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Measuring food security:

Definitional sensitivity and implications

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Measuring food security: Definitional sensitivity and implications

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Abstract

Six methods for measuring food security are identified from the literature. The dietary intake method (DIM) and the food insecurity experienced-based measurement scales (FIEMS), the two most commonly used, were empirically tested using 1152 rural households in the Punjab province of Pakistan. Results show significant differences in the measurement of food insecure households: 22.9% with DIM vs. 4.7% with FIEMS. A slight change in the food security definition resulted in significant differences. With slight definitional changes, 6.5% of the sample households appeared food insecure using DIM and only 1.1% using FIEMS. Given its high definitional sensitivity, food security must be carefully defined according to country specific conditions and should reflect local diversity.

Keywords

Food security; hunger; measurement; vulnerability analysis; value at risk; conditional value at risk

Introduction

Today more than 900 million people are food insecure across the world despite the fact that the world food production has doubled during the past three decades (FAO, 2010). It is feared that this figure may rise significantly because of the global demographic pressures like diminishing arable land, growing water scarcity, environmental changes etc. It can be argued that as these pressures become more acute, food prices will rise. For wealthy nations, this will not affect their food security significantly, but in those nations where people live on less than $1 per day, even a minimal price increase can have a devastating impact (Brown, 1998). Recent global price hikes have depicted the same picture in many parts of the world. In response to this increased malnourishment, many world organisations are focusing on food security and poverty reduction.

It was considered important that growth of food production must remain higher than the growth of population (Sinha *et al.*, 1988). The emphasis of the economists remained focussed on assessing food security in terms of supply, agricultural production and the balance of agricultural trade (Romanoff and Commentary, 1992). During 2000-2011, the world

population grew at the rate of 1.34 percent[1] per annum while cereal production, which constitutes 94 percent of total grain production, grew at a rate of 1.76 percent[2] per annum outstripping population growth by nearly half a percent on a global scale. This is a clear indication of an adequate food supply; hence aggregate food supply cannot serve as a useful proxy for food consumption at the household or individual level. From an economic perspective, malnutrition has been increasingly recognized as the individual-level sign of a complex combination of household, community, regional, national, and international factors (Kennedy and Bouis, 1993). The influential work of Sen (1981) on famine has brought attention to the issues of access to food by households. Since then, as an academic subject, food security has received considerable attention from researchers.

Food security has been defined differently by different researchers according to their research agendas. The literature on food security cites more than 190 different studies focusing only on its concept and definition (Maxwell and Frankenberger, 1992). The majority of definitions try to answer five common questions: who should get, when, how, how much, and what kind of food? The measurement of food security remains a debateable issue due to the selection and sequence of these questions (McKeown, 2006). These questions then become the base line for food security measurement and variations in measurement methods. Other important questions that create diversity in measurement methods include: What is the incidence of food insecurity? What are the changes in this incidence over time? What are the factors of food insecurity? What is the causal relationship between these factors and food security? What are the possible effects of food insecurity on human behaviour and health? To answer such questions a number of methods have been used to measure food security. The selection of measurement method depends on the selection of food security definition (Alinovi *et al.*, 2009). As a result, the incidence of food security is reported to be varying to a great extent (Dutta *et al.*, 2006); but how much of this variation is real and how much is due to the choice of measurement method remains to date poorly understood.

This study, therefore, aims to verify the definitional sensitivity of food security measurement. The underlying objectives are:

1. to highlight food security measurement methods used during 1998-2011;
2. to verify the definitional sensitivity of food security for two most commonly used methods; and
3. to expand the debate to concepts of vulnerability

The study was conducted in two stages. In stage one, literature on the subject of household food security was reviewed with an aim to highlight the most commonly used methods with their pros and cons; and in stage two the two most commonly used methods were put to the test for definitional sensitivity in Pakistan. The rest of the paper is organised as follows: section 2 presents the methodology; section 3 presents and discusses the results of both stages; and section 4 concludes the discussion.

[1] World population in 2000 = 6.1 billion | World population in 2011 = 7.0 billion (source: WPC, 2011)
[2] World cereal production in 2001/02 = 1908.1 million tonnes | World cereal production in 2010/11 = 2245.0 million tonnes (Source: FAO, 2011)

Methods

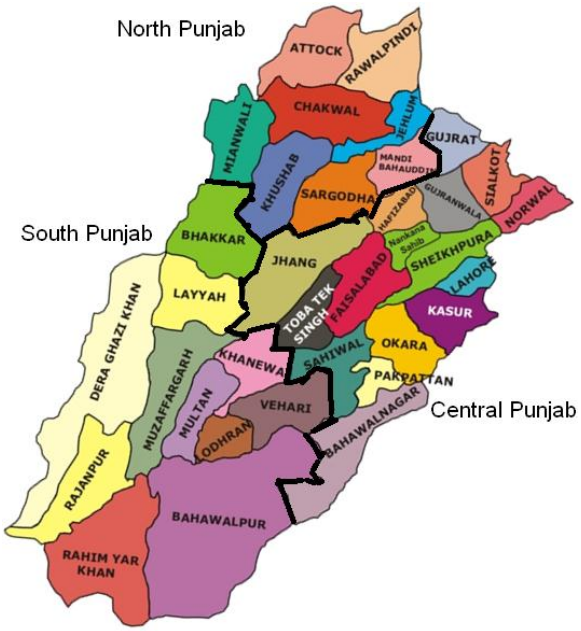
Stage I: Review of Methodology

Meta-analysis is the most common method used to review the existing literature. This method usually provides the syntheses and comparative analyses of existing literature on a specific topic (Zhao, 1991). This study uses the same method but does not synthesize the results of different studies. It simply reviews the measurement methods used for measuring food security in different parts of the world. It synthesizes the pros and cons of each method and identifies the most common methods. For this purpose, we randomly selected 25 studies from around the world covering the period from 1998 to 2011. This may not be a representative sample, but even if it is biased it does not matter. We do not want a complete variability but some. All these studies differed by their research questions, which sprang from the definition of food security most adequate to the need, scale and geographical location of the study.

Stage II: Data Collection for Food Security Measurement

The food security situation was measured using the two most common methods identified by the meta-analysis. For this purpose the data were collected from the Punjab province of Pakistan. The province comprises 36 districts and can be sub-divided into 3 sub-regions on the geographical characteristics of the districts. The districts with desert or semi-desert characteristics situated in the southern part were named South Punjab. Those having characteristics of plains and situated in the central region were called Central Punjab; and those situated at 300 to 900 meters above sea level and situated in the northernmost region of the province were termed North Punjab.

Figure 1. Formation of sub-regions



One third of the total districts were considered to be a sufficiently representative sample of the districts. A pro-rata number of districts were selected from each sub-region because they were not symmetrical in terms of district numbers. Three districts each from South and North and 6 districts from Centre were selected on the basis of homogeneity of their attributes, e.g. total population, total number of villages, irrigated and non irrigated land areas, per capita and per acre wheat production. From every district, six villages were randomly selected, and from each village eight small farmers and eight landless households were randomly selected. The

total sample size thus numbered 1152 households. A comprehensive interview schedule was used to record the data from each household.

Results and Discussion

Stage I: Food Security Measurement Methods

Out of the twenty-five selected studies, ten applied Dietary Intake Assessment (DIA) , eight used Food Insecurity Experience-based Measurement Scales (FIEMS), three applied Anthropometry, three applied Household Expenditure Survey Method (HESM), 1 applied FAO Method and 1 used Rapid Rural Appraisal (RRA) approach. Table 1 shows these studies and the countries where they were carried out, together with the measurement method used. The pros and cons of these methods are discussed below.

Table 1. Food security measurement methods used worldwide

Sr. #	Studies	Country	Measurement Method
1	Gittelsohn *et al.*, 1998	Nepal	Anthropometry
2	Lorenzana and Sanjur, 1999	Venezuela	DIA*
3	Sharif and Merlin, 2001	Indonesia	Anthropometry
4	Rose and Charlton, 2001	S. Africa	HESM**
5	Rainville and Brink, 2001	Canada	FIEMS***
6	Che and Chen, 2002	Canada	FIEMS***
7	Feleke *et al.* 2005	Ethiopia	DIA*
8	Haile *et al.*, 2005	Ethiopia	DIA*
9	Kabbani and Wehelie, 2005	Yemen	FIEMS***
10	Ajani *et al.*, 2006	Nigeria	FIEMS***
11	Amaza *et al.*, 2006	Nigeria	HESM** (Cost of Calories)
12	Mariara *et al.*, 2006	Kenya	Anthropometry
13	Nolen *et al.*, 2006	Australia	FIEMS***
14	Onianwa and Wheelock, 2006	USA	FIEMS***
15	Babatunde *et al.*, 2007	Nigeria	DIA*
16	Omotesho *et al.*, 2007	Nigeria	DIA*
17	Titus and Adetokubo, 2007	Nigeria	HESM**
18	Gyawali and Ekasingh, 2008	Nepal	DIA*
19	Nzomoi, 2008	Kenya	FIEMS***
20	Sindhu *et al.*, 2008	India	DIA*
21	Alinovi *et al.*, 2009	Palestine	The FAO Method
22	Oluwatayo, 2009	Nigeria	DIA*
23	Bashir *et al.*, 2010	Pakistan	DIA*
24	Abebaw *et al.*, 2010	Ethiopia	DIA*
25	Miller *et al.*, 2011	Malawi	RRA ****(Food Diversity Scores)

* = Dietary Intake Assessment | ** = Household Expenditure Survey Method | *** = Food Insecurity Experience-based Measurement Scales | **** = Rapid Rural Appraisal

a. The Food and Agricultural Organization (FAO) Method

This method focuses on the estimation of dietary energy consumption on a per-capita basis at the country level. The calculation of per capita energy consumption (calories) is through the food balance sheets used in the household income and expenditure surveys. The proportion of undernourished population is defined as that part of the distribution lying below a minimum energy requirement level. This minimum calories intake is further adjusted for the sex and age distribution of the country's population assuming the minimum acceptable body weight for a

given height for all sex-age groups and activity levels for adults (FAO, 2003). The advantages of this method are:

- secondary data are available for most of the countries;
- due to frequently updated estimates it is possible to examine and compare global food security trends at national, regional, and global levels; and
- the method is reasonably inexpensive.

On the other hand this method has some limitations including;

- the quality of diet is overlooked,
- it is assumed that calorie consumption above minimum calorie threshold indicates food security, hence does not account for the obesity problem due to excessive calorie consumption, and
- high degree of measurement errors because of the fact that balance sheets provide data on the available amount of calories, not the consumed ones (Pérez-Escamilla and Segall-Corrêa, 2008).

b. Household Expenditure Survey Method (HESM)

This method is a direct method to obtain information from the households. The respondents are required to provide information about their expenditures on food and other necessities (Bickel *et al.*, 2000) especially the information about the amount of money they spend on the purchase of basic and nutritionally adequate diet (Rose and Charlton, 2001). For this, different time references have been used i.e. week(s) or month(s). To obtain quality data, it requires getting information about the quantity of food bought and expenditures on different food types (items) consumed within and outside the house. The tool must also capture the information foods received as gift or aid by any household member and self grown foods. This method estimates an average daily per capita calories consumed, adjusting for the access to culturally appropriate food. The advantages of this method include;

- flexibility for the vulnerable household identification that allows mapping the determinants both at local and national levels
- dietary quality data can help understand the food security dimensions (Rose and Charlton, 2001); and
- it can be used for the evaluation of national food and nutrition programs (Rose and Charlton, 2001)

Like FAO method, HESM also has some limitations as:

- this method measures the available amount of food and ignores the consumed amount at a given timeframe;
- it does not account for the amount of food consumed outside the household e.g. food consumed when visiting the relatives and friends;
- difference of data collection methods worldwide make it difficult to compare the estimates across countries, regions and different purchasing power parities; and
- conversion of available food to the calorie intakes involves major assumptions that can cause measurement errors (Pérez-Escamilla and Segall-Corrêa, 2008).

c. Dietary Intake Assessment (DIA)

Dietary intake assessment is usually carried out using different techniques: the recall method (24-hour or 7 days or 30 days), food frequency questionnaires, and food records (individually or by an observer). These techniques are widely used for food security assessment studies (Jenson and Miller, 2010). Some of the techniques rely on participants' memory e.g. the recalls and food frequency questionnaire, while the food records depend on the recording of food consumption data. The estimations rely on respondents' memory or alternatively weighted values can be used for foods before and after consumption. These adjusted estimations are done to estimate the nutrient intakes. Compared to FAO and HESM methods this method has some unique features. The common advantages:

- it measures food consumption directly, not the food availability;
- it addresses both dietary quality and calorie intakes at individual levels;
- it allows mapping; and
- it is very useful to understand recent and longer term dietary intake patterns.

Limitations of this method include:

- most of the DIA methods rely heavily upon respondents' memory that can lead to measurement errors;
- the assessment of adjusted recall estimations is a very difficult task that may lead to high measurement errors;
- the cost of applying recall methods in national survey is high; and
- it needs highly trained and experienced researchers to interview the respondents and later to enter the data into spreadsheets (Pérez-Escamilla and Segall-Corrêa, 2008).

d. Anthropometry

Anthropometry is a method that uses the measurement of individual human characteristics. The generalized information is collected on the areas of food provisioning, preparation, and consumption practices according to the cultural settings of the study areas (Gittelsohn *et al.*, 1998). More recently the information gathering has been extended to the body size, weight, body proportions and finally the composition of food (Wolfe *et al.*, 2000). These indicators are useful to measure the impacts of both food security and health on individuals' nutritional status. These indicators are commonly used in national surveys that are based on weight and height of infants, young children, youth and adults. This method involves in-depth interviews and participant observation, generally that are done by living in a community for a longer period of time (Wolfe *et al.*, 2000). This method is useful to develop quantitative measures to identify the food security indicators (Chung *et al.*, 1997). This method is also useful for constructing scales of past food supply, current food stores, and adequacy of future food supply (Gittelsohn *et al.*, 1998). The benefits of this method are:

- the highly standardized measurements of weight and height are vastly reproducible across individuals; and
- it allows for mapping nutritional security from the local to the national levels.

The drawbacks of this approach include:

- costly both monetarily and time wise; and

- these indicators measure nutritional status that results from the interaction of food security and health status, hence is an indirect method to measure food security (Pérez-Escamilla and Segall-Corrêa, 2008).

e. Food Insecurity Experience-based Measurement Scales (FIEMS)

This method is based on the perception or experience reported by the respondents. The extent of severity is based on a series of questions, a number of which rely on qualitative and subjective assessments (Rose and Charlton, 2001). Like other methods discussed above this method also has some advantages and limitations. The advantages include:

- this method measures directly the phenomenon of food security based on the experiences of individuals;
- it captures psychosocial dimensions of food security along with the physical experience;
- it can be used for mapping that leads to a better understanding of causes and consequences of food insecurity and hunger; and

While the limitations are:

- difficult to generalize them for different cultures, globally (Rose and Charlton, 2001; Pérez-Escamilla and Segall-Corrêa, 2008);
- these scales do not have questions on issues related to water access, and food and water safety hazards caused by microbial and other environmental contaminants;
- it is a difficult task to establish cut-off points for classifying households into different levels of food insecurity; and
- these scales may lose their validity if used for determining eligibility into food and social assistance programs (Pérez-Escamilla and Segall-Corrêa, 2008).

f. Rapid Rural Appraisal (RRA)

Food security status can be measured by using the rapid rural appraisal (RRA). This approach is similar to participatory rural appraisal (PRA) but it is more action-oriented. It includes focus groups and in-depth interviews. The information collected through RRA is useful to develop quantitative measures for food security status determination (Wolfe, *et al.*, 2000). This can be done through using; livelihood security (Davies, 1996), expert systems (Phillips and Taylor, 1998), food economy approach (Boudreau, 1999), food security ranking (Gervais and Schoonmaker, 1999), and food-related management and coping strategies (Maxwell *et al.*, 1999).

Stage II: Analytical Results of DIA vs FIEMS using data from the Punjab, Pakistan

The results of both methods identified by meta-analysis, DIA and FIEMS, are presented in this section. They were tested for definitional sensitivity of food security. The DIA uses a quantitative definition of food security, i.e. a household whose food intake (calorie intake) is equal to or greater than a certain threshold level defining food security. On the other hand, FIEMS is based on a qualitative definition of food security, e.g. if the members of a household do not skip any meal in a given time period they are considered as food secure. Furthermore, two definitions of food security for each method were tested and the results confirm great variations (Table 2). For DIA, two different threshold levels were considered: first, the Government of Pakistan's (GOP) threshold level defined for rural areas as 2450 Kcal/person/day (GOP, 2003); and second, FAO's threshold level for Pakistan, i.e. 1770 Kcal/person/day (FAO, 2007). Similarly, two different definitions were chosen for FIEMS: first, a household is considered food insecure if any of its members skipped a meal during the

last three months (preceding the date of interview); and second, a household is considered food insecure if any of its members skipped a meal during the last seven days (preceding the date of interview).

Table 2. Comparative analysis of rural household food security using different methods

Method	Definition	Food insecure (%)	Food secure (%)	Total (%)
DIA	GOP (<2450 Kcal/person/day)	22.9	77.1	100
	FAO (<1770 Kcal/person/day)	6.5	93.5	100
FIEMS	Once in 3 months	4.7	95.3	100
	Once a week	1.1	98.9	100

Data source: Field survey, 2010-11

Table 2 shows that, using GOP's DIA threshold level, about 23% of the sample households were measured to be food insecure, while the proportion of food insecure households was significantly reduced to 6.5% when using FAO's threshold level of 1770 Kcal/per/day. On the other hand, using the definition i.e. skipped meal once in 3 months for FIEMS, only 4.7% of the sample households were measured to be food insecure. The number of food insecure households was reduced to 1.1% when used the definition i.e. skipped meal once a week. This shows a significant difference in the results of food security measurement using two different methods. Further, the results are significantly different when changing the definition within a single method. This implies that food security measurement is sensitive to both the selection of measurement method and definitional changes within that method. It is, therefore, important to first define food security at the local level, and use that as the starting point for any future studies on food security.

The results of DIA are more promising compared to FIEMS in reflecting the ground realties because they are in line with FAO's statistics, i.e. 26% of Pakistan's population is undernourished (FAO, 2010). This is because of the cultural behaviour of the people who in most of the cases avoid skipping a meal and / or avoid reporting it during interviews. A common response for such questions was:

> "*Gentleman, you know, why we strive all day long working hard in our fields or in others' fields or in towns?"* They answered this question themselves that *"just to fill in our family's stomachs."*

It implies that for countries like Pakistan quantitative methods to measure food security yield better representation of ground realities compared to the qualitative methods. It is, therefore, important to know the local socio-economic culture before selecting a measurement method.

Definitional Sensitivity of DIA and Vulnerability Analysis

As explained above, the use of the DIA method is a better choice than FIEMS for Pakistan. The sensitivity of the results to changes in definitions is not a healthy sign for a true representation of ground realities. DIA is criticised on different grounds. For instance: first, it measures calorie sufficiency and nutrient adequacy, but it does not assess the components of un-certainty, un-acceptability, un-sustainability (Wolfe *et al.*, 2000) and vulnerability (Haddad *et al.*, 1994); second, there is no consensus on the thresholds needed for subsistence and any of the recommended thresholds would vary significantly across individuals, their jobs and geographical locations (altitudes, climate, etc.); and third, it does not account for the substitution effect of income for simple vs. tasty foods (Jensen and Miller, 2010).

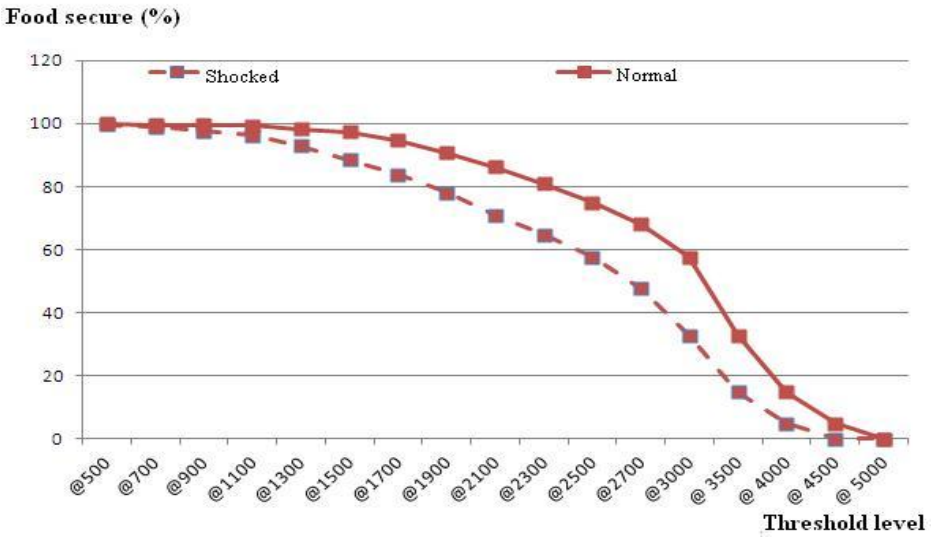
The response to these criticisms depends on two factors: firstly, the question that needs to be answered; and secondly, the available funds to conduct the assessment. Ideally, the food security measurement method should incorporate the principles of more than one of the methods discussed above. In this way, different dimensions (especially un-certainty, un-

acceptability, un-sustainability and vulnerability issues) of food security can be addressed in the same assessment method (Pérez-Escamilla and Segall-Corrêa, 2008).

The focus of this paper is on the definitional sensitivity of food security within the same method, i.e. sensitivity to threshold levels. This study looks beyond threshold levels and discusses the possibility of measuring food security without without being bound by a threshold level. Figure 2 shows the sensitivity of food security to definitional changes using the DIA method. In normal times, almost 100% of households are defined as food secure up to the threshold level of 1100 Kcal/person/day. From here onwards the ratio of food secure households starts declining and eventually hits zero at the threshold level of 5000 Kcal/person/day. The dotted line, however, represents the situation under a possible shock (e.g. flood, drought, etc.) due to which the average intake level may fall by 500 Kcal/person/day. The assumption of a reduction in food intake is based on the fact that the sample households are small farmers (cultivating up to only 5 acres of land) and landless rural households belonging to the lowest income group. For them, even a slight drought or an excessive downpour may endanger their food security. If this happens and these households are forced to reduce their intake by 500Kcal/person/day, the situation will become more difficult for them.

In either case, governments' prime objective is to keep the food insecurity level reasonably low depending upon their resources. In such situations the governments can either reduce the threshold level to keep the records looking good or try to do something for real. For the second option, one needs a good knowledge of ground realities. This can be achieved by keeping the record (data) over time for the same households and/ or by comparing them across regions.

Figure 2. Food security in the Punjab for different threshold levels

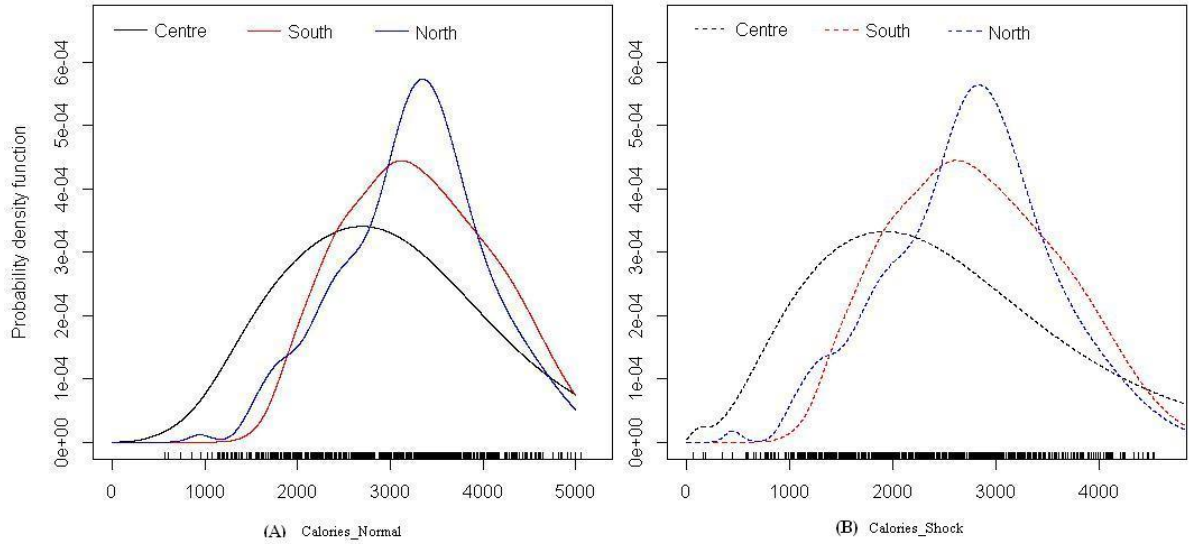


Data source: Field survey, 2010-11

Because of time limitations, the current study collected data for only one time period, so food security among different regions can be compared. For this purpose histograms are used to have a better look at the distribution of households according to calorie intake. Figure 3 compares the situation in the three subregions of the Punjab. The situation in South and North is somewhat similar in terms of the tails of the curves, but significantly different in their peaks. Both these subregions are less food insecure compared to Centre. Under the shocked conditions again the central Punjab is the most affected region while the situation is somewhat similar to normal conditions in the other two regions. The right hand side of Figure 3

represents the situation after a possible shock due to which households are forced to reduce their intake by 500 Kcal/person/day. The central Punjab region will be the most affected one compared to South and North Punjab which remained almost unchanged.

Figure 3. Food security in three subregions of the Punjab



Data source: Field survey, 2010-11

The histograms represent the distribution of households according to their calorie intakes. It is, therefore, essential to identify the households who are more *at risk* of suffering in the future along with the identification of current incidence of an inadequate nutritional status of households. For this purpose it is important to test households for possible risks of becoming food insecure in the future, i.e. carry out a vulnerability analysis. The concept of vulnerability in the food security literature is relatively new and few researchers have as yet focused on this aspect (Ellis, 2003). It has been used in the poverty and famine literature for a long time; however, interpretation of results has remained uncertain (Ellis, 2003). Vulnerability, by definition, is itself a debatable concept, but this is beyond the scope of this paper. The most relevant methodology for the measurement of food insecurity vulnerability is the Value-at-Risk (VaR) analysis. It is widely used for risk assessment by financial and banking institutions to measure the risk associated with an investment and liability situations. VaR is flexible enough to be employed effectively both for measuring and for managing risks. VaR allows us to estimate the probability that a particular household might fall into the food insecure category with a 90, 95 or 99 percent confidence level. It can also be used to identify and assess the strategies that can prevent food insecurity (Scaramozzino, 2006). Conditional value at risk (CVaR), on the other hand, measures extreme risk values: for example, CVaR is the average of the 5% worst cases in the VaR at 95 percent confidence level (Allen and Powell, 2007).

For a complete vulnerability analysis, Scaramozzino (2006) suggests the use of a critical threshold level along with a longitudinal data containing both time series and cross-sectional data. In this study we suggest measuring vulnerability without fixing a threshold level and, due to limited data, we apply VaR to only the cross-sectional data with three different regions, assuming that vulnerability can be measured over time or across regions. Table 3 presents the results of VaR and CVaR for the three regions of the Punjab province of Pakistan for confidence levels ranging from 99 to 75 percent.

According to Table 3, Central Punjab is the most at risk of being a food insecure region: the *lowest* 1 percent of the sample households was only able to consume 802 Kcal/person/day.

These households are at risk of losing another 178 Kcal/person/day. Given the threshold level defined by the Government of Pakistan for rural areas (2450 Kcal/person/day), more than 25 percent of Central Punjab households not only are food insecure (2081 Kcal) but also are vulnerable to seeing their intake fall to 1571 Kcal/person/day, which is only two-thirds of the official GOP threshold. On the other hand, the situation in South and North Punjab is comparatively better than the Central region, where at least 15 percent of the sample household not only are food insecure (2393 and 2394 Kcal/peson/day respectively), but are vulnerable to seeing their food consumption fall to 1979 and 2093 Kcal/person/day, respectively.

Table 3. Calorie intake vulnerability percentiles

CL ➔	99%		95%		90%		85%		80%		75%	
Method ➔	VaR	CVaR	VaR	CVaR	VaR	CVaR	VaR	CVaR	VaR	CVaR	VaR	CVaR
Center	802	624	1251	980	1530	1190	1739	1340	1918	1463	2081	1571
	(386)	(232)	(774)	(540)	(1021)	(723)	(1213)	(856)	(1380)	(966)	(1535)	(1065)
South	1714	1591	2019	1832	2180	1982	2393	1979	2536	2186	2668	2270
	(1234)	(1116)	(1529)	(1348)	(1739)	(1494)	(1902)	(1604)	(2045)	(1697)	(2178)	(1780)
North	1440	1235	1871	1610	2230	1821	2394	2093	2573	2106	2734	2216
	(1004)	(761)	(1376)	(1123)	(1688)	(1333)	(1900)	(1488)	(2078)	(1614)	(2239)	(1723)

CL = confidence level

Figures in parenthesis are intakes after a possible shock as described in Figures 1 and 2

Under a possible shock (figures in parenthesis of Table 3) , the situation in Central Punjab will become more difficult for these households compared to South and North Punjab residents. Under such circumstances the lowest 1 percent of the sample households will be consuming 386 Kcal/person/day with a risk to further reduce it to 232 Kcal/person/day in Central Punjab. This is alarming and points to a possible risk of famine or near famine conditions for these households. On the other hand, the lowest 1 percent of the sample households in South and North Punjab will be consuming 1234 and 1004 Kcal/person/day, respectively, with a risk to further reduce the intakes to 1116 and 761 Kcal/person/day, but these are also insufficient to sustain a healthy life.

Conclusion

The selection of measurement method is strictly dependent on the definition of food security and on the socio-geographical specifics of the study area. The measurement method can change by varying the underlying assumptions of the definition of the problem. Other major factors affecting method selection are the available budget and the scale and scope of the study. Depending upon the importance and multifaceted nature of the problem, it is recommended to generate a tool by mixing the principles of more than one of the six methods discussed in this paper. By doing so, the researchers will be able to incorporate key aspects of the problem of food insecurity.

From the above discussion it can be concluded that a complete measurement of food security cannot be restrained to any single indicator or method. To determine food security at the household level, information on a range of conditions, experiences, and behaviours must be used to assess the severity of the situation (Bickel *et al.*, 2000). For the development of, or the use of, existing food security measurement methods, it is necessary that one gets an in-depth understanding of food security conditions. This will help to make comparisons (Frongillo, 1999).

The VaR and CVaR results suggest that in Central Punjab all the lowest 6 percentiles (i.e. from 1 to 25 percent) are food insecure and are at risk to a further fall in their food consumption to values ranging from as low as 624 to 1065 Kcal/person/day. In South and North Punjab the first 5 percentiles (i.e. 1 to 15 percent) are food insecure, with a risk of a further fall in their food intake to values ranging from 1234 to 1604 Kcal/person/day in the South, and 1004 to 1488 Kcal/person/day in the North. The Central region is found to be more food insecure and at risk of becoming a severely food insecure region. Though food insecurity is high in South and North subregions, they are in comparatively better position than Central Punjab.

Several important points for researchers can be drawn from this analysis. In particular:

1. The careful selection of measurement method is an important step in measuring the correct food security situation, which is entirely dependent on the socio-geographical circumstances of the study areas;
2. The selection of a correct threshold level is also very important and must reflect the socio-geographical circumstances of the study areas;
3. No single measurement method can yield satisfactory results for measuring a complex food security scenario;
4. To achieve the above three, a complete knowledge of the basic principles of all the measurement methods mentioned in this study, as well as of the socio-geographical circumstances of the regions under study, are necessary for any serious food security study;
5. The vulnerability analysis must be carried out at national level with more information on food consumption and household characteristics, over time and across different regions of the country; and
6. The results point to a dangerous situation in Pakistan that must be taken care of on an emergency basis. It is recommended that without further delay a food security information and early warning system (FSIEWS) must be initiated under the guidance of the FAO (2000).

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