The Determinants of Rural Household Food Security in the Punjab, Pakistan: An Econometric Analysis

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Abstract

Pakistan is one of the leading producers of important agricultural commodities in the world with a relatively high proportion of undernourished population (26 %). This study aims to examine the food security trends in Pakistan in general, and to find out the household level food security and its key determinants in the rural areas of the Punjab Province in particular. Both secondary and primary data were used. Secondary data were obtained from Food and Agriculture Organization (FAO), World Bank and Government of Pakistan's data sources. Primary data were collected from 1152 households in 12 districts of the Punjab province using questionnaire survey. The analysis was done in two phases i.e. (Phase-A) identification of food security trends, at national level and (Phase-B) household food security and its determinants. For Phase-A, graphical representations are produced and for Phase-B primary data were analyzed in two further stages. In stage one the food security status of households was calculated using the calorie intake method. The second stage focused on identifying the socio-economic factors affecting food security using the logistic regression. The secondary data revealed that Pakistan is a food sufficient as well as food secure country at the national level. But at the household level 23 percent of the sample households were measured to be food insecure. Econometric analysis revealed that monthly income, livestock assets (small animals), and education levels (middle, intermediate and graduation) were positively impacting the rural household food security. On the other hand, greater household heads' age, joint family system and family size had negative impacts on household food security. It is suggested that income generating opportunities needs to be created along with improvements in secondary and technical education systems, and family planning programs to alleviate food insecurity in the study region.

Keywords: Food security, rural households, logistic regression, Punjab, Pakistan

JEL Classification: I30, Q18 and R20.

1. Introduction

Food security is not a new concept. It has been defined in a variety of ways by different authors and organizations. However, the most comprehensive definition comes from FAO (2004) stating *"Food that is available to everyone at all times, that they have means of access to it, that it is nutritionally adequate in terms of quantity, quality and variety, and is acceptable within the given culture. Only when all these conditions are in place it can be said that a population is food secure".* Food insecurity, the lack of food security, is caused due to the absence of any of these conditions at different levels – household, regional and national. It can be considered as severe food insecurity when food intakes are continuously insufficient to meet the daily dietary energy requirements leading to a most severe stage of food insecurity called as 'hunger'. Due to food insecurity, at a global

scale, the number of undernourished people have increased over the years from 848 million during 2003 to 2005 to 925 million in 2010 (FAO, 2010).

The enormity of food security differs from nation to nation and time to time. It is a multifaceted situation that is affected by a range of factors and can vary in significance across regions, countries, social groups as well as over time. From the FAO definition, the factors affecting food security can be clustered into three core areas. Firstly, food availability defined as constant availability of sufficient quantities of food to all individuals within a country through production, imports, or food assistance programs. Secondly, food accessibility, when households and its members have sufficient sources to attain appropriate foods for a healthy diet which depends on household income, its distribution within the household and the price of food. Finally, the food utilization meaning proper biological use of food that require a sufficient energy and essential nutrients providing diet, drinkable water and satisfactory cleanliness. All these greatly depend on household members' knowledge about food storage, processing, basic principles of nutrition, child care and illness management (Riely *et al.*, 1999).

Food security is an issue of prime importance for every country of the world whether developed or developing. Even the most developed countries have faced food security related problems, for example in the USA more than 14 percent households were food insecure at least for some time during the year (Nord *et al.*, 2008); similarly, 10 percent of Canadian households were food-insecure (Che and Chen, 2002). In Australia the proportion of food insecure population was over 5 percent and much higher among vulnerable groups (Booth and Smith, 2001). The situation in developing countries is bad and getting worse. For instance, in Africa about 239 million people are undernourished (FAO, 2010). Situations in other developing regions such as East Asia, South Asia and Latin America are a little better as compared to Africa (Brown *et al.*, 2008). However, increase in food prices since 2008 deeply impacted the low-income populations everywhere. For example, the prices of soybeans, a key staple food for Indonesians, doubled in one year and caused serious problems for people, resulting in street protests. Similarly the Egyptians were forced to come out into the streets because of increases in the prices of bread and cooking oil. Protests also broke out in Senegal over rice price hikes. China also faced a tough situation due to a 20 percent increase in food prices. Food inflation (increase in food prices) also struck Vietnam and India (Brown *et al.*, 2008). Global food prices moved higher to record level, since the start of 2011(MacFarquhar, 2011), dragging the world into another crisis in less than three years' time (Krugman, 2011). Due to which another wave of widespread protests broke in the world, especially in the Arab countries (Anonymous, 2011). The high-ceiling prices of cereals and oil are having terrible impacts on poor people who spend a major proportion of their income on basic foodstuffs (Krugman, 2011).

Pakistan is the 6th most populous country in the world with a population of about 170 million (GOP, 2010). It is expected that the population will double in the year 2045 if it grows continuously at the present growth rate of 1.8 percent. The average annual rates of change in food and population growth during 1995-97 and 2001-03 were 1.9 and 2.6 respectively (FAO, 2006). Agriculture is the largest sector of Pakistan's economy: it contributes over 21 percent to GDP and employs about 45 percent of the labor force. Nearly 62 percent of the population lives in rural areas and heavily depends on

agriculture and activities for their livelihoods (GOP, 2010). The economy of Pakistan is the 26th largest economy of the world (WB, 2010) and one of the world's leading producers of many agricultural commodities[1]. However, the proportion of the undernourished population in Pakistan is too high i.e. 26 percent (FAO, 2011a). The rural communities are the most vulnerable to food insecurity as they have to deal with provisioning uncertainty in their food on a daily basis (Yasin, 2000).

Therefore, this study aims to examine the food security trends in Pakistan in general, and to find out the household level food security situation and its key determinants for the rural areas of the Punjab Province in particular. Key research questions are;

1. What levels of food security are experienced at the national level?
2. What levels of food security are experienced by rural households?
3. How do food security levels depend on socio-economic characteristics of the household?
4. What is the relative importance of these socio-economic factors for rural household food security?

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

2. Methodology

2.1 Theoretical model

A fair proportion of the literature on food security has remained committed to the measurement of food security and factors affecting it (for example Che and Chen, 2002; Onianwa and Wheelock, 2006; Babatunde *et al.*, 2007; Sindhu *et al.*, 2008; Bashir *et al.*, 2010 among others). To provide an analytical basis for the examination of the determinants of food security and their impacts on the population, it is necessary to develop a relevant theoretical framework. From the FAO (2004) definition and existing literature on household food security, three main concepts can be identified: food availability, access and utilization, as stated above, which are further dependant on several factors. Keeping these in mind, a theoretical framework is proposed that will serve as an organizing tool for considering the kinds of impacts that need to be considered in the analysis.

Generally land holdings in developing countries are small (IAASTD, 2008) e.g. in Pakistan's case more than 85 % of farmers have farms of less than 5 hectares (see Annex-II). These small land holders and the landless people living in rural areas are most likely to become food insecure. Rural households can be categorized into three sub categories i.e. small famers, tenants (renting in lands up to 5 hectares) and landless rural households. Based on consumer behaviour and production theories, the proposed model explains the behaviour of these households in terms of food security. Farming households (land owners and tenants) generally combine the features of both producers and consumers. In order to provide insights into the decision making processes of households, different

[1] World rank 2nd for buffalo milk and meat; rank 3rd apricots and chickpeas; rank 4th onions, cotton lint, goat milk and meat; rank 5th sugarcane, dates, chillies and peppers; rank 6th mangoes, guava, okra and pulses; rank 10th wheat, and spinach; rank 11th rice, oranges and pistachios (FAO, 2011)

production models have been proposed by economists (see for example Strauss, 1983; Gundersen and Gruber, 2001; Feleke *et al.*, 2003; Shaikh, 2007).

For any production cycle (short run—i.e. up to 1 year), these households are assumed to maximize a utility function expressed in equations ($1_{W,T}$) and (1_Z) depending on household categories;

$$U_W = U(X_{FP}, X_{FM}, X_{NFM}) \quad (1_W)$$
$$U_Z = U(X_{FM}, X_{NFM}) \quad (1_Z)$$

Where;

$_W$ = Land owner
$_Z$ = Land less
X_{FP} = consumed food commodities produced by the household
X_{FM} = consumed food commodities purchased from the market
X_{NFM} = consumed non-food commodities (durables, non-durables, services, health issues, etc.) purchased from the market.

For the sake of a simple exposition, only food and non-food commodities are considered and assumed that markets exist for both these commodities. The household makes decisions regarding its consumption (X_{FP}, X_{FM} and X_{NFM}) and its production (X_{FP}, X_{NFM}). A household's utility is maximized subject to production, income and time constraints for respective categories as;

Production Constraint:

$$P(Q_{FP}, Q_{NFM}, L, R^0, A^0, K^0) = 0 \quad (2_W)$$

Where;

Q_{FP} = Quantities of food commodities produced by households
Q_{NFM} = Quantities of non-food commodities purchased from the market
L = Total available labour
R^0 = Technology (Fixed in the short-run)
A^0 = Quantity of land of a household (Fixed in the short-run)
K^0 = Capital stock (Fixed in the short-run)

In the short run, a household holds fixed amount of land, capital stock and technology so these variables are considered constant for land owners but for tenants land is not constant as the tenant can rent in land at any time.

Consumption Constraint:

$$P_{FP}(Q_{FP} - X_{FP}) - P_{FM}Q_{FM} - P_{NFM}Q_{NFM} - w(L_F + L_N) + N = 0 \quad (3_W)$$
$$w - P_{FM}Q_{FM} - P_{NFM}Q_{NFM} = 0 \quad (3_Z)$$

Where;

P_{FP} = Prices of food commodities sold by the household
$(Q_{FP} - X_{FP})$ = Marketed surplus of food commodities
P_{FM} = Prices of food commodities purchased from market
Q_{FM} = Quantities of food commodities purchased from market
P_{NFM} = Prices of non-food commodities purchased from market

w = Wage rate
L_F = On-farm labour
L_N = Off-farm labour
N = Total off-farm income

Time Constraint:

It is assumed that small farmers and landless rural households cannot afford leisure time as to get maximum utility from their time; consequently, their total available time is divided into on-farm labour and off-farm labour.

$$t = L_F + L_N \qquad (4)$$

Where;

t = Total time available to the household to allocate between farm and off farm: assuming zero leisure, in this case t = L, numerically

The consumption and time constraints on household behaviour can be combined into a single identity by incorporating (4) into (3_W, $_T$ and $_Z$), as;

$$P_{FP}(Q_{FP} - X_{FP}) - P_{FM}Q_{FM} - P_{NFM}Q_{NFM} - w(t) + N = 0 \qquad (5_W)$$
$$w(t) - P_{FM}Q_{FM} - P_{NFM}Q_{NFM} = 0 \qquad (5_Z)$$

Income Constraints:

By rearranging the above identity we will get the following income constraints;

$$P_{FP}X_{FP} + P_{FM}Q_{FM} + P_{NFM}Q_{NFM} = P_{FP}Q_{FP} + wt + N \qquad (6_W)$$
$$P_{FM}Q_{FM} + P_{NFM}Q_{NFM} = wt \qquad (6_Z)$$

In income constraints (6_W, 6_T and 6_Z), the left hand sides show the households' consumption expenditures. For land owners and tenants (6_W and $_T$) food (own production and purchased from market) and non-food commodities (clothing, health, schooling and farm inputs) purchased from the market; for tenants land rent is added in expenditures. For landless households the expenditures comprise of only food and non food (clothing, health and schooling) commodities. The right hand sides of these equations show the incomes of these household categories. Equations 6_W and $_T$ include total production i.e. food ($P_{FP}Q_{FP}$), the value of household's time (wt) and non-farm income (N). While in case of landless households income equals total wages.

When there is an imperfect market, which is the case in most of the developing countries (Verpoorten, 2001), production and consumption decisions are independent. Under such conditions the equilibrium is not only characterized by *the first order conditions* but also by equality between consumption and production. The farming household (small farmer and/or tenant) decides for the consumption of food commodities (X_{FP}) keeping in mind its decision to produce the quantities of food commodities (Q_{FP}). As a consumer, the household maximizes its utility by equating the marginal rate of substitution between food and non food commodities to the marginal product of labour. The household offers its excessive production (than its consumption) for sale in the market. Similarly the amount of household supplied labour falls short of the demand; hence, it hires additional labour. While in free times it offers labour to other farmers and businesses as it is assumed that no leisure time for these households due to their very small scale.

In the light of the above discussion the production and consumption equations can be derived separately in terms of prices, wage rate, technology, land, and capital (see for example Strauss, 1983 and Feleke *et al.*, 2003). For the production side the input demand D_Q and output supply Q_S can be derived as;

$$D_{QW} = D(P_{NFM}, w, R^0, A^0, K^0) \qquad (7_W)$$

and

$$Q_S = Q_S(P_{FP}, L_N) \qquad (8_W)$$

Once the optimum level of inputs and labour is selected, the value of income when profits have been maximized can be obtained by substituting consumption and production equations (7 and 8) into income constraint equation (6) as;

$$Y_W = wL + Q_S(P_{FP}, L_N) + N \qquad (9_W)$$
$$Y_Z = wL \qquad (9_Z)$$

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

$$X_W = D(P_{FM}, P_{NFM}, w) \qquad (10_W)$$
$$X_Z = D(P_{FM}, P_{NFM}) \qquad (10_Z)$$

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

$$FS_W = F(X_W(.), Y_W(.)) \qquad (11_W)$$
$$FS_Z = F(X_Z(.), Y_Z(.)) \qquad (11_Z)$$

Where;

F = food security utility maximization function
FS = food security status that can be measured in per capita calorie intake.

These three equations ($11_{W,Z}$) reflect a simplified scenario of the economic behaviour of the rural households for food security in terms of consumption i.e. $X_{W,T,Z}(.)$ related to the food production or availability, consumption (utilization) and income i.e. $Y_{W,T,Z}(.)$ related to the food accessibility in terms of resources to obtain the food.

For more simplistic expression, these equations can be expressed as one equation for a combined household food security function as;

$$FS_i = F(X_i(.), Y_i(.)) \qquad (11^*)$$

Where

i = function for combined household categories

2.2 Empirical Model

After determining the food security equation for rural households (11*), the next step is to calculate the household food security status. To determine whether a household is food secure or not calorie intake can be calculated from the consumed food commodities. A household is food secure if the difference of its calorie consumption and recommended daily calorie consumption is greater than or equal to 0.

$$FS_i = \sum^{c} X_{ij} - \overset{c}{R} \geq 0_c \qquad (12)$$

Where,

FS_i = Food security status of ith household (food secure = 1, food insecure =0)

$\sum^{c} X_{ij}$ = Calorie consumption from self produced and market purchased food commodities

$_{ij}$ = FP, FM from (1w, z)

$\overset{c}{R}$ = Recommended calorie consumption

Further details of calorie intake calculations are in section 2.4.

Assuming a linear function, the household food security status can be written in terms of households' production and consumption demands and expenditures in terms of household income as:

$$FS_i = \sum^{n=k} \beta_{ij} Z_i \qquad (13)$$

Where Z_i is the vector of all socio-economic factors that affect the food security status of the i^{th} household and ε_i is the error term. Since the dependent variable FS_i is in a binary form i.e. 0 = food insecure or 1 = food secure. The logistic regression can be applied to this problem because *it directly estimates the probability of an event occurring for more than one independent variable, that is, for k independent variables* (Hailu, and Nigatu, 2007). The model can be treated as a qualitative response model and can be re-written as:

$$P_i = \Pr(FS_i = 1 | Z_i = z_i) + \varepsilon_i \qquad (14)$$

Equation (14) can be re-written as:

$$\log\left(P_i \big/ 1 - P_i\right) = \log it(P_i) = \beta_0 + \beta_i z_i + \varepsilon_i \qquad (15)$$

Where,

P_i is the probability of i^{th} household to become food secure and z_i is the vector of explanatory variables in terms of socio-economic characteristics of i^{th} household. Therefore the parameter β_0 gives the log odds of a household being food insecure (when z_i = 0) and β_i show how these odds differ for food secure households (when z_i = 1).

Equation (15) can be written in terms of odds:

$$P_i \big/ 1 - P_i = \exp(\beta_0 + \beta_i z_i) + \varepsilon_i \qquad (16)$$

Finally, equation (16) can be written in terms of probability of occurrence as:

$$P_i = \exp(\beta_0 + \beta_i z_i) \Big/ 1 + \exp(\beta_0 + \beta_i z_i) \qquad (17)$$

2.3 Data Collection

Both secondary and primary data were collected for analysis purposes. Secondary data were obtained from Government of Pakistan (GOP), Food and Agriculture Organization (FAO) of the United Nations and the World Bank. For primary data, the Punjab province was selected as the study area for this study because it is better positioned for such a research endeavor, for many reasons. First, it is the most populous province of the country with a population of about 73.62 million i.e. 55.63% of the total population of the country (GOP, 1998). Second, its agricultural share equals 57% of the country's agricultural share of GDP (GOP, 2010). Third, one of the provinces of Pakistan, the Khybar Pakhtunkhwah (KPK), cannot be included in the study because of the ongoing war against terrorism. Fourth, the Balochistan province, though it is the largest one area wise, has the least population i.e. 6.566 Million (GOP, 2011). Finally, the agriculture system of the Sindh province consists of big land lords, very few small farmers, so data collected from this province will surely not correctly represent the situation under study.

Stratified sampling technique was used for data collection and the province was divided into three strata (A = 'Northern Punjab', B = 'Central Punjab' and C = 'Southern Punjab') based on geographical characteristics. It was decided to take one third of the districts (12 districts). The strata were not identical in district number so a proportionate number of districts were selected from each stratum (equation 12). The allocation is said to be proportional when the total sample size is distributed among the different strata in proportion to the size of strata (Chaudhry and Kamal, 1997).

$$n_i = n. \frac{Ni}{N} \qquad \text{for i = A, B and C} \qquad (18)$$

Where;

A, B and C	= selected strata respectively
n_i	= number of districts in the i^{th} stratum
n	= total number of selected districts from all strata
N_i	= number of districts in the i^{th} stratum
N	= total size of districts

Equation 12 suggests selecting three districts each from south and north Punjab and six districts from central Punjab. The selection of these districts was made on different attributes including population, number of villages, irrigated and non irrigated land, per capita and per acre wheat production. Six villages were selected randomly from each district (about 1 % of villages). The decision to include small numbers of villages was based on the fact of homogeneity of information. Each village has about 200 households on an average and more than 80% of these are small land holders or landless households (GOP, 2010). A 10 percent of the sample households (half small farmers and half landless) were selected for questionnaire survey with a total sample size of 1152 households (table 1).

Table 1: Sample size selection

	North Punjab	Central Punjab	South Punjab	Total
Districts	3	6	3	12 (3+6+3)
Village	6 (6x3 = 18)	6 (6x6 = 36)	6 (6x3 = 18)	72 (18+36+18)
Farmers	8 (8x18 = 144)	8 (8x36 = 288)	8 (8x18 = 144)	576 (144+288+144)
Landless	8 (8x18 = 144)	8(8x36 = 288)	8 (8x18 = 144)	576 (144+288+144)
Sample Size	288 (144+144)	576 (288+288)	288 (144+144)	1152 (288+576+288)

A comprehensive interview schedule was designed to record different parameters of household food security. It contained three major parts: the ***first*** part contained general and demographic information about the household, the ***second*** part was related to consumption of food items and the ***third*** part of the schedule was to gather information to calculate the income of a household from crops, livestock and labor.

2.4 Data analysis

For identifying the trends in food security, at the national level, graphical representations were chosen (Phase-A) whereas, at the household level, calorie intake method (either 7 days or 30 days recall method) was used for food security measurements (Phase-B). To measure food security, different methods have been highlighted in the literature such as the FAO method, household expenditure survey method, dietary intake method, food insecurity experienced based measurement scales and anthropometry. A complete array of food security cannot be confined by any single method. To determine the food security at household levels, information on a range of conditions, experiences, and behaviour serves as indicators of severity of the situation (Bickel *et al.*, 2000). Majority of these methods, directly or indirectly, use calorie intake method to assess the household food security. None of them provides a full assessment of food security because they fail to take into account the vulnerability and sustainability elements of food security (Pérez-Escamilla and Segall-Corrêa, 2008). Therefore it is difficult to state any of them as a "*gold standard*" for the analysis of household food security (Maxwell, 1996). In an ideal world, food security measurement should be based on the application of several of these methods (Pérez-Escamilla and Segall-Corrêa, 2008). This principle was kept in mind while designing the questionnaire for the study.

The dietary intake methods are generally criticized on the grounds of skipping the nutrient adequacy (Wolfe *et al.*, 2000), missing the vulnerability analysis, no defined thresh hold levels of calorie intake and substitution effect due to increased income (Jensen and Miller, 2010). The selection of dietary intake method for the current study is justified by the underlying assumptions of the study questions. Accordingly, the selected household categories are from the lowest income groups for whom dietary intake is more important than its nutritional importance to maintain a subsistence level of living; the target population is the most vulnerable to food insecurity and this study opens the debate for further studies in vulnerability analysis; the thresh hold levels are defined both by FAO and GOP and per capita calorie was calculated after adjusting for age and gender of household members (Annex-III).

The analytical problem (Phase – B) was divided into two stages. **First,** the food security status was calculated through the calorie intake method using a 7 days recall method of food consumption. Both food security thresholds defined by FAO (1770/day/person

(FAO, 2007) and GOP (2450 Kcal/day/person (GOP, 2003)) were used. A household was considered as food secure whose daily per capita calorie intake was equal to or greater than these lines.

In the **second stage**, logistic regression techniques (binary and multinomial) were used to identify the determinants of food security. *The logistic regression directly estimates the probability of an event occurring for more than one independent variable, that is, for k independent variables* (Hailu, and Nigatu, 2007). Binary logistic regression was used because the dependent variable (household food security) expresses the status as either food secure (1) or food insecure (0).

The general form of the logistic regression equation can be written as (Burns and Burns, 2008);

$$\text{Logit}(p) = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots\ldots \quad (13)$$

Where

p = the probability that a case is in a particular category (in case of binary logistic regression food secure =1 or insecure = 0 and in case of multinomial logistic regression food insecure landless = 1, food insecure farmer = 2, food secure landless = 3 and food secure farmer = 4)

a = the constant of the equation

$b_{1,2,3,}$ = the coefficient of the predictor variables

$x_{1,2,3,}$= the predictor variables (for this study are ; monthly income, household head's age, family size, total earning members, family structure (nuclear or joint), livestock (large animals), livestock (small animals),education levels (primary = 5 years of schooling; middle = 8 years of schooling; up to intermediate = 10 to 12 years of schooling; and graduation and above)

3. Results and Discussion

Following the aims of the study, the results are discussed in two phases: general trends of food security (Phase-A) and the household food security (Phase-B) in Pakistan.

3.1 General Trends of Food Security in Pakistan (Phase-A)

The trends in food security are discussed in three broad aspects of food security, as described by its definition, i.e. food availability, accessibility and utilization.

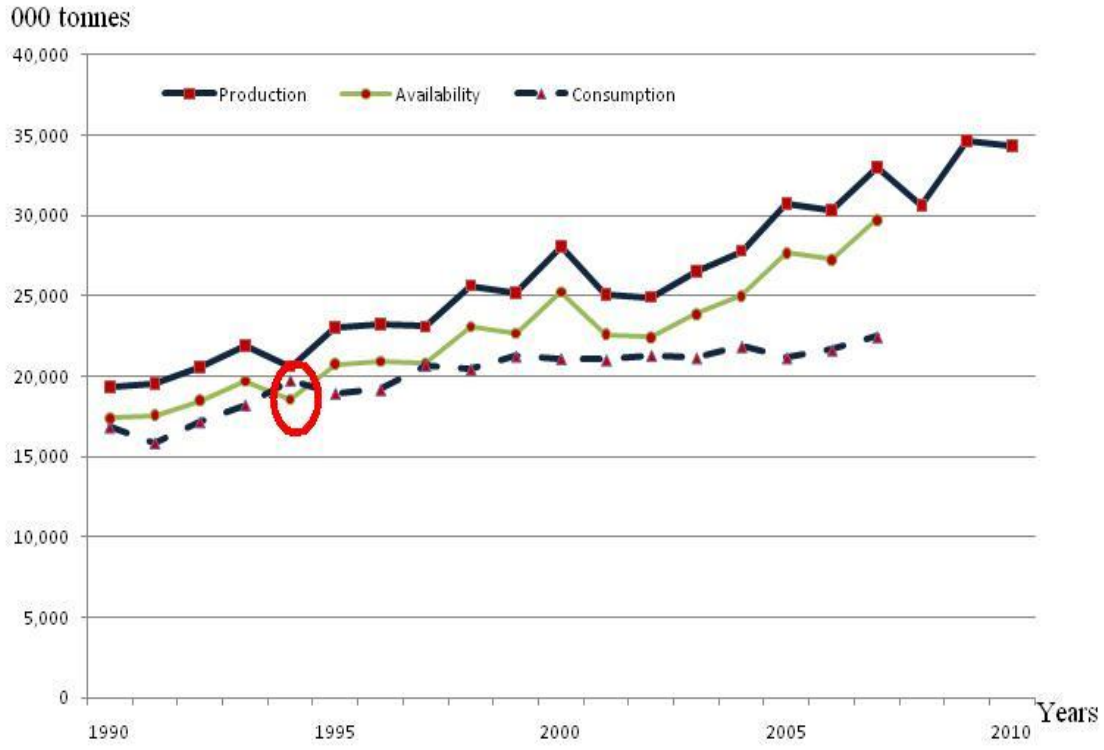
3.1.1 Food Availability

Cereals (wheat, maize, rice and barley) are the main constituents of the dietary intake in Pakistan. Other dietary needs of the population are fulfilled through consuming meat, milk, fruits and vegetables. In Figures 1, 2 and 3 total cereal, wheat, milk and meat production, availability and consumption are compared to review the food security in terms of its availability since 1990. Figure 1 indicates that Pakistan's domestic cereal output far surpassed consumption demand. Similarly, the cereal availability also remained much higher than the consumption demand except for year 1994. The production of wheat (staple food crop, Figure 2) also remained in excess of the consumption needs except for the years 1994, 1997 and 1999 when it was being exceeded

by the demand. But this gap was filled by imports and total availability of wheat remained above the consumption demand. Wheat availability remained below its consumption demand from 2001 to 2004 when Pakistan faced its worst wheat crises. The production of wheat was much greater than its demand but still the availability gone down. This exception could be due to untimely decisions of exporting, smuggling and post harvest losses (Ahmad, 2009).

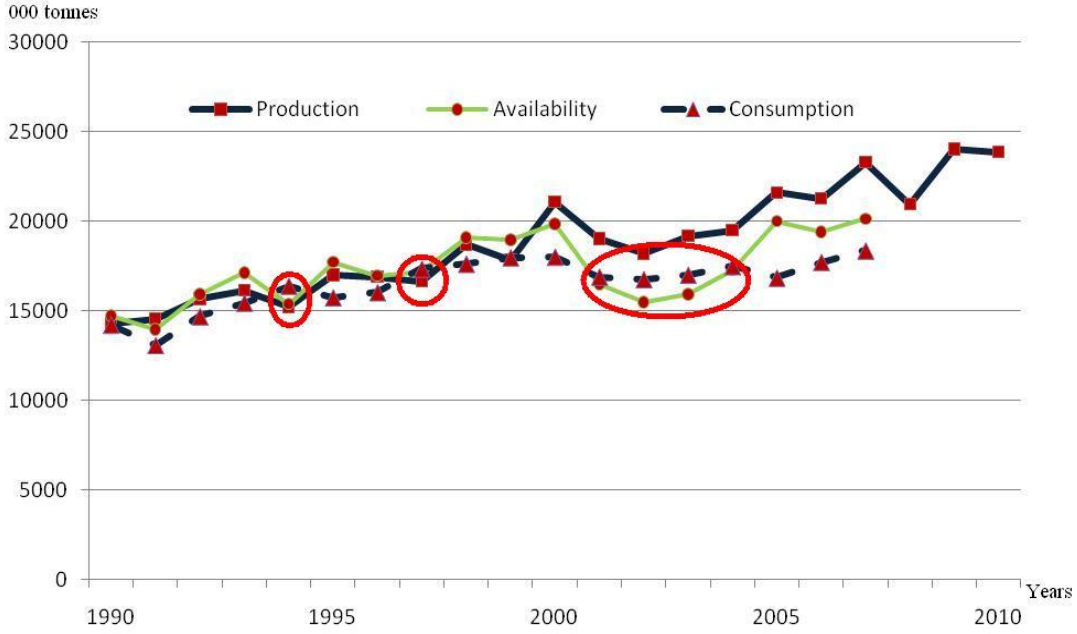
Figure 3 shows the comparison between production and consumption of milk and meat. The production of milk was much above its consumption level while all the produced meat was consumed with no surplus amount. This comparison implies that Pakistan has made sufficient progress in the production of food. The production of major food items remained above the consumption demand of the country except for wheat in 1990s due to smuggling and post harvest losses (Ahmad, 2009).

Figure 1. Total Cereal Production, Availability and Consumption



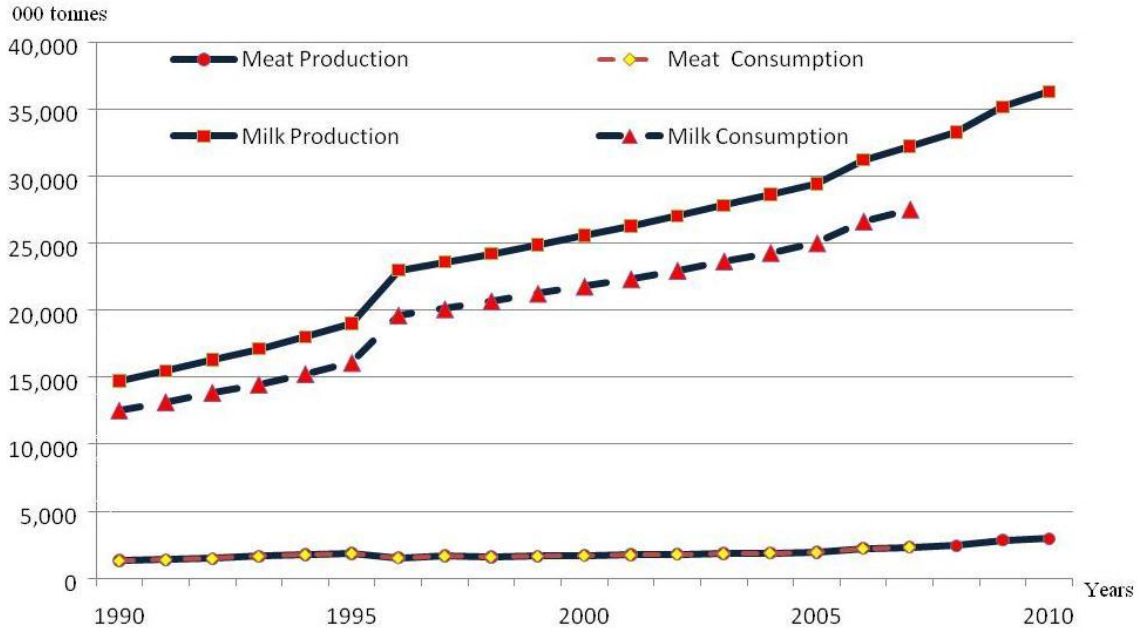
Data Source: FAO, 2011b & GOP, 2011
Circle indicates the year when cereal availability was below the consumption

Figure 2. Wheat Production, Availability and Consumption



Data Source: FAO, 2011b & GOP, 2011
Small circles indicate the years when wheat availability was below its production while the large circle indicates the years when wheat availability was below its consumption

Figure 3. Meat and Milk Production and Consumption

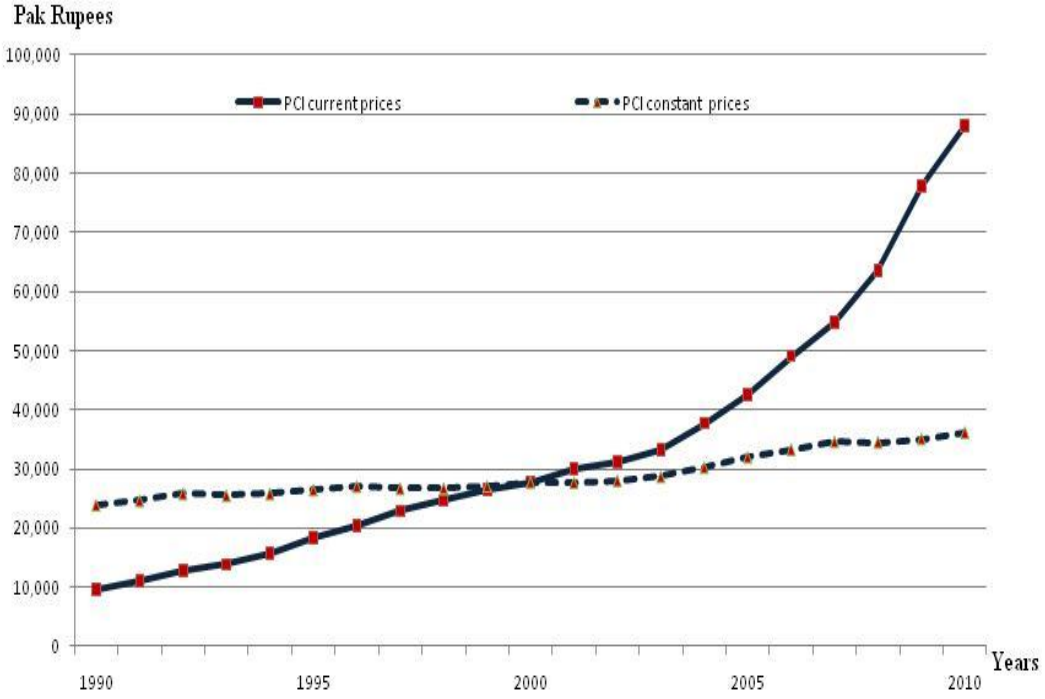


Data Source: FAO, 2011b & GOP, 2011

3.1.2 Food Accessibility

The excess of food production over consumption does not indicate that the population of a country is food secure. Food security depends more on access to food which ultimately depends on purchasing power of individuals or households. Sen (1981) brought attention to the issues of access to food by households. Income is the most important determinant of food access. Figure 4 shows per capita income over 20 years (1990 – 2010) at current and constant prices. The gap between nominal and real incomes indicates that there might be some problems at access level. This gap needs to be studied at more detailed level. But in general the graph explains that income is on the rise for both prices particularly after 2000, hence access issues are also getting better.

Figure 4. Per Capita Income

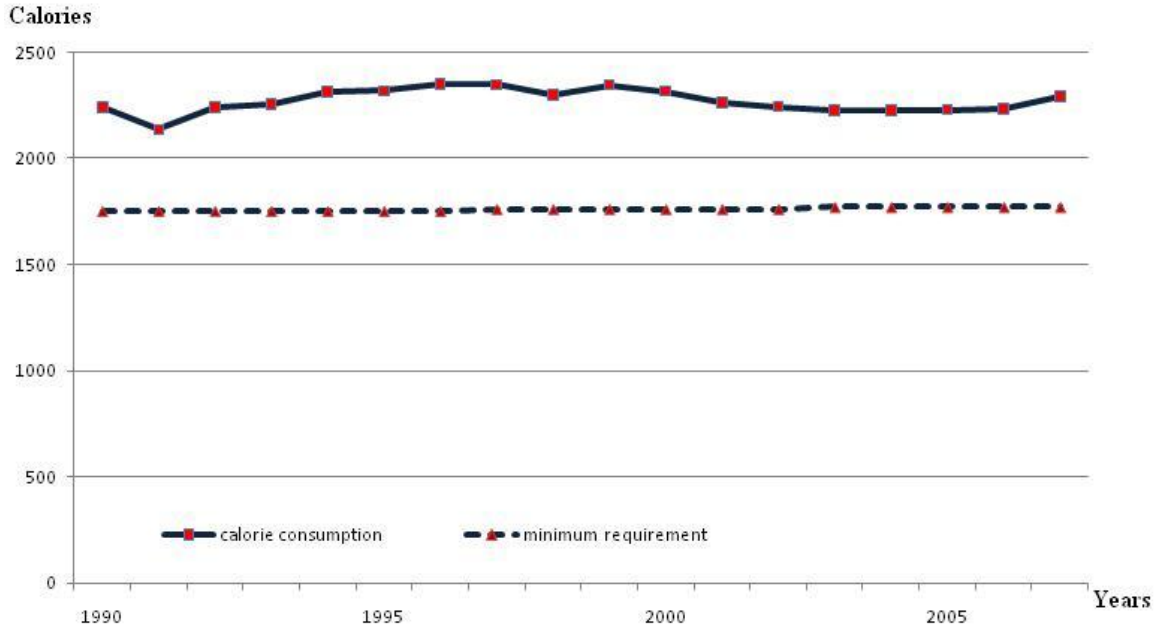


Data Source: World Bank Data, 2011 2000 was the reference year for constant prices

3.1.3 Food Utilization

For reviewing the food utilization, average daily per capita calorie intake was compared with the FAO's recommended daily per capita calorie intake i.e. 1770 Kcal/person/day. Figure 5 shows that an average individual take consumes more than the minimum dietary requirements.

Figure 5. Calorie Intake



Data Source: FAO, 2011b

3.2 Household Food Security (Phase-B)

In this phase, primary data were analyzed in two stages. In stage one the food security status of households was calculated using the calorie intake method. While the second stage focused on identifying the socio-economic factors affecting food security using the logistic regression.

3.2.1 Household Food Security Situation (stage-one)

Tables 2 and 3 reveal the food security situation of the study area on two different food security lines; FAO and GOP, respectively. According to FAO's food security line (1770 Kcal/person/day) for Pakistan a good majority (93.5%) of respondents are food secure. This is in line with general trends of food security at a national level.

Table 2. Food Security Status of Households at FAO's Food Security line

Food Security Status	Frequency	Percent
Food insecure	75	6.5
Food secure	1077	93.5

But, when it was calculated for GOP's food security line for rural households (2450 Kcal/person/day) the number of food insecure households was very high i.e. up to 23 percent. The reason to opt GOP's food security line was the fact that target population belongs to smallest income group who are mostly laborers and a laborer needs more calories as compared to a regular job holder.

Table 3. Food Security Status of Households at GOP's FS line

Food Security Status	Frequency	Percent
Food insecure	264	22.9
Food secure	888	77.1

3.2.2 Socio-Economic Determinants of Rural Household Food Security (stage-two)

This section presents the results of the logistic regression, both binary and multinomial, that seek to explain the socio-economic determinants of rural household food security in the Punjab province of Pakistan. The results are presented in Table 4.

For the binary model, the estimates of relative risk are computed on the grounds of odds-ratios[2]. The outcome of this model is for two broad household categories; namely, food secure and food insecure households. It was revealed that out of eleven variables, six are statistically significant.

Monthly Income

In the overall sample (binary model), the monthly income of households has a positive impact on food security, but its magnitude is relatively small (0.00005). It indicates that an increase in monthly income will increase the chances of a household becoming food secure by a factor of 1.00005 that is the associated odds-ratio of the coefficient ($e^{0.00005}$ or 1.00005). This further suggests that a Rs. 1000 increase in monthly income increases the odds of becoming food secure by about 5 percent (100*(OR – 1)).

Age of Household Head

The age of the household head has a negative sign that shows an inverse relationship between the age of household head and food security. It indicates that an increase in age of one year decreases the chances of a household becoming food secure by about 3 percent.

Family Size

Family size also has a negative sign indicating an inverse relationship with food security. The coefficient of this variable explains that an increase in total household members by one member decreases the chances of a household of becoming food secure by 0.372 times. The odds-ratio (0.690) indicates that each one-member increase in household size decreases the odds of being food secure household by a factor of 0.690 i.e. 31 percent.

[2] 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).

Table 4. Results of Logistic Regression

Variables	β	OR
Household's monthly income	0.00005** (0.000)	1.00005
Age of household head	-0.032** (0.008)	0.969
Household size	-0.372** (0.043)	0.690
Total earning members in a household	0.126 (0.119)	1.135
Household type (nuclear = 0 or joint = 1)	-0.416* (0.201)	0.660
Livestock assets (large animals e.g. buffalos and cows)	0.033 (0.031)	1.033
Livestock assets (small animals e.g. goats and sheep)	0.272** (0.065)	1.313
Education level (primary)	0.140 (0.197)	1.151
Education level (middle)	0.565 (0.293)	1.759
Education level (up to intermediate)	0.686** (0.262)	1.986
Education level (graduation and above)	0.655 (0.362)	1.925
Constant	3.825** (0.484)	N/A
Model Prediction success	80.8 %	
Log-likelihood ratio test statistics	960.466	
H-L model significance test results (df = 8)	5.219 (p-value = 0.734)	
Cox & Snell R^2	0.216	
Nagelkerke R^2	0.327	

** Significant at < 1 %; * significant at < 5 % | SE = Standard errors | Data Source: Field survey, 2010-2011

Figures in parenthesis are Standard Errors

Family Structure

Family structure has a negative sign signifying that being a joint family type reduces the odds of becoming food secure by the factor of 0.660 (about 34 percent).

Livestock (Small animals)

Livestock (small animals (goats and sheep), has a positive impact on food security. It expounds that with an increase of one small animal the odds of being food secure increase by 0.272 with an odds-ratio of 1.313 explaining that an increase of one animal increases the odds of being food secure by a factor of 1.313 (31.3 percent).

Education Levels

Education level of up to intermediate also had a positive impact on food security. households whose head had up to intermediate level of education (10 and 12 years of schooling) were 133 percent more like to become food secure.

Table 5 explains the results of earlier studies for a comparison with the results of this study. These results can be grouped into three broad categories on the basis of similarities with the results of the current study: first, those that confirm the current study (^{C}); second, those that are different or contradict the results of the current study (^{D}); and third, those that have a similar pattern of results (^{CD}). The results of the current study conform with the results of almost all the studies presented in Table 5 (marked as ^{C}), except for the variables 'age of household head' and 'education'. For the age variable, only the study conducted by Onianwa and Wheelock (2006) in the USA (marked as ^{D}) contradicts our results, in that it shows that an increase in the household head's age reduces the chances of household food insecurity (by 2 percent): in Table 4, an increase in age of household head *increases* the chances of household food insecurity (by about 3 percent). This contradiction may be due to the differences in social and geographical makeup of both countries (i.e. Pakistan and USA). For family type variable, the results contradicted with an earlier study where Bashir *et al.* (2010) found for another district (Faisalabad) of the same province that household with joint family systems have 5 times more chances to become food secure compared to nuclear families. The reason for this contradiction is that in this data set the majority of the households have only one earning member due hence the pooling of resources was not possible that is why the advantage of being a joint family became the disadvantage. Other results for the role of age in household food security, categorized as ^{CD} in Table 5, are for Nigeria, where Titus and Adetokubo (2007) found a similar relationship to that of the current study. However, it is difficult to compare the magnitudes of their study to ours due to different methods of measurement. Another case where results are qualitatively similar is for Kenya, where Mariara *et al.*, (2006) found a positive relationship between educational level and food security of households.

Table 5. Results of Earlier Studies

Variables	Units	Study	Economy	Methods	Coefficient Values	Interpretations*
Income	Pak Rupee	Bashir *et al.*, 2010 [C]	Pakistan	Multinomial Logistic Regression	15.06	Households in higher income group (Rs. 5001 – 10000) were 15 times more likely to become food secure as compared to the households having zero net income
	Indian Rupee	Sindhu *et al.*, 2008 [C]	India	Binary Logistic Regression	-0.00036	An increase of Rs. 1000 in the monthly income of households reduces the probability of food insecurity by 30%
		Babatunde *et al.*, 2007 [C]	Nigeria	Binary Logistic Regression	0.488	An increase in the annual income of household will increase the chances of its becoming food secure by 63 %
	US $	Onianwa and Wheelock, 2006 [C]	USA	Binary Logistic Regression	-0.06 and -0.05	An increase in the annual income of household with children and without children reduces the chances of them becoming food insecure by 6 and 5 %, respectively
	Can $	Che and Chen, 2002 [C]	Canada	Multivariate logistic regression	7.96 (low income)	Households in lower income group were 7.96 times more likely to become food insecure as compared to the households in upper middle income group
Age of Household Head	Years	Bashir *et al.*, 2010 [C]	Pakistan	Multinomial Logistic Regression	-1.808	From 35 years of age onward every year reduces the chances of becoming food secure by 83 percent
	Years	Titus and Adetokubo, 2007 [CD]	Nigeria	Descriptive and Food security incidence	0.58	Increasing age of household heads increase the incidence of food insecurity. It was highest for the age group of 61 – 70 years at 0.58
	Years	Onianwa and Wheelock, 2006 [D]	USA	Binary Logistic Regression	-0.02	An increase in the age of household head reduces the chances of them becoming food insecure by 2 %
Family Size	Number of HH members	Bashir *et al.*, 2010 [C]	Pakistan	Multinomial Logistic Regression	-4.056	Households with family members of 4-6 and 7-9 were 97 percent less likely to be food secure and 10+ were 100 percent less likely to be food secure
	Number of HH members	Sindhu *et al.*, 2008 [C]	India	Binary Logistic Regression	0.6743	An increase of one additional family member increases the probability of food insecurity by 96%

	Number of HH members	Amaza *et al.*, 2006 [C]	Nigeria	Binary Logistic Regression	-0.014	With an increase of an additional family member the probability of food security decreases by 1.5%
Family Structure	Joint or Nuclear	Bashir *et al.*, 2010 [D]	Pakistan	Multinomial Logistic Regression	1.665	Households with joint family system were 5.287 times more likely to be food secure as compared to the households with nuclear family system
Livestock Assets	Numbers of (Cows and Buffalos)	Bashir *et al.*, 2010 [C]	Pakistan	Multinomial Logistic Regression	3.612	Households having two milking animals were 37.027 times more likely to be food secure than the households having no milking animal
	Number of Ox	Haile *et al.*, 2005 [C]	Ethiopia	Binary Logistic Regression	0.046	Having livestock (especially Ox) increased the probability of a household becoming food secure by 5%
Education	Years of education	Bashir *et al.*, 2010 [C]	Pakistan	Multinomial Logistic Regression	1.857 (middle) and 3.037 (graduation)	Having an education level of middle (8 years of schooling) the odds of becoming food secure increased by 6.402 and with graduation level of education the odds increased to 20.833
	Years of education	Ojogho, 2009 [C]	Nigeria	Binary Logistic Regression	-1.503 (secondary) and -2.562 (tertiary)	With an increase of educational level from primary to secondary the probability of food insecurity decreases by about 78% and with tertiary level of education it decreased by 92%
	Years of education	Amaza *et al.*, 2006 [C]	Nigeria	Binary Logistic Regression	-0.8957	Higher education levels of household head help decreasing the chances of the household becoming food insecure by 59%
	Years of education	Mariara *et al.*,2006 [CD]	Kenya	Regression	0.0475	With an increase in the educational level of mothers within the household improves the food security by 0.0475
	Years of education	Kaiser *et al.*, 2003 [C]	USA	Binary Logistic Regression	-0.34	Higher education levels of mothers within households help decreasing the chances of the household becoming food insecure by about 29%

* = Interpretations were made by the authors on the basis of coefficients of variables | Odds ratio = exp (coefficient value); % = 100*(odds ratio-1)

[C] = Confirmed by current study | [D] = Different / contradicting results of current study | [CD] = Similar pattern of results

3.2.2.1. Model Significance

The results show that in terms of predictive efficiency, the binary model predicted with more than 80 percent accuracy (Table 4). Goodness of fit statistics assesses the fit of a logistic model against actual outcomes. To check this there are two alternatives; one, inferential goodness of fit test known as the Hosmer and Lemeshow (H-L) Test, and second, two descriptive measures named Cox & Snell R^2 and Nagelkerke R^2 (Peng, *et al.*, 2002). The Hosmer and Lemeshow (H-L) Test yielded a χ^2 (8) of 11.96 and was insignificant ($p>0.05$), suggesting that the model fits to the data well. In other words the null hypothesis of a good model fit to the data was accepted. While the descriptive measures of goodness of fit are the variations of OLS R^2, none can be tested in an inferential framework (Menard, 2000). The values of Cox & Snell and Nagelkerke R^2 are 0.20 and 0.31 respectively imply that the model explains with 20 and 31 percent variations in the data. The pseudo R^2 are not a good measure of goodness of fit as they are based on various comparisons of the predictive values from the fitted model (Hosmer and Lemeshow, 2000).

3.3 Rankings of the Factors

The relative importance of the factors identified above (Table 4) with food security can be pointed out by assigning them ranks. The ranks can be assigned following the simple logic of comparing the magnitudes (Omotesho *et al.*, 2007; and Mengistu *et al.*, 2009) of the relationships of factors with food security. Table 6 presents the rankings of the determinants of rural household food security in comparison to earlier rankings.

Table 6. Comparison of ranks

Ranks	Determinants and their relationship status (+ or -)		
	Current study	Mengistu *et al.* 2009	Omotesho *et al.* 2007
1	Education level (up to intermediate) (+)	Livestock assets (bullocks) (+)	Family (household) size (-)
2	Livestock assets (small animals) (+)	Marital status ** (+)	Expenditure on food (+)
3	Household size* (-)	Inaccessibility to economic factors*** (-)	Access to health facilities (+)
4	Monthly income (+)	Household size (-)	Farm size (+)
5	Age of household head (-)	Household income (+)	--

* household size and household type were strongly correlated, hence household size was selected for ranking

** polygamy or monogamy

*** average distance (in time) to markets (input, output, credit, etc.)

-- no ranking

Below are the rankings:

1. Education level of intermediate (10 – 12 years of schooling) creates the maximum chances for a household to become food secure i.e. 98.6 percent.
2. Livestock assets (goats and sheep), provides 2nd best chances for a household to become food secure i.e. 31.3 percent.

3. Household size reduces the chances of a household to become food secure by 31%.
4. Monthly income creates 3rd best chances for a household to become food secure i.e. 5 percent.
5. Age of household head reduces the chances by 3.1%

For Ethiopia, Mengistu *et al.* (2009) ranked livestock assets (oxen) as the most important factor affecting food security followed in order by access to economic factors and marital status of the respondents. The above findings imply that the ranks of the determinants are sensitive to different regions and countries. Furthermore, they are expected to change with the selection of measurement method and sample size. The above ranks can be considered as the most important 'to do list' for improving the rural household food security by the policy makers and implementers.

4. Conclusions

From the above discussion it may be concluded that Pakistan is a food sufficient and food secure country at the national level, but with a high rate of undernourished population, 26 percent. The household survey of rural households revealed that about 23 percent of them were measured as being food insecure. It was found that monthly income, livestock assets (large milking animals) and education levels of middle (8 years of schooling), intermediate (10 to 12 years of schooling) and graduation (14 years of schooling and above) had a positive impact on rural household food security. Additionally, household head's age, family size, family structure (nuclear) and orphans (number of orphans supported by the household) adversely affected rural household food security.

The similarity of the results of both binary and multinomial models implied that the model selection was robust. The data, on the other hand, pointed out that two household categories i.e. small farmers (up to 5 acres of land) and landless households are very similar to each other. Hence they can be considered as one category while designing specific food security policy instruments. However, the limitation of the study is that it does not explain the relative importance of these determinants. The study of the relative importance of determinants is relevant not only to help the policy making process but also for academic reasons. For policy making it will highlight the most important areas to be addressed as a priority. While from academics point of view it is important to define a common measure to compare the importance of these factors due to their diverse units.

On the basis of the above findings, the following suggestions can be made for improving the implementation and design of food security policy options in the studied regions and other areas with similar characteristics in Pakistan:

1. Income generating opportunities especially in remote areas must be created and launched. For this purpose guidance can be sought from the success experiences of Grameen Bank of Bangladesh.
2. Special emphasis must be given to secondary education through increasing the enrolments and improving the infrastructure.
3. Technical educational programs must be restructured and reforms must be planned for this aspect of education policy, both in the short and long term.

4. Family planning programs should be made effective, so as to slow down the pace of rapidly growing population, a comprehensive campaign using print and electronic media.
5. Guidance may also be sought from the Islamic Economics welfare concepts of ownership, equality and social justice.

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Annex-1

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		AIOU, (2001)	

Annex-II

Area of Farms in Pakistan

Size of farm (Hectares)	Farms	
	Number (Millions)	**Percent**
Under 0.5	1.29	19
0.5 to under 1.0	1.1	17
1.0 to under 2.0	1.42	22
2.0 to under 3.0	0.97	15
3.0 to under 5.0	0.89	13
Sub total	**5.67**	**85.64**
5.0 to under 10.0	0.58	9
10.0 to under 20.0	0.26	4
20.0 to under 60.0	0.1	1
60 and above	0.01	*
Total farms	6.62	100

(Source: GOP, 2010, from Table:- 2.10)

Annex-III

Adult Equivalent Units by Current Study

Age groups (years)	Male	Female
< 1	0.43	0.43
1-9	0.71	0.71
10-17	1.01	0.82
Adult	0.87	0.61

Summarized[3] from (NSSO, 1995)

[3] summarization was feasible because for the current study the villagers were becoming confused due to the twelve male and females group categories as explained by NSSO