirements. This may lead to hunger, the most severe stage of food insecurity (FAO, 2010).

Food security is an important matter of concern for both the developed and developing countries. However, the situation in developing countries is terrible. According to Figure 1 906 million undernourished people live in developing countries out of the total 925 million

undernourished people of the world. The situation is getting worse in Africa and Asia where more than 800 million undernourished people live.

Figure 1 Undernourishment across the world



Source: FAO, 2010

Since the start of 2011, the prices of major food items have increased to record levels (MacFarquhar, 2011). For wealthy nations, higher food prices may not hurt their food security situation by much but for the people who are already living on or below the $1 and $2 per day line, would feel a destructive impact (Brown, 1998). The majority of the world's poor populations (more than 2 billion) living below these lines are living in the rural areas (USAID, 2009) having small land holdings. More than 400 million farms out of the 525 million farms worldwide have less than two hectares of land. These small land holders along with the landless rural people are the most vulnerable to food insecurity (IAASTD, 2008).

Being a developing country, Pakistan is not an exception. Despite the fact that Pakistan's economy is the 26th largest economy of the world (WB, 2010) and Pakistan's agriculture sector is one of the world's leading producer of important agricultural commodities (FAO, 2011a), the proportion of the undernourished population is 26% that is too high (FAO, 2011b). More than 60% of the population lives in rural areas and more than 85% of the farmers own less than 2.5 hectares of land (GOP, 2010).These households are the most vulnerable ones to become food insecure as they have to deal with the uncertainty in their food provisioning on a daily basis (Yasin, 2000).

Therefore, this study aims to examine the food security at the rural household level in the Punjab Province. Key research questions are;

1. What levels of food security are experienced at the province level?
2. How do different regions of Punjab differ in terms of food security?
3. Which socio-economic factors correlate with and best explain the levels of food security in each region?

The rest of the paper is organized as follows: section 2 discusses the methodology; section 3 presents the results are discussion and section 4 concludes the paper.

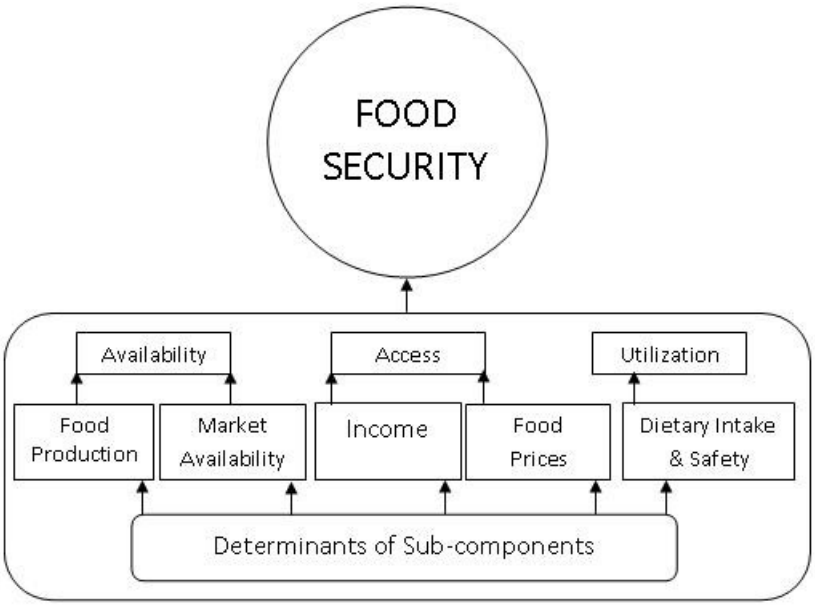
2 Methodology

Conceptual model

Food security is a multifaceted phenomenon affected by various factors. These factors can differ in their significance across countries, regions and time. Three prime areas of concern are food availability, access and utilization, as per the definition of food security stated above. Rural households generally, combine features of both producers and consumers. Farmers usually sell their surplus at local markets that is usually purchased by landless, farmers and retailers. Thus, the availability component can further be divided into food production and market availability. Similarly, to buy food items from the market the most important source needed is the income. Therefore, access is divided into income, its distribution within the household and prevailing market prices of food items. On the other hand, utilization can be sub-divided into dietary intake and its safety. As a whole, rural household food security can be regarded as a function of the factors that affect these components of the food security definition. They determine how effectively households utilize their resources to ensure their food security. Figure 2 presents the rural household food security conceptual model. Any positive change to these factors may improve household food security by improving the availability, access and utilization of food.

These factors may include input availability, prices, credit availability, farm size and job opportunities along with various household characteristics, including technology adoption, farming practices, educational levels, gender, age, family size and family type. All these factors can be directed to improve overall household food security both in the short and long run. In other words, they can be regarded as possible policy levers to achieve the goal of food secure nations. For instance, education and technology adoption may serve as policy levers for a longer term policy intervention while input availability, input prices and credit availability may serve as policy levers for short term policy interventions.

Figure 2. Rural Household Food Security Model



As discussed earlier, small land holders and landless rural households are the most vulnerable to food insecurity. The conceptual model presented in figure 2 above guides the exploration of the decision making process to better utilize the resources by these households to ensure their food security. Consumer behavior and production theories are utilized to provide insights into such decision making processes (see for example Strauss, 1983; Feleke *et al.*, 2003; Shaikh, 2007). Similar theory can be used to explore decision making for selected household categories (small farmers and landless households). They are assumed to maximize their utility functions, for a given production cycle (usually in the short run, up to 1 year), as expressed in equations (1_F) and (1_L), depending on household categories:

$$U_F = U(Y_P, Y_M, Y_{NM}) \quad (1_F)$$
$$U_L = U(Y_M, Y_{NM}) \quad (1_L)$$

Where; $_F$ represents farmers, $_L$ represents Landless households, Y_P are the consumed self produced food items, Y_M are consumed market purchased food items, and Y_{NM} are consumed market purchased non-food items including durables, non- durables, services, etc.

Only food and non-food items are considered for the sake of simplicity, and it is assumed that markets do exist for these commodities. A farmer makes simultaneous decisions about the production of food i.e. Y_P and the consumption of both food and non-food items from self production and from market purchases i.e. Y_P, Y_M and Y_{NM}, while a landless household makes decisions about the consumption of both food and non-food items purchased from the market only i.e. Y_M and Y_{NM}. These utility functions are maximized subject to production, consumption and income constraints for respective categories as;

Production Constraint:

$$P(Q_P, Q_{NM}, L_R, T_{ch}^0, L_D^0, C^0) = 0 \quad (2_F)$$

Where; Q_P are the Quantities of self produced food items, Q_{NM} are the Quantities of market purchased non-food items, L_R, T_{ch}^0, L_D^0 and C^0 represent Labour, Fixed technology, Fixed Land and Fixed capital, respectively.

A household generally owns fixed amounts of technology, land and capital stock therefore, they are considered constant for farmers.

Consumption Constraint:

$$P_P(Q_P - Y_P) - P_M Q_M - P_{NM} Q_{NM} - W(L_{On} + L_{Off}) + I_N = 0 \quad (3_F)$$
$$W - P_M Q_M - P_{NM} Q_{NM} = 0 \quad (3_L)$$

Where; P_P are theprices of self produced food items, $(Q_P - Y_P)$ is the marketed surplus, P_M are the prices of market purchased food items, Q_M are the quantities of market purchased food items, P_{NM} are the prices of market purchased non-food items, W is the wage rate, L_{On}, L_{Off}, I_N represent on-farm labour , off-farm labour and off-farm income, respectively.

Time Constraint ➔ It is assumed that small farmers are too small to afford leisure time, so to get maximum utility from their time their total available time (T) is divided into on-farm labour (L_{On}) and off-farm labour (L_{Off}) i.e. $T = L_R$.

$$T = L_{On} + L_{Off} \rightarrow L_R \quad (4)$$

The consumption and time constraints can be combined into a single identity by incorporating (4) into (3_F and $_{LL}$), as;

$$P_P(Q_P - Y_P) - P_M Q_M - P_{NM} Q_{NM} - W(T) + I_N = 0 \quad (5_F)$$
$$W(T) - P_M Q_M - P_{NM} Q_{NM} = 0 \quad (5_L)$$

Income Constraints:

By rearranging the above identity the following income constraints are formed;

$$P_P Y_P + P_M Q_M + P_{NM} Q_{NM} = P_P Q_P + WT + I_N \quad (6_F)$$

$$P_M Q_M + P_{NM} Q_{NM} = WT \quad (6_L)$$

In income constraints (6_F and 6_{LL}), households' consumption expenditures are shown at the left hand sides. For farmers food (self produced and market purchased) and market purchased non-food items (farm inputs, cloths, health and schooling expenditures, etc)while for landless households the expenditures consist of only market purchased food and non food (cloths, health and schooling expenditures, etc) items. On the other hand the income of the households is shown by the right hand sides of these equations.

In most of the developing countries the production and consumption decisions are independent due to the imperfect markets (Verpoorten, 2001). The equilibrium, under such market conditions, is characterized by *the first order conditions*. The farmers decide for the production of food items (Y_P) keeping in mind its decision to consume the quantities of self produced food items (Q_P). Being a consumer, the household maximizes its utility by equating the marginal rate of substitution between food and non-food items to the marginal product of its labour. The household offers the surplus production for sale in the market. Similarly, its hires labour because the amount of household supplied labour falls short of its demand while, when they are free they usually offer labour to other farmers or businesses because of the assumption that no leisure time for such small scale income earners.

From the above discussion the production and consumption equations can be derived in terms of prices, wage, technology, land, and capital (see for example Strauss, 1983 and Feleke *et*

al., 2003). For the production side the input demand D_{In} and output supply Q can be derived as;

$$D_{In} = D(P_{NM}, W, T_{ch}^{0}, L_{D}^{0}, C^{0}) \quad (7_F)$$

and

$$Q = Q(P_P, L_{Off}) \quad (8_F)$$

At the optimum level selection of inputs and labour, the value of income at maximized profits level can be obtained by substituting consumption and production equations (7 and 8) into income constraint equation (6) as;

$$Y_F = WL_R + Q(P_P, L_{Off}) + I_N \quad (9_F)$$

$$Y_L = WL_R \quad (9_L)$$

Similarly, the consumption demand in terms of prices, wage rate and income can be written as;

$$Z_F = D(P_M, P_{NM}, W) \quad (10_F)$$

$$Z_L = D(P_M, P_{NM}) \quad (10_L)$$

For the food security the utility maximization function can be written as;

$$FS_F = F(Y_F(.), Z_F(.)) \quad (11_F)$$

$$FS_L = F(Y_L(.), Z_L(.)) \quad (11_L)$$

Where; F and FS represent food security utility maximization function, and food security, respectively.

The equations (11_F and $_L$) reveal a simplified phenomena of the economic behavior of the selected categories of rural households for food security in terms of consumption i.e. Y_F and $_L(.)$ related to the food production or availability, consumption (utilization) and income (access) i.e. Z_F and $_L(.)$ related to the food accessibility in terms of resources to obtain the food.

These equations can be written as one equation for a combined household food security function, as;

$$FS' = F(Y'(.), Z'(.)) \quad (11')$$

Where; ' stands for the combined household categories

Data Collection

Primary data were collected from the Punjab province. The province was selected for many reasons. First, it is the most populous province of the country, providing shelter to more than 55% of the total population (GOP, 1998). Second, its agricultural share is the largest, i.e. 57%

of the country's agricultural share of GDP (GOP, 2011). Third, Khyber Pakhtunkhawa (KP) province was excluded from the study because of the ongoing war against terrorism. Fourth, Baluchistan province was also excluded despite the fact that it is the largest province area wise, but has the smallest population and an extra layer of un-official tribal elders in the administration. Finally, the province of Sindh was not selected because of its landlord system that comprises big landlords.

For the purpose of data collection, a stratified sampling technique was adopted, the province was divided into 3 strata on the basis of geographical homogeneity. The strata were; Northern Punjab situated at 350 to 900 meters above sea level; Central Punjab – mostly plains; and South Punjab, Thal desert and mixed characters of both Thal and plains.

Figure 1: The Strata Formation

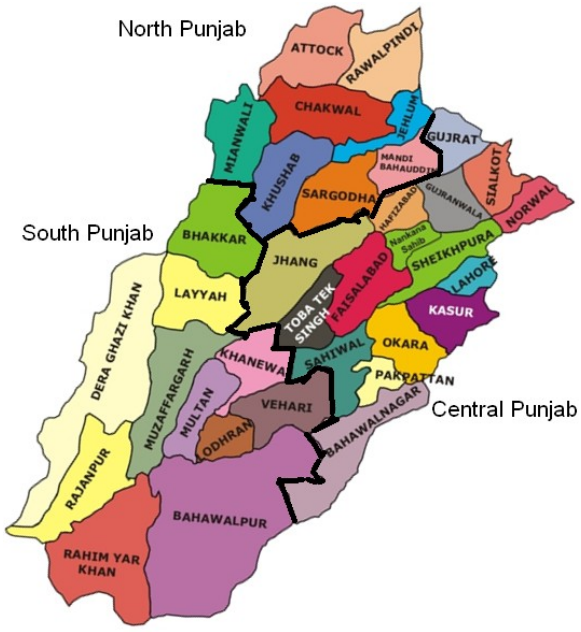


Figure 1 shows the division of the three strata based on the geographical homogeneity. According to the division, 8, 17 and 11 districts form each stratum of North, Central and South Punjab, respectively. Out of the total (36) districts of the province, one third (12 districts) were considered to be a good representative sample. The strata were not identical in terms of district numbers, so a proportionate sample was drawn from each stratum. A sample is considered to be proportional when the total sample is distributed among all the strata in proportion to the size of the particular strata (Chaudhry and Kamal, 1997). Three districts each from South and North Punjab and six districts from Central Punjab were the representative proportions of each stratum. Furthermore, the districts were selected based on

the homogeneity of different attributes including population, number of villages, irrigated and non irrigated land, per capita and per acre wheat production. One % of the villages (6 villages) were randomly selected from each district. On average, each village consists of about 200 households. In Pakistan, more than 80% of rural households are small land holders or landless households (GOP, 2010). It was decided to collect the information from 10 % of these households (i.e. 5% small farmers and 5% landless). The total sample size (n), thus, numbered 1152 households.

A comprehensive interview schedule was designed to document various parameters 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 calculations from different sources e.g. crops, livestock, labor, etc.

Data analysis

Several measurement methods are highlighted in the literature to measure food security. Almost all the mainstream methods use calorie intakes, directly or indirectly, to measure the extent of food insecurity. (Pérez-Escamilla and Segall-Corrêa, 2008) but none of them can be regarded as a criterion for the analysis of household food security (Maxwell, 1996). Despite the criticism, Dietary Intake Method was selected for measuring the rural household food security for the current study. The underlying assumptions of the study questions justify this selection: the targeted household categories belong to the lowest income groups. For them it is more important to fill their stomachs to maintain a subsistence level of living than to choose the nutritional or taste values of food items. They are the most vulnerable ones to become food insecure and results should further provoke debate on the approach to be used. There are two threshold levels for Pakistan: first, one defined by FAO that is general and represent an average threshold level and second, defined by the GOP that has separate categories for urban and rural areas. Per capita calorie calculation is adjusted for age and gender of household members (see Annex-II).

The food security status of rural households was measured by calculating the per capita calorie intake over a time period of the last 7 days prior to the interview day. It was adjusted for the age and gender variations with the adult equivalent units defined by the National Sample Survey Organization of India (NSSO), 1999. The threshold level defined by the GOP for the rural population was used as the threshold for food security (2450 Kcal/day/person (GOP, 2003)). A household whose per capita daily calorie intake was equal to or above this threshold was considered as food secure and marked as ‘1’ and those below this threshold level were considered as food insecure and marked as ‘0’. From equation 11' above, rural household food security status can be measured (after adjusting to the adult equivalent units) as:

$$RFS_{ij} = \sum_{j=3}^{i=n} FS' - Th \geq 0 \qquad (12)$$

Where, RFS_{ij} is the rural household food security status of i[th] household of j[th] region, 1 for food secure and 0 for food insecure and Th is the threshold level.

To indentify the determinants of food security in three different regions, binary logistic regression was chosen. There were two reasons for this choice; first, the dependent variable 'food security' was in the binary form; and second, both household categories belong to the lowest income group, hence were considered as similar. *The logistic regression directly estimates the probability of an event occurring for more than one independent variable* (Hailu, and Nigatu, 2007).

The food security status calculated by equation 12 is subject to vary with households' socio-economic characteristics (S(.)). Assuming a linear function, rural household food security can be written as:

$$RFS_{ij} = \sum_{j=3}^{i=n} \beta_i S_i \qquad (13)$$

Where, β_i represent the coefficients and S_i represents the socio-economic factors.

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

$$\delta_{ij} = \delta(RFS_{ij} = 1 \mid S_i = s_i) + \omega_i \qquad (14)$$

Where, δ_{ij} is the probability of i[th] household from j[th] region to become food secure, s_i is the vector of socio-economic factors and ω_i is the error term.

In general logit expression, equation 14 can be re-written as:

$$\log it(\delta_{ij}) = \beta_0 + \beta_i s_i + \omega_i \qquad (15)$$

For the current study the model can be expressed as:

$$\delta_{ij}(RFS) = \beta_0 + \beta_1 MI + \beta_2 HHHA + \beta_3 THM + \beta_4 TE + \beta_5 FSt + \beta_6 Orp + \beta_7 LSA + \beta_8 Edu_P + \beta_9 Edu_M + \beta_{10} Edu_I + \beta_{11} Edu_G + \omega_i \qquad (16)$$

Where

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

RFS = food security status of the household (food insecure '0'; food secure '1')

β_0 = the constant term

β_{1-11} = the coefficient of the predictor 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, number of total individual members 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

3 Results and Discussion

The food security status of households was calculated using the calorie intake method for each region of the province. Table 1 shows the comparative results for the food security situation in each region of the province. According to the results, on average, the incidence of food insecurity was high i.e. 23% in the Punjab. The Central Punjab was the most affected region of the province with more than 31% of the household measured as food insecure. On the other hand, situation was better in the South and North Punjab where 13.5 and 15% of the households were measured as food insecure.

Table 1. Food Security Status of Households in Each Stratum

Food Security Status	South Punjab (S) n = 288		Central Punjab (C) n = 576		North Punjab (N) n = 288		Total (S+C+N) n = 1152	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
FIns	39	13.5	182	31.6	43	14.9	264	22.9
FS	249	86.5	394	68.4	245	85.1	888	77.1

FIns = Food Insecure | FS = Food Secure

The descriptive statistics of the continuous variables are presented in Table 3. It was revealed that the mean calorie intake was 3303, 2920 and 3254 for South, Central and North Punjab, respectively. The minimum and maximum ranges for South, Central and North Punjab were about 1600 - 5000, 600 - 5000 and 1000 – 5000, respectively. In terms of calorie intake, the sample households from Central Punjab were at the lower side compared to South and North Punjab. The lowest income earning household belonged to the Central Punjab and highest income household belonged to South Punjab. On average, mean income of the sample households from North Punjab were the minimum amongst all three regions i.e. Rs 12332. In terms of age of household head, South had slightly younger household heads compared to other regions and Central Punjab has the oldest household heads, though the difference was not much. North Punjab had the least family sizes compared to South and Punjab. On average, South and Central Punjab had 7 members per household compared to 6 of North Punjab. A similar pattern was observed in terms of total earners across all the three regions. The sample households from North Punjab had least livestock assets both large and small while Central Punjab's households were slightly better in livestock ownership.

Table 2. Descriptive Statistics

Variables	South Punjab (n = 288)			Central Punjab (n = 576)			North Punjab (n = 288)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
*CI**	1575.7	4980.2	3303.1 (119.8)	590.1	4988.6	2920.3 (893.1)	952.2	4943.4	3254.1 (746.8)
MI	7000.0	56216.0	21533.9 (12526.9)	2192.7	42833.3	15762.2 (6718.9)	3050.0	33600.0	12331.7 (4539.5)
HHHA	24.0	73.0	42.8 (8.8)	25.0	76.0	46.9 (10.5)	22.0	72.0	46.5 (11.0)
THM	3.0	19.0	7.1 (2.8)	1.0	25.0	6.7 (2.7)	2.0	14.0	6.4 (2.1)
TE	1.0	7.0	1.3 (0.7)	1.0	4.0	1.4 (0.7)	1.0	4.0	1.4 (0.6)
LSA_L	0.0	20.0	3.6 (4.2)	0.0	26.0	3.6 (4.8)	0.0	10.0	2.2 (2.5)
LSA_S	0.0	8.0	1.6 (2.3)	0.0	10.0	1.9 (2.3)	0.0	7.0	1.3 (1.9)

* Calorie Intake

Figures in parenthesis are standard deviations

Determinants of Rural Household Food Security

This section presents the results of the binary logistic regression, and explains the socio-economic determinants of rural household food security in these three regions of the Punjab province. The results are presented in Table 4. The results show that in terms of predictive

efficiency, all three models predicted with high accuracy i.e. 88.2%, 75.9% and 89.2% for South, Central and North Punjab, respectively. The goodness of fit of the logistic regression model can be tested by two methods: one, the Hosmer and Lemeshow (H-L) Test; and two, pseudo R^2s (Peng, *et al.*, 2002). For good model prediction, the Hosmer and Lemeshow (H-L) Test results must be non-significant to accept the null hypothesis that the model is a good fit. In case of all three models H-L test results were statistically non-significant ($p>0.05$) yielding χ^2 values (8 degrees of freedom) of 6.038, 9.89 and 6.47 for South, Central and North Punjab, respectively. This accepts the hypothesis of a good model fit to the data for all the three models. On the other hand, the pseudo R^2s are the descriptive measures and cannot be tested in an inferential framework (Menard, 2000). The values of the descriptive measures i.e. Cox & Snell are 0.234, 0.234 and 0.247; and of Nagelkerke R^2 are 0.428, 0328 and 0.434 for South, Central and North Punjab models, respectively. This implies that the models explained 23 to 43% of the variation in the data. The descriptive measures, however, are not considered good representatives of goodness of fit (Hosmer and Lemeshow, 2000).

The estimates of relative risk in binary logistic models are computed on the grounds of odds-ratios (OR)[1]. It was revealed that out of eleven variables in all three models, four are statistically significant for South and North Punjab each and five are statistically significant for Central Punjab. Only the results of the statistically significant variables are explained below:

Monthly income has positive impacts for Central and North Punjab. It has comparatively small impact in Central Punjab compared to North Punjab. The results indicate that an increase in monthly income will increase the chances of a household becoming food secure in both regions by a factor of the associated odds-ratios i.e.1.00004 and 1.0001, respectively. It is better to explain the impact of an increase in the monthly income of households by Rs (Pak rupees) 1000 to rule out the inflationary effects by recalculating the odds-ratios i.e. $\exp^{0.00004*1000}$ and $\exp^{0.0001*1000}$. This yields 1.041 for Central Punjab and 1.105 for North Punjab. The odds-ratios can be converted into %ages (% = (OR-1)*100) that will more clearly interpret the results i.e. 4.1 and 10.5% for Central and North Punjab, respectively. This implies that an increase of Rs 1000 in monthly income increases the chances of a household to become food secure by 4.1 and 10.5% in Central and North Punjab, respectively. The coefficient of monthly income is statistically non-significant for South Punjab. A positive impact of income was found by Bashir *et al.* (2012), for rural household food security in the Punjab province of Pakistan. They found that an increase of Rs. 1000 increases the chances of household food security by 5%. In a related study of Faisalabad, an adjacent district to our study area, Bashir *et al.* (2012) found that households who belonged to a higher income group of Rs 5001–10000, had 15 times more chances of becoming food secure compared to households belonging to a lower income group. For India, Sindhu *et al.*

[1] 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).

(2008) found that chances of becoming food insecure are reduced by 30% with an increase of Indian Rupees (IR) 1000 in the monthly income of households. Similarly, for the USA, Onianwa and Wheelock (2006) found that an increase in the annual income of household by $1000 with and without children reduces the chances of food insecurity by 6% and 5%, respectively.

The coefficient of age of the household head is statistically non-significant for South and North Punjab while it is statistically significant for Central Punjab with a negative sign. This implies that age of the household head has a negative impact on household food security. Chances of a household becoming food secure are reduced by 2.95% with an increase of one year increase in the household head's age. It may be due to the reason that the older people are weaker compared to the young men due to which their performance is poor in filed. The older men may also take a little longer to decide on key matters both regarding field work and food intakes of the family resulting in poor household food security. Most recently, Bashir *et al.* (2012) found that an increase of one year in the age of household head decreases the chances of household food security by 3%. Similar relationship of household head's age with food security of the households was found by Bashir *et al.* (2010). They calculated that households with their heads belonging to an older age group (i.e. 36-45 years) were 83% less likely to become food secure compared to the households whose heads belonged to a younger age group of up to 35 years. The high magnitude of the chances of food insecurity compared to our results is because of the reason that the earlier study did not include age variable in the form of a continuous variable, they rather incorporated the multivariate form (in groups). On the other hand, contradicting results were found in 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 is statistically significant for all the three regions with a negative sign. This implies that an inverse relationship exists 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 36.81%, 30.51% and 45.66%, respectively. This implies that an increase of one family member deteriorates household food security in all the three regions of the province. The extreme effect of this increase was observed for North Punjab followed by South and Central Punjab. These results are in line with the results of Bashir *et al.* (2012), who found that an increase of one member in the household decreases the chances of food insecurity by 31%. Earlier for district Faisalabad, it was found that large families having household members up to 9 were about half as food secure compared to families with 4 to 6 members (Bashir *et al.*, 2010). Similarly for India it was found that an increase of one member in the family size increases the probability of food insecurity by 49% (Sindhu *et al.*, 2008).

Number of earners in the household was 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 20 times more chances of becoming food secure than the households having only one earning member.

The ownership of large livestock assets (buffalos and cows), is statistically significant for South and Central Punjab while the ownership of small livestock assets (goats and sheep) is statistically significant for Central and North Punjab. It implies that for the sample households from the Central Punjab region, an increase of one animal in both large and small livestock assets increases the chances of a household to become food secure by 6.82 and 26.11% respectively. On the other hand for an increase of one animal in the ownership of large animals in South Punjab and of small animals in North Punjab increases the chances of food security by 16.42 and 98.97%, respectively. The impact of livestock ownership is highest for the North Punjab region and least for the South region. In a recent study, Bashir et al. (2012) found that an increase of one small animal increases the chances of household food security by 31%. Earlier in 2010, it was found that the household who owned two milking animals were 37.03 times more food secure than the households having zero milking animal, in district Faisalabad of the Punjab Province (Bashir *et al.*, 2010). Similarly in Ethiopia, an increase of ownership of one ox increased the probability of household food security by 40% (Haile *et al.*, 2005).

Table 3. Results of Binary-Logistic Regression

Variables	South Punjab		Central Punjab		North Punjab	
	B	OR	β	OR	β	OR
MI	0.00001 (0.000)	1.0001	0.00004** (0.000)	1.00004	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***	N/A	3.368***	N/A	4.086***	N/A

	(1.292)	(0.640)	(1.296)
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

Education Levels (Edu_I and Edu_G)

The impact of all educational levels for the South region was statistically non-significant. It was found that education levels of up to intermediate and graduation and above were 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 the South, up to intermediate (secondary and higher secondary) in the North and highest in Central Punjab. Bashir *et al.* (2012) found that households headed by household head whose education level is up to intermediate are 133% more likely to become food secure. Earlier, for district Faisalabad, having middle and graduation levels of education increased the odds of food security by 6.4 and 21 times, respectively (Bashir *et al.*, 2010). In Nigeria, higher education helped decreasing the chances of household food insecurity by 59% (Amaza *et al.*, 2006). Similarly, higher education of mothers within households helped decreasing the chances of household food insecurity by 29% in the USA (Kaiser *et al.*, 2003).

Relative importance of the determinants

Table 4 presents the comparison of the determinants for their relative importance to rural household food security within and across the regions. For South Punjab, only two factors were significantly affecting the food security i.e. livestock assets (large animals) and family size. For Central Punjab, five variables were significantly impacting the food security i.e. education level (graduation and above), Livestock assets (both large and small), monthly income and family size. For North Punjab, six factors were responsible for changing the household food security status i.e. education level (up to intermediate), livestock assets (large), total earning members, monthly income, family size and household head's age.

All these variables can be ranked for their relative importance to food security in each region as to identify the most important areas for policy concentrations. There were only two factors identified for the South Punjab, one positively and other negatively impacting food security. There was only one factor in each rankings i.e. livestock assets (large animals) for positive impacts and family size for negative impacts. 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 the three regions because of socio-economic differences of the characteristics at household level.

Table 4. Comparison of ranks

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%

4 Conclusion

From the above discussion it may be concluded that on average 23 % of the sample households were measured to be food insecure in the Punjab. The situation is more alarming in the Central Punjab region where more than 31 % of the sample households were found to be food insecure while the situation in South and North Punjab regions was much better (13.5 and 15 %, respectively). Similar trends were observed in from the descriptive statistics of calorie intake, and monthly incomes. A significant difference in the determinants of food security was observed across all the regions. The determinants were also ranked in each region for their relative importance to food security (Table 4). The rankings were also different across all the three regions though there were some similarities in Central and North regions. The difference of ranks is due to the regional differences of socio-economic characteristics at household level.

The findings of this study suggest that all the three regions of the province are different from each other[2]. Furthermore, the determinants of food security also varied across all of them; hence a blanket policy approach to target food insecurity is highly discouraged. It is, therefore, important to know the local conditions before launching any policy options. Livestock assets were found to improve food security across all the three regions but varied in their types e.g. in South, large animals, in North, small animals and in Center, both large and small was helpful in improving household food security. It is, therefore, recommended that, keeping the role of livestock in mind for each region, existing livestock policies be redesigned or launch new policies. Similarly education is very important not know to earn livelihood but also for food intake and safety. Though, it was statistically non-significant in the South Punjab, special emphasis should be given to secondary, higher secondary and tertiary education including technical training to improve agricultural skills. Last, but not the

[2] 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.

least, family planning programs must be made effective to control the population menace across all the three regions.

References

AIOU. 2001. Food composition table for Pakistan. Allama Iqbal Open University, Islamabad, Pakistan, online available at http://www.aiou.edu.pk/FoodSite/FCTViewOnLine.html accessed on 05/03/2011.

Amaza, P.S., Umeh, J.C., Helsen, J. and Adejobi, A.O. 2006. Determinants and measurement of food insecurity in Nigeria: some empirical policy guide. Presented at international association of agricultural economists annual meeting, August 12-18, Queensland, Australia, online available at http://ageconsearch.umn.edu/bitstream/25357/1/pp060591.pdf.

Bashir, M.K., Naeem, M.K. and Niazi, S.A.K. 2010. Rural and peri-urban food security: a case of district Faisalabad of Pakistan. WASJ, 9(4), 403-41.

Bickel, G., Nord, M., Hamilton, W. and Cook J. 2000. Guide to measuring household food security. Analysis, Nutrition and Evaluation, Food and Nutrition Service, USDA, USA, online available at http://www.fns.usda.gov/fsec/files/fsguide.pdf.

Brown, L. 1998. Food Scarcity: An Environmental Wakeup Call. The Futurist (Jan/Feb). Online available at http://www.allbusiness.com/legal/laws-government-regulations-environmental/663828-1.html

Chaudhry, S.M. and S. Kamal. 1997. Introduction to statistical theory Part II. Ilmi Kitab Khana. Kabir Street, Urdu Bazar Lahore, 54000.

FAO, 2010. The state of food insecurity in the World: addressing food insecurity in protracted crises. Food and Agriculture Organization of the United Nations, Rome, online available at http://www.fao.org/docrep/013/i1683e/i1683e.pdf accessed on 05/04/2011.

FAO, 2011a. Country rank in the World, by commodity. Food and Agriculture Organization of United Nations, Statistics Division, online available at: http://faostat.fao.org/site/339/default.aspx accessed on 10/05/2011.

FAO, 2011b. Food balance sheets. Food and Agriculture Organization of United Nations, Statistics Division, online available at: http://faostat.fao.org/site/368/default.aspx#ancor accessed on 10/04/2011.

Feleke, S., Kilmer, R.L. and Gladwin, C. 2005. Determinants of food security in Southern Ethiopia. Agricultural Economics, 33, 351–363.

GOP. 1998. Population census of Pakistan. Population Census Organization, Statistics Division, Government of Pakistan.

GOP. 2003. Economic Survey of Pakistan, 2002-03. Ministry of Food and Agriculture. Finance Division, Economic Advisor's Wing, Islamabad, Pakistan.

GOP. 2010. Economic survey of Pakistan, 2007-08. Ministry of Food and Agriculture. Finance Division, Economic Advisor's Wing, Islamabad, Pakistan.

GOP. 2011. Economic survey of Pakistan, 2007-08. Ministry of Food and Agriculture. Finance Division, Economic Advisor's Wing, Islamabad, Pakistan.

Haile, H.K., Alemu, Z.G. and Kudhlande, G. 2005. Causes of household food insecurity in Koredegaga peasant association, Oromiya Zone, Ethiopia. Working paper, Department of Agricultural Economics, Faculty of Natural and Agricultural Sciences at the University of the Free State.

Hailu, A. and R. Nigatu. 2007. Correlates of household food security in densely populated areas of southern Ethiopia: does the household structure matter? Stud. Home Comm. Sci., Vol. 1 (2), pp: 85-91.

Hosmer, D.W. and S. Lemeshow, 2000. Applied logistic regression. John Wiley and Sons, New York, USA.

IAASTD. 2008. Food security in a volatile world. International Assessment of Agricultural Knowledge, Science and Technology for Knowledge, online available at http://www.agassessment.org/docs/10505_FoodSecurity.pdf.

Jensen, R.T. and Miller, N.H. 2010. A revealed preference approach to measuring hunger and under-nutrition. Working Paper No. 16555, NBER Working Paper Series, online available at http://www.nber.org/papers/w16555.pdf accessed on 04/04/2011.

Kaiser, L.L., H.M. Quiñonez, M. Townsend, Y. Nicholson, M.L. Fujii, A.C. Martin and C.L. Lamp. 2003. Food insecurity and food supplies in Latino households with young children. Journal of Nutrition Education and Behaviour, Vol. 35, pp: 148-153.

MacFarquhar, N. 2011. Food prices worldwide hit record levels, fueled by uncertainty, U.N. Says. NYT, Februrary 3, 2011, online available at http://www.nytimes.com/2011/02/04/world/04food.html accessed on 03/02/2011.

Maxwell, D. 1996. Measuring food insecurity: the frequency and severity of coping strategies. Food Policy, Vol. 21, pp: 291-303.

Maxwell, S. and Frankenberger, T. 1992. Household food security: concepts, indicators, measurements: a technical review. IFAD/UNICEF, Rome, Italy.

Menard, S. 2000. Coefficients of determination for multiple logistic regression analysis. The Americani Statistician, Vol. 54, No. 1, Pp17-24.

NSSO. 1995. Measurement of poverty in Sri Lanka. National Sample Survey Organization of India. Online available at: www.unescap.org/stat/meet/povstat/pov7_ska.pdf accessed on 21/03/2011.

Onianwa, O.O. and Wheelock, G.C. 2006. An analysis of the determinants of food insecurity with severe hunger in selected southern states. Southern Rural Sociology, 21(1), 80-96.

Peng, C.Y., T.S. So, F.K. Stage, and E.P. St. John. 2002. The use and interpretation of logistic regression in higher education journals: 1988–1999. Research in Higher Education, Vol. 43, pp. 259–293.

Pérez-Escamilla, R. and Segall-Corrêa, A.M. 2008. Food insecurity measurement and indicators. Rev. Nutr., Campinas, 21(Suplemento), pp: 15-26.

Shaikh, F.M. 2007. Determinants of household food security and consumption pattern in rural Sindh: an application of non-separable agricultural household model. Presented at the Mediterranean Conference of Agro-Food Social Scientists. 103rd EAAE Seminar 'Adding Value to the Agro-Food Supply Chain in the Future Euromediterranean Space'. Barcelona, Spain.

Sindhu, R.S., I. Kaur. and K. Vatta. 2008. Food and nutritional insecurity and its determinants in food surplus areas: the case study of Punjab state. Agricultural Economics Research Review, Vol. 21, pp: 91-98.

Strauss, J. 1983. Socioeconomic determinants of food consumption and production in rural Sierra Leone: Application of an agricultural household model with several commodities.

USAID, 2009. Agriculture. USAID. Online available at http://www.usaid.gov/our_work/agriculture/food_security.htm (accessed on 30-10-2009).

Verpoorten, M. 2001. Imperfect markets: a case study in Senegal. Discussions Paper Series (DPS) 01.20, Center for Economic Studies, Katholieke Universiteit Leuven.

Wolfe, W.S. and Frongillo (Jr.), E.A. 2000. Building household food security measurement tools from the ground up. Background Paper, Food and Nutrition Technical Assistance Project, Washington, DC., USA.

Yasin, M.A. 2000. An investigation into food security situation in rain-fed areas of district Rawalpindi. M.Sc. (Hons.) Thesis (Unpublished), Department of Agricultural Economics. University of Agriculture Faisalabad, Pakistan.

WB. 2011. Gross domestic product 2010, PPP. World Development Indicators database, World Bank, online available at http://siteresources.worldbank.org/DATASTATISTICS/Resources/GDP_PPP.pdf accessed on 06/07/2011.

Annex-I

Food Composition Table for Pakistan (Revised 2001) Amount in 100g of edible portion

No	Name of Food	kcal	No	Name of Food	Kcal
A)	Cereal and Cereal Products		F)	Fruits	
1	Corn Whole grain flour	276	35	Apple	57
2	Rice Polished Fried	268	36	Banana Ripe	96
3	Vermicelli	345	37	Dates Dried	293
4	Wheat Whole grain flour	357	38	Dates Fresh	131
5	Wheat flour Granular	370	39	Guava Whole	73
6	Wheat Bread	369	40	Lemon	30
7	Wheat Bread	259	41	Lichi	62
8	Wheat Bread	364	42	Mango Ripe	64
9	Wheat Bread	293	43	Melon Water	23
10	Wheat Bread	263	44	Mandarin	44
11	Wheat Flour	440	45	Orange Sweet	43
B)	Legumes		46	Peach	47
12	Broad Bean Cooked	175	47	Pomegranate	66
13	Chickpea Cooked	187	48	Zizyphus	79
14	Lentil Cooked	178	G)	Dairy Products	
15	Mung Bean Cooked	120	49	Butter Milk	31
16	Mash Cooked	158	50	Curd	52
C)	Vegetables		51	Cream	361
17	Bath Sponge	18	52	Milk Buffalo Fluid Whole	105
18	Bottle Gourd	15	53	Milk Cow Fluid Whole	66
19	Bringal	26	54	Milk Goat Fluid Whole	70
20	Cauliflower	27	55	Yogurt	71
21	Cocumber	16	56	Ice-cream	148
22	Lady Finger	35	H)	Meat & Products	
23	Spinach	27	57	Beef	244
24	Tinda	23	58	Buffalo Meat	123
D)	Roots & Tubers		59	Chicken Meat	187
25	Carrots	37	60	Goat Meat	164
26	Onion	44	61	Sheep Meat	175
27	Potato	83	I)	Eggs	
28	Reddish	23	62	Chiken Egg White	400
29	Turnip	26	63	Duck Egg White (Raw)	895
E)	Spices & Condiments		J)	Fats & Oils	
30	Cumin Seed	336	64	Butter	721
31	Liquorice Root	212	65	Ghee	874
32	Clove	304	66	Ghee (Buffalo)	900
33	Turmeric	365	67	Lard (Raw)	899
34	Pepper Black	268	68	Dalda (Hydrogenated Oil)	892
69	Corn Oil	900	75	Jaleebe	395
70	Soybean	887	76	Koa (Whole Buffalo Milk)	401
K)	Sugar, Sweets & Beverages		77	Halwa Sohen	481
71	Sugar	380	78	Carbonated Beverages Pepsi, Coke, etc.	39
72	Gur	310	79	Lemon Juice	43
73	Honey	310	80	Mango Juice	74
74	Barfi	384			

Source: AIOU, 2001

Annex-II

Adult Equivalent Units

Age groups (years)	Male	Female
< 1	0.43	0.43
1-3	0.54	0.54
4-6	0.72	0.72
7-9	0.87	0.87
10-12	1.03	0.93
13-15	0.97	0.80
16-19	1.02	0.75
20-39	1.00	0.71
40-49	0.95	0.68
50-59	0.90	0.64
60-69	0.80	0.51
70+	0.70	0.50

Source: NSSO, 1995