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

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**Forschung zur Entwicklungsökonomie und -politik  
Research in Development Economics and Policy**

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**Discussion papers in this series are intended to stimulate discussion among researchers, practitioners and policy makers. The papers mostly reflect work in progress. This paper has been reviewed by Dr. Stefan Schwarze (University of Göttingen) and Prof. Dr. Gertrud Buchenrieder (IAMO, Halle) whom we thank for their valuable and pertinent comments.**



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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 usefulness of a standardized food insecurity 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 shortages represent the building blocks for the 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 for 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 a 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.

*Keywords: Food insecurity scale, poverty, Bangladesh, Uganda*

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

Gabriela Alcaraz V., Manfred Zeller

## **1. Introduction**

An important dimension of poverty is lacking 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 responses of households to limited food access due to 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 developed and 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 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, tools for 17 countries had been developed and certified (IRIS Center, 2007). This work focuses on two of those countries - Bangladesh and Uganda - and takes as a point of reference one practitioner tool: the Freedom from Hunger’s food security scale.

The two countries present very different conditions and backgrounds in the social, cultural, economic, geographic, and environmental ways, to mention some. This situation is convenient for the testing of the food insecurity scale under dissimilar settings since it can be expected that the perceptions and responses of the households towards food shortage will differ within and across the countries. Under such a diverse scenario, a tool that is able to identify food insecure households in an easy and practical way and that can predict poverty status with a high level of accuracy, can become a useful instrument for agents and organisations involved in development work.

In Bangladesh, according to Ahmed and del Ninno (2002), approximately half of the total population (80 % rural) cannot afford an adequate and nutritious diet. In order to support the affected families, the government has launched a Food for Education Program which provides food conditional to school attendance.

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

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

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

## 2. Literature Review

### 2.1. Food security

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

The indicators typically used for measuring food security (or its opposite, food insecurity) can be classified in two 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.

The main purposes of outcome indicators are to assess the quantity of food available, the qualitative aspect of the food, the psychological aspect related to the feeling of deprivation and anxiety, and the acceptability of the consumption patterns (Barrett, 2002). Some examples are: type and diversity of foods consumed; diet quality; frequency of consumption of key items; caloric and nutrient intake; and perceptions as regards food consumption, food shortage, and hunger events (Maxwell and Frankenberger, 1992; Hoddinott, 1999; Ruel, 2002).

Since outcome indicators can be directly related to the households’ actual food consumption, they seem well suited for assessing food insecurity at the household level. Several methods are available for measuring food security outcomes<sup>3</sup>. This paper will focus on indices of household coping strategies.

The indices of household coping strategies measure how the households respond to the presence of food scarcity. In order to produce the index, a set of questions related to the household’s preoccupation for not having enough food to eat and the corresponding changes in the eating habits of its members are asked to the households. The final index can be calculated by simply counting the number of different coping strategies implemented by the households, or by assigning weights to the different strategies according to their severity or to other criteria. This method of food insecurity assessment is easy to implement and captures the sense of vulnerability of a household, however, it is subjective as each household may

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<sup>3</sup> The reader can find a general description of these methods on Hoddinott, 1999 and Maxwell and Frankenberger, 1992.

interpret what is meant by the questions differently, thus making objective comparisons difficult.

The relationship between outcome indicators with other socioeconomic indicators has been also explored. As an example, Haddad et al (1994) related demographic and factor market indicators (i.e. wages, assets' value) to food expenditures, consumption of certain items, and children nutritional status and found that some of them can act as screen for food and nutrition security status as measured by the alternative outcome indicators. In this line, it is not only interesting to assess whether certain household characteristics can help to identify food insecure households, but also whether food insecurity status can help to identify the extent of a broader type of deprivation, namely poverty.

## **2.2. 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 then referred to 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 between the purposes 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 since this will guide the selection of items composing the scale.

In order to see whether a scale fulfils its purpose and whether it provides an adequate measurement of the construct the scale is usually evaluated in three ways, namely by its multidimensionality, its internal consistency, and its external validity.

### *Internal consistency*

Internal consistency refers to how well the items relate with the total score and measure the same underlying construct. Hence, the internal structure of a scale can be assessed by correlating the items with the total score. Additionally, the reliability measure of Cronbach alpha<sup>4</sup> provides a means 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*

External validity refers to how well the scale relates to other variables that are known to be related to such a construct. 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.

### *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 to be 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).

When designing a scale it is important to keep in mind its expected internal consistency and external validity, since this will influence the selection of items. 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 conversely , 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).

### **2.3. A practitioner's tool: the Freedom from Hunger 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 more comprehensive FSS of the United States (USDA), which was developed in the early 1990's and covered both adult and children household members. The FFH scale is designed to capture various different levels of severity of food insecurity, focusing on adult household members. Each of these levels is assumed to show the particular conditions, experiences and behaviours that the persons face when food insecure, such as: anxiety, perceptions about food quantity and quality, adjustments to normal food intake, feeling of hunger, and physical manifestations of impaired food intake. The FFH's scale incorporates 17 items that account for a maximum scale score of 9 points. In addition, through the use of the scale over longer periods it is possible to measure the changes in the food security of a household over time (Melgar-Quiñonez, 2004).

The FFH's scale has proven to be a simple instrument for measuring food security and has been found to be a reliable proxy of nutritional status (Melgar-Quiñonez, 2004), nevertheless, the extent to what this reliability holds for total household expenditure and poverty level has not been widely explored and/or documented.

## **3. Data and methodology**

### **3.1. Scale construction**

The scale created for this study closely follows FFH's scale. Due to the questionnaire design, it was not possible to reproduce FFH's scale in its entirety; therefore the direct comparison of our results with FFH's food security scores and food security assessments may lead to inappropriate results. Nevertheless, the scale does provide an insight into the food security

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<sup>4</sup> 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. Values range up to 1. The closer the alpha value to one, the higher the inter-item correlation and therefore, the more reliable the scale.

status of the households in the two 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 sample characteristics in 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 questions used for our scale<sup>5</sup>. Table 1 presents the questions with their original coding in the left column, and their conversion into binary items in the right side. On each of them, 0 and 1 indicate the absence or presence of the specific coping strategy, respectively. After all items are evaluated for all households, the final scale score can be obtained by adding up the individual item scores. We produced 7 binary items, thus the maximum score that can be achieved by a household is 7 points.

**Table 1. Scale construction**

<i>Item</i>	<i>Criteria</i>
<b>ITEM 1</b>	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
<b>ITEM 2</b>	
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
<b>ITEM 3</b>	
In past 12 months did you have to eat the same food daily because you did	No = 0

<sup>5</sup>Specifically, we used questions E9, E10, E11, E13 A-B-C-D, and E14 of the questionnaires, which correspond to items 1 to 7 in the scale. The scale was constructed equally for both countries.

<p>not have money to buy other food?</p> <p>1=Yes</p> <p>0=No</p> <p>*No follow up question on frequency</p>	<p>Yes = 1</p>
<b>ITEM 4</b>	
<p>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?</p> <p>1=Yes</p> <p>0=No</p> <p>How often?</p> <p>1=More than half the time</p> <p>2=Less than half the time but more than 30 days</p> <p>3=Less than 30 days but more than 10 days</p> <p>4=Less than 10 days</p>	<p>4 and 0 = 0</p> <p>1-3 = 1</p>
<b>ITEM 5</b>	
<p>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?</p> <p>1=Yes</p> <p>0=No</p> <p>How often?</p> <p>1=More than half the time</p> <p>2=Less than half the time but more than 30 days</p> <p>3=Less than 30 days but more than 10 days</p> <p>4=Less than 10 days</p>	<p>4 and 0 = 0</p> <p>1-3 = 1</p>
<b>ITEM 6</b>	
<p>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?</p> <p>1=Yes</p> <p>0=No</p> <p>How often?</p> <p>1=Less than half the time but more than 30 days</p> <p>2=Less than 30 days but more than 10 days</p> <p>3=Less than 10 days</p>	<p>3 and 0 = 0</p> <p>1 and 2 = 1</p>
<b>ITEM 7</b>	

Did you or any other adult household member lose weight during the past 12 months because you did not have enough money to buy food? 1=Yes 0=No	No = 0 Yes = 1
<b>Classification</b>	<b>Total score (points)</b>
• Non Food Insecure (NFI)	0 - 1
• Moderately Food insecure (MFI)	2 - 4
• Severely Food Insecure (SFI)	5 - 7

As it can be appreciated, the scale is designed to depict an increasing severity in the food insecurity status. The classification into the three 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

### **3.2. Scale evaluation**

In consistency with the theory presented previously, the scales for both countries were evaluated in three ways: multidimensionality, internal consistency (reliability), and external validity. All analyses were performed using the software SPSS.

The external validity of the scale was explored via correlation analysis of the total score with other food insecurity related indicators (our main construct), such as food expenditures per capita and the frequency of the consumption of selected food items (country specific).

### **3.3. Prediction of poverty status**

As food insecurity is 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<sup>6</sup>.

In addition, a calibration exercise was performed. On it, the poverty status of the households was predicted by using alternative scale scores as cut off points. The “best” score cut off was selected based on its accuracy performance when compared with the households’ poverty status as defined by the poverty line.

The accuracies of the different regression models and score cut offs were evaluated according to alternative measures that aim to reflect the ability of the models for predicting poverty status and the size of the prediction errors. Taking as example the work done by Zeller and Alcaraz V. (2005) and Zeller, Alcaraz V., and Johannsen (2005) on the development and testing of poverty assessment tools, the different models were evaluated according to the following measures:

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

Measures a) to e) are widely used when evaluating the targeting performance of projects or programs. While total accuracy refers to the overall proportion of households with a correctly predicted status (being it poverty, food insecurity, or whatsoever), poverty accuracy and non-poverty accuracy refer to the proportion of households within each poverty status which are correctly predicted as such. These three measures reflect the success of the targeting procedure. In the other side, undercoverage and leakage give a sense of the size of the exclusion and inclusion errors derived from the targeting procedure (Grosh and Baker, 1995;

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<sup>6</sup>The poverty lines used in both countries reflect 1dollar a day in purchasing power parity (PPP) adjusted for 2004. For more about the derivation and selection of the poverty line see Zeller and Alcaraz V. (2005) and Zeller, Alcaraz V., and Johannsen (2005).

Hoddinott, 1999b). Ideally, a targeting tool should have a high level of accuracy, and therefore, a low level of error.

Measure f), PIE, aims to capture the deviation (being it over or under estimation) between the predicted and the actual poverty incidence. Ideally, a poverty assessment tool should be able to make a prediction of the poverty incidence that lies close to the actual level; therefore a PIE value of zero or close to zero is preferred. Finally, the BPAC measure provides an accuracy measure adjusted by the size of the errors; consequently higher BPAC values are preferred over lower ones, since the “adjusted” accuracy is higher. Further comments about these measures can be found in the above mentioned references.

## **4. Results and Discussion**

### **4.1. Scale construction**

As previously shown, Table 1 presents the individual items composing the food insecurity scale used for our analyses. The ordering of the questions in the questionnaire was intended to reflect an increasing severity of food insecurity and therefore, this order was kept when assembling the scale and calculating the final scale score.

In addition, the table presents our criteria for the classification of households into the food insecurity groups. This grouping is intended to follow the classification proposed by FFH<sup>7</sup>, which is based on the perceived severity of food insecurity.

Table 2 presents the proportion of households with different food insecurity (FI) 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 proportion was found in scores 6 and 7. The scale’s performance for Uganda shows a similar proportion of households with the scores of 0, 1, 6, and 7 points, and a lower proportion with 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.

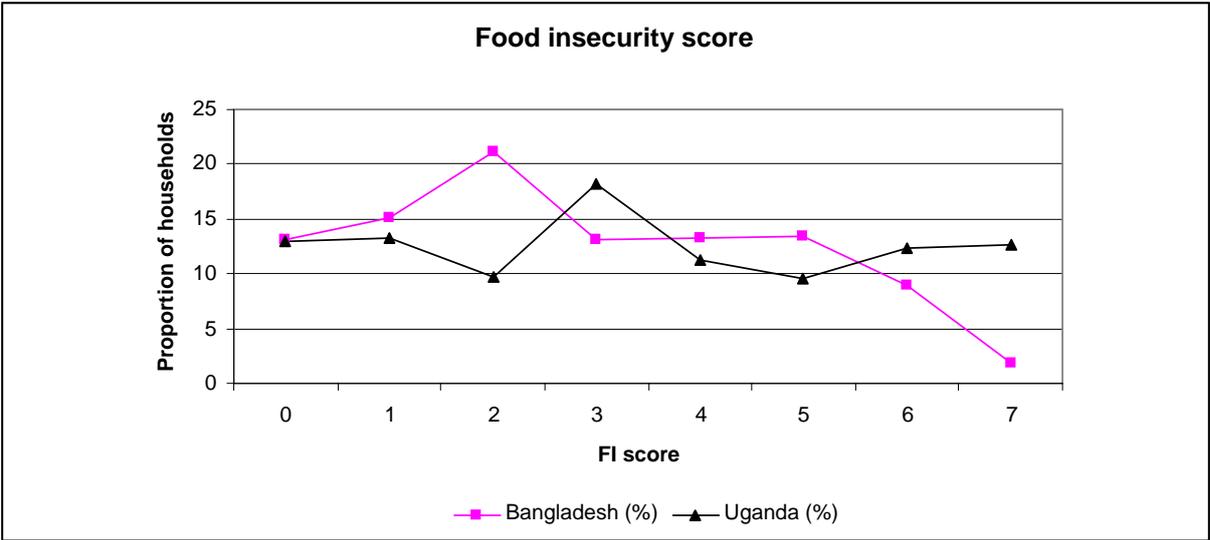
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<sup>7</sup> In a similar study prepared by Melgar-Quiñonez (2004) for FFH, three groups were created: the Food Secure (0-2 points), the Food Insecure with out Hunger (3-5 points), and the Food Insecure with Hunger (6-9 points). For our study, we decided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

**Table 2. Proportion of households by FI score**

FI 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 FI score**



By observing these results it is possible to start questioning the functionality of the scale as it was constructed. If, as mentioned above, the scale was conceived to picture increasing levels of food insecurity, 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. As we can see from Figure 1, this situation did not occur in any country.

The mean score was 2.83 for Bangladesh and 3.43 for Uganda. This would indicate that, *on average*, the Ugandan households face a higher degree of food insecurity than their Bangladeshi counterparts. Also, based on the groups cut-offs and these mean figures, both countries would be classified as MFI. Nevertheless, it is necessary to keep in mind that as the questions composing the scale are rather subjective, the interpretation of 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 is not 100 % comparable. Table 3 presents the proportion of households by food insecurity group in each country.

**Table 3. Proportion of households by food insecurity group**

<b>Group</b>	<b>Bangladesh (%)</b>	<b>Uganda (%)</b>
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 % of the households in Bangladesh and Uganda, respectively.

**4.2. 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 1s 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 1s. The same situation is observed in Uganda.

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

<b>Item</b>	<b>Bangladesh (Proportion of 1)</b>	<b>Uganda (Proportion of 1)</b>
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 %

This result suggests that either the respondents perceived the severity indicated by the questions in a different perspective from what the questionnaire implied, or that 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 should not be conceived of as an additive scale with an increasing severity.

For this specific scale, most probably a combination of the three situations occurred. In the face of monetary constraints for acquiring food, different households may follow different coping strategies. For example, some households may prefer to eat lesser amounts of a much varied and richer diet than to eat the same food, or that changes in food availability due to seasonality in agricultural production may impede the households to eat the same food over long periods of time (12 months was asked). In addition, 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 the severity of food insecurity, then our scales are subject to no such 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 for the identification of those coping mechanisms which are more often executed in 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 that the correct ordering can be identified.

***Multidimensionality of the Scale and Internal Consistency***

Factor analysis is helpful in evaluation if the items measure the same underlying construct. Both scales presented two dimensions (or two factors). Table 5 shows the items that contribute to each factor for the two 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 in factor 1 in Uganda.

**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 multidimensionality of scale indicates that for the two countries there are two underlying food insecurity constructs being measured, and that therefore the scales should be split into subscales. Theoretically speaking, it would be advisable to create two subscales for each country; however, as stated earlier, a subscale should have a minimum of three items and as

our scale had only 7 items, we preferred to work with a single scale rather than with two small subscales for each country. This approach was also preferred for facilitating the later use of the scale results in the regression framework.

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.

In addition, 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**

<b>Item</b>	<b>Bangladesh Correl. (sign.)</b>	<b>Uganda Correl. (sign.)</b>
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 for 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 to be 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 observe that those food items that are considered to be “superior” present a negative correlation with the households’ scale score, and that the “inferior” food items present a positive correlation, as 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.

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

<b>Variable</b>	<b>Bangladesh Correl.(sign.)</b>	<b>Uganda Correl.(sign.)</b>
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

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 a strong relationship with the score.

**4.3. 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 a 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).

**Table 8. Mean daily expenditures per capita, by scale score**

<b>Food insecurity score</b>	<b>Bangladesh (Taka)</b>	<b>Uganda (Ug.Sh.)</b>
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

The shaded area in Table 8 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<sup>8</sup>. As it can be seen, only in Bangladesh the average daily expenditures per capita, at the score level of 7, were found to fall below the poverty line. This result is surprising to 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 at the higher score points may have been pulled up by these cases. This situation can be better observed in the food insecurity groups (Tables 9 and 10). Due to the grouping and aggregating procedure, none of them presented average daily expenditures below the poverty line.

Tables 9 and 10 present the mean daily expenditures per capita (DEPC), the poverty headcount, and the proportion of the poor, disaggregated by FI group.

**Table 9. Bangladesh: DEPC and poverty headcount by food insecurity group**

<b>Group</b>	<b>DEPC (mean, Taka)</b>	<b>Poverty Headcount* (% of total)</b>	<b>Prop. of poor** (% of poor)</b>
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 (mean, %, %)	35.96	31.4	100
Sum of MFI and SFI		29.0	92.4

\*Poverty headcount by group: considers the number of poor households as a proportion of the total households in the sample that are classified as NFI, MFI or SFI.

\*\*Proportion of poor by group: considers the number of poor households as a proportion of the total number of poor households in the sample that are classified as NFI, MFI or SFI.

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.

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<sup>8</sup>See Zeller and Alcaraz V. (2005a and 2005b) and Zeller, Alcaraz V., and Johannsen (2005) for information about the choice of the corresponding poverty lines.

**Table 10. Uganda: 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

\*Poverty headcount by group: considers the number of poor households as a proportion of the total households in the sample that are classified as NFI, MFI or SFI.

\*\*Proportion of poor by group: considers the number of poor households as a proportion of the total number of poor households in the sample that are classified as NFI, MFI or SFI.

The same was observed as 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 Least 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<sup>9</sup>
- Individual items plus selected control variables<sup>10</sup> as regressors

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<sup>9</sup>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 the results would change across the different models.

<sup>10</sup>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.

- 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<sup>2</sup>**

<b>Regression</b>	<b>Bangladesh R<sup>2</sup></b>	<b>Uganda R<sup>2</sup></b>
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. In addition, 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 six 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.

It is interesting to note, 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 than or equal to 5 (the SFI group), were clearly below the poverty line when using either variable as a regressor. As a consequence, both variables predicted the same households as poor, and derive with the same accuracy the results.

**Table 12. Accuracy of regression models for Bangladesh**

Measure (%, % pts.)	Items	Score	FS groups	Items	Score	FS groups
				+ control	+ control	+ control
Total accuracy	69.59	69.46	69.46	72.72	<b>73.72</b>	71.34
Poverty accuracy	5.98	39.84	39.84	40.64	<b>43.43</b>	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	<b>-7.26</b>	<b>-7.26</b>	-10.01	-9.26	-12.39
BPAC	-85.26	<b>16.73</b>	<b>16.73</b>	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 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 on the total score, and not by the responses to individual items. If we adopt this model as best, we would be subject to a methodological error. The second best model, in terms of PIE and BPAC, is the score + control variables model. As in case of Bangladesh, the regressions underestimated the poverty incidence. In addition, when 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	<b>72.59</b>	70.81
Poverty accuracy	22.35	20.39	0	<b>43.14</b>	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	<b>-8.76</b>	-10.41	-9.64
BPAC	-35.29	-40.39	--	<b>16.08</b>	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. For this, each score point served as cut off, for instance, if the score cut off was established at 5 points, all households with a score larger or equal than 5 were predicted as very poor. Tables 14 and 15 present the accuracy results.

In the case of Bangladesh, we found that the best results were obtained 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 %). In addition, the PIE level was the closest to zero from all models, and BPAC achieved a maximum of 37.85 percentage points.

**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	<b>6.01</b>	19.15	40.30
BPAC	-46.61	16.73	<b>37.85</b>	14.34	-35.86

\*VP = very poor

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 by 2.28 percentage points. BPAC was 41.57 percent points, 25.4 percentage 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	<b>2.28</b>	13.58	31.73
BPAC	14.12	<b>41.57</b>	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 the two

countries. However, given the relatively low poverty accuracy of the cut offs, it would not be advisable to assess poverty status in this way without the support of any other alternative measure.

## **5. Summary and conclusion**

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 two constructs and in the items that compose them.

In future exercises, the inclusion of more items could aid in the definition of the two 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 potential new items for detecting differences in perceptions within the target population, and for identifying perceptions with the associated severity of food insecurity. This evaluation would be relevant for the adequate ordering of the items during the data collection process.

The FFH's scale has proven to be a simple instrument for measuring food security and has been found to be a reliable proxy of nutritional status (Melgar-Quiñonez, 2004), nevertheless, the extent to what this reliability holds for total household expenditure and poverty level has not been widely explored and/or documented.

Our undertaking for finding whether the food insecurity scale can be considered a reliable proxy of poverty status and total household expenditures provided insightful results, despite the lower performance of the scale when compared with other exercises on poverty assessment tool development. The ability of our scale to predict daily expenditures per capita, via regression analysis, was much lower than expected. Two potential reasons for this result

are the limited number of explanatory variables (few controls plus the score) in the models, and the inherent shortcomings of the scale itself for measuring a single dimension of food insecurity status of the households.

Alternatively to the regression analysis, the use of scale cut offs in order to determine poverty status yielded better results in both countries, and therefore appears as 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 for a good predictive ability, our scales were given the purpose of representing (or measuring) the food insecurity status of the sampled households; therefore the good internal consistency results should outweigh the not so satisfactory results obtained in the external validation in an overall assessment of the scale's performance.

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