Use of household food insecurity scales for assessing poverty in Bangladesh and Uganda

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Abstract

An important dimension of poverty is access to food. Household food security implies access to the food needed for a healthy and productive life. Lack of access to and/or impaired utilization of food contribute to household food insecurity. This study compares the utility of a standardized food security scale for determining the food insecurity status of rural and urban households in Bangladesh and Uganda and for predicting poverty status. The analysis uses data from the IRIS Composite Survey Household Questionnaire (2004), which consists of 1,587 households (approximately 800 households in each country). The coping mechanisms adopted in the presence of food shortage represent the building blocks for development of the scale (7 items). In order to assess the suitability of the scale as an estimator of the households' poverty status, the benchmark indicator "daily expenditures per capita" and its relation to the corresponding poverty line serves as the basis for evaluation on each country. The scale provides the means for classifying the households into 3 main groups: Non Food Insecure, Moderately Food Insecure, and Severely Food Insecure. The reliability of the scale is measured via the Cronbach's Alpha statistic. In addition, the scale is used in regression analysis in order to predict per capita daily expenditures and the poverty incidence. The results show that food insecurity does not always reflect (income) poverty. However, the use of the scale as predictor of poverty status produces rough estimates of poverty incidence that could be useful as background information. The differentiation of households according to their food security status may be valuable for focusing and developing improved food insecurity mitigation strategies.

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I. Introduction

An important dimension of poverty is access to food. Household food security is defined as the "access by all people at all times to enough food for an active, healthy life. Food security includes at a minimum: the ready availability of nutritionally adequate and safe foods, and an assured ability to acquire acceptable foods in socially acceptable ways" (Keenan et al, 2001 after Anderson, 1990). Consequently, food insecurity represents the inability to fulfil such conditions. The most evident sign of food insecurity is the prevalence of hunger. This study explores the households' responses to a limited food access given by the lack of monetary resources for buying food in a time frame of 12 months. A food insecurity scale that measures the occurrence and severity of food insecurity is used for the analysis.

The US Agency for International Development (USAID) has among its mandates, the development and certification of poverty assessment tools. In 2004, the IRIS Center of the University of Maryland together with the USAID Microenterprise Development Division, initiated the development of such tools for a number of countries. The tools seek to incorporate and test poverty related indicators as used by practitioners in their poverty assessment and targeting schemes all around the world, as well as conventional indicators for assessing poverty, such as the level of expenditures (Zeller, 2004). By 2007, 17 country tools had been developed and certified (IRIS Center, 2007). This work focuses on two of those countries[2] - Bangladesh and Uganda - and takes as point of reference one practitioner tool: Freedom from Hunger's food security scale.

The two countries present very different conditions and backgrounds, situation that is convenient for testing the food insecurity scale under dissimilar settings. According to Ahmed and del Ninno (2002), from the total population (80 % rural) in Bangladesh, approximately half of them cannot afford an adequate and nutritive diet. In support to the affected families, the government has launched a Food for Education program which provides food conditional to school attendance.

By 1999 around 41% of the Ugandan population was considered as food insecure. It was observed that the rural areas were specially affected (with 89 % of the population living there) and that among the most important causes of their food insecurity were weather related problems that affected their agricultural production, and crop and land management. The government helps farmers to overcome these problems by offering extension programs and by supporting the agricultural production through the Plan for Modernization of Agriculture (Bahiigwa, 1999).

The objective of this analysis is to evaluate the performance of a standardized food security scale for determining the extent of food insecurity of rural and urban households in Bangladesh and Uganda; and to examine its suitability as a predictor of poverty status.

The structure of this document is the following: section II briefly presents the literature review on the topics of food security, scale theory, and the food security scale used by

[2] Data is available

Freedom from Hunger. Section III describes the methodology used for constructing and evaluating a food security scale, as well as its use as a predictor of poverty status. Section IV presents the empirical results and finally, section V presents the conclusions of the analysis.

II. Literature review

Food security

Different elements contribute to food (in)security, namely, the continued access to food, the availability and consumption of nutritive food, and the importance of social values. The emphasis on each of these elements leads to the measurement of the extent and prevalence food (in)security in alternative ways.

The indicators typically used for measuring food (in)security can be classified in 2 main groups, namely "process" indicators and "outcome" indicators (Hoddinott, 1999 after Maxwell and Frankenberger, 1992). While process indicators focus on food supply and food accessibility, outcome indicators focus on food consumption. As outcome indicators can be directly related to the households' actual food consumption, they seem better suited for assessing food insecurity at the household level. Several methods are available for measuring food security outcomes[3]. This work focuses on indices of household coping strategies.

The indices of household coping strategies measure how the households respond to the presence of food scarcity. The index can be calculated in several ways, namely by counting the number of different coping strategies, or by assigning weights to the different strategies. This method of food insecurity assessment is easy to implement and captures the sense of vulnerability from the household, however, it is subjective as each household may perceive different situations for what is meant by the questions thus difficulting objective comparisons.

Scale theory

A scale can be defined as an instrument of data collection and measurement, where measurement refers to the assignment of numbers to objects or events according to pre-defined rules (Dawis, 2000). The scale score is derived based on the numbers assigned.

Scales can be used in very different applications, however, when we are interested in measuring variables that can not be observed directly such as needs, attitudes, or preferences, we must infer their value based on the behaviour of the individuals. These variables are referred then as theoretical constructions (or "constructs") that are defined and shaped by the methods used to measure them. For this reason, it is important to make a distinction of the purpose of the scale, being either the representation of a theoretic concept, or the prediction of a certain condition.

Irrespective of the scale's purpose, its construction can involve one or multiple indicators (or "items"). Hence, a clear description and definition of the construct or variable to be measured is needed as this will guide the selection of items.

When designing a scale it is important to keep in mind its expected internal structure or consistency and its external validity because this will influence the items' selection. Internal consistency relates to how well the items correlate with the total score and measure the same underlying construct. External validity refers to how well the scale relates to other variables

[3] Hoddinott (1999) presents different methods for assessing food insecurity using outcome indicators.

that are known to be related to such construct. In most situations, there is a trade off between internal consistency and external validity because the incorporation of items that may increase the scale's relation to other variables may tend to decrease its internal consistency, and in the other way round, the incorporation of items that are highly intercorrelated will decrease the ability of the scale to correlate with external variables. This phenomenon is commonly referred as the "attenuation paradox" (Dawis, 2000).

Scales are usually evaluated in 3 ways, namely by their multidimensionality, their internal consistency, and their external validity.

Multidimensionality
It is important to evaluate if the items used measure the same underlying construct. If the scale presents items measuring different constructs it is considered as multidimensional and its internal consistency will be lower. Factor analysis allows us to evaluate if the items behave in a one-dimensional or multidimensional way. In order to correct for multidimensionality, it is necessary to create *n* subscales according the number of dimensions encountered. However, it is important to note that a subscale should have a minimum of 3 items (Dawis, 2000).

Internal consistency
The internal structure of a scale can be assessed by correlating the items with the total score. As well, the reliability measure of Cronbach alpha[4] provides a mean for assessing consistency based on a single statistic. Theory suggests a minimum alpha statistic of 0.7 for a scale to be considered as consistent. This level can be achieved by the incorporation of 4 or 5 items (Dawis, 2000).

External Validity
In many applications, it is required to relate and compare the scale to other external variables that theory or practice says should be highly correlated with the scale's underlying construct. Validity is then assessed by evaluating the correlation of the scale with these variables.

Freedom from Hunger's scale

Freedom from Hunger (FFH) is an international development organization whose mission is to fight against chronic hunger and poverty. Currently, FFH works in 17 countries where since 1970, Applied Nutrition programs, Integrated Microcredit Health, Nutrition and Education programs, and Credit with Education programs have been implemented (FFH, 2006).

In the past years, FFH worked on developing a food security scale (FSS) for assessing the food security status of its clients. Their scale was developed as an adaptation and modification of the United State's (USDA) FSS, which was developed in the early 1990's. The scale is designed to capture various levels of severity on food insecurity. Each of these levels is assumed to show particular conditions, experiences and behaviours that the adult household members face when food insecure, such as anxiety, perceptions about food quantity and quality, and adjustments to normal food intake. Through the scale it is possible to measure the changes on households' food security over time. FFH's scale incorporates 17 items that account for a maximum scale score of 9 points (Melgar-Quiñonez, 2004).

[4] The alpha statistic indicates the extent to which the items measure the same underlying construct. The statistic is calculated based on the number of items tested and the intercorrelation among them. It takes values up to 1. The closer the alpha value to one, the higher the inter-item correlation and therefore, the more reliable the scale.

The scale used in this study is a short version of FFH's scale and focuses on coping strategies performed by the adult household members in face of food stress.

III. Methodology

Scale construction

The USDA's scale is composed by 18 items which refer to children and adult food insecurity. The final scale score is imputed by considering the presence or absence of children within the household and the total household's raw score. The FFH's scale considers only adults and therefore, a differentiation between households with and without children is not performed when calculating and analyzing the household's total score.

The scale created for this study closely follows FFH's scale, but includes only 10 items. Due to data availability, it was not possible to reproduce FFH's scale on its entirety; therefore the direct comparison of our results with FFH's food security scores and food security assessments may result inappropriate. Nevertheless, the scale does provide an insight into the food security status of the households in the 2 countries and the performance of a food security scale based on the type of items used.

The analysis uses data from the IRIS Composite Survey Household Questionnaire (2004) from 1,587 households. The total number of households under analysis was 799 in Bangladesh and 788 households in Uganda. General details about the IRIS project and specific information about the sampling frame used on each country can be found in Zeller and Alcaraz V. (2005) and Zeller, Alcaraz V., and Johannsen (2005).

Specifically, Module E from the IRIS questionnaire includes the items used for our scale[5]. In order to construct it, we combined the results from the indicator and frequency variables into one single binary item (see Table 1). After all items were evaluated for all households, the final score was obtained by adding up their scores. We produced 7 binary items, so the maximum score that can be achieved by a household is 7 points.

The scale was designed to picture an increasing severity on the food insecurity status. The classification into the 3 food insecurity groups was done according to the following criteria:

- Total score of 0 or 1 meant a Non Food Insecure (NFI) household
- Total score of 2, 3 or 4 meant a Moderately Food Insecure (MFI) household
- Total score larger than 5 meant a Severely Food Insecure (SFI) household

Scale evaluation

The scales were evaluated in 3 ways: multidimensionality, internal consistency (reliability), and external validity.

Multidimensionality

Factor analysis was used to evaluate whether the food security scale is multidimensional or not.

[5] Specifically, we used questions E9, E10, E11, E13 A-B-C-D, and E14.

Internal consistency
The scale's consistency was assessed by correlating the individual items with the total scale score. As well, the reliability statistic Cronbach alpha was calculated.

External Validity
This paper explored the scale's validity via correlation analysis of the total score with other food security related indicators, such as food expenditures per capita and the frequency of consumption of selected food items.

Prediction of poverty status

Being food insecurity one of the most important dimensions and expressions of poverty, it is important to evaluate the extent to which a measure of food insecurity could also be a good and reliable poverty assessment tool.

The scale's adequacy as predictor of poverty status was tested using regression analysis, where the benchmark indicator of daily expenditures per capita served as dependent variable. The models were evaluated by their ability to predict expenditures to fall below or above the corresponding poverty line in each country[6]. As well, a "best"score cut-off was selected based on its accuracy performance.

Following Zeller and Alcaraz V. (2005) and Zeller, Alcaraz V., and Johannsen (2005), the regression models were evaluated according to the alternative measures:

- Total Accuracy: proportion of households whose poverty status is correctly predicted
- Poverty Accuracy: proportion of poor households with a correctly predicted status
- Non-Poverty Accuracy: proportion of non poor households with a correctly predicted status
- Undercoverage: error of predicting poor households as non poor
- Leakage: error of predicting non poor households as poor
- Poverty Incidence Error (PIE): actual minus predicted poverty incidence
- Balanced Poverty Accuracy Criterion (BPAC): poverty accuracy minus the absolute difference between undercoverage and leakage.

Further comments about these measures can be found in the above mentioned references.

IV. Results and discussion

Scale construction

As discussed, we constructed our scale based on 10 items/questions. Table 1 presents the questions used and their corresponding conversion into the binary items. The ordering of the questions in the questionnaire was intended to reflect an increasing severity on food insecurity and therefore, this order was kept when calculating the final scale score. The scale was identical for both countries.

[6] The poverty lines used in both countries reflect 1dollar a day in PPP adjusted for 2004. More about the derivation and selection of the poverty line see Zeller and Alcaraz V. (2005) and Zeller, Alcaraz V., and Johannsen (2005).

Table 1. Scale construction

Item	***Criteria***
ITEM 1	Binary item
What best describes the food consumed in the household during the past 12 months. (due to lack of money to buy food) 1=Always enough of what wanted 2=Enough but not always what wanted 3=Sometimes not enough food 4=Often not enough food	1 = 0 2 - 4 = 1
ITEM 2	
In past 12 months were you and your household members worried that your food would run out before you had money to buy more? 1=Yes 0=No *No follow up question on frequency	No = 0 Yes = 1
ITEM 3	
In past 12 months did you have to eat the same food daily because you did not have money to buy other food? 1=Yes 0=No *No follow up question on frequency	No = 0 Yes = 1
ITEM 4	
In the past 12 months have you or any other adult in your household eaten less food than you wanted to because you did not have enough money to buy food? 1=Yes 0=No How often? 1=More than half the time 2=Less than half the time but more than 30 days 3=Less than 30 days but more than 10 days 4=Less than 10 days	4 and 0 = 0 1-3 = 1
ITEM 5	
Did you or another adult in your household skip meals during the past 12 months because you did not have enough money to buy food? 1=Yes 0=No How often? 1=More than half the time 2=Less than half the time but more than 30 days 3=Less than 30 days but more than 10 days 4=Less than 10 days	4 and 0 = 0 1-3 = 1
ITEM 6	
Did you or another adult in your household stop eating for an entire day (during the past 12 months) because you did not have enough money to buy food? 1=Yes 0=No How often? 1=Less than half the time but more than 30 days 2=Less than 30 days but more than 10 days 3=Less than 10 days	3 and 0 = 0 1 and 2 = 1
ITEM 7	
Did you or any other adult household member lose weight during the past 12 mo because you did not have enough money to buy food? 1=Yes 0=No	No = 0 Yes = 1
Classification	**Total score (points)**
• Non Food Insecure (NFI)	0 - 1
• Moderately Food insecure (MFI)	2 – 4
• Severely Food Insecure (SFI)	5 – 7

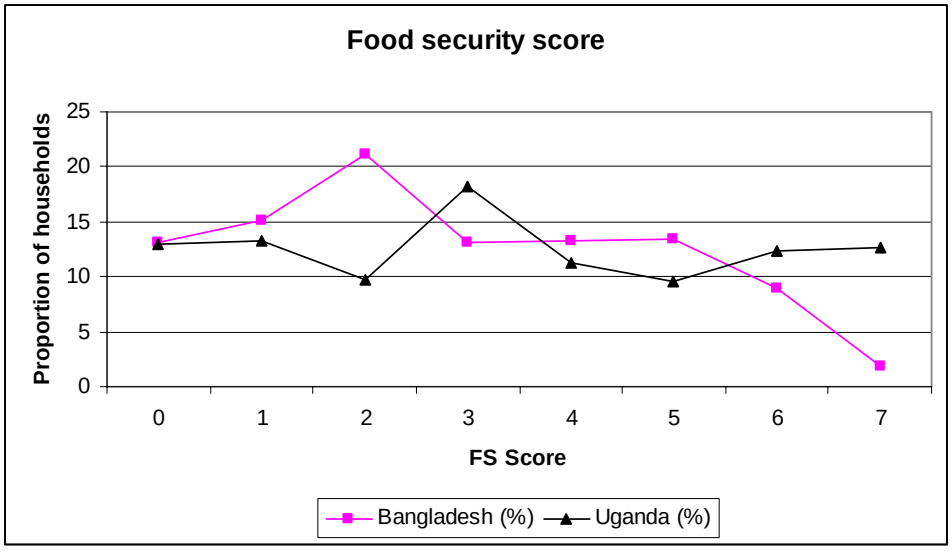
The table also presents our classification criteria into the food insecurity groups. This grouping aimed to follow the classification proposed by FFH[7] which is based on the perceived severity of food insecurity.

Table 2 presents the proportion of households with different food security (FS) scores for the 2 countries. From the table we can see that the scale identified approximately the same proportion of households as NFI in both cases (26 - 28 %). From there on, the scales behave in different way. In Bangladesh we found that 5 different scores (0, 1, 3, 4, and 5) presented a similar proportion of households. The highest proportion was found in the score of 2 points, while the lowest were found in scores 6 and 7. The scale's performance for Uganda shows a similar proportion of households on the scores of 0, 1, 6, and 7 points and a lower proportion on the scores of 2 and 5. The score with the largest number of households was 3 points. These results can be better appreciated in Figure 1.

Table 2. Proportion of households by FS score

FS score	Bangladesh (%)	Uganda (%)
0	13.14	12.94
1	15.14	13.20
2	21.15	9.77
3	13.14	18.15
4	13.27	11.29
5	13.39	9.64
6	8.89	12.31
7	1.88	12.69
Total	100	100
N	799	788
Mean score	2.83	3.43

Figure 1. Proportion of households by FS score



The mean score was 2.83 for Bangladesh and 3.43 for Uganda. This would indicate that, *on average*, the Ugandan households face the highest degree of food insecurity from the 2

[7] In a similar study prepared for FFH, 3 groups were created: the Food Secure (0-2 points), the Food Insecure with out Hunger (3-5 points), and the Food Insecure with Hunger (6-9 points). See Melgar-Quiñonez, 2004.
For our study, we decided to use different food insecurity group names since our scale differs from FFH's scale.

countries. Also, based on the scale cut offs and these mean figures, both countries would be classified as MFI.

Nevertheless, it is necessary to keep in mind that being the questions composing the scale rather subjective, the interpretation about the implied severity will be different not only for each country but also for different population subgroups. Therefore, the extent and severity of food insecurity present in both countries can not be 100 % comparable.

By observing these results it is possible to start questioning the functionality of the scale as it was constructed. It would have been expected to start with an initial proportion of households with a score of 0, reach a maximum in the proportion of households at that score or at the score of 1 point and slowly decrease until 7 points. Based on the score results, the resulting food insecurity groups are presented in Table 3.

Table 3. Proportion of households by food insecurity groups

Group	Bangladesh (%)	Uganda (%)
Non Food Insecure (NFI)	28.28	26.15
Moderately Food Insecure (MFI)	47.56	39.21
Severely Food Insecure (SFI)	24.16	34.64
Total	100	100

It can be observed that for both countries about 73 % of the households were found to have some degree of food insecurity. Severe food insecurity was observed in 24.16 and 34.64 percent of the households in Bangladesh and Uganda, respectively. Having as background that 31.4 and 33 percent of the population in the same countries are considered as very poor (Zeller, Alcaraz V., and Johannsen (2005) and Zeller and Alcaraz V. (2005)), these results may indicate that the scale may tend to under estimate the proportion of those in extreme need in Bangladesh, and to slightly over estimate it in Uganda. It is clear that the direct comparison of extreme poverty incidence and severe food insecurity incidence can not be made as many other dimensions in life also contribute to poverty status; however it is interesting to examine the extent to which both proportions come close together.

Scale evaluation

Table 4 presents the proportion of households scoring 1 on each item. The additive nature of the scale would imply that a specific score can only be obtained by registering a 1 in the precedent items and that, under the assumption that not all households are SFI, it would be expected to find a diminishing proportion of 1's on the upper extreme items. The table shows that our scale did not behave in this way. For example, in the case of Bangladesh we see that 40% of the households had 1 in item 4, but only 24% of them scored 1 in item 3. If, conceptually speaking, a score of 4 can only be achieved by scoring 1 from items 1 to 4, we see that some of those households not scoring 1 in item 3 may have scored 1 in item 4 given the higher proportions of 1's. The same situation is observed in Uganda.

This result suggests that either the respondents perceived the severity indicated by the questions in Module E with a different perspective as what the questionnaire implied, the questionnaire was not properly designed in terms of the ordering of the questions and the introduction of skip rules, or that the food security scale shouldn't be conceived as an additive scale with increasing severity.

For this specific scale, most probably a combination of the 3 situations occurred. In face of monetary constraints for acquiring food, different households may follow different coping strategies. For example, some households may prefer to eat less from a much varied and richer diet than to eat the same food, or seasonal changes in agricultural produce availability may impede the households to eat the same food over long periods of time (12 months as asked). As well, weight loss could be a direct consequence of most coping strategies and therefore, it is not surprising that a large amount of households scored 1 in that item.

If we rather consider the items to be independent of each other in terms of severity on food insecurity, then our scales have no such a criticism. Under this approach, only the increasing score would indicate an increase in the severity of food insecurity, but the items themselves would not need to be considered more or less severe than other items in the scale and would not necessarily follow that specific order when adding up the score. The use of this approach would allow the identification of those coping mechanisms which are more often executed on different scenarios and would eventually help in the development of a region or country specific scale. However, if the construction of an additive scale (such as ours) is the objective, it is important to evaluate the individual items prior to the administration of the questionnaire, so the correct ordering can be identified and to maintain independent items.

Table 4. Proportion of households with a score of 1 by item

Item	**Bangladesh (Proportion of 1)**	**Uganda (Proportion of 1)**
Item 1, Food assessment	84 %	84 %
Item 2, Worried about food	73 %	64 %
Item 3, Ate same food	24 %	70 %
Item 4, Ate less food	40 %	44 %
Item 5, Skipped meals	22 %	29 %
Item 6, Stopped eating	3 %	17 %
Item 7, Lost weight	37 %	35 %

Multidimensionality of the scale and internal consistency

Factor analysis is helpful to evaluate if the items measure the same underlying construct. Both scales presented 2 dimensions (or 2 factors). Table 5 shows the items that contribute to each factor for the 2 countries with their corresponding factor loadings.

It is interesting to note that items 1 and 2 are present only in the second factor for both scales. Item 3 was present in factor 2 for Uganda, but in factor 1 for Bangladesh. Item 4 was present in both factor 1 and 2 for Bangladesh and Uganda and Item 7 was present in both factors in Bangladesh, but only on factor 1 in Uganda.

The multidimensionality of scale indicates that for the 2 countries there are 2 underlying food insecurity constructs being measured and that therefore, the scales should be decomposed into subscales. Theoretically speaking, it would be advisable to create 2 subscales for each country; however, as stated earlier, a subscale should have a minimum of 3 items and having our scale only 7 items, we preferred to work with a single scale than with 2 small subscales for each country. This approach was also preferred for facilitating the later use of the scale results in the regression framework.

Table 5. Multidimensionality analysis results: Factors and factor loadings.

Items	Bangladesh factors		Uganda factors	
	1	2	1	2
Item 5, Skipped meals	0.787		0.878	
Item 6, Stopped eating	0.704		0.828	
Item 4, Ate less food	0.661	0.522	0.746	0.388
Item 7, Lost weight	0.648	0.483	0.707	
Item 3, Ate same food	0.475			0.841
Item 1, Food assessment		0.819		0.824
Item 2, Worried about food		0.814		0.771

The factor loadings represent the correlation between the item and the factor. In general, we can see that the loadings are above 0.6. Only in the cases where the item was present in both factors, the loading in the second factor was lower than this level.

As well, in order to be internally consistent the items must show a high correlation with the total score. Table 6 presents the correlation results.

Table 6. Correlation of items with the total score

Item	Bangladesh Correl. (sign.)	Uganda Correl. (sign.)
Item 1, Food assessment	0.597**(0.000)	0.616**(0.000)
Item 2, Worried about food	0.707**(0.000)	0.754**(0.000)
Item 3, Ate same food	0.595**(0.000)	0.727**(0.000)
Item 4, Ate less food	0.832**(0.000)	0.816**(0.000)
Item 5, Skipped meals	0.727**(0.000)	0.789**(0.000)
Item 6, Stopped eating	0.335**(0.000)	0.643**(0.000)
Item 7, Lost weight	0.798**(0.000)	0.757**(0.000)

**Significant at the 0.01 level (ETA statistic).

We can see that item 6 presents a weaker correlation with the total score in Bangladesh. This item would be a candidate of exclusion if the scale was to be modified based on this result.

Reliability results

The scale reliability is expressed via the Cronbach alpha statistic. The corresponding statistics were 0.797 for Bangladesh and 0.855 for Uganda. These results show that the 2 scales achieved the advisable minimum of 0.7 and therefore, can be considered as internally consistent.

External Validity

The external validity of the scale was evaluated by testing its correlation with other variables that can be correlated to food insecurity. The following variables were used:

- Annualized food expenditures per capita, recall period of 1 week (ln)
- Frequency of consumption of different food items in the last 7 days (country specific)

Table 7 presents the correlation results. Most of the variables related to the consumption of different food items presented correlation coefficients in the range of 0.300 to 0.400 (in absolute terms). We can appreciate that those food items that are considered as “superior” present a negative correlation with the households’ scale score and that those “inferior” food items present a positive correlation, as it would be expected.

The correlation between the variable on food expenditures per capita and the scale score yielded unexpected results. While for Bangladesh a correlation can not even be established, for Uganda the size of the correlation coefficient was very low and significant only at the 0.05 level.

In general, the results suggest that the scale does not appear to have a clear external validity since none of the variables registered a correlation coefficient large enough for establishing strong relationship with the score.

Table 7. Correlation of food insecurity related variables with the total score

Variable	Bangladesh Correl.(sign.)	Uganda Correl.(sign.)
Annualized food expenditures per capita, recall 1 week (ln)	0.041 (0.243)	-0.088 (0.013)*
Food items		
Large fish, any fish	-0.396 (0.000)**	-0.108 (0.002)**
Meat	-0.309 (0.000)**	-0.303 (0.000)**
Chicken, duck, or eggs	-0.373 (0.000)**	-0.067 (0.060)
Lentils	-0.300 (0.000)**	
Plain rice with vegetables	0.354 (0.000)**	
Plain rice	0.318 (0.000)**	
Nakatti (red african aubergines)		0.212 (0.000)**
Staple food, plant protein and vegetables		-0.051 (0.156)
Staple food and vegetables		0.308 (0.000)**

**Significant correlation at 0.01 level
*Significant correlation at 0.05 level

Prediction of poverty status

As noted earlier, it is useful to assess the extent to which the scale score can predict the poverty status of the population. The variable "daily expenditures per capita" is used as benchmark for determining poverty status.

A simple correlation between the score and the benchmark yielded a correlation coefficient of -0.504 for Bangladesh, and -0.326 for Uganda. In both cases, the correlation is significant at the 0.01 level. Interestingly, these correlation results are much stronger than the ones obtained previously for the food expenditures per capita variable. If we examine the average daily expenditures by scale score we see that, in general, the expenditures decrease as the scale score increases (see Table 8).

The shaded area in the table indicates the score level that presents an average daily expenditure per capita below the corresponding poverty line. The corresponding poverty lines were 23.1 Taka for Bangladesh and 664.98 Ug.Sh. for Uganda[8]. As it can be seen, only in Bangladesh the average daily expenditures per capita at certain score levels (7) were found to fall below the poverty line. This result is surprising at some extent, however if we consider that we found a relatively large proportion of households registering a 1 in the upper scale items, the average expenditures by scale score may have been pulled up by these cases. This situation can be better appreciated in the food insecurity groups (Tables 9 and 10). Due to the

[8] See Zeller and Alcaraz V. (2005a and 2005b) and Zeller, Alcaraz V., and Johannsen (2005)

grouping and aggregating procedure, none of them presented average daily expenditures below the poverty line.

Table 8. Mean daily expenditures per capita by scale score

Food security score	Bangladesh (Taka)	Uganda (Ug.Sh.)
0	61.09	1989.15
1	42.67	1596.02
2	37.26	1301.36
3	28.12	1415.26
4	27.57	1048.25
5	26.41	983.42
6	26.47	941.37
7	18.46	886.77
Total mean	35.96	1293.77

Tables 9 and 10 also present the poverty headcount disaggregated by groups, as well as the proportion of the poor within each FS group.

Table 9. Bangladesh: Daily expenditures per capita (DEPC) and poverty headcount by food insecurity group.

Group	DEPC (mean, Taka)	Poverty Headcount (% of total)	Prop. of poor (% of poor)
Non Food Insecure	51.23	2.4	7.6
Moderately Food Insecure	32.03	16.5	52.6
Severely Food Insecure	25.81	12.5	39.8
Total	35.96	31.4	100
Sum of MFI and SFI		29	92.4

From Table 9 we can see that 92 % of the poor households in Bangladesh were classified as MFI or SFI and that the food insecurity group with the highest incidence of poverty is the MFI group. For Uganda, the proportion of poor households in the MFI and SFI groups was lower (84%) and the group with the highest incidence of poverty was the SFI group.

Table 10. Uganda: Daily expenditures per capita (DEPC) and poverty headcount by food insecurity group.

Group	DEPC (mean, Ug.Sh.)	Poverty Headcount (% of total)	Prop. of poor (% of poor)
Non Food Insecure	1790.68	5.1	15.7
Moderately Food Insecure	1281.17	11.5	35.7
Severely Food Insecure	933.08	15.7	48.6
Total (mean, %)	1293.77	32.4	100
Sum of MFI and SFI		27.2	84.3

Same as observed in Table 8, as the degree of food insecurity increases the average daily expenditures per capita decrease. A One-way ANOVA confirmed that the null hypothesis of equal means on daily expenditures per capita between the food insecurity groups can be rejected for both countries.

Regression analysis
Ordinary Leasts Squares regression was used in order to predict the benchmark indicator based on the scale score and the food insecurity groups. Table 11 presents the adjusted R^2 of the models.

Six different models were compared:

- Individual items as regressors[9]
- Individual items plus selected control variables[10] as regressors
- Scale score as regressor
- Scale score plus selected control variables as regressors
- Food insecurity groups as regressors
- Food insecurity groups plus selected control variables as regressors

Table 11. Regression results: R^2

Regression	**Bangladesh R^2**	**Uganda R^2**
Items	0.285	0.111*
Score	0.253	0.105
FS groups	0.210	0.095
Items + Control	0.384	0.371*
Score + Control	0.365	0.366
FS groups + Control	0.315	0.361

*Signs of some item coefficients not as expected.

From the table it can be observed that the models including the control variables achieved a higher R-square in both countries. As well, when the individual items were used in the regression, the sign of some of the coefficients did not behave as expected. This situation is not surprising given the high degree of multicollinearity among items.

Table 12 presents the accuracy results for the 6 different regression models for Bangladesh. Taking the accuracy measures as criteria for selection of the best model, the model incorporating the control variables and the scale score would be the best one. It achieved a Total accuracy of 73.72 % and a Poverty accuracy of 43.43 %. Nevertheless, by considering PIE and BPAC, the models with the score or the food insecurity groups as single explanatory variables would be the best.

Interesting to note, is that the models with the scale score and the food insecurity groups yielded the same accuracy results. A further exploration of this issue revealed that the predicted values for those households with a score greater or equal than 5 (the SFI group), were clearly below the poverty line by using either variable as regressor. As a consequence, both variables predicted the same households as poor and derive in the same accuracy results.

[9] Theory advises to work with the scale's results by focusing on the total score and **not** on its independent items (see Dawis, 2000), however, it was interesting to assess how different the results would be for the different models.

10 The control variables used were: age of household head, household size, household size squared, and regional dummies. It would be useful to include a control variable related to the presence or absence of children in the household (USDA's scale accounts for this), however, in order to be able to compare with the results obtained by the models developed by Zeller and Alcaraz V. (2005); and Zeller, Alcaraz V., and Johannsen (2005) the control variables were kept as listed above.

Table 12. Accuracy of regression models for Bangladesh

Measure (%, % pts.)	Items	Score	FS groups	Items + control	Score + control	FS groups + control
Total accuracy	69.59	69.46	69.46	72.72	**73.72**	71.34
Poverty accuracy	5.98	39.84	39.84	40.64	**43.43**	34.66
Non-pov accuracy	98.72	83.03	83.03	87.41	87.59	88.14
Undercoverage	94.02	60.16	60.16	59.36	56.57	65.34
Leakage	2.79	37.05	37.05	27.49	27.09	25.90
PIE	-28.66	**-7.26**	**-7.26**	-10.01	-9.26	-12.39
BPAC	-85.26	**16.73**	**16.73**	8.76	13.94	-4.78

In a similar exercise executed by Hoddinott (1999), he argues that the incorporation of control variables is necessary as it has been found that a negative association exists between food access and household size and that food access varies with location. If we take the best model according to PIE and BPAC as the best model for Bangladesh, we would be failing to recognize (in our model) that food access (and therefore, food insecurity) is affected by these factors. Following this reasoning, the best model would be then the model incorporating the scale score and the control variables. All the models tended to underestimate the incidence of poverty. In comparison with the OLS models developed by Zeller, Alcaraz V., and Johannsen (2005), our models presented a lower performance in all measurements.

Table 13 presents the accuracy results for the regression models in Uganda. In this case, the model with the highest Total accuracy was registered in the score + control variables model however, the highest Poverty accuracy was observed in the items + control variables model. In terms of PIE and BPAC, the best model was also the items + control variables. As mentioned earlier, scale theory points out that scales should be analyzed based in the total score and not in the responses to individual items. If we take this best model as best, we would be incurring in a methodological error. The second best model in terms of PIE and BPAC is the score + control variables model. As in Bangladesh, the regressions underestimated the poverty incidence. As well, compared with the models developed by Zeller and Alcaraz V. (2005), our models achieve a lower performance in all accuracy measures.

Table 13. Accuracy of regression models for Uganda

Measure (%, % pts.)	Items	Score	FS groups	Items + control	Score + control	FS groups + control
Total accuracy	68.40	68.15	67.64	71.95	**72.59**	70.81
Poverty accuracy	22.35	20.39	0	**43.14**	41.57	40
Non-pov accuracy	90.43	90.99	100	85.74	87.43	85.55
Undercoverage	77.65	79.61	100	56.86	58.43	60
Leakage	20.00	18.82	--	29.80	26.27	30.19
PIE	-18.65	-19.67	-32.36	**-8.76**	-10.41	-9.64
BPAC	-35.29	-40.39	--	**16.08**	9.41	10.19

Again, the model using the food insecurity groups presented interesting results. In this case, the predicted values for all groups were located above the poverty line and therefore, none of the households were predicted as poor.

Calibration: Finding the best cut off score

Given the relative low performance of the scale score and the food insecurity groups as predictors of household expenditures in a regression framework, we decided to evaluate

whether we would achieve better results by assessing the households' poverty status based solely on their scale score. Tables 14 and 15 present the results.

Table 14. Accuracy based on different scale score cut offs for Bangladesh

Measure (%, % pts.)	**VP* if >= 6**	**VP if >= 5**	**VP if >= 4**	**VP if >= 3**	**VP if >= 2**
Total accuracy	69.84	69.46	66.96	65.33	54.94
Poverty accuracy	19.12	39.84	56.97	75.30	92.43
Non-pov accuracy	93.07	83.03	71.53	60.77	37.77
Undercoverage	80.88	60.16	43.03	24.70	7.57
Leakage	15.14	37.05	62.15	85.66	135.86
PIE	-20.65	-7.26	**6.01**	19.15	40.30
BPAC	-46.61	16.73	**37.85**	14.34	-35.86

*VP = very poor

In the case of Bangladesh, we found that the best results were registered by establishing the scale cut off at 4 points. This cut off marked the change from poverty incidence underestimation to poverty incidence overestimation. In comparison with the best regression model, this cut off showed a lower Total accuracy (66.9 vs. 69.4 %), but a significantly better Poverty accuracy (56.97 vs. 39.8 %). As well, the PIE level was the closest to zero from all models and BPAC achieved a maximum of 37.85 percentual points.

For Uganda we observed similar results. The best cut off score was 5 points. As in the case of Bangladesh, the Total accuracy was lower than in the best regression model, but the Poverty accuracy was higher. This cut off overestimated the poverty incidence in 2.28 percentual points. BPAC was 41.57 percentual points, 25.4 percentual points higher than the best regression model.

Table 15. Accuracy based on different scale score cut offs for Uganda

Measure (%, % pts.)	**VP if >= 6**	**VP if >= 5**	**VP if >= 4**	**VP if >= 3**
Total accuracy	66.50	64.47	62.06	52.03
Poverty accuracy	36.86	48.63	62.35	74.90
Non-pov accuracy	80.68	72.05	61.91	41.09
Undercoverage	63.14	51.37	37.65	25.10
Leakage	40.39	58.43	79.61	123.14
PIE	-7.36	**2.28**	13.58	31.73
BPAC	14.12	**41.57**	20.39	-23.14

Based on these results, it is possible to say that the scale score alone with its corresponding best cut off could be useful for giving a rough estimate of the poverty incidence in our 2 countries, however given the relatively low Poverty Accuracy of the cut offs; it wouldn't be advisable to assess poverty status in this way without the support of any other alternative measure.

V. Conclusions

Food security scales represent a practical approach for assessing food insecurity at the household level. The low number of items required to assemble such a scale allows for rapid data collection and data analysis. Nevertheless, in order to be able to derive valid and reliable information about the food insecurity status of the population, the scale has to be carefully designed and tested.

The scales developed in this study presented good internal consistency and reliability, given by the high correlation registered between the items and the total score, and the Cronbach alpha statistic. Nevertheless, the results obtained by the factor analysis suggest the presence of two underlying constructs. Further research would be advisable in the exploration of the 2 constructs and in the items that compose them.

In future exercises, the inclusion of more items could aid in the definition of the 2 constructs/factors found. Their specification and measurement would lead to the assessment of food insecurity in a more flexible and integral way. For this, it is recommended to pre-evaluate and to test the potential new items for detecting differences in perceptions within the target population and for identifying the associated severity of food insecurity perceived on them. This evaluation would be relevant for the adequate ordering of the items during the data collection process.

The ability of our scale to predict daily expenditures per capita was much lower than expected. The use of scale cut offs in order to determine poverty status yielded better results in both countries and therefore is more suitable for assessing poverty. Nevertheless, as mentioned before, the scale alone would not be adequate for such purpose if no other complementary information is employed.

As mentioned earlier in this text, there is always a trade off between internal consistency and external validity. Rather than aiming a good predictive ability, our scales had the purpose of representing (or measuring) the food insecurity status of the sampled households; therefore the good internal consistency results should overweight the not so satisfactory results obtained in the external validation in an overall assessment of the scale's performance.

References

- Ahmed, Akhter U. and Carlo del Ninno. 2002. The Food for Education Program in Bangladesh: An Evaluation of its Impact on Educational Attainment and Food Security. Food Consumption and Nutrition Division. IFPRI.
- Bahiigwa, Godfrey B.A. 1999. Household Food Security in Uganda: an Empirical Analysis. Economic Policy Research Center, African Capacity Building Foundation. Kampala, Uganda.
- Bickel, Gary, Mark Nord, Cristofer Price, William Hamilton, and John Cook. 2000. Measuring Food Security in the United States. Guide to Measuring Household Food Security, Revised. USDA, USA.
- Dawis, Rene V. Scale Construction and Psychometric Considerations. In: Tinsley, H. and Brown, Steve (Eds). 2000. Handbook of Applied Multivariate Statistics and Mathematical Modeling. Academic Press. USA.
- FFH. 2006. Freedom from Hunger. Website information: www.freedomfromhunger.org
- Hoddinott, John.1999. Choosing Outcome Indicators of Household Food Security. IFPRI.
- Hoddinott, John and Yisehac Yohannes. 2002. Dietary Diversity as a Household Food Security Indicator. Food and Nutritional Technical Assistance Project, Academy for Educational Development, Washington, D.C., USA.
- IRIS Center, 2007. Poverty Assessment Tools. Website information: www.povertytools.org
- Keenan, Debra P., Christine Olson, James C. Hersey, and Sondra M. Parmer. 2001. Measures of Food Insecurity/Security. Journal of Nutrition Education. Vol. 33, Supplement 1. September.
- Melgar-Quiñonez, Hugo. 2004. Testing Food-Security Scales for Low-Cost Poverty Assessment. Research Report. Ohio State University for Freedom from Hunger, USA.

- Zeller, Manfred, Gabriela Alcaraz V., and Julia Johannsen. 2005. Developing and Testing Poverty Assessment Tools: Results from Accuracy Tests in Bangladesh. Accelerated Microenterprise Advancement Project.
- Zeller, Manfred, and Gabriela Alcaraz V. 2005. Developing and Testing Poverty Assessment Tools: Results from Accuracy Tests in Uganda. Accelerated Microenterprise Advancement Project.
- Zeller, Manfred. 2004. Review of Poverty Assessment Tools. Report submitted to IRIS and USAID as part of the Developing Poverty Assessment Tools Project. Accelerated Microenterprise Advancement Project.