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**Socio-economic determinants of food insecurity
in Pakistan using PSLM data**



By

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ISLAMABAD PAKISTAN**

2012



*IN THE NAME OF ALLAH,
THE MOST BENEFICIENT,
THE MOST MERCIFUL.*

Certificate

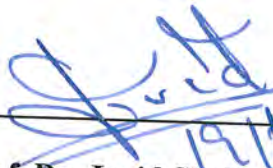
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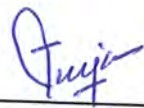
Muhammad Ahmad

**A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR
THE DEGREE OF THE MASTER OF PHILOSOPHY IN
STATISTICS**

We accept this thesis as conforming to the required standard.

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ISLAMABAD, PAKISTAN

2012

DECLARATION

I hereby solemnly declare that this thesis entitled "*Socio-economic determinants of food insecurity in Pakistan using PSLM data*", submitted by me for the partial fulfillment of Master of Philosophy (M.Phil.) in Statistics, is my original work and has not been submitted concurrently or latterly to this or any other university for any other degree.

Date. 19-3-12

Signature. 

Dedicated

To

My beloved son

Muhammad Huzaiifa

And

Daughter.

Acknowledgement

Allah never spoils any effort. Every piece of work is rewarded according to the devotion for it. All kinds of praises are for almighty **ALLAH**, The Omnipotent, The merciful and The Beneficent, Who presented me in a Muslim country and gave me thoughts and opportunity to contribute a drop of material to the existing ocean of knowledge. I offer my humble prays to Holy Prophet **MUHAMMAD** (peace be upon him) who is forever torch of guidance for humanity.

Success always solicits for two things Exertion and Fortune. If I am successful then My exertion is the effort of my Parents, Which they made to fulfill my wishes an My fortune is due to prayers of my loving **PARENTS**. No acknowledgment could ever adequately express obligation an indebtedness to my affectionate **PARENTS, Mr. and Mrs. Hafeez ur Rehman**, loving brothers Muzammal, Mudassar and Mubasshar, loving sisters and wife for their encouragement, moral support and day night prayers which boosted my moral to fly high to accomplish my goals. I am very grateful to all of my friends and class fellows for their comments, encouragement and suggestions in my academic career specially Mr. Rizwan Munir, Mr. Raheel Ahmad, Mr. Abdul Rauf, Mr. Kamran Ali and Mr. Nasir Abbas and thanks to all those who support me, help me and prayed for me throughout my study program.

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List of Abbreviations

AHMs	Agricultural Households Models
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
FBS	Federal Bureau of Statistics
FSRI	Food Security Risk Index
GDP	Gross Domestic Product
HDI	Human Development Index
MDG	Millennium Development Goal
OLS	Ordinary Least Square
POST	Parliamentary Office of Science and Technology
PPS	Probability Proportional to Size
PSLM	Pakistan Social and Living standard Measurement
PSU	Primary Sampling Unit
SDPI	Sustainable Development Policy Institute
SSU	Secondary Sampling Unit
UN	United Nations
UN-ESCAP	United Nations Economic and Social Commission for Asia and Pacific
USAID	United States Agency for International Development
WFS	World Food Summit
WFP	World Food Programme

Abstract

The study investigates the determinants of household food insecurity for general and farmer households of Pakistan. It is based on the 2007-08 Pakistan Social and Living standard Measurement (PSLM) survey conducted by the Federal Bureau of Statistics, Pakistan. The descriptive results reveal that 50.4% of general and 39.5% of farmer households found to be food insecure. The main objective of this study is to investigate the determinants of household food insecurity using logistic regression. The model is initially fitted with 16 (for general) and 19 (for farmer households) variables, selected from factors identified by previous researchers that affect food insecurity. Twelve out of 19 variables for farmer households are found to be significant such as household size, household size square, annual income, agricultural income, number of rooms, dependency ratio, electricity connection, irrigation availability, age and age square of household head. While only female education variable is found insignificant for general household model. The results obtained are further analyzed to compute partial effects on continuous variables and change in the probabilities on discrete variables for the significant factors in the logistic models. Household size, education of household head, annual income and agricultural income are found to be some important factors influencing the household's food insecurity status.

Chapter 1: Introduction

1.1: General background

The term food security reflects the desire to eliminate hunger and malnutrition. In simple words, food security and insecurity refer to, whether or not the availability of food and one's access to it in terms of quality and quantity. Many factors like poverty, health, food production, natural disasters, climate change, political situation and infrastructures etc. have the effect on them.

Food is the basic need of each and every human but the prevalence of food insecurity in today's world is not deniable. In November 1996, the world turned its attention to Rome, where heads of states and governments of more than 180 nations attending the world food summit (WFS) pledged to eradicate one of the collective conscience: hunger. As an important step toward this noble and long overdue objective, in September 2000, leaders of 189 countries committed themselves to the eight goals called as Millennium Development Goals (MDGs) at United Nations and one of the aim/goal in MDGs was to reduce the poverty and hunger by half between 1990 and 2015 that was 820 million in 1990. Currently, worldwide 925 million people are estimated undernourished in 2010 that is a decline after increasing sharply from 854 million in 2006 to 1023 million in 2009 (owing to high food prices and the global economic crises) (FAO 2010).

If we look at the food insecurity prevalence in different regions, most of undernourished people of the world live in Asia; 542 million people (16% of the regional population) are undernourished in 2005-06 that increased to 582 million in 2007 due to sudden price shock. The worst conditions are in south and south-west Asia where the 21 percent of the population are

undernourished and on average 42% of the children are underweight (UN-ESCAP 2009). Projections for 2010 shows the region with most undernourished people is still Asia, where 578 million people are still food insecure (undernourished) even though after a 12% decline from 658 million in 2009. Five of the seven countries, those contain two-third of the undernourished people; belong to Asia like Pakistan, India, Bangladesh, China and Indonesia (FAO 2010).

It has 50% of total malnourished children. In South Asia, 86 million children are undernourished /malnourished. This is almost one half of the total of all developing countries total which indicate towards a severe problem of food and nutrition insecurity. Being a part of south Asia Pakistan is also under high food insecurity and malnutrition. As there are 35% of all the children in Pakistan are malnourished and this malnutrition is associated with the accessibility of food instead of availability (Smith et al. 2000).

Countries with poor resources and marginalized economies have the largest number of food insecure and poor people. Mozambique, Burundi and Democratic Republic of Congo are among the food insecure countries in the world. Pakistan is one of the countries those are highly influenced by the malnutrition/food insecurity and ranked 11th at the 'extreme risk' on the Food Security Risk Index (FSRI) ahead of Bangladesh and India which, though at 'high risk', are better off than Pakistan (SDPI, 2009).

Another report indicates that Pakistan is among one of those countries where the food security situation is not very encouraging. About 42 million people lack adequate income to purchase food they need for a healthy life. The fact that about one third of the population does not access to food needed for adequate nutrition is manifested by the widespread incidence of malnutrition. In 1998, the estimated number of malnourished children was about 8 million.

Nearly half of the children under five years of age are underweight. In human development index (HDI), Pakistan ranked at 135th number among 174 nations around the world (UN-PAK, 2000).

Another study related to food insecurity in Pakistan shows that across the country 48.9 percent of the population is food insecure with various degrees of food insecurity. 22.4 percent of total food insecure population of Pakistan is extremely food insecure. In Pakistan, 45 districts are extremely food insecure in 2009 that was 38 during 2003. Only the 26 districts are food secure among 131 districts and rest of the others are either extremely food insecure, food insecure or at border line (SDPI 2009).

Pakistan placed at 11th in food security risk index amongst the 148 countries of the world. This index measures the availability, stability and access to the basic needs, as well as the impact on the nutrition and health that result from the food insecurity. It rates each country based on the performance across the 19 key indicators including imports, exports, production of exports, production of cereal, food production per capita, rate of malnourishment per capita, water resources, GDP per capita and global aid shipments, in addition, poor governance, conflict, displacement, and destruction of infrastructure are the other major indicators used in determine the index value of food security in these countries (Khan and Shah, 2011).

Pakistan is among those countries which are worst hit by high food prices. Eighty five percent of the population earns less than US\$2 per day and 23 percent of the Pakistan's people are unable to purchase enough food to lead a healthy life. According to WFP-led inter-agency in June 2008, an additional 10 million people have become food insecure, bringing the number of Pakistanis with access to 1700 kcal per day to 45 million (WFP, 2009). The high rate of underfed population and ongoing food trend in the country indicate that it would be less likely for Pakistan to meet the targets corresponding to World Food summit (WFS) or Millennium Development

goals of reducing the underfed by half “between” 1990 to 2015. In terms of meeting the WFS and MDG targets, Pakistan is lowest among other south Asian countries regarding the achievements of these goals (Khan and Shah, 2011).

The following table shows the prevalence of undernourishment in Pakistan for different years:

Table 1.1: Prevalence of undernourishment in Pakistan for different years

Year	Population undernourished (millions)	Population undernourished (percentage)	Moderately/severely Underweight children under five (percentage)	severely underweight children under five (percentage)
1990	---	---	39	17.5
1991	29.5	25	---	---
1995	---	---	34.2	---
1996	26.8	20	---	---
2001	36.3	24	31.3	12.7
2007	42.8	25	---	---

Data source United Nations (2011)

1.2: The statement of the problem:

Pakistan is not a food insecure country in terms of food availability. It has the economic ability to import the required food (as food imports cost less than 20% of the exports). Total availability (inclusive of cereals, pulses, sugar, milk, meat, eggs and edible oil) measured calories per day increased from 2078 in 1949-50 to 2546 in 1996-97 and is estimated to go up to 2715 in 1999-2000. Total level of availability after deduction of 10 percent loss amount to 10-15 percent margin over requirement, such a margin imply that a significant portion of population would not have access to food (UN-PAK, 2000). However, there are number of factors have the

influential impact on the food availability and its stability but we will restrict our self in this study to the factors affecting the food access instead of availability and production.

The severity of food crises in apparently food self-sufficient country such as Pakistan led many to believe that issues of food security are not only food production but socio economic access to food as well. Available food if not in the socio-economic access of the general masses, cannot make a society food secure. There are number of factors that restrict the access to food for millions of poor people in Pakistan. The higher incident of poverty, illiteracy, unemployment, lack of access to employment opportunities, depleting sources of livelihood and depletion of natural resources are hindering access to food (SDPI, 2009). According to the UN report on Pakistan food insecurity, there is no significant difference in the prevalence of chronic malnutrition in low and medium socio-economic groups but significantly low in the high socio-economic groups (UN-PAK, 2000). So the main theme of this study is to look at the prevalence of food insecurity in Pakistan regarding the different socio economic groups.

1.3: Objective of the study:

The **main objective** of this study is to assess the status of household food insecurity and its core determinants in Pakistan.

The **specific objectives** of this study include:

1. To identify and evaluate the socio-economic factors those affect the food insecurity of general and farmer households of Pakistan.
2. To develop the models which predict the status of general and farmer household's food insecurity on the basis of some socio-economic factors.

1.4: Limitations of the study:

Some of the limitations of this study are:

1. The study focused on identifying factors that are expected to influence the households food insecurity Pakistan. However, due to lack of data the study could not incorporate some of the most influencing factors such as political, climate and weather (rainfall, temperature), topology, natural disasters and ecological conditions:
2. The study did not make a comparative analysis of food security among different provinces/ regions.
3. Household's caloric consumption is only considered to assess the status of food insecurity and didn't take into account other aspects of food insecurity such as vulnerability and dietary diversity etc.

1.5: Organization of the thesis

Definition of food insecurity, causes, and determinants of food insecurity according to the reviewed literature is presented in chapter 2. In chapter 3, we look at the theoretical models, empirical model, methods used for assessing the food insecurity of households, determinants of household food insecurity. In chapter 4 the results of logistics models are presented. Chapter 5 the concludes our study.

Chapter 2: Literature review

2.1: Conceptual framework

2.1.1: Concept and definition of food insecurity

Since the World Food Conference in 1974 due to major food crises and famine in the world especially in Bangladesh, the terminology of food insecurity was introduced, evolved, developed and diversified by different researchers. Food security is a 'flexible concept' as reflected in many attempts in definition in research and policy usage. Maxwell and Smith (1992) listed more than 180 studies in relation to the concept and definition of the food insecurity and some about the indicators of food insecurity, they list some 30 definitions of food insecurity which have either been influential in literature and summarized the views of different agencies. They also discussed in their work that many definitions and conceptual models agree with that the defining characteristic of household food security is the secure access at all time to the sufficient food. They further discussed the terms i) sufficiency ii) security iii) access and iv) time by different aspects regarding the food insecurity.

People often go hungry even though food is available because they are too poor to buy it (Sen, 1981). In the 1943 Bengal famine 2-3 million died, although there was no overall food shortage, but the reason behind that the economic boom raised the prices of food beyond the reach of the poor. Until early 70's, food insecurity was understood as the inadequacy of food supply at world and national level. So the many studies and frameworks were made to improve the production levels by using new technologies and policies. A complex definition of food security is given by the UN report on world food conference 1974 which is, "*availability at all times of adequate world supplies of basic food stuffs, to sustain a steady expansion of food*

consumption and to offset the fluctuations in the production and prices' (Maxwell and Smith (1992). This definition defines the food security in terms of food supply means the availability of food and stability of prices at international and national level. Evidence shows that the food production increasing day by day. However, availability of a large amount of food does not guarantee the food security at national level and even availability of food at national level does not ensure the food security at household level. For example the per capita calorie supply for the world was almost 2800 kcal in 2003 (FAO 2006). Even though it is much more than minimum requirement, millions of people are still undernourished in the world. This implies that availability of food is not a guarantee to access to food. Now a standard definition of food security is:

"Food security exists when all people, at all times, have physical, social, and economic access to the sufficient food which meets their dietary needs and food preferences for an active and healthy life" (FAO 1996).

This definition points out the four distinct but interrelated elements of food security, which are essential to achieve food security.

- i) availability
- ii) access
- iii) utilization and
- iv) sustainability

2.1.2: Availability:

The term food availability refers towards the availability of sufficient quantities of food with appropriate quality (FAO, 2006). The food availability is a function of home

production, stocks, imports as well as the donations. It reflects the physical availability of food in the country (SDPI, 2009). Usually the information on food availability comes from the national, regional and sub-regional balance sheets. However, these balance sheets do not provide information on food security at household level. But such information is useful to understand aggregate indicators (such as macroeconomic and demographic factors) on food consumption (Suresh Babu, 2009). Any shortage in food availability leads to panic buy by the consumers and often the storing by the suppliers, both results into the negative impact on the access to food of the population (SDPI, 2009)

2.1.3: Accessibility:

The lack of purchasing power deprives a person/household to access the food or food commodities even though the food is available to lead active and healthy life. Food accessibility means that individual having the sufficient resources to obtain appropriate foods for nutritious diet (FAO, 2006). Food access represents the household's capacity to fulfill nutritional requirements and it depends on the ability of households to obtain food from purchases, gathering/storing, current production or stocks or through food transfers from the relatives, members of the community, the government or donors (FANTA, 2003). Constraints to the individual food access include: economic growth that is inadequacy in the aggregate, in general, leading to lack of job opportunities or lack of incentives to become a productive participant in the economy; inadequate training or job skills; lack of credit; and food losses associated with ineffective and inefficient harvesting, storage, processing and handling; political decisions favoring one group over another (USAID, 1992).

2.1.4: Utilization:

Food utilization relates to how food consumed is translated into nutritional and health benefits to the individuals. In this regard, consumption of foods both in quantity and quality that is sufficient to meet energy and nutrient requirement is the basic measure of food utilization (Suresh Babu, 2009). The indicators used to assess food utilization include, access (or lack of access) to clean drinking water, environmental hygiene, health infrastructure, individual status, culinary (cooking) habits and female literacy rate etc. (SDPI, 2009). Adequate food utilization realized when “food is properly used, proper food processing and storage techniques are employed, adequate knowledge of nutrition and child care techniques exists and is applied and adequate health and sanitation services exists” (USAID, 1992). Utilization also considers both food and health factors that influence child and maternal nutritional status. Constraints to food utilization include loss of nutrients during processing, inadequate sanitation, improper care and storage and cultural practices that negatively impact consumption of nutritious foods for certain family members (FANTA, 2003).

2.1.5: Sustainability:

A population, household or individual having access to adequate food at all times reflects the sustainability dimension of food insecurity. It means that any sudden shock (e.g. an economic or climate crisis) or cyclical events (e.g. seasonal food insecurity) should not result into the risk of losing access to food for them (UN-ESCAP, 2009).

2.2: Causes of food insecurity:

Achieving food security is still a challenge for the developing countries as well as for developed countries. But the developing countries are more affected in terms of magnitude and severity. The root cause of food insecurity in developing countries is the inability of people to gain food due to poverty (Mwaniki, 2005). The key shocks to the food security arise from the war or conflict, natural disasters, climate change, water management, economic problems or failure, agricultural production, plant, animal pests and diseases and possible impacts arising out of the climate change (FAO 2005).

Food insecurity may be function of some immediate causes of hunger, underlying determinants of conditions in a community (affecting poverty, food production and ability to respond shocks). Food security may also be result of corruption and poor governance (POST, 2006) Some of the main influential factors to the food security are food production at national or household level, human resources, education level, health conditions and factors influencing the proper use of resources like economic, political, technical, ecological, cultural and other constraints (Latham, 1997).

2.3: Determinants of food insecurity:

Most of the factors or causes discussed above are determinants of food security at national, regional or community level. However, many studies show that these factors are not a guarantee of food security at household level. A study made by Maharajan and Joshi (2006) shows that the factors used to determine the food security at national, regional or community level are not good indicators of household food security. On the basis of depth and

severity of food insecurity a division is also made among the households. The results in this study show that the socio-economic factors like household size, land holding, dependency ratio, occupational caste, job of household head and caste/ethnicity are the main determinants of food security. Food security and severity is higher among households having small land, less livestock, labors and less income/expenditure.

Rose et al. (1998) described some main socio-economic factors which affect food security at the household level. These influential factors are income, education of household head, home ownership status, age of the household head, household size, household composition, race ethnicity and region. Which shows that the households having the characteristics like higher income, home ownership, headed by a high school graduate, and elderly household are less likely to be food insecure as compared to other groups of households. This shows that the households in poverty are (3.5 times) more likely to be food insufficient as compared to others, holding all other factors constants. However, there is not a one-to-one correspondence between food insufficiency and poverty.

Iram and Butt (2004) conducted a study on the determinants of household food security for Pakistan. They used the maternal, household and socio-economic characteristics as the determinants of food security. In maternal characteristics mother's age and education of a household is taken. While the household size, type of household, room per capita and dependency ratio are used to indicate the household characteristics. In socio-economic characteristics income, access to safe drinking water and sanitation facility are considered. Higher education and mother's age of a household play a significant and positive role in food security improvement. Income is to be found a most influential variable in determining the household food security as the household having high income are less likely to be food insecure.

No facility of toilet and no access to the safe water are negatively associated with food security as well as the dependency ratio. Room per capita is also increase the probability of a household to be food secure.

Feleke et al. (2005) made a study on the determinants of food insecurity in a concept of supply and demand side variables. This study is about food security in southern Ethiopia at household level. Technology adoption, farm size, farming system and land quality are considered as supply side variables affecting the food security situation of a household while the demand side variables are household size, market access, per capita aggregate production and access to off farm work. The conclusion from this study was that the supply side variables are more powerful than the demand side. Households having adopted technology, high per capita aggregate production, high farm size, good land quality, less family size are less likely to be food insecure as compared to others and other factors discussed above are found insignificant in this study.

Haile et al. (2005) conducted a study on the key factors influencing the food security in Koredegaga peasant association, Oromiya, Ethiopia. They include the factors like aggregate production, off-farm work, technology adoption, land quality, land size, household size, age of household head, household labour availability, ox ownership, wealth and education level of household head. Six factors from these have a significant effect on food security which are farmland size, ox ownership, fertilizer application, education level of household heads, household size, and per capita production. Partial effects are analyzed those reveals a low probability of food insecurity among households lead by the introduction of fertilizer use and improvement in the education level. A simulated is study is also made of these factors.

Kindane et al. (2005) have made a study on the causes of household food security for Koredegaga peasant association, Oromiya Zone, Ethiopia. They defined the state of food insecurity on the basis of usual method of per capita calories intake. A household was considered to be food secure if the per capita available calories were found to be greater than per capita calories demand. Eleven explanatory variables were used to assess the household's food security. These included per capita aggregate production, off-farm work, technology adoption, land quality, land size, household size, age of the household head, household labour availability, ox ownership, education level of the household head and wealth. Out of these variables six were found to be significant. Household size had a negative impact on the household's food security status and a negative effect was observed for farm size, per capita aggregate production and ox ownership. Households having a literate head and user of fertilizer were found to be more probable to be food secure than their respective categories. Furthermore, a simulation study was also made of these significant variables.

Onianwa and Wheelock (2006) have made a study on the determinants of food insecurity for the southern states such as Alabama, North Carolina and Tennessee. Standard matrix scale values for analyzing household's food security derived by ERS (Economic research services) were used to define the state of food insecurity. Households were classified into two groups: household with children and household without children. These two groups were classified into four food security statuses; food secure, food insecure without hunger, food insecure with moderate hunger, food insecure with severe hunger. Further these groups were collapsed into two such as severe food insecure and moderate food insecure (this is based on the observed results as neglected categories have very low frequency in the observation). Age of the household head, household head gender, education of the household head, working members of the household,

home ownership, race, food stamp receiver, region and states were used as the determinants household's food insecurity. For the group of households with children, food stamp receipts, income, region and states variables were found to significant predictors of severe food insecurity (moderate taken as base category). For the groups of households without children, age of the household head, age of the household head, income of the household and state were found to significant predictors of severe food insecurity.

Babutunde et al. (2007) conducted a study on the food security status of farming households for Kwara state, North Central Nigeria. They have taken the socioeconomic characteristics of the farming households as determinants of food security. The characteristics like household income, farm size, membership of cooperatives, quantity of food from own production, access to the consumption credit, age of the household head, education of the household head and household size have taken to assess the food security. the state of the food security was made on the base of minimum required calories. A household considered to be food secure if it has the daily per capita intake calorie equal to or greater than 2260 kcal (this was taken as the minimum requirement) and insecure otherwise. The four variable such as household income, quantity of food from own production, education of the household head and household size were found to be important (statistically significant). Household size was found to be negatively associated with household food security status and other three with a positive association.

A study on the determinants of food security of rural areas of Pakistan is conducted by Khan and Gill (2009). Three basic component of food security i.e. food availability, food accessibility and food absorption have been taken in this study. In this study all three concept of food security have been analyzed at district level instead of household level. For each of these

components are analyzed separately on the basis of their indicators. Food availability has been taken a function of production of grains (wheat, rice, maize and pulses), fruits, oil seeds, milk, poultry meat, fish, eggs per head and per day in the district and locality of the district. While the access to food per capita/per day have been taken as a function of houses electrified, adult literacy, female attending school, male attending school, ratio of marginal cultivator and locality of a district. Third level of food security has been taken the function of immunization rate, female literacy rate, provision of safe drinking water, number of hospitals in the districts and locality of the districts. The factors used in food availability assessment like grains production, fruits production, oil seed production, fish and poultry, milk etc. have been a positive relationship with food production. This means as the production of these things increase the more the food will be available. Adult literacy rate and farmland size observe a positive relation with food accessibility. In third component of food security increased health facilities, access to safe drinking water and female literacy rate are positively associated with food absorption. The results of this study shows that out of 120 districts of Pakistan (for rural areas) only 40 have been found to be food secure. From the food insecure districts 38 have been found extremely food insecure.

Another study on the determinants of food insecurity was made by Pankomer et al. (2009) for Malawi. Household whose daily per adult equivalent calorie intake was lower than 2228 kcal were considered to be food insecure, otherwise secure. Household size, education, gender, age of household head, ownership of an off-farm enterprise, per capita land holding, tobacco producer (Y/N), credit borrow, livestock size, community level, irrigation availability, health clinic facility and geographical location were taken as the determinants of household's

food insecurity status. Almost all variables were found to be significant and had signs according to the expectation.

Faridi and Wadood (2010) make a study on the assessment of household food security in Bangladesh. The key factors they used to assess the food security levels among households were land size, employment type, household head education, construction material, occupancy status and electricity. Household having the characteristics like electricity connection, made of bricks/cement, ownership, high educated head, high land size and self-employed in agriculture are to be found less likely to be food insecure than the other groups.

Arene and Anyaeji (2010) have conducted a study on the determinants of food security in Nsukka metropolis of Enugu state, Nigeria. They assessed food insecurity state on the basis of expenditure. A household have been considered to be food secure if its per capita monthly food expenditure is less than the two-third of the mean per capita monthly food expenditure of all households. Sex of the household head, household size, income of the household head, access to the credit, age of the household head and education level of the household head have considered as the determinants of the food insecurity. Household head income and age have been found to be significantly influencing the food security status of a household. A household having head with high income and age are more likely to be food secure than the others.

Carter at al. (2010) conducted a study on the determinants of food insecurity for New Zealand. The state of food insecurity was defined on the basis of three question such as household had used a special food grant or food bank, forced to buy cheaper food to pay for other things and had gone without fresh fruit and vegetables often. A household was considered to be food insecure if he/she faced any of these conditions. Marital status, ethnicity, age, family status, household composition, education, labor market activity, income benefits, household

income, wealth, dwelling tenure and health were taken as the determinants of the respondent's food insecurity status. As a result, they found that the association of these socioeconomic factors was similar in males and females.

Austin et al. (2011) have conducted a study on the dimensions of farm household's food insecurity for Abia state, Nigeria. The state of the food insecurity was defined on the basis of household's daily per capita calorie intake. A household was considered to be food secure having daily per capita calorie intake up to 2260 kcal and insecure otherwise. Seven variables were taken as the determinants of food security those include age of the household head, education of the household head, gender of the household head, household size, household income, farm size, and occupation of the household head. Household size and income were found to be significant/important determinants of household's food security. They had a negative and positive association with household's food security, respectively. Furthermore, severity of food insecurity among children was also studied. To determine the factors that expose children to the risk of malnutrition, anthropometric assessment of height and weight was under taken to determine the manifestation of insecurity.

Maharajan and Joshi (2011) described the determinants of household food security. They include the factors like human capital stock, resource ownership and some other qualitative factors. They considered age, gender of household head, family size, dependency ratio, participation in community organization as human capital stock. Landholding, irrigation, fertilizer and livestock holding are taken as the variables showing the resource ownership of a household. Ecological regions, occupation and caste/ethnicity also considered as the determinants of food security. they found in their study that the household headed by male, high age and higher education are less likely to be food secure. Household having less farm size, large family

size, high dependency ratio, not participating in community activity, on-farm occupation, no irrigation availability, no fertilizer and less livestock are found more likely to food insecure than the other groups.

2.4: Measurement of household food insecurity:

There is no a single indicator to capture the broad concept of food insecurity and also the collection of data for a complete analysis is difficult or it can be an impossible task in a situation where the food insecurity is subject to varying in its interpretation. However, a number of methods are used in the assessment of the food security by using the information on a variety of characteristics, experiences etc. those are most likely to show the food insecurity level. Household level surveys are conducted to get the information about these characteristics. The characteristics used to define food security situation are under consideration over the last two to three decades.

In most of the studies two objective methods are used to study the household food insecurity status. One is to estimate gross household production and purchases over a time period of time, estimate the growth or depletion of food stocks held over that period of time, and presume that food that has come into the household's possession and disappeared has been consumed (Maxwell, 1996).

The second method is used a twenty-four hour recall of food consumption for individual members of the household and analyze each type of food mentioned for caloric content. In this method, a household considered to food insecure if the estimated total acquires daily calories is lower than the sum of its member's daily requirements (Maxwell, 1996). However, none of them can be taken as a standard one because both have their limitations and advantages. Hoddinot (1999) describes the four method of measuring household food insecurity and individual food

insecurity and their advantages/disadvantages. These include individual intakes, household caloric acquisition, dietary diversity and indices of household coping strategies,

Chapter 3: Methodology

In this chapter we discuss methods which are used in our study to assess the determinants of household food insecurity. In section 3.1, some theoretical backgrounds are presented for the general and farmer households. Logistic regression and empirical model is discussed in section 3.3. Description of the variables included in this study is presented in section 3.4.

3.1: Theoretical framework:

In this section two theoretical models are presented. First one is for the farmer household and later one for general households.

3.1.1: Theoretical model for farmer households:

For the agricultural households we modeled the household's food insecurity within the framework of consumer demand and production theories. This theoretical model is based on the Agricultural Household Models (AHMs) which were presented by Singh et. al (1986). In AHM models a household is considered as both the consumer as well as the producer. For the construction of this model we made the assumption of the "Separability" about the consumption and production variables. In AHM a household can separate the production decisions from the consumption decisions. This means that it solves the production decisions first which are independent from the consumption preferences and then it solves the consumption decisions based on the optimal production decisions.

Households produce meals by combining the own produce food items, market purchased produce items, capital goods (to cook or store the meals) and human capital such as nutrition knowledge and cooking skills etc.

Thus consider a household utility function that has vector of nutrients N , founds in these meals,

$$U = U(N, X_0, l) \quad (3.1)$$

As well as vector of other goods X_0 and the vector of leisure (l). Household both as a producer and a consumer is assumed to maximize this utility subject to a farm production, income and time constraints. The amount of nutrients consumed is a function of farm production, market purchased food goods, income, capital goods and demographic characteristics (Dh), as represented by

$$N = n(X_i, X_m, Y, K_1, Dh) \quad (3.2)$$

Where X_i is a vector of home produced food goods and consumed by the household; X_m is a vector of market purchased goods consumed by the household; Y is the total income and K_1 is the capital goods as well as human capital such as nutrition knowledge and cooking skills concerned to make these meals. (Dh) is a vector of demographic characteristics of the household such as household size and composition. Household drives these nutrients from various combinations and levels depend on the preferences of its members, which are shaped by the characteristics of the households (Dh). Household is assumed to maximized its utility from the consumption of these goods subject to constraints farm production, income and time as specified as

$$Q = G(.) \quad (3.3)$$

$$P_i(Q_i - X_i) - P_0X_0 - P_mX_m - w(L - L_f) + n^0 = 0 \quad (3.4)$$

$$T = L_f + l \quad (3.5)$$

Where $G(\cdot)$ is production function that is assumed to be well behaved (twice differentiable, increasing in outputs, decreasing in inputs, and strictly convex); Q_i is a vector of quantities of goods produced on-farm; L is total labor input to the farm; P_i is the price of good i ; P_m is the price of a market-purchased good; $(Q_i - X_i)$ is the marketed surplus of good i ; w is the wage rate; L_f is the household labor supply for non-farm use such as time to food shopping and meal preparation etc.; n^0 is non-farm income that adjusts to ensure that equals zero; and T is total time available to the household to allocate between work and leisure.

The income and time constraints can be combined by incorporating Eq. (3.5) into Eq. (3.4) as

$$P_i(Q_i - X_i) - P_0X_0 - P_mX_m - w(L - T + l) + n^0 = 0 \quad (3.6)$$

$$P_iQ_i - P_iX_i - P_0X_0 - P_mX_m - wL + wT - wl + n^0 = 0 \quad (3.7)$$

Rearranging this we get

$$P_iX_i + P_0X_0 + P_mX_m + wl = P_iQ_i + wT - wL + n^0 \quad (3.8)$$

The left-hand side of Eq. (3.8) is the household expenditure on food and leisure, and the right-hand side is the full income equation. The expenditure side includes “purchases” of its own farm-produced goods (P_iX_i), the household’s purchases of the market goods (P_mX_m) and purchases of other goods P_0X_0 , and the household’s “purchases” of its own leisure time (wl). The full income side consists of the value of total agricultural production (P_iQ_i), the value of the household’s entitlement of time wT , the value of labor on the farm, including hired labor wL , and non-farm income n^0 .

Given the assumption of “separability” the production side can be solved first. The first-order conditions for input demand (L^*) and output supply (Q^*) in terms of all prices, wage rate, fixed land A^0 and fixed stock of capital K^0 as

$$L^* = L^*(P_i, w, A^0, K^0) \quad (3.9)$$

$$Q^* = Q^*(P_i, w, A^0, K^0) \quad (3.10)$$

These solutions involve the decision rules for the quantities of labor input used and outputs produced (production side). Once the optimum level of labor is chosen, the value of full income when profits have been maximized can be obtained by substituting L^* and Q^* into the right-hand side of the income constraint (Eq. (3.8)) as

$$Y^* = P_i Q_i^* + wT - wL^* + n^0 \quad (3.11)$$

$$Y^* = wT + \pi^*(P_i, w, A^0, K^0) + n^0 \quad (3.12)$$

Where the profit is $\pi^* = P_i Q_i^* - wL^*$. Y^* is the full income under the assumption of maximized of profit π^* . Now the reduced form nutrient demand equation for this optimization problem is of the form

$$N = n(P_i, P_m, w, Y^*) \quad (3.13)$$

Incorporating the household characteristics that shape its preferences (D_h), prices of other goods and capital goods, the nutrient demand equation can be rewritten as

$$N = n(P_i, P_0, P_m, w, Y^*(w, A^0, K^0, n^0), K_1, D_h) \quad (3.14)$$

For purposes of explanation, we consider the case of one nutrient, food energy, E . Our indicator I_i of food insecurity is defined by,

$$I_i = 1 \text{ If } E_i < E_{min} \text{ (Insecure)}$$

$$I_i = 0 \text{ otherwise. (Secure)}$$

Where food insecurity occurs when the household falls below some minimum level of energy consumption, E_{min} . Thus, our indicator of food insecurity is based on nutrient intake below a minimum level, a nutrient intake that is a function of prices, wages, total income, capital, and household characteristics.

3.1.2: Theoretical model for general households:

We model the food insecurity for general households within the frame work of consumer demand and production theory. This model is based on the theoretical model of food insecurity presented by Rose et al. (1998).

Thus consider a household utility function that has vector of nutrients N , founds in these meals,

$$U = U(N, X_0, l) \tag{3.15}$$

As well as vector of other good X_0 and the vector of leisure (l). Household both as a producer and a consumer is assumed to maximize this utility subject to income and time constraints. The amount of nutrients consumed is a function of marketed purchased food goods, income, capital goods and demographic characteristics (Dh), as represented by

$$N = n(X_m, Y, K_1, Dh) \tag{3.16}$$

Where X_m is a vector of market purchased goods consumed by the household; Y is the total income and K_1 is the capital goods as well as human capital such as nutrition knowledge

and cooking skills concerned to make these meals. (Dh) is a vector of demographic characteristics of the household such as household size and composition. Household drives these nutrients from various combinations and levels depend on the preferences of its members, which are shaped by the characteristics of the households (Dh) . Household is assumed to maximize its utility from the consumption of these goods subject to income and time constraints as specified as

$$P_0X_0 + P_mX_m - wL - n^0 = 0 \quad (3.17)$$

$$T = L + L_f + l \quad (3.18)$$

Where P_m is the price of a market-purchased good and P_0 is the vector of other goods prices; w is the wage rate; L is time spent in labour market; L_f is the household non-labor time spent such as time to food shopping and meal preparation etc.; n^0 is non-wage income that adjusts to ensure that equals zero; and T is total time available to the household to allocate between work and leisure.

The income and time constraints can be combined by incorporating Eq. (3.18) into Eq. (3.17) as

$$P_0X_0 + P_mX_m - w(T - L_f - l) - n^0 = 0 \quad (3.19)$$

$$P_0X_0 + P_mX_m - wT + wL_f + wl - n^0 = 0 \quad (3.20)$$

Rearranging this we get

$$P_0X_0 + P_mX_m + wL_f + wl = wT + n^0 \quad (3.21)$$

The left-hand side of Eq. (3.21) is the household expenditure on food and leisure, and the right-hand side is the full income equation. The household's purchases of the market goods (P_mX_m) and purchases of other goods P_0X_0 , and the household's "purchases" of its own

leisure time (wl). The full income side consists of the value of the household's entitlement of time wT and non-wage income n^0 .

$$Y = wT + n^0 \quad (3.22)$$

Now the reduced form nutrient demand equation for this optimization problem is of the form

$$N = n(P_0, P_m, w, Y) \quad (3.23)$$

Incorporating the household characteristics that shape its preferences (D_h) and capital goods, the nutrient demand equation can be rewritten as

$$N = n(P_0, P_m, w, Y, K_1, D_h) \quad (3.24)$$

For purposes of explanation, we consider the case of one nutrient, food energy, E . Our indicator I_i of food insecurity is defined by,

$$I_i = 1 \text{ If } E_i < E_{min} \text{ (Insecure)}$$

$$I_i = 0 \text{ otherwise. (Secure)}$$

Where food insecurity occurs when the household falls below some minimum level of energy consumption, E_{min} . Thus, our indicator of food insecurity is based on nutrient intake below a minimum level, a nutrient intake that is a function of prices, wages, total income, capital, and household characteristics.

3.2: Data description:

The data for this study was taken from the Pakistan Social and Living standard Measurement (PSLM) survey 2007-08 conducted by the Federal Bureau of Statistics, Pakistan.

For the urban areas FBS has developed its own frame, which was up dated in 2003. Each city/town has been divided into enumeration blocks consisting of 200-250 households identifiable through sketch map. Keeping in view of the living standard of majority of the people each enumeration block has been classified into three categories of the income groups i.e. low, middle and high. Rural frame is constructed on the base of list of villages published by Population Organization as the outcome of the Population Census 1998.

In urban domain Islamabad, Lahore, Gujranwala, Faisalabad, Rawalpindi, Multan, Bahawalpur, Sargodha, Sialkot, Karachi, Hyderabad, Sukhur, Peshawar and Quetta, have been considered as large sized cities. Each of these cities considers a separate stratum and has been further sub-stratified on the base of low, middle and high income groups. After excluding population of large sized city/cities, to form a stratum the remaining urban population in each division in all the provinces has been grouped together. While in rural domain each district in Punjab, Sindh and NWFP provinces have been grouped together to constitute a stratum. The defunct administrative division has been treated as stratum in Baluchistan province.

A two-stage stratified sample design has been adopted in this survey. Keeping in view the objectives of the survey, the sample size for the four provinces has been fixed at 15512 households comprising 1113 sample village/ enumeration blocks, which is expected to produce the reliable results. Enumeration blocks and villages in urban and rural areas respectively have been considered as primary sampling units (PSUs). Sample PSUs have been selected from Strata/sub-strata with PPS method of sampling techniques. Households within sample PSUs have been taken as secondary sampling units (SSUs). A specified number of households i.e. from each sample PSU of rural and urban area have been selected respectively using the systematic sampling technique with random start.

3.3: Logistic Regression:

The main objective of this study is to examine the determinants of household's food insecurity using a logistic regression model. This model was fitted with sixteen variables for general household and 19 variables farmer households that help to explain the food insecurity of household. The logistic regression model was chosen for this study because of the nature of the response variable which is dichotomous (Agresti, 2002).

3.3.1: Empirical Model

By empirical point of view, we restrict ourselves to cross sectional data and ignore the prices P_i, P_m, P_o . The dependent variable I_i (defined in the following section) is a discrete variable; the food insecurity model can thus be called as a qualitative response model where φ_i the probability of food insecurity is given below

$$\varphi_i = E(I_i = 1|X_i) = \frac{1}{1+e^{-(\beta_0 + \sum_{j=1}^{n=k} \beta_j x_{ij})}} \quad (3.25)$$

$$\begin{aligned} \text{Where } I_i &= 1 \text{ if a household is insecure} \\ &= 0 \quad \text{Otherwise} \end{aligned}$$

where φ_i stands for the probability of household I being food insecure, I_i is the observed food insecurity status of household I, x_{ij} are the factors determining the food insecurity status for household i , β_j stands for the parameter to be estimated.

Denoting $\beta_0 + \sum_{j=1}^{n=k} \beta_j x_{ij}$ as z_i , equation 1 can be written to give the probability of food insecurity of the household i as

$$\varphi_i = E(I_i = 1|X_i) = \frac{1}{1+e^{-z_i}} \quad (3.26)$$

From the equation 3. 26, the probability of household being food secure is given by

$$1 - \varphi_i = \frac{1}{1+e^{z_i}} \quad (3.27)$$

Therefore the odds ratio, i.e. $\frac{\varphi_i}{1-\varphi_i}$ is given by the equation 3.28 as

$$\frac{\varphi_i}{1-\varphi_i} = \frac{1+e^{z_i}}{1+e^{-z_i}} = e^{z_i} \quad (3.28)$$

The natural logarithm of equation (3.28) gives

$$\ln\left(\frac{\varphi_i}{1-\varphi_i}\right) = \beta_0 + \sum_{j=1}^{n=k} \beta_j x_{ij} + \varepsilon_i \quad (3.29)$$

Rearranging the equation (3.29), with the dependent variable (food insecurity) in log odds, the logistic regression can be manipulated to calculate conditional probabilities instead of log odds or odds as

$$\hat{\varphi}_i = \frac{e^{(\hat{\beta}_0 + \sum_{j=1}^{n=k} \hat{\beta}_j x_{ij})}}{1+e^{(\hat{\beta}_0 + \sum_{j=1}^{n=k} \hat{\beta}_j x_{ij})}} \quad (3.30)$$

Once the conditional probabilities have been calculated for each sample household, the partial effects of the continuous individual variables on the food insecurity can be obtained by averaging (mean) the values of the expression

$$\frac{\partial \varphi_i}{\partial x_{ij}} = \hat{\varphi}_i (1 - \hat{\varphi}_i) \hat{\beta}_j \quad (3.31)$$

The “partial” effects of the discrete variables are obtained by taking the difference of the mean probabilities estimated when the value of the variables is to 1 and 0 ($x_i = 0, x_i = 1$) respectively.

3.3.2: Assumptions:

Logistic regression does not make many of the key assumptions of linear regression and general linear models that are based on OLS algorithms:

1. Logistic regression does not need a linear relationship between the dependent and independent variables. It can handle all sorts of relationships, because it applies a non-linear log transformation to the predicted odds ratio.
2. Independent variables do not need to be multivariate normally distributed although multivariate normality yields a more stable solution.
3. Logistic regression does not need the assumption of homoscedasticity of the variances. That is variance can be heteroscedastic for each level of the independent variables.
4. Error terms are not assumed to be normally distributed.
5. The independent variables does not necessarily be the interval or ratio scaled.

3.4: Variables in the study:

On the basis of the result from the past studies and subject to the data set available explanatory and dependent variables are considered to assess the status of household food security.

3.4.1: The dependent variable:

Collecting data for a complete analysis of food insecurity is difficult or can be an impossible task in a situation where the household and also food insecurity is subject to varying in interpretation. In most of the studies the two objective methods are used to study the household food insecurity. One is to undertake 24-hour recalls of food consumption for individual members of a household and analyze each type of food mentioned for caloric content. In this method, if the estimated total energy in the food that the household acquires daily is lower than the sum of its member's daily

requirements, the household is classified as food energy deficient and secure otherwise. The second method is to estimate gross household production and purchases over a period of time, estimate the growth or depletion of food stocks held over that period of time, and presume that food that has come into the household's possession and disappeared has been consumed (Maxwell, 1996).

Even if a household fulfills the food energy requirement, it does not guarantee whether it could manage the required nutrient to maintain a healthy life. In this situation the dietary quality is taken into account by the measure of diet diversity. In diet diversity it is considered that a household should have taken different food items over a specific period of time. Sometimes a more complete study of nutrient intake is to be considered to assess the food insecurity situation of a household instead of just caloric consumption. There is another factor that does not taken into account in the above method is the vulnerability to the food deprivation in the future. One measure of vulnerability might be percentage of the household's income on food which is true for the poorer households; the household suffer more food deprivation whenever it suffers some income shock.

But in our study, we restrict ourselves to the caloric consumption level of a household to assess its food insecurity status and also ignore the prices of food items as we have the cross sectional data under this study. In this regard, we calculate the daily required calories for each household's member depending upon the recommended (FAO 1996) caloric requirement for a person considering age and sex of that person and sum up it for each household. These minimum caloric levels are recommended for an individual to maintain a healthy life depending upon sex and age. We also compute the consumed calories by each household that are acquired by the used of cereals, other food items, non-food items etc. Then we compare these total required

minimum calories with the consumed calories for a household. A household is considered to be food insecure if the calories consumed by a household are less than the required. So the dependent variable in our study is defined by a dummy variable I_i which is taken the value 1 if the household is food insecure, 0 otherwise.

$$I_i = 1 \quad \text{If a household consumed calories are less than the minimum required calories. (Insecure household)}$$
$$= 0 \quad \text{Otherwise (Secure household)}$$

3.4.2: Explanatory variables:

On the base of the review literature on household food security, some of the most common/important explanatory variables are included in this study. These variables are expected to be helpful in the assessment of the household food insecurity. These could be categorized into the demographic and socio-economic variables.

Explanation of the independent/explanatory variables:

1) Geographical location:

Geographical location is of one the main factor that affects the household food security level. Two household located at two different geographical locations are different in their cultural backgrounds, their living styles, income resources etc. A household located at a populated area may have some harms of less availability of food grains or at high price as well as may vary in income resources. While as comparative to this a household in industrial area, agriculturally rich area or in a backward area may have a different probability to be food insecure. In our study, we divide the households on the basis of province, which are Punjab, Sindh, KPK and Baluchistan. Baluchistan is taken as a base line category. We further divide the

households in an urban or rural area location which is also an important factor to determine the food insecurity with their plus or minus affects. Urban area is denoted by 1 and rural by 0 as later one taken as base category.

2) Household Size:

Household size is measured by the number of family members in a household. Increasing family size, according to reviewed literatures, tends to exert more pressure on consumption than labour it contributes to the production. Larger the household higher the chances to be food insecure as it requires more food as well as less income for the food items due to more other needs (health etc.). The expected sign related to food insecurity of household size is positive. We also include the square term of the household size as its expected sign is negative. The reason behind is that increase in a family size may also increase the income level and availability of labor for agriculture (Maharajan and Joshi, 2011). Increase in household size increases the chances of food insecurity with decreasing rate. Household size is taken as continuous variable.

3) Age of the household head:

Household head age is another factor that may influence the household food insecurity level. Older heads are more mature and may have better experiences in obtaining the types of resources they required for the food security (Hofferth, 2003). Older people are supposed to have more agriculture production practices, particularly in the rural settings where the agriculture is the mainstay as well as older people may have paid off their mortgages and having some level of savings. So this result into the less level of food insecurity with the higher age of the household head and the expected sign is negative. On the other hand, there is equal possibility that the older household heads have low tendency of adopting improved technology in agriculture and also

economically not much active as comparative to younger one. So there are some characteristics of elderly people that increase the likelihood of food insecurity. The elderly people are less mobile, which might prevent them to access low cost food stores (Rose et al., 1998). Age is also expected to have impact on the ability to seek and obtain off-farm jobs and income. Young people are stronger and are expected to cultivate larger size farm than the older people (Babatunde et al., 2007). So this shows the positive relation of age with the food insecurity. So the expected sign of age with the household food insecurity is both negative and positive. A square term of age is also included in this study.

4) Education:

Education is another important factor affect the household food insecurity. Education is a social capital which could impact positively on the ability of a household regarding production as well as nutritional decisions (Babatunde et al., 2007). Education plays significant role in imparting knowledge and skill in modern agriculture practices and its adoption resulting into high production. Higher level of education also opens up opportunities in the off as well as non-farm sectors with high level of income (Maharajan and Joshi, 2011). Education also affects the present and future income of the household. Education also portrays another dimension of the human capital in form of purchasing efficiency, food knowledge and meal preparation skills of the main food purchaser as well as the preparer of the household (Rose et al., 1998). So this justifies the possible negative relationship between education and food insecurity. Female education also plays an important role in food insecurity. As the food purchasing, preparation and serving etc. is most of the time concerned to female. So the education level of female is much more of importance in a household's food security level i.e. it portrays the fact of a household human capital, such as purchasing efficiency, food knowledge and meal preparation in the household.

Female education may also play the role in the income level of household and directly affects the household food insecurity status. So the expected sign of the education of female and household head is negative associated with the food insecurity.

5) Household head gender:

Household head gender is another factor affects the household food insecurity. Food activities (purchasing, preparation etc.) is most of the time concerned with the female, so a household having female household head is more independent in their spending on food as comparative to household headed by male. On the other hand, death of husband, separation, migration of husband outside the city or village may result into the female heading household. These household possess less physical for agricultural activities, livestock and cultivate land they own etc. (Maharajan and Joshi, 2011). So under these conditions a household headed by a female is more likely to be food insecure. Male household head is denoted by 1 and female by 0 and female is taken base category. Here the expected sign on food household food insecurity is both positive and negative.

6) Household Income:

Income is another factor having high influence on the food insecurity. According to reviewed literature the household having higher income are less likely to be food insecure, as comparative to households with low income. So the expected sign is negative of income with the household food insecurity. Household with high income have more income for spending on food after having all other needs. We have taken the total annual income of the household. Household income has a direct effect of food insecurity as a lack of money prevents a household to purchasing enough food (Rose et al., 1998). Agricultural income is also included in this study for

the farmer households. Because it is more representative of the farmer household's production than any other characteristics and may have an effect of the household food insecurity. So the expected sign is negative of total income and agricultural income.

7) Occupational status:

Another factor that is included in this study as a determinant of household food insecurity is occupational status of a household. On the bases of reviewed literature occupation is the influential variable on the food insecurity status of a household. This is the single most common factor among all households, taken as proxy variable of wealth of a household. A household owner has more income to spend on foods than a renter. So having ownership of house results into the less probability to be food insecure than the renters. A dummy variable is included for the home ownership. This takes a value of 1 for owners and 0 for renters. The expected influence of the ownership to the food insecurity is negative.

8) Irrigation availability:

Irrigation availability is taken also as a determinant of farmer household's food insecurity. It takes a value equal to one if a household having the access to irrigation otherwise zero. Farmer households having the availability of irrigation are more probable to get high production and crops in a specific time frame than others. The expected sign of this variable with food insecurity is negative. This means that a household having the access to irrigation is less probable than the others.

9) Age Dependency ratio:

Dependency ratio is taken another indicator of household food insecurity. It is calculated as the ratio of the dependent members of the household by the independent members. This

dependence is based on the age distribution. According to the reviewed literature a household having the more dependent persons than the independent is more likely to be food insecure. The expected sign of this associated with food insecurity is positive.

10) Dwelling type:

Dwelling type is other variable is considered in this study. It has five categories such as independent house/compound, apartment/flat, part of a large unit, part of a compound and other dwelling type. This variable indicates the living standard of the household. A household having better living standard is less probable to be food insecure. There are more people in the economically active age more will be the income and hence results into the decreasing the probability of being food insecure. So this variable is also taken as one of the determinants of household food insecurity.

11) Livestock ownership:

Another variable taken as the determinants of the farmer households food insecurity is the livestock that is of great importance. Livestock provides not only food for households but also a range of other products which could be sold or consumed by the livestock owner to provide, nutrition, income as well as may be useful for agricultural activities (Haile et al., 2005). The major products of livestock include draught power, meat, milk, eggs, and manure (which is used as fertilizer) and some other products of daily used. In addition to these products livestock serve as an asset and may provide a reserve that may be converted into cash in times of need. Because livestock is both an income resource for the household as well as it may be used in economic shocks. In simple a household in any economic shock may sold the livestock to fulfill its requirement. A dummy variable is used for the ownership of livestock that takes the value 1 for

the household having an ownership of livestock and 0 otherwise. Expected effect of this is to be negative on food insecurity.

12) Number of rooms:

According to the reviewed literature number of rooms of a household is also influential variable to assess the food insecurity status of the household. It shows the living standard of a household. Larger number of rooms indicates that more rooms are available for the use. It also shows the ability a household to fulfill its nutritional needs. So a negative impact is to be expected on the food insecurity.

13) Fertilizer application:

Fertilizer application is another variable is considered in this study as a determinant of household food insecurity. It takes a value one if the farmer household is user of the fertilizer and zero otherwise. Its expected effect on the household food insecurity is negative. A user of the fertilizer is less probable to be food insecure than the non-user.

Table 3.1: Explanatory variables and their expected signs as per theory

Households characteristics	Base category	Expected signs
Provinces	Baluchistan	
Region		
Household size		+
Household size square		-
Log of income		-
Log of agricultural income		-
Log of farm size		-
Number of rooms		-
Dependency Ratio		+
Household head age		-/+
Household head age square		+/-
Household head education		-
Gender	Female	-/+
Female education		-
Livestock ownership	Not have	-
Occupational status	Renters	-
Electricity connection	not available	-
Irrigation availability	not available	-
Fertilizer application	non-user	-
Access to safe water	not have access	-

Chapter 4: Results and discussions

This chapter reviews the prevalence of food insecurity among households according to their different characteristics. The later part of this chapter shows the results of logistic regression of general household model as well as farmer household model.

4.1: Descriptive analysis results:

This section reports the descriptive results of the relationship between food insecurity and its determinants. In total observed data of 14525 general households 7317 (50.4 %) are found to be food insecure and 7208 (49.6%) are food secure. While in the observed data of 3518 farmer households 1391 (39.5%) are found to be food insecure and 2127 (60.5%) food secure. The prevalence of food insecurity, however, is not evenly distributed throughout the population. This section reviews our findings on the prevalence of food insecurity among various socio-economic groups of general and farmer households. Since the food insecurity and household characteristics are highly correlated, so it's not surprising to expect that a household having a better living characteristic provide evidence for the lower probability to be food insecure. The following Table 4.1 shows the difference in proportionality of food insecurity among different provinces and regions for general households and farmer households.

This difference of food insecurity level is observed among four provinces in which the Sindh is found to be the most food insecure. Table 4.1 shows that proportion of food insecure household is high in Sindh for both general households as well as farmer households. However, food insecurity level in general households of KPK is almost same to the PUNJAB that is 44.2% and 44.4 % respectively while Punjab has a least proportion of food insecure farmer households as comparative to other provinces. This difference of food insecurity may be because of

environmental difference, population size, economic resources, their cultural difference and their production level etc.

Table 4.1: Prevalence of food insecurity among different provinces and regions

Geographical location	General households		Farmer households	
	Secure	Insecure	Secure	Insecure
Provinces				
Punjab%	55.6	44.4	69.6	30.4
Sindh%	38.2	61.8	43	57
KPK%	55.8	44.2	65.7	34.3
Baluchistan%	44.8	55.2	47.6	52.4
Regions				
Urban%	45.4	54.60	---	---
Rural%	52.50	47.50	---	---

Difference in proportion of household food insecurity status is also observed among rural and urban households. Urban households are found to be more food insecure than rural households.

Table 4.1 shows that 54.6% urban households are food insecure while food insecurity in rural areas is 47.5% and this may be because of that in urban areas most of the households depend on the market purchased food and affected by the high prices of cereals in the urban areas as compared to rural areas. In rural area, most of the households produce cereals by their own and expected to be less affected by high price. So this difference shows that the household situated in a particular ecological region (this distribution of household is made by their provincial status and further in urban and rural level division) have a different level of probability to be food insecure. So these two variables are important for further empirical analysis.

We further look at the household food insecurity status by its different socio-economic characteristics¹. These variables are also important for the empirical analysis. As Table 4.2 shows the household head characteristics such as gender, education, age and also the female education level seemed to be correlated with the food insecurity level of household. Household food insecurity varies according to these characteristics of head.

Table 4.2 shows that tendency of food insecurity at different levels of education of household head among farmer and general households. As the reviews literature shows that education is a social capital which could affect the ability of a household in terms of production as well as its nutritional decisions (Babatunde et al., 2007). The study of Rose et al. (1998) points out the education in terms of human capital. This capital may increase the knowledge about food items, purchasing efficiency and cooking skills etc. According to the argument of Maharajan and Joshi (2011) education also plays a significant role to adopt the modern agricultural practices which results into the high production as well it opens the opportunity for non-forms income . This shows that education is also a significant factor to influence the food insecurity of farmer households. Female education also plays an important role in reducing food insecurity. As the food purchasing, preparation and serving etc. is most of the time concerned to female. So the education level of female is much more of importance in a household's food security level i.e. it

¹ Household food insecurity among different socio-economic groups of households for different provinces is presented in Appendix A.

portrays the fact of a household human capital, such as purchasing efficiency, food knowledge and meal preparation in the household.

Table 4.2: Household food insecurity by household head characteristics and female education

Household characteristics	General households		Farmer households	
	Secure	Insecure	Secure	Insecure
Household head education				
Average	9.74	9.23	9.15	8.89
Median	10	10	10	10
Primary(<=5) %	46.4	53.6	55.5	44.5
Secondary(6-10) %	48.0	52.0	60.3	39.7
Graduation (11-14)%	55.8	44.2	75.4	24.6
Higher (>14) %	70.6	29.4	75	25
Household head age				
Average	45.64	46.48	47.39	48.39
Median	45	45	46	48
≤35 %	56.4	43.6	66.9	33.1
36-55 %	46.1	53.9	58.6	41.4
>55 %	51.0	49.0	59.0	41.0
Gender				
Male %	49.3	50.7	61	39.9
Female %	56.1	43.9	70	30.0
Female education				
Average	8.23	7.96	7.83	7.85
Median	8	8	8	8
Primary(<=5)%	51.6	48.4	70.3	29.7
Secondary (6-10)%	48.1	51.9	59.2	40.8
Graduation (11-14)%	65.5	34.5	82.4	17.6
Higher (>14)%	78.8	21.2	83.3	16.7

Female education also plays the role in the income level of household and indirectly affects the household food insecurity status. So the expected sign of the education of female as well as household head is negatively associated with the food insecurity and this negative impact of

education on food insecurity status of a household, as literature review portrays, is reflected by the proportions given in Table 4.2.

Results of Table 4.2 show that there is a decrease in the food insecurity with an increase in the education level of the household head. There are almost 54 percent households are food insecure among those having household head education primary or less in general household data set. While the proportion of this is very low for the household head have the education more than graduation. There is also a decreasing trend in food insecurity among farmer households with increase in education levels of the household head. Hence, both descriptive results and previous literature show the importance of education variable for further empirical analysis.

Age is one of the most important factors pertaining to the individual's personality make up, since the needs and the way in which an individual thinks are closely related to the number of years a person lived. According to Hofferth (2003) older people are more mature and may have better experiences in obtaining the types of the resources they required. As well as, older people are supposed to have more agriculture production practices, particularly in the rural settings where the agriculture is the mainstay. On the other hand, there is equal possibility that the older household heads have low tendency of adopting improved technology in agriculture and also economically not much active as comparative to younger one. Rose et. al. (1998) makes a point about the older people as they are less mobile, which might prevent them to reach at low cost stores. Babatunde et al., (2007) also give an argument as the young people are stronger and are expected to cultivate larger size farm than the older people. It would be interesting to know that food insecurity varies among the different age groups of households in the observed data sets. Households head having age between 36 and 55 are more food insecure in proportion as compared to other age groups in general households. However, the proportion of food insecurity

is less in the upper and lower quarter of the household's groups by age. Farmer households having age of the head less than 35 are found to be the least food insecure. So this difference shows that age of household head having the impact on food insecurity status of a household and hence a useful variable for further analysis to assess the food insecurity. Age is included as continuous variable in further empirical analysis and square term is also included.

Household head gender is another factor which affects the household food insecurity. Table 4.2 shows the difference of food insecurity among households having male and female head. In most of the literature we have reviewed, households headed by female are more likely to be food insecure. Maharajan and Joshi (2011) argued that death of husband, separation, migration of husband outside the city or village may result into the female heading household. These household possess less physical access for agricultural activities, livestock and cultivate land they own etc. This will have a positive impact towards probability of being food insecure. However, there is another argument that food activities (purchasing, preparation etc.) is most of the time concerned with the female, so a household having female household head is more independent in their spending on food as compared to household headed by male. So in this case a household having female head is less likely to be food insecure. If we look at the Table 4.2 it shows the greater proportion of food insecurity among those households headed by male in both general and farmer households. So, this difference shows the importance of this variable for further empirical analysis.

Household size is one of the most of the important factor for the assessment of food insecurity. Table 4.3 shows the household food insecurity for different household sizes. This proportion shows that food insecurity is increasing in trend with household size. Positive impact of household size on the food insecurity is reflected by the finding given in the Table 4.3.

Household size is measured by the number of family members in a household. Increasing family size, according to reviewed literatures, tends to exert more pressure on consumption on the household. Larger the household higher the chances to be food insecure as it requires more food as well as less income for the food items due to more other needs (health etc.). Household having size less than 3 are 25.5% and 17.7% food insecure in general and farmer household groups, respectively. These results urge us to include the household size for further empirical analysis.

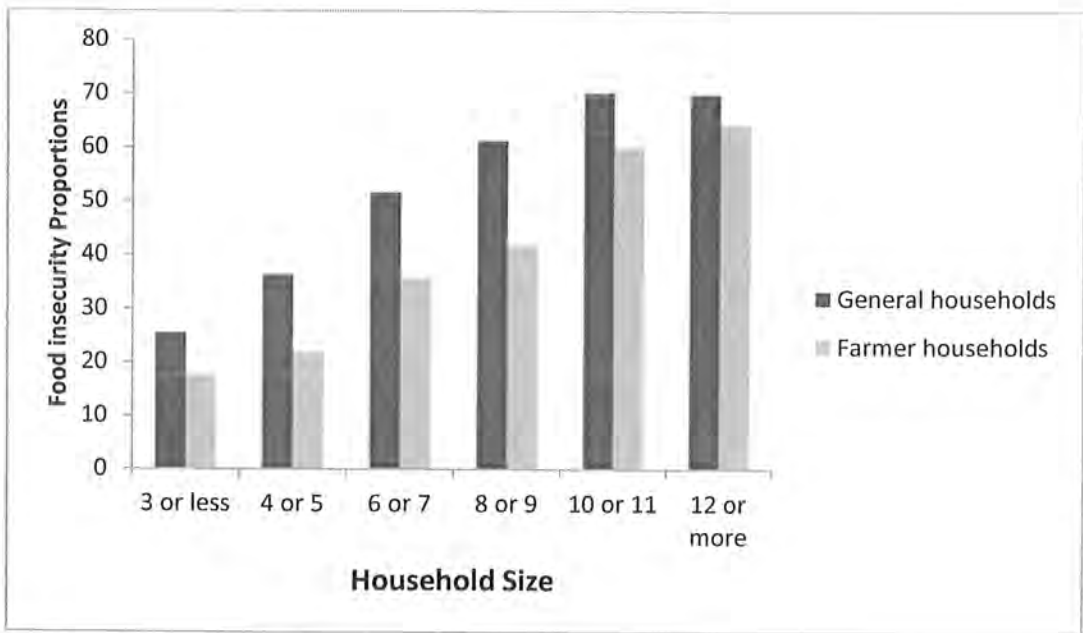


Figure 4.1: Households food insecurity for different household sizes

Note: food insecurity prevalence for different household sizes in different provinces is presented in Appendix A.

If we look at the proportion of the food insecurity there is an increasing trend but with decreasing trend as indicated by Figure 4.1. So that's why we also include the square term of household size in further analysis. Maharajan and Joshi (2011) has made a point about this as, increase in family size may also increase the income level. So the increase in household size increases the chances of food insecurity but expected to be with a decreasing rate. This variable is taken as continues variable and square term is also included.

Table 4.3: Food Insecurity and security according to household size

Household size	General households		Farmer households	
	Secure	Insecure	Secure	Insecure
Average	6.21	7.86	7.02	9.13
Median	6	7	7	8
less or equal 3	74.5%	25.5%	82.30%	17.70%
4 or 5	63.6%	36.4%	78.20%	21.80%
6 or 7	48.4%	51.6%	62.20%	35.80%
8 or 9	38.8%	61.2%	58.30%	41.70%
10 or 11	29.8%	70.2%	40.00%	60.00%
greater or equal 12	30.1%	69.9%	35.70%	64.30%

Another important factor to assess the food insecurity of the household is income level of the household. More the income is less the chance to be food insecure. Table 4.4 shows the income level of secure and insecure households. Income should be one of the most important factor having high influence on the food insecurity.

Households having higher income are less likely to be food insecure, as compared to households with low income. Rose et al. (1998) argued that household income has a direct effect on food insecurity as the lack in income prevents a household to purchasing enough food.

Households with high income have more income for spending on food after having all other needs. Results given in Table 4.4 shows the mean income of insecure households is less than secure households for both general households and farmer households groups. So this difference shows that income plays a role to determine the household food insecurity and hence a useful variable for further empirical analysis. It is taken as a continuous variable and expected a negative impact on food insecurity.

Table 4.4: Household food insecurity among different income groups

Household income	General households		Farmer households	
	Secure	Insecure	Secure	Insecure
Annual Income				
Mean	149653.72	121824.89	137383.95	116353.57
Median	96865	96000	90140.00	82500.00
Agricultural Income				
Mean	---	---	18391.91	140402.94
Median	---	---	93000	83000

Number of the rooms available in a household is also considered as a determinant of food insecurity in this study. More the rooms available show the ability to access food or living standard of a household. Table 4.5 shows that household food insecurity proportion decreases as the number of rooms increases. The mean rooms for secure is 3 which is greater than insecure households in general households and 2.75 for secure farmer households. According to the study made by Irum and Butt (2004) number of rooms capture household's standard of living and it may also indicate the ability of households to afford required food for the family which is necessary for the family nutritional requirement. Results of Table 4.5 show that there 40% and 34% food insecure households in general and farmer households having number of rooms five or

more. This proportion is least one among the above classes in both data sets. So, this difference in the prevalence of food insecurity among different household groups by number of rooms they lived urges us to include this variable for further analysis.

Table 4.5: Household food insecurity prevalence for different households regarding number of rooms

Number of rooms	General households		Farmer households	
	Secure	Insecure	Secure	Insecure
Average	3	2.44	2.75	2.64
Median	2	2	2	2
1	48%	52%	59.7%	40.3%
2	48%	52%	59.1%	40.9
3	49.6%	50.4%	60.1%	39.9
4	51%	49%	61.6%	38.4%
5 or more	60%	40%	66%	34%

Dependency ratio shows the ratio of number of peoples in dependent age by independent age in household. It shows that the more the dependent people in household put more burden on the expenditure of a household. We found the Mean dependency ratio .95 for the secure household group while this is 1.06 for insecure household as given in Table 4.6. The median of dependency ratio is 0.75 for secure households and .86 for insecure in general households. Dependency ratio is also low for secure farmer households. This difference shows that it's an influential variable on food insecurity and hence useful for further empirical analysis.

Table 4.6: Proportion of food insecurity according to some other characteristics of households

Household characteristics	General households		Farmer households	
	Secure	insecure	Secure	Insecure
Occupational status				
Renters %	48.5	51.5	58.5	41.5
Owners %	49.8	50.2	60.6	39.4
Dependency ratio				
Mean	.95	1.06	1.02	1.12
Median	.75	0.86	0.8	0.88
Dwelling type				
Independent house/compound %	50.1	49.9	---	---
Apartment/flat %	48	52	---	---
Part of large unit %	48.8	51.2	---	---
Part of compound %	44.7	55.3	---	---
Other %	51.5	48.5	---	---
Electricity connection				
Not Available	44.7%	55.3%	50.4%	49.6%
Available	50.8%	49.2%	64.5%	35.5%
Access to safe water				
No	52.4%	47.6%	58%	42%
Yes	49.3%	50.7%	61%	39%
Livestock Ownership				
Not have	---	---	60.5%	39.5%
Have	---	---	60.4%	39.6%
Irrigation				
Not available	---	---	65.7%	34.3%
Available	---	---	58.9%	41.1%
Fertilizer use				
No	---	---	60.8%	39.2%
Yes	---	---	60.4%	39.6%
Land size				
1	---	---	55.7%	44.3%
1-2.5	---	---	65.2%	34.8%
2.5-4	---	---	60.1%	39.9%
>4	---	---	60.2%	39.8%

Table 4.6 shows that household having dwelling type independent house/compound and other dwelling type are found to be least food insecure than other categories of dwelling types.

There are 49.9% food insecure households among independent house/compound group while in other dwelling type 48.5% are food insecure for general households. For farmer households the dwelling type variable is not considered as there are most of the farmer households have the independent house/compound. Household having an electricity connection are less in proportion of food insecurity than the households not having an electricity connection. So these two variables are seemed to be useful for further analysis. However, the proportion of food insecurity is high for household having access to the safe water. This is not the result according to our expectation in both groups of households (general and farmer households).

If we look at the Table 4.6 it shows the proportion of food insecurity prevalence according to some other characteristics of the farmer households. Households having a livestock ownership are found to have the same proportionality of food insecurity in contrast those not have the livestock ownership. As we have discussed earlier livestock is both an income source as well a wealth. A household can sold out the livestock in any economic shock which prevents her to go into the food deprivation. However, this variable is included for further empirical analysis. In fertilizer application and irrigation availability variables again the food insecurity is greater in proportion for the users of fertilizer and has the irrigation availability. The proportionality of food insecurity for different farm sizes varies. There is a decreasing proportion of food insecurity with the increase in farm size from 1 to between 1 and 2.5 acres. Household having the farm size equal to one acre are found to be more food insecure than the farmers with larger farm size. Variation in proportion of food insecurity in different farm sizes shows the importance of this variable for further empirical analysis.

4.2: Parameter estimates of general household model:

In this section we will describe the results of logistic regression for general household model. Table 4.7 shows three models where the dependent variable is household food insecurity. It takes a value equal to 1 if household is unable to meet its minimum calorie requirement, 0 otherwise. In the first model, we include the eight variables such as provinces, region, household size, household size square, log of total income, dependency ratio, occupational status and number of rooms in a household. These all variables are found to be highly significant. All these variables have the signs according to the theory reviewed in literature except for the dependency ratio. In our estimated model dependency ratio is negatively associated with the household food insecurity. This means that food insecurity reduces as the dependent people increased in a household. So this sign is puzzle able and not much helpful to the household's food insecurity status.

Baluchistan is base category and the negative signs of Punjab and KPK coefficients show less probability of the households being food insecure lived in Punjab and KPK as compared to Baluchistan. However, Sindh is to be found more food insecure as indicated by a positive sign of its coefficient. Household size has a positive sign and its square has a negative sign. This tells us there is an increasing trend in food insecurity of a household with household size but with decreasing rate. We have discussed earlier the point made by Maharajan and Joshi (2011) as the increase in family size may increase the income level of a household. So this is reflected by the signs of their coefficient but the amount of magnitude of change in probability of food insecurity associated with household size will be discussed in partial effects later. Occupational status variable (having base category renters) shows a negative signs. This implies household having own land have lower probability of being food insecure than renters.

Table 4.7: Parameter estimates of three different models for general households

Household characteristics	Parameter estimates					
	Model I	P-value	Model II	P-value	Model III	P-value
Provinces (Baluchistan)						
Punjab	-0.226** (0.055)	.000	-0.228** (0.055)	.000	-0.245** (0.058)	.000
Sindh	0.454** (0.060)	.000	0.465** (0.061)	.000	0.467** (0.064)	.000
KPK	-0.505** (0.063)	.000	-0.491** (0.064)	.000	-0.501** (0.065)	.000
Region	0.68** (0.041)	.000	0.697** (0.041)	.000	0.7** (0.043)	.000
Household size	0.513** (0.018)	.000	0.49** (0.018)	.000	0.492** (0.018)	.000
Household size square	-0.013** (0.001)	.000	-0.012** (0.001)	.000	-0.012** (0.001)	.000
Ln of total income	-0.554** (0.029)	.000	-0.555** (0.031)	.000	-0.542** (0.032)	.000
Dependency ratio	-0.161** (0.022)	.000	-0.145** (0.023)	.000	-0.146** (0.023)	.000
Occupational status (renters)	-0.17** (0.055)	.002	-0.17** (0.056)	.002	-0.155** (0.056)	.006
Number of rooms	-0.168** (0.015)	.000	-0.154** (0.040)	.000	-0.149** (0.016)	.000
Age			0.04** (0.008)	.000	0.038** (0.009)	.000
Age square			-0.0004** (0.000086)	.000	-0.0004** (0.000086)	.000
Education of household head			-0.03** (0.006)	.000	-0.029** (0.007)	.000
Gender of household head			0.253** (0.092)	.006	0.245** (0.092)	0.008
Female education					-0.011 (0.011)	0.277
Electricity connection (not available)					-0.149** (0.051)	0.003
Dwelling type (other)						
Independent house/compound					.378* (0.221)	0.087
Apartment/flat					0.544** (0.255)	0.033
Part of the large unit					0.510** (0.232)	0.027
Part of compound					0.122 (0.323)	.600
Access to safe water (not access)					0.131** (0.063)	.037
Constant	4.087** (0.320)	.000**	3.288** (0.361)		2.861** (0.418)	.000

**..Sig. at 0.05 level of significance. *..Sig. at 0.10 level of significance.

Number of rooms and log of annual income are also negatively associated with food insecurity.

In the second model, we further include four variables related to household head. These are age of the household head, age square, household head education and gender of the household head. Household head age is positively associated with the household food insecurity. However, the negative sign of its square term shows the decreasing rate of increasing trend in household food insecurity with the age of the household head. Household head education is negatively associated with the household food insecurity. Gender of the household head has a positive sign where its base category is female. So its positive sign shows that the households having female head are less probable to be food insecure than those headed by male. These four variables are also found highly significant as well as the earlier ones in this model.

In the third model, we include the remaining four variables which are expected to be influential factor on the household's food insecurity status. These include female education, electricity connection, dwelling type and access to safe drinking water. In these variables female education is to be found insignificant even though it has a negative impact on the household food insecurity. The sign of variable access to safe drinking water is not favorable. Household having electricity connection are found less likely to be food insecure than those having no electricity connection. In dwelling type categories all sign are positive. This means that these are more probable to be food insecure as comparative to the base category i.e. other dwelling type. So we will discard the insignificant variable that is the female education and get the final model to estimate the partial effects of each variable.

Table 4.8: Parameter estimates of final model for general households

Household characteristics	Parameter estimates	P-value
Provinces (Baluchistan)		
Punjab	-.244** (0.058)	0.000
Sindh	.468** (0.064)	0.000
KPK	-.502** (0.065)	0.000
Region (rural)	.697** (0.043)	0.000
Household size	.494** (0.018)	0.000
Household size square	-.012** (0.001)	0.000
Log of total income	-.547** (0.031)	0.000
Dependency ratio	-.147** (0.023)	0.000
Occupational status (renters)	-.154** (0.056)	0.006
Number of rooms	-.150** (0.016)	0.000
Household head age	.039** (0.009)	0.000
Household head age square	-.0004** (0.000086)	0.000
Education of household head	-.031** (0.006)	0.000
Gender (female)	.246** (0.092)	0.000
Electricity connection (not available)	-.148** (0.051)	0.004
Dwelling type (other dwelling type)		
Independent house/compound	.378* (0.221)	0.087
Apartment/Flat	.537** (0.255)	0.035
Part of large unit	.510** (0.230)	0.027
Part of a compound	.122* (0.232)	0.600
Access to safe water (not have access)	.132** (0.063)	0.036
Constant	2.825** (0.417)	0.000

**..Sig. at 0.05 level of significance. *..Sig. at 0.10 level of significance.

Table 4.8 shows the results of model after discarding the female education variable which was insignificant. This model predicts the 67% of the values correctly. In this model all variables are significant and have the signs as expected but the dependency ratio and water access are still puzzle able and not favorable. So we will find the partial effects of all other variables except for the dependency ratio and water access in the following section.

4.2.1: Change in probabilities for discrete variables of the logistic regression:

The change in the probabilities of household food insecurity due to the discrete variables is presented in the following table 4.9. This change is calculated by the difference of mean probabilities of respective variable categories.

Table 4.9 shows the partial effects of six discrete variables which are found to be significant in our empirical model. In provinces, mean probability of being food insecure is higher in Sindh among all other provinces. Households belong to Punjab and KPK are almost 17% less probable to be food insecure than the households of Sindh. According to the results in Table 4.9, a shift from the urban to the rural region decreases the probability of food insecurity by 7 percent. Probability of food insecurity among renters and owner however is quite small. A shift from the renter household to the owner household reduces the probability of being food insecure by 1.3%. There may be more income available to spend on the food items in case of owners as comparative to renter households resulting into less probability of food insecurity.

The partial effects shows that households having female household head are less likely to be food insecure than the household headed by male. A shift from the male household head to the female household head decreases the probability of being food insecure by almost 6.8%. This shows that the female head plays a part to reduce probability of a household to being food insecure. In dwelling type of the household independent house/compound category is found to be

the least probable to be food insecure except the other dwelling type household. A shift from the independent house

Table 4.9: Partial effects of discrete determinants of food insecurity

Household characteristics	Probabilities	Change in probabilities
Province		
Punjab	0.4444	-0.1735
Sindh	0.6179	
KPK	0.4422	-0.1757
Baluchistan	0.5515	-0.0664
Region		
Urban	0.5464	
Rural	0.4747	-0.0717
Occupational status		
Owners	0.502	
Renters	0.5151	0.0131
Gender of the household head		
Male	0.5068	
Female	0.4393	-0.0675
Electricity connection		
Have connection	0.4915	
Not have connection	0.553	0.0615
Dwelling Type		
Independent house/compound	0.4991	
Apartment/Flat	0.5197	0.0206
Part of large unit	0.5119	0.0128
Part of compound	0.5529	0.0538
Other	0.4848	-0.0143

The "partial" effects of the discrete variables are obtained by taking the difference of the probabilities estimated when the value of the variables is to 1 and 0 ($x_i = 0, x_i = 1$) respectively.

log of income is -0.2756. As indicated by negative sign it shows that a one percent change in income reduces the probability of being food insecurity by 27.56%. Households have the more income less the probable to be food insecure. The partial effect of the number of rooms of a variable is found to be -0.0756. This indicated that a unit (room is a unit here) increase in housing rooms reduce the probability of food insecurity by 7.56%. This variable shows the living standard of a household as well as it shows the ability of a household having to meet its nutrition requirements. Households having the large number of rooms in housing shows the living standard of a household and hence results into negative association with food insecurity as shows by the result of its partial effect.

Education of the household head is another effective variable on the food insecurity as discussed earlier. Its coefficient of partial effect shows that a unit increase in (here unit a year of schooling) education of the household head decreases the probability of a household food insecurity by 1.56%. The change in probabilities in household size and age of the household head is presented in the following table 4.11. It shows that there is an increasing trend in household food insecurity with the increase in household size. However, there is a decreasing rate in the increasing trend of household food insecurity with family size. A shift of the household size from 3 to 4 increases the probability of a household being food insecure by 20.69%. If we further look at the shift of the household size from 4 to 5, it indicates the increase in probability of household food insecurity by 19.49%. This is less than the increase of probability in household food insecurity than shift of household size from 3 to 4. So this shows that an increase in household size increases the probability of food insecurity but its rate of change is decreasing with family size. As the reviewed literature point out this i.e. an increase in family size may also increase the income level of the household as reflected by results.

Table 4.11: Change in probabilities of food insecurity for household size and head age

Household characteristics	Change in probabilities
Household size	
3	
4	$0.2489(4-3)-0.006(16-9)=0.2069$
5	0.1949
6	0.1829
7	0.1709
8	0.1589
9	0.1469
10	0.1349
Household head age	
35	
40	$0.0196(40-35)- 0.0002 (40^2-35^2) =0.023$
45	0.013
50	0.003
55	-0.007
60	-0.017

The above table also shows the change probabilities for different ages of the household head. A household having headed by 40 years of old is 2.3% more probable than the household head 35 years of old. There is an increasing trend in household food insecurity with age of the household head but with decreasing. It is interesting to know that a shift of the household head age from 50 to 55 decreases the probability of the household food insecurity instead of increasing. So this pattern was also revealed by the descriptive findings about the age of the household head as discussed earlier.

4.3: Parameter estimates of farmer household model:

In this section we will describe the results of the logistic regression for the farmer household. Table 4.12 shows the three models for farmer households. the dependent variable is here household food insecurity takes a value equal to 1 if a farmer household is unable to meet the minimum requirement of calories, 0 otherwise.

In the first model eight variables are included such as provinces, household size, household size square, log of the income, log of the agricultural income, log of the land size, number of rooms in housing and dependency ratio. All these variables are found to be significant except the log of land/farm size. In provinces Baluchistan is taken as the base category. The negative signs of the Punjab and KPK provinces show that there is less probability of household food insecurity in these provinces than Baluchistan. Sindh is found to be more food insecure than Baluchistan i.e. the sign of its coefficient is positive. These results are the same for all provinces as indicated by the proportion of the household's food insecurity in the descriptive results section.

Household size is also found to be highly significant as well as its square term. Household size is positively associated with the household food insecurity as shown by the negative sign of its coefficient. The sign of the household size square is found to be negative. This indicated there is an increasing trend in household food insecurity with the increase of household size but with decreasing rate. As the reviewed literature points out that there is a possibility of increase in income level of the household as well as more labor for agriculture with increase in its family size. We will discuss the magnitude of this probability in terms of the partial effects later. Sign of the log of the income is negatively associated with food insecurity as its sign is negative here. This variable is also found to be highly significant in this model. Log of

Table 4.12: Parameter estimates of three different models for farmer households

Households characteristics	Parameter estimates					
	Model I	P-value	Model II	P-value	Model III	P-value
Provinces (Baluchistan)						
Punjab	-0.669** (0.126)	0.000	-0.666** (0.127)	0.000	-0.642** (0.140)	0.000
Sindh	0.306** (0.137)	0.026	0.326** (0.139)	0.019	0.260* (0.149)	0.082
KPK	-1.245** (0.150)	0.000	-1.233** (0.151)	0.000	-1.133** (0.157)	0.000
Household size	0.470** (0.035)	0.000	0.453** (0.036)	0.000	0.456** (0.036)	0.000
Household size square	-0.011** (0.001)	0.000	-0.010** (0.001)	0.000	-0.010** (0.001)	0.000
Log of income	-0.363** (0.062)	0.000	-0.377** (0.064)	0.000	-0.355** (0.065)	0.000
Log of agricultural income	-0.324** (0.056)	0.000	-0.325** (0.056)	0.000	-0.343** (0.061)	0.000
Log of farm size	-0.020 (0.050)	0.687	-0.023 (0.051)	0.648	-0.011 (0.055)	0.840
Number of rooms	-0.091** (0.030)	0.002	-0.086** (0.030)	0.004	-0.073** (0.030)	0.016
Dependency Ratio	-0.173** (0.046)	0.000	-0.156** (0.046)	0.001	-0.165** (0.047)	0.000
Household head age			0.038** (0.017)	0.027	0.038** (0.017)	0.031
Household head age square			0.00036** (0.00017)	0.040	0.00035** (0.00017)	0.046
Household head education			-0.022 (0.015)	0.153	-0.026* (0.016)	0.092
Gender (female)			0.272 (0.232)	0.241	0.209 (0.233)	0.370
Female education					0.029 (0.034)	0.395
Livestock ownership (not have)					-0.077 (0.078)	0.320
Occupational status (renters)					-0.010 (0.179)	0.955
Electricity connection (not available)					-0.228** (0.093)	0.014
Irrigation availability (not available)					0.215* (0.114)	0.059
Fertilizer application (non-user)					-0.063 (0.136)	0.0645
Access to safe water (not have access)					-0.129 (0.127)	0.311
Constant	5.366** (0.695)	0.000	4.575** (0.814)	0.000	4.458** (0.876)	0.000

**..Sig. at 0.05 level of significance. *..Sig. at 0.10 level of significance.

the agriculture income is also found to be the highly significant and sign of its coefficient shows a negative association with the household food insecurity. Previous works on this issue shows the importance of income in the household food insecurity i.e. greater the income lesser the chances to be food insecure. In this model log of the farm size is found to be insignificant. However, its coefficient shows a negative association with the household food insecurity. Number of rooms in housing is found to be highly significant and showing a negative association with the household food insecurity. However, the dependency ratio has not a sign as expected i.e. it shows the decrease in household food insecurity as the dependency ratio increases which is a puzzle.

In the second model we include the further four variables related to household head and also the female education. These variables are age of the household head; age square, gender of the household head and female education. In this model age and its square are found to be significant while the other two not. Household head age is found to be positively associated with the household food insecurity and its square term has a negative sign. We will discuss magnitude of their probability for food insecurity in the partial effects section.

In the third model we include seven more variables those include female education, livestock ownership, occupational status, electricity connection, irrigation availability, fertilizer application and access to safe water. In this model 12 variables are found to be significant. Two out of these significant variables are not have the signs according to the reviewed literature. These are the dependency ratio (which has also a negative sign in first two models of general households) and irrigation application. Household having Irrigation availability is found more food insecure as reflected by the descriptive statistics of this variable earlier and hence not a useful variable. So to construct the final model we drop out the insignificant variable and find

out the partial of the significant variables. Table 4.13 shows the results of final model that is further used to calculate the partial effects. In this model all variables have significant effect on the food insecurity as revealed by their coefficients.

Table 4.13: Parameter estimates of final model for farmer households

Household characteristics	Parameter estimates	P-Value
Provinces		
Punjab	-.631** (0.130)	0.000
Sindh	.271* (0.142)	0.057
KPK	-1.141** (0.153)	0.000
Household size	.453** (0.036)	0.000
Household size square	-.010** (0.001)	0.000
Log of income	-.336** (0.063)	0.000
Log of agricultural income	-.353** (0.048)	0.000
Number of rooms	-.076** (0.030)	0.012
Dependency ratio	-.161** (0.046)	0.000
Household head age	.037** (0.017)	0.034
Household head age square	-.0003* (0.00017)	0.053
Household head education	-.025* (0.015)	0.107
Electricity connection (not available)	-.230** (0.092)	0.012
Irrigation availability (not available)	.220** (0.101)	0.029
Constant	4.656** (0.769)	0.000

**..Sig. at 0.05 level of significance. *..Sig. at 0.10 level of significance.

4.3.1: Change in probabilities for discrete variables of the logistic regression:

The change in the probabilities of household food insecurity due to the discrete variables is presented in the following table 4.14. This change is calculated by the difference of mean probabilities of respective variable categories.

Results of table 4.14 show the partial effect of two discrete variables those are found to be significant in our empirical model of farmer household. In province Punjab is to found least probable to be food insecure than the other provinces and Sindh has the highest probability of food insecurity. A household belongs to Sindh is 26.54% more probable to be food insecure than the households belongs Punjab. However, KPK households are found to be almost 4% more insecure than the Punjab households as shown by the partial effects in table 4.14. Households have an electricity connection are almost 14% less probable to be food insecure than the households not have the electricity connection.

Table 4.14: Partial effects of discrete determinants of food insecurity

Household characteristics	Probability	Change in probability
Provinces		
Punjab	0.3042	
Sindh	0.5696	0.2654
KPK	0.3434	0.0392
Baluchistan	0.5241	0.2199
Electricity connection		
Not have	0.4956	
Have	0.3548	-0.1408

4.3.2: Partial effects of the continuous variables of logistic regression:

Partial effects were carried out on continuous variables to assess the marginal effect of a unit change in any of the variables that were found to be statistically significant on the household

food insecurity level in the logistic model of the farmer households. The partial effects are calculated from the logistic regression to show the effect of the change in an individual variable on the probability of food insecurity when all other exogenous/explanatory variables are held constant. The results of the partial effects of eight significant continuous variables are given in table 4.15.

Household's income is playing a great role in the food insecurity status of the farmer household. A one percent increase in the income of the household reduces the probability of a household to be food insecure by almost 13% as reflected by the results given in the table 4.15. Agricultural income is also negatively affecting the household food insecurity. A one percent increase in the agricultural income decreases the probability of being food insecure by almost 14%. So this shows both agricultural and other income affecting the household food insecurity. A one unit increase in the number of rooms in housing reduces the probability of food insecurity by 3%. Similarly the education of the household head is also negatively associated with food insecurity. As revealed by its partial, a one unit increase in the education of the household head (here unit is one year of schooling) reduces the probability of food insecurity by 9%.

Table 4.15: Partial effects of the continuous variables of farmer households

Household characteristics	Partial effects
Household size	0.1791
Household size square	-.004
Log of income	-0.1329
Log of agricultural income	-0.1396
Number of rooms	-0.0301
Household head age	0.0146
Household head age square	-0.0001
Household head education	-0.0909

Table 4.16 shows the change in the probability of food insecurity according to household size and age of the household head. It shows that there is an increasing trend in probability of farmer household food insecurity with the household size but with decreasing rate. A shift in the household size from 3 to 4 increases the probability of food insecurity by almost 15% and shift from 4 to 5 increases by 14.31%. So these results of probabilities of household food insecurity verify the statement made by Maharajan and Joshi (2011) i.e. increase in a family size may also increase the income level and availability of labor for agriculture i.e. resulting into an increase trend of food insecurity associated with household size but with decreasing rate.

Table 4.16: change in probabilities of household size and age of the household head.

Household characteristics	Change in probabilities
Household size	
3	
4	$0.1791(4-3)-0.004(16-9)=0.1511$
5	0.1431
6	0.1351
7	0.1271
8	0.1191
9	0.1111
10	0.1031
Household head age	
35	
40	$0.0146(40-35)-0.0001(40^2-35^2)=0.0355$
45	0.0305
50	0.0255
55	0.0205
60	0.0155

Probability of food insecurity is also increasing with the age of the household head. a shift in the household head age from 35 to 40 years old increases the probability of household food insecurity by 3.55%. However, there is also a decreasing rate in the increasing trend of the household food insecurity with the age of the household head.

Chapter 5: Conclusion and recommendations

5.1 Conclusion:

The major objective of this study was to identify the determinants of food security among the general and farmer households of Pakistan. As a result, this study found that household food security in the study region was determined by 16 key factors (19 for farmer households).

In this study, 50.4% and 49.6% general households are found to be food insecure and secure, respectively. While 39.5% and 60.5% farmer households are found to be food insecure and secure, respectively. This shows a low tendency of food insecurity among farmer households as compared to general households.

According to the descriptive results of general and farmer sample households, Sind is found to be the more food insecure among all other provinces. Rural households were also found to be less food insecure than the urban households. The average of some variables such as household size and dependency ratio were found higher with food insecure households than the food secure households. On the other hand, the food secure households have relatively greater averages on the educational level of household head, annual income, agricultural income, and number of rooms than food insecure households. There are only 30 % and 25 % food insecure households having a head with higher educational level in general and farmer households, respectively. This was the lowest proportion of food insecurity as compared to households with less educated head. In addition, it was found that female headed, owners and have the electricity connection households were better food secure than their counterparts. However, it was also found that households having irrigation availability, fertilizer user and access to safe water were not less food insecure than their complements.

The food insecurity related factors were studied through the logistic regression for general and farmer households. Out of 16 factors included in this study for general households, only female education was found to be insignificant. The signs of factors like access to safe water and dependency ratio were found to be puzzle able/unfavorable. Educational level of head, annual income, number of rooms, household size square and age square were found negatively associated with household food insecurity while household size, age have a positive association with food insecurity.

For farmer households, out of 19 factors twelve were found to be significant determinants of household food insecurity such as households size, households size square, annual income, agricultural income, number of rooms, dependency ratio, age, age square, electricity connection and irrigation availability. Educational level of head, annual income, number of rooms, agricultural income, age square and household size were found negatively associated with household food insecurity. Household size and age of household head have a negative impact of household food insecurity. One important aspect of farmer household revealed by the model was that only significant factor particularly related to farmer household was agricultural income while the factors like farm size, fertilizer application and irrigation availability were not playing part to assess the food insecurity status.

So the results of general and farmer household models showed some important indicators to assess the household's food insecurity such as educational level of head, household size and income. Education plays a part in imparting knowledge and skill in modern agriculture practices and its adoption resulting into high production and agricultural income i.e. reducing the probability of a household being food insecure. Education also opens up more opportunities for income as well as has an impact on the ability of household nutritional decisions. As far as

household size is concerned, large households have more people to feed as compared to small households thus, reducing the calories intake per household member increasing the food insecurity in those households. Obviously, households having low income are highly food insecure as they are left with very small amount to meet their dietary needs after sparing money for other needs. However, we believe that some other factors and elements that affect food security are complex and multifaceted in nature and not easy to comprehend may also be included. Therefore, effort has been made in this study to see the impact of some demographic and socioeconomic factors on household food insecurity.

5.2 Recommendations:

As Pakistan is constantly facing the problem of food insecurity, there is a need for integrating food insecurity relief and prevention strategies at regional level with the overall development strategy. The strategy should aim food security at household level by incorporating the following recommendations.

- Based on the study, household with highly educated heads were better in food security status than households with less educated heads in the study region. Therefore, it is recommended that the government should improve the education sector.
- Income is another important factor found in this study. So it is recommended that more income opportunities should be provided by the government as well as the attention should be paid towards the agricultural sector to improve the income of farmer households.

- Finally, we recommend that further studies be conducted in the area of food insecurity by considering detail and accurate information on various variables including political, climatic and weather (rainfall and temperature), topology, natural disasters, ecological conditions and other factors that affect food insecurity. It is also recommended to conduct a study that compare status of food insecurity in rural households with urban households or among different provinces of Pakistan.

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Appendix- A

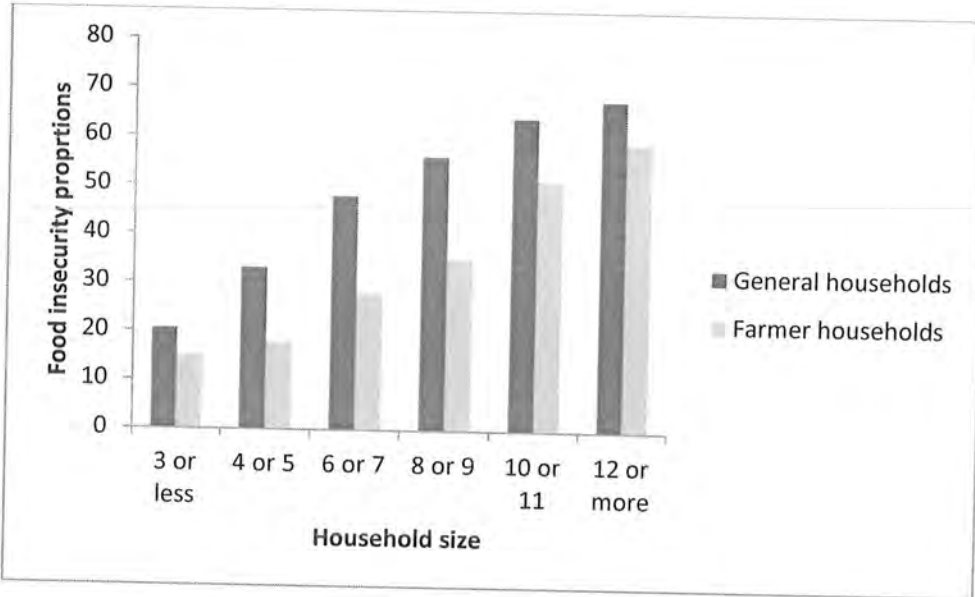


Figure A.1: Percentage of food insecurity in Punjab for different household sizes

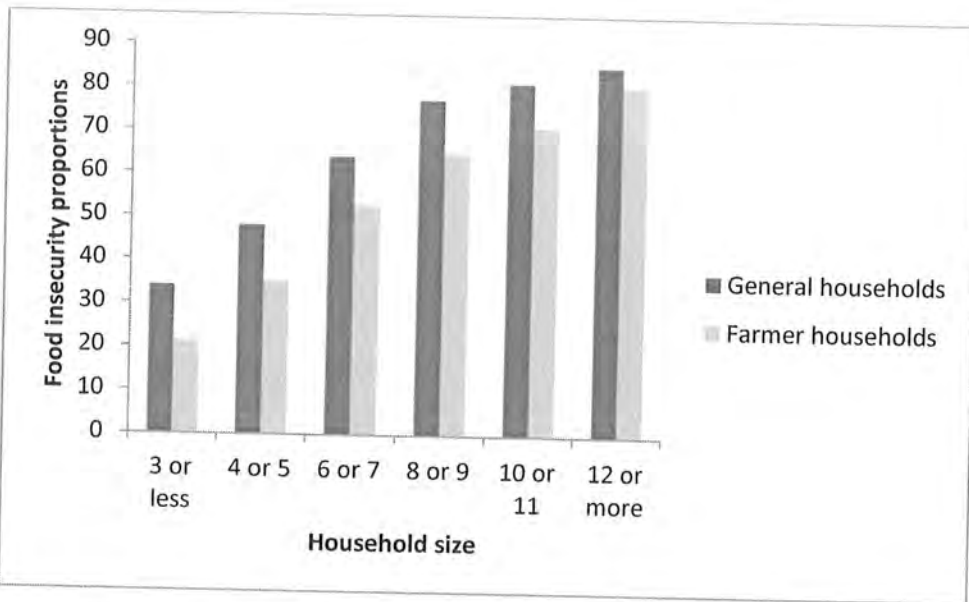


Figure A.2: Percentage of food insecurity in Sindh for different household sizes

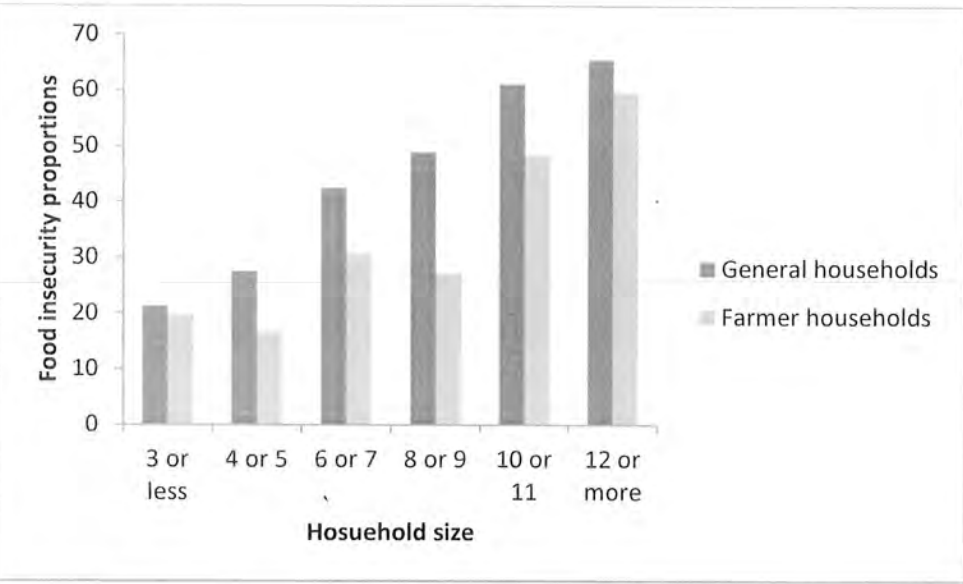


Figure A.3: Percentage of food insecurity in KPK for different household sizes

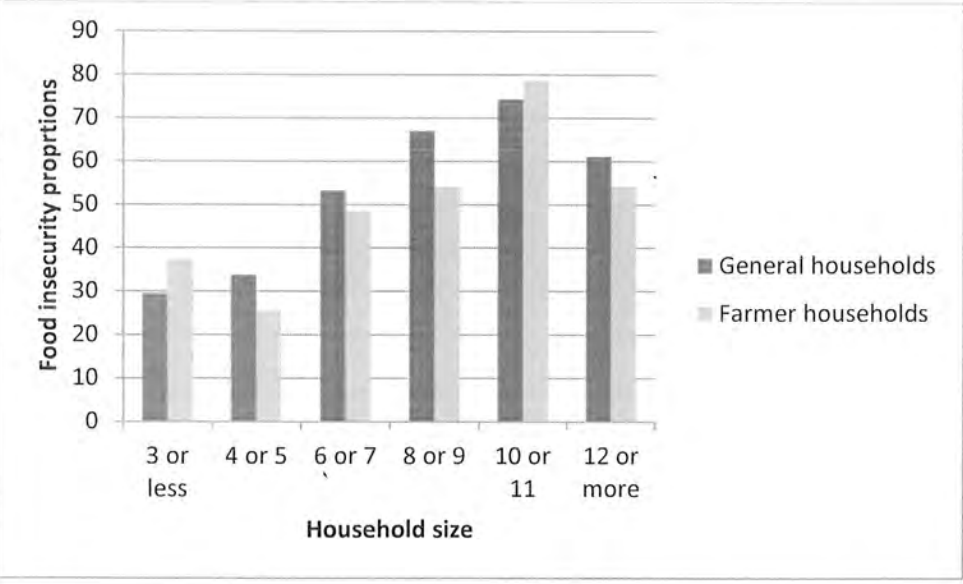


Figure A.4: Percentage of food insecurity in Baluchistan for different household sizes

Table A.1: Percentage of food insecurity according to different household groups in Punjab.

Household characteristics	All households		Farmer households	
	Secure	Insecure	Secure	Insecure
Region				
Urban %	49.4	50.6	---	---
Rural %	60.0	40.0	---	---
Household head education				
Average	9.373	9.084	9.005	8.81
Median	10	10	10	10
Primary(<=5) %	53.5	46.5	67.9	32.1
Secondary(6-10) %	54.6	45.4	68.7	31.3
Graduation (11-14)%	61.6	38.4	83.3	16.7
Higher (>14) %	68.5	31.5	77.3	22.7
Household head age				
Average	46.2	46.73	47.84	49.16
Median	45	45	46	48
≤35 %	61.8	38.2	75.4	24.6
36-55 %	52.0	48.0	69.3	30.7
>55 %	57.5	42.5	66.3	33.7
Gender				
Male %	55.3	44.7	69.7	30.3
Female %	59.2	40.8	67.2	32.8
Female education				
Average	8.186	7.92	7.788	
Median	8	8	8	
Primary(<=5)%	55.5	44.5	72.2	27.8
Secondary (6-10)%	54.4	45.6	68.7	31.3
Graduation (11-14)%	66.0	34.0	85.0	15
Higher (>14)%	76.7	23.3	100	0
Annual income				
Average	156683.2546	139037.81	157286.04	143724.4089
Median	100000.00	97190.00	101500.00	87100.00
Agricultural income				
Average	---	---	225935.70	179005.95
Median	---	---	106750.00	85450.00
Electricity connection				
Not Available	55.1	44.9	67.8	32.2
Available	55.6	44.4	70.0	30.0
Occupational status				
Renters %	52.3	47.7	65.1	34.9
Owners %	56.1	43.9	69.8	30.4

Table A.2: Percentage of food insecurity according to different household groups in Sindh

Household characteristics	All households		Farmer households	
	Secure	Insecure	Secure	Insecure
Region				
Urban %	34.9	65.1	---	---
Rural %	40.8	59.2	---	---
Household head education				
Average	10.065	9.161	8.940	8.328
Median	10	10	10	10
Primary(<=5) %	35.1	64.9	37.2	62.8
Secondary(6-10) %	34.4	65.6	43.2	56.8
Graduation (11-14)%	46.1	53.9	63.2	36.8
Higher (>14) %	67.3	32.7	81.8	18.2
Household head age				
Average	42.45	44.81	41.75	45.08
Median	40.00	45.00	40.00	45
≤35 %	46.9	53.1	54.3	45.7
36-55 %	33.0	67.0	36.1	63.9
>55 %	38.3	61.7	40.8	59.2
Gender				
Male %	38.3	61.7	43.1	56.9
Female %	32.6	67.4	25.0	75.0
Female education				
Average	8.363	7.967	7.808	7.898
Median	8	8	8	8
Primary(<=5)%	40.2	59.8	55.3	44.7
Secondary (6-10)%	36.2	63.8	42.1	57.9
Graduation (11-14)%	56.2	43.8	66.7	33.3
Higher (>14)%	83.8	16.2	--	---
Annual income				
Average	156314.92	113412.52	125648.48	103280.66
Median	96000.00	96000.00	130125.00	80000.00
Agricultural income				
Average	---	---	195905.67	143279.88
Median	---	---	130125.00	104000.00
Electricity connection				
Not Available	36.5	63.5	37.8	62.2
Available	38.9	61.1	48.5	51.5
Occupational status				
Renters %	37.3	62.7	52.2	47.8
Owners %	38.3	61.7	42.8	57.2

Table A.3: Percentage of food insecurity according to different household groups in KPK

Household characteristics	All households		Farmer households	
	Secure	Insecure	Secure	Insecure
Region				
Urban %	55.5	44.5	---	---
Rural %	55.9	44.1	---	---
Household head education				
Average	10	9.375	9.52	9.40
Median	10	10	10	10
Primary(<=5) %	57.1	42.9	65.8	34.2
Secondary(6-10) %	52.4	47.6	64.8	35.2
Graduation (11-14)%	67.8	32.2	75.7	24.3
Higher (>14) %	82.6	17.4	75.0	25.0
Household head age				
Average	47.44	48.69	49.62	51.06
Median	46	48	50.0	52
≤35 %	63.5	36.5	77.6	22.4
36-55 %	53.6	46.4	63.6	36.4
>55 %	55.1	44.9	63.6	36.4
Gender				
Male %	55.2	44.8	64.8	35.2
Female %	63.1	36.9	76.9	23.1
Female education				
Average	8.231	7.964	7.91	7.96
Median	8	8	8	8
Primary(<=5)%	66.4	33.6	83.3	16.7
Secondary (6-10)%	54.0	46.0	64.9	24.4
Graduation (11-14)%	82.5	17.5	80.0	20.0
Higher (>14)%	91.7	8.3	100	0
Annual income				
Average	137813.63	114881.46	100656.02	103374.197
Median	96000.00	96000.00	71668.00	85000.00
Agricultural income				
Average	---	---	63117.09	50500.58
Median	---	---	34720.00	35410.00
Electricity connection				
Not Available	53.1	46.9	64.4	35.6
Available	56.2	43.8	65.9	34.1
Occupational status				
Renters %	47.2	52.8	60.3	39.7
Owners %	57.6	42.4	66.1	33.9

Table A.4: Percentage of food insecurity according to different household groups in Baluchistan

Household characteristics	All households		Farmer households	
	Secure	Insecure	Secure	Insecure
Region				
Urban %	41.7	58.3	---	---
Rural %	46.6	53.4	---	---
Household head education				
Average	10.19	9.56	9.44	9.66
Median	10	10	10	10
Primary(<=5) %	39.9	60.1	53.7	46.3
Secondary(6-10) %	43.3	56.7	46.9	53.2
Graduation (11-14)%	51.8	48.2	50.0	50.0
Higher (>14) %	66.4	33.6	33.3	66.7
Household head age				
Average	45.63	46.96	49.07	50.43
Median	45	45	50	50
≤35 %	55.8	44.2	56.6	43.4
36-55 %	42.0	58.0	47.9	52.1
>55 %	42.0	58.0	43.1	56.9
Gender				
Male %	45.0	55	47.6	52.4
Female %	10	90	47.6	52.4
Female education				
Average	8.21	8.04	7.91	7.96
Median	8	8	8	8
Primary(<=5)%	40.6	59.4	71.4	28.6
Secondary (6-10)%	44.3	55.7	47.2	52.8
Graduation (11-14)%	75.0	25.0	---	---
Higher (>14)%	58.8	41.2	---	---
Annual income				
Average	13829.74	105101.06	131569.86	94455.00
Median	100000.00	86400.00	100000.00	72200.00
Agricultural income				
Average	---	---	221486.77	150326.21
Median	---	---	144000.00	100000.00
Electricity connection				
Not Available	43.2	56.8	41.0	59.0
Available	45.7	54.3	54.0	46.0
Occupational status				
Renters %	54.1	45.9	44.4	55.6
Owners %	43.9	56.1	47.8	52.2