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# Food Security and Agriculture in Developing Countries: Measurement and hypotheses for impact evaluations

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**Food Security and Agriculture in Developing Countries:**

**Measurement and hypotheses for impact evaluations**[1]

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## 1. Introduction

With recent re-occurrence of world food prices crises, investment in agricultural interventions has come to the forefront of the political agendas of many donors and developing country governments. Yet, surprisingly little hard evidence exists regarding the link between increasing agricultural production through agricultural interventions, and potential gains in food security.

Establishing credible causal links between particular interventions and aggregate food security is challenging for a number of reasons. A first set of challenges result from the lack of a common measurement of food security, with a multitude of indicators and definitions being used in different studies, making comparisons and broader inferences particularly hard. A second set of challenges comes from the need to have credible exogenous variation in order to establish a causal relationship between an intervention and resulting food security outcomes.

The literature to date includes many studies focusing on a particular dimension of food security (e.g. nutritional status which can be measured at the individual level), and establishing an observational relationship between these outcomes and prior interventions. While these studies often suffer from omitted variable and selection biases, they are nevertheless useful in generating hypotheses for future more rigorous work. In order to derive useful hypotheses, this paper reviews some of the evidence on agricultural interventions. It

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also briefly discusses the need for considering non-agricultural interventions along with agricultural ones. Prior to this review, the paper discusses the different approaches to measuring food security outcomes, paying attention both to uni-dimensional proxy variables, and more multidimensional aggregate indicators.

In the next section, we hence discuss the main methodologies and indicators used in the literature for defining and measuring food security. Section 3 then reviews studies that consider the relationship between nutritional outcomes and a variety of agriculture and nonagricultural interventions. This review is used to raise hypotheses regarding the impacts of specific types of interventions on food security outcomes in developing countries. The last section concludes.

## 2. Food Security Measurement

In order to establish the impacts of a particular intervention on food security, a good measure of food security is obviously needed. Very often, measures of nutritional status (such as energy intake or anthropometric measures) are used for this purpose. But food security is a wider concept than nutritional status: it is characterized by multiple dimensions and can be defined either at the national, local, household or individual level. In turn, nutritional status concerns single individuals only, and while it is affected by food (in)security it is also determined by the quality of care and health services (The World Bank, 2007).

The FAO defines food security based on food availability, accessibility and utilization (FAO, 1996).[2] Interventions such as improving agricultural and post- harvesting technologies, expanding the quantity and quality of available farmland and increasing access to agricultural inputs may primarily target food availability and are often thought as necessary for addressing chronic food insecurity. Instead, interventions aiming at solving transitory food insecurity may deal with all the three dimensions of availability, accessibility and utilization (Staatz et al., 2009). This then implies that all 3 dimensions ought to be accounted for when measuring the impacts of such interventions on food security.

If one were to follow the FAO definition in applied empirical work, ideally one would hence like to use a measurement that captures each of those 3 dimensions. This clearly poses a challenge, and for lack of an obvious measure that encompasses all these aspects, the literature has used more than 450 indicators (Hoddinott, 1999). Measures capturing at most one of the 3 dimensions such as food production, food share consumption and expenditures are often used when measuring the impacts of particular interventions on food security. Arguably however, such measures rather capture the consequences of being food insecure, but not necessarily food security status per se. An alternative is to use either an aggregate

[2] The relation between the three dimensions is unidirectional: utilization requires accessibility, which requires availability, but it is not true the other way round. Food security results not only from producing enough food, but also from physical and economic access to food and from good health conditions that allow the body to absorb energy intakes (Sen 1981; Staatz et al., 2009).

index or "hunger scales" to obtain a combined measure of the 3 dimensions. We briefly discuss the most common measures in each of those categories.

### *2.1. Uni-dimensional measures of food security*

Indicators related to the determinants and consequences of food security have commonly been used as proxy for identifying households' and individuals' food (in)security. A first common measure is household food consumption and/or income generated from agriculture activity. Information is typically collected using either recall methods (periods can vary between 24 hours and 1 month) or by estimating food expenditures and production with food balance sheets.3 Recall methods might allow investigating intra-household allocation issues by interviewing each member, although data might be noisy. Focusing on consumption/income shares rather than total consumption/income might be useful in addressing substitution effects (e.g. Bushamuka et al., 2005; Grainer and Mitra, 1995). And food quantities consumed can (with some measurement error) be differentiated into their caloric components (Maxwell and Frankenberger, 1992; Hoddinott, 1999; and Bashri and Schillizzi). Hence, collecting information on the diet composition and expenditures can allow detecting the determinants and consequences of accessibility to food and also the utilization of food in a remarkable level of detail.

Such indicators relate to a broader type of variables capturing nutritional status. Like food consumption, some of those are also based on household level reports (e.g. morbidity and mortality), while others, such as anthropometric measures or micronutrient levels, can actually be observed and therefore may be much more objective. Anthropometric measures are collected by measuring the weight and height of children (and sometimes adults) ideally during house visits by enumerators with specific standardized training, nurses or doctors. Anaemia can be easily measured with simple blood samples, based on the level of haemoglobin (Olney et al., 2009). Other micronutrient indicators (vitamins, microminerals, trace minerals and acids) can be obtained through more extensive blood analyses. Vitamin A levels are measured by the serum retinol amounts (Kidalaet al., 2000)., which is detected with blood analysis, as well as serum ferritin, which indicates iron levels. Serum retinols and ferritin can also be indirectly measured by looking at the eaten amount of food rich in iron/vitamin A or even by asking respondents about symptoms of deficiency in vitamin A, such as night-blindness (Grainer and Mitra, 1995). More generally a common method is deriving the levels of micronutrients and caloric intakes from the reported types and amounts of foods consumed (e.g. Schipani et al., 2002).

A potential concern with specific outcomes such as anthropometric measures or blood sample results is their potential lack of sensitivity to modest short-term changes, in particular in light of measurement error and when using small samples. In a review article, Masset (2010) indicates that for 8 reviewed impact evaluation studies focusing on programs explicitly aiming at improving nutritional status, only three found a significant effect on either Height-

[3] For a theoretical assessment of those methods see Hoddinott (1999), Maxwell (1995), Masset (2010).

for-Age, Weight-for-Age or Weight-for-Age. The ex-post power calculations indicate however that none of the studies would have been able to detect a reduction of 2% of stunting or underweight prevalence, and only half had sufficient power to detect a large 30% reduction.

To assess the food availability dimension, studies sometimes rely on survey questions capturing natural, physical and human resources. Some examples include soil and water availability, infrastructure and market access (Grainer and Mitra, 1995), land, livestock and productive asset ownership (Bushamuka et al., 2005) and, at a more macro level, average per capita availability of staple and micronutrients-rich food, food production, import and export (The World Bank, 2007).

Less common indicators of food security are the ones assessing coping strategies implemented by households when facing insufficiency of food. While this methodology tries to capture the food insecurity experience more directly, it still looks at its consequences, in terms of behaviors adopted by households and individuals (Coates et al., 2006a). Maxwell (1995) proposes six different indicators of short-term food-based coping strategies.4 The use of coping strategies in assessing food security is adopted also by Bonanno and Li (2011), which define ”Low food secure households” as those having “enough food to avoid substantial disruption in their eating patterns or reduced food intake by using a variety of coping strategies” while ”Very low food insecure households” face disruption of normal eating patterns of one or more members.

### *2.2 Multi-dimensional measures of food security*

*Index approach*

Following the model of the multidimensional poverty index by Foster-Greer-Thorbecke, Christiaensen and Boisvert (2000) developed an indicator specifically capturing the three canonical dimensions together with vulnerability and uncertainty of being food insecure. The index captures the different dimensions m of food security and, by establishing a threshold zj , assesses whether a person i is deprived for a certain dimension j, according to whether xij (the value of dimension j for person i) is less than or equal to the threshold:

$$fis_i = \sum_j a_j P_j \left(\frac{x_{ij}}{z_j}\right) \quad (1)$$

[4] Eating foods that are less preferred, limiting portion size, borrowing food or money to buy food, buffering in favor of another member, skipping meals, and skipping eating for whole days. The author then develops a relative frequency scale, such that the higher the number the less frequently the strategy is used.

where aj reflects the relative importance attached to the future, so that vulnerability in the remote future can be discounted to current food storage, while in the present time current under-nutrition and food vulnerability might have the same importance.

The index can be used also at the aggregate level

$$FIS_i = \frac{1}{n}\sum_j a_j P_j \left(\frac{x_{ij}}{z_j}\right) \quad (2)$$

Meaning that if FIS=1 everyone has maximal food insecurity, while if FIS=0 everyone is food secure.

*Hunger Scales*

Under impetus of USAID's Food and Nutrition Technical Assistance (FANTA) project, a growing number of studies uses measures of food security based on people's reported experience of food security and hunger. Originating in qualitative interviews describing the hunger experience of households and individuals, the "hunger scales" offer a quantitative measure by combining answers to various specific questions capturing the different dimensions. The validity of this method, and in particular the comparability across countries, is still an open question and existing work illustrates important differences according to the context in which it is implemented (see appendix).

*Household Food Security Survey Measure (HFSMM):*

Radimer et al. (1990) first proposed a conceptual framework based on interviews of 32 women in urban and rural areas of the New York State. They identified a household and an individual dimension, interpreting hunger as a managed process, where women adopt coping strategies that differ across households. By analyzing the answers given to the qualitative interviews, they propose three scales (household hunger, women hunger, child hunger) which contain four dimensions: food quantity and quality, a psychological (uncertainty/worry of not having enough food) and a social component (acceptability of the way in which food is acquired).5 This then leads to a definition of hunger as "the inability to acquire or consume an adequate quality or sufficient quantity of food in socially acceptable ways, or the uncertainty that one will be able to do so". Based on Radimer et al. (1990) the US Department of Agriculture (USDA) has developed a national household food insecurity scale, the Household Food Security Survey Measure (HFSSM), based on 18 items representing the range of their hunger experience. The HFSSM is part of the Current Population Survey (CPS) since 1998 and is annually administrated to 45,000 households. Its external validity is the object of several validations, since the scale mainly reflects the status and perceptions of food

[5] Figure 1 in the appendix provides the specific survey questions.

insecurity of women in the United States, where the severity of hunger might be highly different from that of developing countries (Deitchler et al., 2010).

*Household Food Insecurity Access Scale (HFIAS):*

Validation studies of the HFSSM in different developing countries led to the Household Food Insecurity Access Scale (HFIAS) in 2006. The main difference between the HFIAS and the HFSSM is the reduction of dimensions and items, and the elimination of the social component. For the latter it proved hard to successfully determine an appropriate cross-cultural question that addressed the sensitive and highly cultural specific issue of what is socially acceptable (Coates et al., 2007). Questions about households' coping strategies were also eliminated and the recall period in collecting information about food insecurity was reduced from the 12 months of the HFSSM to only 4 weeks in the HFIAS (Deitchler et al., 2010). Such changes have restrained the questions from 30 to 9, each one having a "frequency- of-occurrence" follow-up question that assesses how often a certain condition takes place (see appendix).

The HFIAS questionnaire allows categorizing households according to a hunger scale with four levels: food secure, mild, moderately and severely food insecure. While the food secure household does not worry about not having enough food, the mild one experiences uncertainty, and the moderately insecure one cuts on quality and, rarely, also a bit on quantity. A severe food insecure household cuts on quantity and/or quality or experiences any of the three most severe conditions (running out of food, going to bed hungry and going a whole day and night without eating, as described by questions 5 to 9). In this way the four categories and their prevalence in the sample can be calculated. Such indicator can be useful for evaluating programs' impacts, even if they do not shed light on the causes of food insecurity. A potential drawback is potential respondent bias.

*Escala Latinoamericana y Caribe~na de Seguridad Alimentaria (ELCSA):*

A second initiative to obtain a hunger scale adapted to developing country context is based on a number of HFSSM scale validity studies conducted in Latin America and Caribbean countries.6 A Latin American Scale was proposed (the Escala Latinoamericana y Caribenn˜a de Seguridad Alimentaria, or ELCSA), made of 15 questions, out of which 4 pertain the whole household, 4 only to adults and 7 to youths younger than 18 years old, with a recall period of 3 months (Comite Cientifico de la ELCSA, 2012). The items concern mainly food quantity and quality (only one question concerns uncertainty feelings about not having enough food) and the social acceptability component is dropped. There is also no question

[6] Ecuador (Hackett et al., 2007), Brazil (Pérez-Escamilla et al., 2004 and Melgar-Quiñonez et al. 2008), Colombia (Hackett et al., 2008), Trinidad and Tobago (Guillford et al., 2006), Venezuela (Lorenzana and Mercado, 2002), Domincan Republique (Bezuneh et al.,2008), and Bolivia (Melgar-Quiñonez et al. 2006).

about the frequency with which a condition occurs, in contrast to other hunger scales. An interesting feature of the ELCSA is that it focuses not only on the household as a whole, but also on members younger than 18 years old.

### *2.3. Which Indicator for Which Study?*

All of the above measures have advantages and disadvantages, and there is no clear ideal measurement of food security. Even when just focusing on nutritional status, the choice of the indicators for evaluating the impacts on nutritional outcomes is large, and important differences exist between disciplines. Papers published in nutritional and medical journals look predominantly the food utilization dimension of food security, by investigating specific micronutrients. Instead, economics papers usually present wider indicators for assessing food availability and accessibility, aiming at describing the impacts on household's welfare, but often lacking in precision about nutritional status effects. In absence of a measure that is clearly superior, assessing agriculture interventions by using a combination of indicators of nutritional outcomes, food accessibility and long-term human development seems to be the most useful strategy.

## 3. Hypotheses on Interventions to Increase Food Security

When considering policy measures that could help increase food security, interventions targeting constraints to agricultural productivity often seem obvious candidates. Recent work, often relying on randomized control trials, has made some advances in establishing credible causal evidence regarding the importance of several key constraints to adoption of (new) agricultural technologies, often linked to a combination of market imperfections, and possibly also behavioral constraints. The ATAI (Agricultural Technology Adoption Initiative) white paper by Jack (2011) provides a detailed review of the evidence and ongoing studies. While these evaluations often do not (yet) allow understanding impacts of the interventions on food security or nutritional gains, this literature provides a first set of hypotheses regarding potential constraints to food security gains that stem from adoption constraints. The emerging evidence suggests in particular that interventions targeting externalities, input and output market inefficiencies, credit, insurance or labor market imperfections, asymmetric information, or property rights insecurity might by important for increasing agricultural productivity through increased technology adoption, and potentially in turn food security.

Additional recent reviews, including of studies without strong causal identification strategies, allow widening the hypotheses towards interventions that go beyond adoption. World Bank (2007) offers a recent review of evidence on a wide set of different agricultural interventions, irrespective of whether their main aim was enhancing the nutritional status of the population or not. It describes programs' effects on nutritional outcomes, by looking at 52 studies conducted from 2001 to 2007. Berti et al. (2003) examine a total of 30 projects that have been assessed between 1985 and 2001, all of which had a nutrition monitoring component. Two

recent meta-analyses also focus on specific nutritional indicators. Masset (2010) considers evaluations programs that were explicitly aiming at improving the nutritional status of children, either by increasing households income or by changing the members' diet, presenting a total of 23 studies produced after 1990. They provide ex-post power calculations for assessing the capacity of the methodologies applied to detect nutritional impacts and evaluate the internal and external validity of the studies reviewed. Gunaratna et al. (2010) focuses on quality protein maize bio-fortification programs aiming at improving nutritional status and implemented with a randomized design, based on 10 studies that considered anthropometric indicators. We draw on these studies, and a handful of more recent evidence, to formulate additional hypotheses regarding constraints to increasing nutritional and food security outcomes, organizing the discussion by the type of interventions considered.

*Cash crops*

Empirical studies on the relationship between cash crops initiatives and food security often focus on the non-trivial link between agricultural production for commercialization, and food availability and nutritional status. This relationship can be positive or negative. A positive effect may occur if greater commercialization leads to a higher income and, given the greater supply, lower staple prices. The assumption is that if households increase their income they will also increase their food security, by consuming more and/or better quality food. However, in the presence of other constraints, this assumption may not hold. In case of incomplete labor markets with labor-constrained households and labor-intensive cash crops, for instance, farmers might not be able to hire additional workers, or they might do so at the expenses of household labor income, resulting in no welfare increase. Under labor constraints, households might also abandon food crops, with potential detrimental effect on the food security level. If cash crops are instead laborsaving, adoption might be more likely for labor-constrained households, but agricultural wages may be depressed. As a consequence, out-migration and off-farm work might increase, which might have a negative impact on the welfare and food security of the labor-supplier households that do not have access to off-farm work, as it is the case for the poor ones.

Other imperfections in input or output markets could similarly interact negatively with cash crops initiatives. High transport costs, delay of delivering of the necessary inputs and weak storage capacities might limit the possibility of the farmers producing cash crops to purchase on the market the food once home-grown. In addition, with incomplete risk markets, and in case of harvest loss, farmers may find themselves with food shortage if cash crop production has substituted household food production.

The existing empirical evidence of the impacts on cash crops on nutritional outcomes and food insecurity is fairly mixed. A recent randomized control trial in Nicaragua has shown that upgrading of farmers' activities through specific cash crops might lead only to short-term positive impacts (Carter et al., 2012). Positive impacts on income coming from the target activities and of investments reached their peak six months after the assistance stopped ,

while households' per capita consumption was not affected by the intervention. A large cross-country study by IFPRI in The Gambia, Guatemala, Kenya, the Philippines, and Rwanda - all countries where policies for transforming subsistence production into cash crops had been recently implemented (Von Braun and Kennedy, 1994) - raises further hypotheses related to the distributional consequences of such interventions. The empirical work sheds light on participation into cash crop production with farmers decisions related to farm size, household characteristics, local context and labor market alternatives in Guatemala (Von Braun et al., 1994) and Mozambique (Heltberg and Tarp, 2001). An element that is hence worth exploring with regard to selection in cash crops programs is whether inequalities are reinforced (Leavy and Poulton (2007).

One of the main hypothesis concerning the impact of crash crops is that of a worsening situation where subsistence food production has been abandoned after cash crops have been introduced. Blanken et al. (1994) shows for instance, that Rwandan children living in households having commercial potato fields present lower under-nutrition prevalence but they also find that producing food for own subsistence increases calorie consumption more than an increase in income would do. In addition, calorie consumption is positively related to children anthropometric indicators, even if the effect is small. In related work, Peters and Herrera (1994) show that home-food production is positively correlated with Weight-for-Age, Weight-for-Height and Height-for-Age, while the income share coming from cash crops sales and off-farm activities is not associated with anthropometrics, despite total income presenting a positive significant correlation. But Sahn and Shively (1991) using the same data and implementing a two-stage least square estimation, find that the income share coming from tobacco sales is positively related to calorie consumption, while cash crops income intensity has no relationship with Height-for-Age. Overall, these studies highlight a potential important hypothesis regarding trade-offs between cash crops and children's nutritional status that deserve further attention.

A related question regarding agricultural commercialization policies is whether leaving subsistence agriculture might decrease food availability of farmers, thus, affecting food security. Govereh and Jayne (2003) investigate such substitution of land destination and production in Zimbabwe, finding that producing cash crops does not have any significant relationship with the value of grain production per household, while it is positively related to the value of grain production per hectare, representing a 25% increase over the mean grain yields. But Kennedy (1994) shows (with descriptive statistics and t-tests) that while there is a statistically significant difference of income and calorie consumption among households cultivating and not-cultivating cash crops, there is no such difference in terms of nutritional status (illness) and anthropometric indicators of children and women. Mixed evidence (mainly none or negative effects) of the relationship between cash crops and food insecurity and nutritional outcomes appears also in the review conducted by DeWalt (1993), by The World Bank (2007) and by Kennedy and Bouis (1993), and morbidity and sanitation conditions appear to be more important for children nutritional status than commercial food production (Blanken et al., 1994 and DeWalt, 1993).

Given the strong assumptions and potential selection and omitted variable bias in a lot of the existing literature, these findings do not allow drawing unique conclusions of the impacts of agriculture commercialization on food security and nutrition, but indicate the need for future rigorous tests of the various hypotheses.

*Fertilizers subsidies.*

Learning from popular but costly and inefficient large scale fertilizer distribution programs of the'80s and '90s, several "smart" subsidy programs have appeared, focusing on raising farmers' awareness, enhancing private distribution networks and local traders' capacity, making good quality fertilizers and seed varieties more accessible in smaller quantities, building farmer associations for reducing transaction costs of input and credit acquisition, supporting market information systems, training farmers and agro-dealers and promoting soil fertility management practices (for a review of such projects see Kelly et al. (2003)).

Together with fertilizer market development projects, input voucher systems have recently been introduced in many countries in Sub-Saharan Africa, allowing farmers to buy inputs at a subsidized price from local private agro-dealers. Such programs have the advantage of encouraging private market development and distribution network, but also present several potential shortcomings: the administrative costs can be very high in case of a fragmentation of smallholders; vouchers may be sold by farmers, thus missing the efficiency-enhancing mechanism; there has to be already a system of local suppliers put in place; and only farmers keen to use fertilizers and having access to suppliers' stores will take part in the project (Minot and Benson, 2009).

The Malawi Starter Pack program (renamed in 2005 Farm Inputs Subsidy Program) is one of the first examples of government-run distribution programs that has used vouchers in an effort to combine the goal of fighting food insecurity with that of reinforcing an input market development. Offering a small pack of improved maize seeds, legumes and fertilizer to all smallholders, it was expected to be the most cost-effective policy able to reduce food insecurity by increasing the number of months the households could feed themselves and, as a consequence, by reducing the demand of food on the market, lowering, thus, the consumer price (Harrigan, 2008). The initial introduction of the Starter Pack (together with a very good rain season) coincided with an increase of the maize production by 100-150 kg per household (Minot and Benson, 2009), reinforcing food security, increasing maize exports and stabilizing food prices (HLPE, 2012). After many adjustments and rescaling, the program now provides vouchers enabling households to purchase the necessary inputs at a subsidized price (farmers pay 30% of the full cost) (Chibwana et al., 2010). While the longer-term impact on food security is unclear, it's targeting has come under scrutiny. The FISP program seems to miss many of the poor, as well as female-headed households, while households with some degree of education were more likely to receive a higher amount of the packet size than the one recommended, and larger families (which are usually more at risk of food insecurity) were less likely to receive any voucher (Chibwana et al., 2010). Certainly, more work is needed to

understand the impact of smart subsidy programs on food security, and understanding the role of targeting in reaching such potential impacts is an important area for future research.

*Home gardening*

While cash crop programs or input subsidies target agricultural production more broadly, home gardening interventions arguably target food security at the household level in a more direct way. These interventions typically consist in promotion of horticultural activities close to a house, managed by the family members. Its products are often mainly grown for own consumption, although several projects encourage undertaking market transactions once the needs of the household are fulfilled. Home gardening is thought to be a cost-effective way to fight food insecurity at the household level, by assuring a basis of home-grown food always accessible to the household's members. The programs often specifically focus on women and nutrition education is often an integral part, also aiming at increasing the nutritional status of participants by teaching illness symptoms and remedies.

Strong evidence on the impact of this type of interventions on food security outcomes is lacking and the studies below all suffer from substantial internal validity concerns. Nevertheless they indicate this may be an important avenue for future research, as evidence to date at best suggests impacts on intermediate outcomes, but not necessarily on final food security outcomes. Descriptive results from the "NGO gardening and nutrition education surveillance project" (NGNESP) in Bangladesh, for instance, suggest a potential impact on higher diversification of vegetables, fruits and vitamin-A rich crops, and a higher production and a higher consumption. But a homestead program in Cambodia (evaluated by Olney et al., 2009), might have led to better levels of food production and consumption but not of health indicators, such as children and mothers dietary diversity, anemia, morbidity symptoms and anthropometric measures. And in Nepal, treatment households were not found to be better off then control households along a variety of outcomes (Jones et al., 2005). Another study in Bangladesh (Grainer and Mitra, 1995) points to the importance of accounting for general equilibrium price effects when analyzing this type of programs.

While causal inference in any of the above studies is difficult, one of the few existing RCTs in this area also suffers from potential biases: the Lusikisiki project in South Africa evaluated by Laurie and Faber (2008), offered training in the cultivation of β-carotene rich vegetables and promotion of the cultivation and consumption of such vegetables, together with nutrition education and community-based growth monitoring of children 1-5 years old. Comparing treatment with control households suggests impacts on nutrition knowledge, child morbidity, intake and cultivation of β-carotene rich vegetables, but impacts are likely underestimated due to control group participation.

*Bio-fortification*

Agricultural interventions aiming to introduce or enhance the production of bio-fortified crops arguably in their design attempt to directly target the agricultural-food security linkage. While little is known about the impact of interventions targeting production of bio-fortified crops, some lessons regarding their potential impact can be learned from RCTs focusing on impacts of increasing intake of such crops among vulnerable children. A meta-analysis of randomized control trials evaluating the impact of the Quality Protein Maize (QPM) varieties has been conducted by Gunaratna et al. (2010). Considering 10 studies where children below 5 years of age were randomly assigned to a group receiving QPM and to a control one receiving conventional maize shows promising results. Among several outcomes, the authors considered the estimated impacts on child growth in height and weight, revealing quite high summary effect sizes: consumption of QPM led to a 12% increase in the rate of growth in weight and a 9% increase in the rate of growth in height in infants and young children with mild to moderate under-nutrition.

Along the same line, an RCT of the introduction of orange-fleshed sweet potato in Mozambique (Low et al., 2007) found positive and large impacts on children's food consumption, micro-nutrient intake, the number of meals a day consumed and diet diversity. The project combined the introduction of bio-fortified crops for reducing vitamin A deficiency with the encouragement of diet diversity and hygiene practices, and the development a local market for orange-flesh potatoes roots and processed roots. While the results are suggestive of potential impacts of this type of interventions, the study does not allow to separately identify the role of increased production of bio-fortified crops, versus the role of the complementary educational and market development interventions. This indicates a path for future research in this area.

*Nutritional education, behavioral change and women empowerment*

More generally, many interventions, in addition to changing production practices, have components targeting nutritional education and women empowerment.[7] An interesting example is the "Social Marketing of Vitamin A-rich foods (SM/VAF) Project" in Thailand, analyzed by Smitasiri (1999). Initially, the treatment consisted in providing the target communities with vitamin A-rich seeds. A few years later women community leaders were selected by the same communities in order to identify new projects for community action and encouraging the implementation of these activities in the participating villages. The study finds significant impact of the agriculture intervention on nutritional outcomes, detecting higher improvements of vitamin A and fat intakes in the treated than in the control groups. In addition, particularly interesting are the impacts on knowledge, attitudes and practices towards rich vitamin A-foods, which appear considerably enhanced in the intervention group, as compared to the control one, after the follow-up intervention. Other more recent work

[7] Indeed, it is often assumed that interventions should focus on women, given the greater hypothesized impact of women's income on child nutrition and household food security compared to income controlled by men and given women's multiple roles in nutritional decisions and child care within the household (World Bank , 2007).

further suggests that social marketing and behavioral changes can be equally (or even more) important than liquidity constraints in households' decisions about diet composition, expenditures, childcare and children's health (e.g. Macours, Schady and Vakis, 2012; Fitzsimons et al., 2012).

Program designs often reflect a belief that impacts are higher when combining several types of interventions, and some comparisons across studies point in that direction. The review by Berti et al. (2003), for instance, suggests impacts of interventions combining home gardening with nutrition education and health interventions are higher than the non-home gardening ones (see also Gillespie and Mason, 1994). However, few studies explicitly test this complementarity within the framework of a single intervention. RCTs of agricultural interventions that randomly vary women targeting or additional nutritional information could help shed light on this question.

*Non-agricultural income*

While agricultural interventions often seem to be the most direct candidates for increasing food security, interventions increasing non-agricultural income might be equally important. If returns in those activities are higher, or even if they just provide a good risk diversification strategy, they potentially could significantly affect household-level food security. An RCT in rural Nicaragua shows, for instance, that addressing credit or human capital constraints can be effective in helping households to manage their future shocks and protect their longer term food consumption (Macours, Premand and Vakis, 2012). Similarly interventions targeting entrepreneurship and nonagricultural income in other settings might be equally or more important for household-level food security than agricultural interventions. A growing number of impact evaluations of micro-finance (e.g. Crepon et al., 2011; Banerjee et al., 2010), entrepreneurship trainings and business grants (see a recent review by McKenzie and Woodruff, 2012) may offer an opportunity to further investigate this hypothesis.

## 4. Conclusions and implications.

The literature to date leaves many open questions regarding the type of interventions that might be most effective to increase food security. This is due in part to the multitude of approaches to measurement of food security, and in part due to methodological concerns that limit causal inference in many of the existing studies. Likely the optimal policy will also be strongly context-specific, and understanding the sensitivity of impacts to contextual changes hence is equally important. Many of the existing studies also point to the key role of targeting, an aspect of the policy design that might be particularly important to understand for food security outcomes.

The existing literature points to several hypotheses that would be fruitful to investigate. Future work addressing these questions likely will be particularly useful if it also allows shedding light on the channels and mechanisms through which programs can increase food

security and the heterogeneity of such impacts within the household. Equally important is to investigate the reasons why some interventions, despite increasing food availability, do not improve nutritional status. Possibly the use of multidimensional indicators of food security can help understand some of the existing puzzles. A better understanding is also needed on whether and how health, social learning, lack of information and liquidity impedes households to establish a positive loop between increasing agriculture production and nutritional status.

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# Food security and agriculture in developing countries. Measurement and hypothesis for impact evaluations.

## Appendix: validation of hunger scales

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# Contents

# Multidimensional measures of food security

## 1 Household Food Security Survey Measure (HFSSM)

Under impetus of the USAID's Food and Nutrition Technical Assistance (FANTA) project, a growing literature uses measures of food security based on people's experience of food security and hunger. A first example is proposed by Radimer et al. (1990), who use a conceptual framework based on interviews of 32 women in the urban and rural areas of the New York State. They identify a household and an individual dimension, interpreting hunger as a *managed process*, where women adopt coping strategies that differ across household. By analysing the answers given to the qualitative interviews, they propose three scales (household hunger, women hunger, children hunger) which contain four dimensions: **food quantity and quality**, a **psychological** (uncertainty/worry of not having enough food) and a **social component** (acceptability of the way in which food is acquired). In order to capture these elements in a questionnaire, each one is identified by two survey items (see Figure 1). This also leads to a new definition of hunger as "the inability to acquire or consume an adequate quality or sufficient quantity of food in socially acceptable ways, or the uncertainty that one will be able to do so".

**TABLE 2**

***Items used to form hunger scales***

Household hunger
1. Do you worry whether your food will run out before you get money to buy more?
2. The food that I bought just didn't last, and I didn't have money to get more.
3. I ran out of the foods that I needed to put together a meal and I didn't have money to get more food.
4. I worry about where the next day's food is going to come from.

Women's hunger
1. I can't afford to eat the way I should.
2. Can you afford to eat properly?
3. How often are you hungry, but you don't eat because you can't afford enough food?
4. Do you eat less than you think you should because you don't have enough money for food?

Children's hunger
1. I cannot give my child(ren) a balanced meal because I can't afford that.
2. I cannot afford to feed my child(ren) the way I think I should.
3. My child(ren) is/are not eating enough because I just can't afford enough food.
4. I know my child(ren) is/are hungry sometimes, but I just can't afford more food.

Figure 1: Source: Radimer et al. (1990)

A validation of the hunger scales for the United States context has been conducted by Frongillo (1999), who proposes six criteria for assessing the validity of a certain method for defining and measuring food insecurity:

1. The construction is well-grounded in an understanding of the phenomenon
2. The performance is consistent with that understanding
3. It is precise within specified performance standards
4. It is dependable within specified performance standards
5. It is accurate within specified performance standards
6. Its accuracy is attributable to the well-grounded understanding for that purpose and context

The food security measures proposed by Radimer et al. (1990) appear to have a well-grounded construction, providing an in-depth understanding of the experience of food security in US households. Their conceptual framework is confirmed in empirical data and the sequence of items corresponds to the sequence of hunger severity (Frongillo, 1999).

From the work of Radimer et al. (1990) the US Department of Agriculture (USDA) has developed a national household food insecurity scale, the Household Food Security Survey Measure (HFSSM), which asks respondents about 18 items representing the range of their hunger experience. Their methodology reflects the status and perceptions of food insecurity of women in the United States, where the severity of hunger might be highly different from that of developing countries. Doubts remain about using this framework in other contexts and with other populations.

## 2 HFSSM validity assessment

In an effort of demonstrating the validity of the hunger scales for capturing food insecurity, the HFSSM approach is being tested in different contexts, in particular in developing countries (see for a critical review Coates et al., 2006a). In-depth interviews are conducted with rural women, codes are extracted from the answers and households are classified into gradations of food insecurity status in order to find themes with proper indications of severity. Such themes are then captured by survey questions and a final questionnaire is tested in the study area.

The interviews methodology relies on an ethnographic approach[1], aiming at a deep understanding of the local experiences of food insecurity (Wolfe and Frongillo, 2001). In

[1] The ethnographic approach keeps, however, its own differences from the HFSSM, by considering the hunger experience as culturally determined, using a specific analysis for every different country (Wolfe and Frongillo, 2001), while the HFSSM rather looks for similarities across countries.

the preparatory phase, parallel activities are often put in place, such as focus groups and participatory methods at the community level (as in the case of the Rapid/Participatory Rural Appraisal, see Chambers, 1992) for ameliorating the range of survey items.

Recent studies applying the HFSSM method in developing countries have highlighted interesting commonalities and discrepancies of local hunger experiences as compared to the one detected in the United States. Looking at the four dimensions of food insecurity of Radimer et al. (1990), Coates et al. (2006a) show that all 22 reviewed studies, both in developing and developed countries, have detected **uncertainty** and worry about food in the present and future time as a common component among households across different contexts. In addition, households appear to express such feeling in very similar ways in all the studies, as described by the survey item adopted[2]. Such uncertainty is a central concept to food security: perceived or actual vulnerability together with exposure to risk might bring household members to adopt preventive actions, such as reducing food intake or disinvest productive assets.

The dimension of **food quality** is also reported as a common component of food insecurity, but is differently expressed according to the context (Coates et al., 2006a). It ranges from considering it as "not being able to eat healthy or proper diets", "lacking diet variety", "eating socially unacceptable food", or "lacking food freshness and safety". **Food quantity** appears also to be a dimension affecting households and individuals' food insecurity across countries and is usually expressed in the surveys as "running out of food" or "consuming not enough as they should or would want".

The last dimension, **social acceptability**, is the subject with most different interpretations. Originally conceived by the American researchers as indicating the means by which households procure food, it is often understood by the interviewees rather in terms of the quality of food and of the coping strategies that are outside of culturally normative patterns (distinguishing the most severe coping strategies, often considered as socially unacceptable, from the other ones). Due to the sensitiveness that an open question about eating unacceptable food would have, researchers have rather opted for including it as an implicit component of the other three dimensions.

An interesting pattern emerging from the comparison of the interviews conducted in different countries are the relative response frequencies of the different items. If, as proposed by Frongillo (1999), prevalence is inversely related to severity (meaning that the item with the higher number of affirmative answers is the one characterising less severe situations, while the most rare one indicates a highly severe food insecurity), then a worrying feeling appears to be the experience of households starting to experience hunger, followed by a reduction of quality, quantity and actual feelings of hunger. However, such hierarchy is not shared by all countries. Households in Burkina Faso (Frongillo and Nanama, 2006) report that food inadequate variety is almost as important as worrying; similarly, Coates

[2] Common ways of reporting such food-related worry are either "worries about food running out", "worries that the food won't last" or fears that the respondent "doesn't know where it [the food] will come from"

et al. (2006a) report that in Bangladesh households answering affirmatively to all the four dimensions were reporting "eating socially unacceptable food" as the first form of being food insecure, while, at the other extreme, those answering affirmatively only to one item were identifying "eating lower quality food" as the only aspect of being food insecure.

The fact that the four dimensions are detected everywhere, but the list of item for describing them slightly changes form country to country is not only due to the different context's characteristics, but also to the methodology used to assess the validity and pertinence of the single items. Some studies (Frongillo et al., 2003; Coates et al., 2003; Coates et al., 2006b; Frongillo and Nanama, 2006) go through each of the Frongillo's six requirements (Frongillo, 1999 and Wolfe and Frongillo, 2001), assessing the precision and dependency of the measures by estimating the Cronbach's $\alpha$ coefficient, the accuracy by looking at the model fit in the estimating regressions and by responding to the other three criteria in a qualitative way.

A qualitative and quantitative test of the survey items is also performed by Coates et al. (2003), which evaluate the Food Access Survey Tool (FAST) developed in Bangladesh by the Food Insecurity Measurement and Validation Study since 2000. By conducting a Principal Components Analysis (PCA), the authors find that 11 out of 30 items have a high reliability coefficient (in terms of the Cronbach's $\alpha$), explaining 47% of sample variance. The 11 items are found to cover the four dimensions of the food security concept (quantity, quality, acceptability and insecurity) (Figure 2)

1. The family ate few meals per day on a regular basis;
2. Obliged to eat wheat instead of rice (when rice would have been preferred);
3. The adult respondent (where not the main working adult) personally skipped entire meals due to a lack of food in the household;
4. The respondent adult personally went without food for an entire day (because there was insufficient food in the household);
5. The main working adult sometimes skipped entire meals (due to an insufficiency of food in the household);
6. There were times when food stored in the house ran out and no cash to buy more;
7. Worried frequently about where the next meal would come from;
8. Needed to purchase rice frequently (because own production or purchased stores ran out);
9. Took food (usually rice or lentils in kind) on credit from a local store;
10. Needed to borrow food from relatives or neighbors to make a meal (making ends meet on a day-to-day (hand-to-mouth) basis); and
11. Needed to borrow food in order to meet social obligations (to serve a meal to guests or relatives).

Figure 2: Source: Coates et al. (2003)

In addition Coates et al. (2003) evaluate the FAST module in the light of the enumerator assessments[3], finding a high correlation between such rating and the result coming from the FAST survey items. Furthermore, the FAST module appears to have some correlation with standard measures of poverty[4] (0.4-0.6 in the first round and 0.2-0.4 in the

[3] Each enumerator, after having interviewed a household/individual had to give a rating of "food secure", "food insecure without hunger" or "hungry"

[4] Total expenditure, per capita expenditures, land owned, assets and food stocks

second round) and of food consumption[5] (0.1-0.5 in the first round and 0.2-0.4 in the second round), while there is a poor correlation with anthropometric measures. The authors assess the validity of the FAST module also by using the Rasch model, showing a divergent outcome as compared to the other validity assessment methods.

Coates et al. (2006b) go more in detail of the different item selection made by the quantitative (Rasch model) and the qualitative ethnographic method of the FAST module. They find that the former had selected 13 out of 23 items[6], while the latter had identified 10 items as adequately capturing the food security experience of the interviewed households. The Rasch method considered the three items discarded as having different meanings to households, according to the geographic location, hence their technical quality was automatically neglected. Such difference between the two approaches brings the authors to argue that a selection of survey items, which have to be able to adequately and precisely capture the food insecurity dimension of households, should be done by using both methods and it is necessary to improve the flexibility of the Rasch method, by relaxing its assumptions.

# 3 Household Food Insecurity Access Scale (HFIAS) and Household Hunger Scale (HHS)

Validation studies for different developing countries led to the development of the Household Food Insecurity Access Scale (HFIAS) in 2006 by the USAID Food and Nutrition Technical Assistance project. While keeping the underlying approach to measure food insecurity, the HFIAS is a more universal method than the HFSSM.

The main difference of the HFIAS as compared to the HFSSM is the reduction of dimensions and items. The social component dimension has been dropped in the HFIAS due to the difficulties in successfully determine an appropriate and cross-cultural question to address the sensitive and highly cultural specific issue of what is socially acceptable (Coates et al., 2007). In addition, questions about households' strategies to adopt a coping strategy in order to augment the resource base (such as taking a loan) have also been eliminated. The recall period in collecting information about food insecurity is reduced from the 12 months of the HFSSM to only 4 weeks in the HFIAS, in order to better capture only the present household situation (Deitchler et al., 2010).

[5] Food share in total expenditures, food expenditure per capita, value of foods consumed, number of food groups, number of unique foods consumed

[6] It is interesting to notice that the items eliminated by using the Rasch model were the ones relating mainly to food quality and children's diet, because such aspects of food security were either not universally applicable (either because one third of the households did not have children or because were concerning religious groups' practices), or nonspecific or uncharacteristic to food insecurity in the Bangladeshi context, or unavailable and inaccessible (in particular with regard to access loans), or had a poor technical formulation or, finally, had differential meaning across population subgroups due to different tastings.

Such changes have reduced the questions from 30 to 9, each one having a "frequency-of-occurrence" question that assesses how often a certain condition occurs. The items selected are listed in Figure3 .

Figure 3: Selected items of HFIAS (Coates et al., 2007)

| No. | Occurrence Questions |
|---|---|
| | |
| 1. | In the past four weeks, did you worry that your household would not have enough food? |
| 2. | In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources? |
| 3. | In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources? |
| 4. | In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food? |
| 5. | In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food? |
| 6. | In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food? |
| 7. | In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food? |
| 8. | In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food? |
| 9. | In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food? |

Three dimensions of food security are investigated in the questionnaires: food quality and quantity and a psychological component (worrying/uncertainty of not having enough food). As detailed by Coates et al. (2007), the HFIAS module allows to calculate four types of indicators that capture Household Food Insecurity Access-related:

1. Conditions
2. Domains
3. Scale Score
4. Prevalence

The Conditions indicator measures the percentage of households experiencing a *specific* condition at any time during the 4 week recall period, informing about the behaviours and perceptions of the interviewees. It can be computed with respect to a certain question or to the related frequency sub-question. It is expressed as:

$$\frac{Number\ of\ HHs\ with\ response\ =\ 1\ to\ Qn}{Tot.\ number\ of\ HHs\ responding\ to\ Qn}\ x100$$

Information on the prevalence of households experiencing *one or more* behaviours in each dimension is summarised by the Domains indicator, which considers households experiencing any of the conditions at any level of severity:

$$\frac{Number\ of\ HHs\ with\ response\ =\ 1\ to\ Qn\ or\ Qm\ or\ Qz}{Tot.\ number\ of\ HHs\ responding\ to\ Qn\ or\ Qm\ or\ Qz}\ x100$$

The Scale Score indicates the severity level of household's food insecurity. The score variable is calculated by summing the codes for each frequency question: the score ranges from a minimum of zero (households never experiencing any of the situations presented in the questionnaire) to a maximum of 27 (households reporting often such situations). Hence, the higher the score, the more severe the food insecurity status is. The score indicator uses the score variable and is expressed as the average HFIAS score:

$$\frac{Sum\ of\ HFIAS\ scores\ in\ the\ sample}{N.\ of\ households\ in\ the\ sample}$$

The questionnaire elaborated by the HFIAS method allows to categorize households according to a hunger scale, which has four levels: food secure, mild, moderately and severely food insecure. While the food secure household does not worry about not having enough food, the mild one experiences uncertainty and the moderately insecure one cuts on quality and, rarely, also a bit on quantity. A severe food insecure households, instead, cuts on quantity and/or quality or experiences any of the three most severe conditions (running out of food, going to bed hungry and going a whole day and night without eating, as described by questions 5 to 9). In this way the four categories and their prevalence in the sample can be calculated.

Such indicators are useful for targeting decisions and for evaluating programs' impacts, however, they do not shed light on the causes of food insecurity and should not be used to establish program eligibility criteria, as are sensitive to respondent bias.

## 4 HFIAS validity assessment

In order to validate the HFIAS method, FANTA together with the European Commission and FAO Food Security Information for Action Programme carried out an assessment study from 2006 to 2008, using seven datasets[1] in order to test HFIAS internal and external validity[2]. The study by Deitchler et al. (2010) applies the Rasch model, as previously done by Coates et al. (2006b) for the HFSSM method. Such method, based on the Item Response Theory, has as core assumption that households are more likely to posited answer to less-severe items than to more severe ones and that, in general, items are more likely to be affirmatively answered by more severe households. Hence, one the one side, households positively responding to a higher number of questions are the ones more likely to be food insecure and, on the other side, items more rarely indicated are the ones describing more food insecure status conditions. By using a logit-based scale households and items are placed on the same interval scale and can be categorized as more or less food insecure (Deitchler et al., 2010).

[1] The datasets are from Gaza/West Bank, Malawi, Kenya, Zimbabwe, South Africa and 2 from Mozambique.

[2] The HFIAS method has been used by Mohammadi et al. (2011) and FAO (2008), although no validation assessment has been conducted in those studies.

While Coates et al. (2006b) only assessed the internal validity of the HFSSM method with an application to the Bangladesh context, Deitchler et al. (2010) conduct an analysis of not only the internal and external validity, but also of its cross-cultural equivalence by applying the HFIAS method to six different countries.

The first item selection concerned testing the internal validity by using the Rasch method for estimating the severity parameters for each item[3]. Two main requirements have to be fulfilled in order for an item to be considered as efficient:

1. Monotonicity trend of item-step
2. Fit statistics

When the trend of increasing item-step severity is monotonic a scale is considered efficient: moving from never to rarely is calibrated as less severe than from rarely to sometimes, which is less sever than moving from sometimes to often. The fit statistics measure the difference between the model's theoretical expectation of how an item should perform and the actual performance of such item. Such comparison is allowed by the translating the item responses in a logistic form.

Hence, Deitchler et al. (2010) select the best[4] frequency response categories by comparing the ranges of food insecurity measured by the different scales. The study shows that using the 3 frequency response "never, rarely *or* sometimes, often" measures a larger range of food insecurity severity than the 4 frequency response "never, rarely, sometimes, often" used in the HFSSM questionnaire.

The authors then estimate the infit values for each item-step for each data set in order to assess the item's measurement efficiency and discard the items presenting too much high infit values (items 1-4)[5]. Suppression of items according to the infit/outift values is not straightforward, provided that there is not even one item resulting as out of fit across all the datasets used. The seven datasets actually differ with respect to the language used, the phrasing of the questions and the sample design and size, hence the fact that, *for the same item*, some data set present out-of-the range fit statistics while others do not might be due to several reasons rather than only to their adequacy in respecting the Rasch model predictions. In addition, *for the same data set*, items presenting fit values between 0.7 and 1.3, appear sometimes to have single item-steps much higher/lower (or the other way round). The authors do not provide any clarification on the criteria for eliminating some out-of-fit items, while keeping others that are out-of-fit too for certain datasets. According to the estimates provided, it seems that the datasets of Mozambique and the one of South

[3] For dichotomous item a single parameter is estimated, while for polytomous items a parameter is estimated for each "item-step", which is the threshold between two adjacent categories (such as never-rarely or rarely-sometimes, etc.).

[4] In terms of the largest insecurity range measured by the scale.

[5] The discarded items were: "worrying about not having enough food", "not able to eat preferred food", "eat limited variety of foods" and "eat food that do not want to eat".

Africa have the main discrepancies in terms of fit-statistics. Hence, arguably the decision to which item to eliminate should not rely on such three datasets.

The internal validity of the scales with the 5 items and 3 frequency response structure is often confirmed, but, yet, it is not possible to find a scale also presenting an adequate cross-cultural comparability. For instance, frequency responses of moving from rarely/sometimes to often happens to be ranked as less sever than moving from never to rarely/sometimes.

The cross-cultural validation method aims at checking whether the items refer to the same condition and function the same way relative to the food security status in each population. In order to test such comparability, the authors calibrate the items, in order to have the same metric and making them directly comparable. The standardization procedure make each item's mean equal to zero and the average standard deviation of the sub-items was also adjusted in the standardization procedure. The first round of data collected in Mozambique was used as the standard for the calibration process. The cross-cultural equivalence was then assessed graphically by comparing the plotted standardized item calibrations of two different calibrations. A certain item is considered as being valid in both countries if it lies on the perfect equivalence line (the 45 degrees line) for the two populations. Instead, items and sub-items deviating from the line are defined as no-equivalent.

Thus, the authors eliminate all the items that present such inconsistency, which is viewed as due to a culturally biased experience or interpretation of the items[6].

Deitchler et al. (2010) find that the only scale internally valid and being applicable in different contexts is the one made of just three items: "No food to eat of any kind in your household", "Go to sleep at night hungry" and "Go a whole day and night without eating" [7]. All the other items present inconsistency when compared across countries with important differences in the severity calibration of sub-items.

In the end, the items selected capture hunger rather than food insecurity and describe only the food quantity dimension, leaving aside the psychological component and the food quality aspects. Hence, the authors rename the 3 items 3 frequency response scale as the **Household Hunger Scale**, out of which households can be categorized as "little or no hunger", "moderate hunger" and "severe hunger".

The HHS scale appears to be internally valid and cross-country comparable, but it is highly reduced as compared to the previous ones, lacking the psychological and food quality dimensions that were the ones appearing as extremely relevant in several case studies (Coates et al. (2003); Coates et al. (2006b); Coates et al. (2006a); Frongillo et al. (2003); Frongillo and Nanama (2006); Webb et al. (2006); Wolfe and Frongillo (2001);

[6] Item 5 "Eat less than it was needed" and item 6 "Eat fewer meals in a day" were eliminated. It seems that it was often difficult for the interviewees to distinguish the difference between the last three concepts and, due to the absence of specific concepts, such as meal portion (item 5) and meal frequency (item 6), it was also difficult to translate them in some local languages Deitchler et al. (2010).

[7] They correspond to items 7, 8, 9 in the HFSSM questionnaire.

Pérez-Escamilla et al. (2004)). The HHS scale presents important advantages, as shown by Deitchler et al. (2010) and is externally valid. However, the limitation of items reduces the depth of analysis offered by such scale which, in granting a cross-cultural comparability, looses its ability to depict local food insecurity characteristics and specificity. The validation of a hunger scale in the light of its usefulness for cross-country comparison is delicate and there is an evident trade-off about the capacity of measuring food insecurity at the local context and comparing it with different realities. Hence, the HHS can be considered a good basic component of food insecurity questionnaires to be placed side by side with more contextualised units when inquiring about the hunger experience of households and individuals in a specific country.

The Living Standard Measurement Studies-Integrated Surveys on Agriculture (LSMS-ISA) project represents the first opportunity to investigate the validity of the HFIAS scale across different countries thanks to the undergoing data collection in Sub-Saharan Africa. By applying the same sample design and questionnaires in six countries (Ethiopia, Malawi, Niger, Nigeria, Tanzania, Uganda), the LSMS-ISA data allows us to assess the capacity of the HFIAS scale to adequately measure food security cross-culturally. Often, the pre/post-harvest dimension can also be exploited due to the longitudinal data structure. Of particular interest is whether the only applicable cross-cultural dimension is the quantity-related one (as found by Deitchler et al. (2010)) or, if, instead, the quality and psychological aspects can also be captured by the same questions in different countries. Understanding whether the HFIAS can be a universal scale for measuring food security in developing countries is the main goal of our ongoing analysis.

# 5 Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ELCSA)

In the first decade of the XXI century several studies assessing the validation of the HFSSM scale have been conducted in Latin America and Caribbean countries: Ecuador (Hackett et al., 2007), Brazil (Pérez-Escamilla et al., 2004 and Melgar-Quiñonez et al., 2008), Venezuela (Lorenzana and Mercado, 2002), Domincan Republique (Bezuneh et al., 2008), Bolivia ETC.

Drawing from those studies, in 2007 the First Latin-American Conference on the measurement of food insecurity (*Primera Conferencia Latinoamericana y Caibeña sobre la medicion de la inseguridad alimentaria*) organised in Colombia edited the Escala Latinoamericana y Caribenña de Seguridad Alimentaria (ELCSA). The main sources of such Latin American scale were the investigations conducted in Venezuela, Colombia and Brazil and the HFIAS. In Brazil Pérez-Escamilla et al. (2004) and Melgar-Quiñonez et al. (2008) adapted the HFSSM, formulating the *Escala Brasileira de Inseguridad Alimentaria (EBIA)*.

**Escala Lorenzana, ECSA.** The Venezuelan scale (Escala Lorenzana, ECSA) has been proposed by Lorenzana and Mercado (2002) who investigated the use of a qualitative measure (the Community Childhood Hunger Identification Project Hunger Index, which estimates the female-perceived changes in food intake due to constrained resources and experiences of hunger in the household) and a quantitative measure (build on the energy contributions of the food consumed by the household). Lorenzana and Mercado found that both measures were affecting food security and that a Food Diversity score index (which counts all kinds of food available at home during the past week), can be used in place of the food predictors of energy availability, having a high correlation with the quantitative measure. The Food Diversity score index would make it easier for the researchers to measure, analyse and interpret such quantitative measure, than the food predictors would actually do. Lorenzana and Mercado (2002) tested it for the first time in the Nineties in two communities in Venezuela (one of which had a follow up an year later) and later it has been applied in Colombia by Hackett et al. (2008). The authors tested the Colombia Household Food Security Survey (CHFSS), which was developed from the Lorenzana scale. By looking at a sample of 1,319 poor households participating in the *Plan Departamental de Seguridad Alimentaria y Nutricional de Antioquia*, they find that all items except one (children buying less staples) had a good infit.

**Escala Brasileira de Inseguridad Alimentaria (EBIA).** The EBIA has been tested by Pérez-Escamilla et al. (2004) and Melgar-Quiñonez et al. (2008) in the favelas of Campinas, a one-million-inhabitant city in Brasil. The US HFSSM module has been adapted to the Brazilian context in consultation with an expert panel and with three focus groups with local communities. In 2003 the 15-item questionnaire was tested in a convenience sample (n=125) selected to be representative of the very poor and marginalized households of the favelas, including 25 mothers. In the adaptation process some changes were made with respect to the HFSSM:

1. Recall period shortened to 3 months, instead of 12
2. Questions targeting members below 18 years old were formulated as "children/adolescents" and not only "children"
3. The term "balanced diet" appeared to be incomprehensible and was replaced by "healthy and varied diet"
4. All items were reformulated as questions rather than statements to be agreed/disagreed on

By using a stratified cluster sampling in 2 stages, a representative sample of 1000 households was selected, but only 847 (85,7%) responded to the interview. Out of 15 questions, 9 were about the whole households or adults and the other 6 about children;

however, no questions related to frequency of occurrence were included. Thus, the food insecurity score ranges from 0 to 9 for households with only adults and from 0 to 15 for households with children (younger than 18 years old).

Results show that only 8% of households earning below the minimum monthly income were food secure, while all households earning four times more the minimum wage were food secure in both the convenience and representative samples. The level of food insecurity was also strongly associated with the likelihood of daily consumption of fruit, non-root/tuber vegetables and meat.

The study by Melgar-Quiñonez et al. (2008), in addition to the one by Pérez-Escamilla et al. (2004), reports all items having a food statistical infit, with "Adult hungry" having a slightly low value (0.74). In addition, they find that the less reported item (hence indicating the most severe condition, according to the Rasch model) was "child/adolescent ever hungry", which was one logistic point more severe than "adult ever hungry", suggesting that adults put in place coping strategies by reducing their food consumption in order to guarantee an adequate level to their children. A similar funding was presented in Radimer et al. (1990), Maxwell (1995), Lorenzana and Mercado (2002), Coates et al. (2003), Coates et al. (2006a) and Hackett et al. (2007), while Frongillo et al. (2003) does not detect any worries of mothers with respect to their children being hungry in Bangladesh. However, Melgar-Quiñonez et al. (2008) report that the question investigating whether the child has ever gone without food for a whole day was answered only by one household, leading the authors to eliminate it from the questionnaire.

As compared to HFSSM, EBIA presented some relevant differences. It had some items with common severity scores ("worrying bout food quantity" and "child food quantity"), while some other items had significantly higher scores ("household ran out of food" and "adult felt hungry"), whereas others had a much lower score ("child has a health, diverse diet" and "child cuts meal size"). Such discrepancy suggests that the HFSSM needs to be adapted and contextualized and cannot only be translated into another language without reformulating and re-assess the food security scale.

**Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ELCSA).** The initial version of ELCSA, coming out from the First Latin-American Conference on the measurement of food insecurity was validated during a study conducted in **Haiti** in 2007 by Pérez-Escamilla et al. (2009), who investigated the relationship between malaria and food insecurity within the framework of a larger evaluation project related to the introduction of orange-fleshed sweet potato varieties in Haiti.

A sample of 153 mothers was randomly chosen in three districts of Camp Perrin ac-

cording to eligible criteria[1] and interviewed in Creol[2]. For each item affirmatively answered a score was assigned and an additional one was used to indicate the severity of household food insecurity (however, the criteria for assigning the additional score are not specified in the study and no information were collected about the frequency of conditions). The authors classify the households into four categories: food secure (score 0), food insecure (score 1-5), very food insecure (score 6-10) and severely food insecure (score 11-16).

In the Haitian study ELCSA shows a good internal validity, assessed both with the Cronbach's $\alpha$ coefficient (0,92) and with the Rasch model, apparently presenting a very good overall fit (although no estimations are provided). Experiencing hunger appears to be a widespread situation: 56% of households (86) were classified as severely food insecure, 25% (38) as very food insecure, 17% (26) as food insecure and only three were food secure. The most striking finding is that to the items "Child went to sleep without having eaten" and "Child did not eat for a whole day or just once" respectively 49% and 54.9% of households responded affirmatively: these items are often actually dropped in the literature (see for instance Melgar-Quiñonez et al. (2008)), as almost none positively answers them, and are considered the most severe items. So, having such high percentages indicates that the severity of food security in the sample is so high that coping strategies fail to protect children. It is also interesting to notice that the social acceptability component is quite relevant in the sample, with 13% of households reported having done things they would not have wanted to because they did not have enough food. Finally, children living in food insecure households were also more likely to contract malarias[3].

While Pérez-Escamilla et al. (2009) validates ELCSA within the framework of a wider project, Alvarez et al. (2006) conduct an ad hoc validation study adapting the first version of the ELCSA to the **Colombian** context.

A sample of 1624 randomly selected households with children younger than 10 years old was selected and interviewed about their last 6 months hunger experience. The questionnaire in the study contains 12 items about food quality and food quantity, with frequencies reported. Different scores are given to households according to whether they respond affirmatively to an item and an additional one according to the frequency of the occurring item (3=always, 2=sometimes, 1=rarely, 0=never). Thus, households are classified as being food secure (score 0), mild food insecure (score 1-12), moderately (score 13-24) and severely (score 25-36). The authors estimate fit statistics, finding a very good infit interval (0.8-1.2) and a statistically significant correlation of expected sign with standard indicators of food hunger and poverty.

[1] Women were interviewed if they were healthy, between 17 and 45 years old, nonpregnant, living in the target community for at least the past 12 months, had at least one healthy child aged between 1 and 5 years old.

[2] We have some doubts about the adherence of the Creol version to the original one due to the translation conducted from Spanish into English, from English into French and then from French into Creol.

[3] The authors did not due any medical test of malaria and all health indicators were reported by the mother. In addition, the study is cross sectional, not allowing a causality direction between malaria and food insecurity.

A comparative study confronting the locally adapted versions of ELCSA in **Mexico, Guatemala and Colombia** has been conducted by Melgar-Quiñonez et al. (2010) in order to investigate whether ELCSA is cross-cultural valid and can be implemented in different South-American countries.

By using the Rasch model and estimating infit statistics, 3 out of 15 items appear to be above the maximum level of 1.2. All countries report a high infit for the item concerning uncertainty about having enough food (as also shown in Deitchler et al. (2010)), Colombia and Mexico present a high infit also of the item "Doing something for getting food that did not want to do"[4] (such item was also dropped in HFIAS (Coates et al., 2007)) and Mexico reports a higher infit for the item asking whether adults went to sleep without having eaten. In turn, the lowest infit was 0.75, which is in the right range for validating the scale.

Adopting the Rasch model, according to which the lowest frequency items are the most severe ones, it appears that the most severe item is "Child went to sleep without having eaten" (although the authors do not report the number of households affirmatively responding to it) and the less severe is "Worrying about not having enough food". Furthermore, there are 4 items that are not equivalent (i.e. the probability of affirmatively responding is different across the three countries): "Does not have a varied diet", "Went to sleep without having eaten", "Did not eat for a whole day", "Child does not have a varied and healthy diet". Such discrepancies arise mainly between Guatemala and Mexico and only for the second item the discrepancy is between Guatemala and Colombia [5]. In addition, the social acceptability item was also not consistent between Colombia and Mexico (however, a part from this one item, Colombia and Mexico did not differ on the others). In conclusion, the items' severity ranking changes quite a bit across countries, in particular with respect to the household/adult ones.

Such differences should be taken with caution, because the data set of the three countries differ with respect to the sample size and design (for instance, the Guatemala sample was only about poor households with children, with a size of 987, while the Colombian (n=13,611) and Mexican (n=1,511) were both national representative and much larger) and for the different phrasing of the various items. In addition, Melgar-Quiñonez et al. (2010) cast some doubts about the econometric methodology used by the statistical software *Winsteps*, which applies Joint Maximum Likelihood estimation, whereas they would rather propose Conditional MLE. Indeed, the authors are more cautious than Deitchler et al. (2010) in discarding items which might show discrepancies across countries because of the different data sets and of the econometric estimation, than because of the inadequacy of the item scale *per se*.

Thanks to the validation study by Pérez-Escamilla et al. (2004), Alvarez et al. (2006),

[4] This item was not present in the Guatemala scale.

[5] The authors compared it also with the EBIA and found substantial discrepancy, suggesting, thus, to revise the second item in ELCSA.

Pérez-Escamilla et al. (2009), Melgar-Quiñonez et al. (2010) and Pérez-Escamilla et al. (2011), the Second Latin-American Conference on the measurement of food insecurity in 2008 agreed to start an harmonization process for having an ELCSA common to all countries in Latin America and the Caribbean. During two workshops in 2010 and 2011 the harmonized version has been elaborated, accommodating the differences of the participating countries (Mexico, Guatemala, Nicaragua, Honduras, El Salvador and Peru) (Comité Cientifico de la ELCSA, 2012). Hence, the final version of ELCSA is now made of 15 questions, out of which 4 pertain the whole household, 4 only to adults and 7 to youths younger than 18 years old, with a recall period of 3 months (Comité Cientifico de la ELCSA, 2012).

Some concerns remain about the characteristics of ELCSA. Firstly, the items concern mainly food quantity and quality (only one question concerns uncertainty feelings about not having enough food). The social acceptability component is dropped. However, it is an important criteria governing, for instance, coping strategies adopted by the household and explain key local aspects of food access and insecurity. It would be, thus, useful to include questions dealing with it when assessing, for example, food quality. Secondly, there is no question about the frequency with which a condition occurs, in contrast to the HFIAS and HHS. In this way scale scores are based only on positive answers, without an investigation of the frequency of insecurity, which is however an important aspect in detecting the insecurity severity. Thirdly, ELCSA focus on the household as a whole and on members younger than 18 years old. Having questions addressing single members (possibly differentiating according to gender), young children and elderly would be particularly useful in shading light on intra household food allocation and insecurity level, which can be arguably considered homogeneous within the household unit. Finally, the studies show a variety of monotonicity trends, where items are ranked in different ways according to the country (for instance, "adult ate less" is less severe than "adult skipped a meal" in Colombia and Haiti, while there is no difference in Brasil), meaning that it is actually still difficult to have an appropriate hunger scale equally efficient in all Latin American and Caribbean countries.

# 6 Local implementations of food security scales in developing countries

Since the introduction of the HFSSM scale several studies all over the world have applied the experiential approach in studying and measuring food insecurity. While the benchmark was almost always the United State scale, several adjustments to local contexts have been put in place, raising the discussion about the need for finding a universal cross-cultural valid scale. We review in this section the current literature which has investigated food security by using qualitative interviews for assessing the hunger conditions of households and individuals in developing countries. In order to provide an exhaustive

and fluent review we categorize the different studies according to the questionnaire items they analyse.

**Psychological component.** Radimer et al. (1990), drawing from their ethnographic work in the New York state, define the psychological dimension of food insecurity both at the household level in terms of *food anxiety*, meaning the uncertainty about whether one's food supply would last, and at the individual level, indicating whether a person felt deprived and /or without choice about eating this way. The psychological component is, thus, the main factor determining a self-perception of being actually food insecure. It is such component that pushes individuals to adopt coping strategies, making the hunger experience a managed process that differs across households and individuals. In the questionnaire proposed by Radimer et al. (1990) and later adopted by USDA and developed in the HFSSM scale, such uncertainty feeling was expressed investigating with regard to the last 12 months and addressed as "Do you worry whether your food will run out before you get money to buy more?".

Following the work of Radimer et al. (1990), one of the first implementation is the one by Welch et al. (1998), who look at the uncertainty dimension in investigating household food security in a sample of 4,800 mothers in **Russia** in 1993. They find higher percentages of households worrying about running out of food than those found in the United States (56.3% versus 39% in the United States, as found by Radimer et al., 1990). Feelings of uncertainty at the household level are the most common expression of food insecurity, formulated in terms of fear to run out of food before having enough money to buy more and also in terms of worrying from where the next day's food is going to come (which entails a concern about food cultural norms and social acceptance, see below).

The HFIAS and the ELCSA scales have both kept the uncertainty dimension, although they have reduced the recall period from 12 to 1 month for the HFIAS and to 3 months for the ELCSA, in order to reduce the likelihood of reporting errors and to focus on more recent food insecurity.

In **Haiti**, worrying about running out of food is a common condition pertaining to 72.5% of the random sample selected by Pérez-Escamilla et al. (2009) and, indeed, almost 90% of households have actually run out of food in the preceding 3 months. Another study conducted in the Caribbean is the one by Gulliford et al. (2006), which randomly selected a large sample of 3,858 individuals (adults and children) in **Trinidad and Tobago**.The psychological component is confirmed to be the least severe item, as in the United States, Russia and Haiti. However, they find that a lower amount (51%) of households worried about food running out in the last 12 months. When looking at ethnic subgroups they find a similar pattern among Afro-Caribbean, Indo-Caribbean and mixed groups with regard to uncertainty feelings.

High percentages are found in **Indonesia** (Studdert et al., 2001) during the 1998 economic crisis, when almost 80% of households declared being worried about both running

out of food before having enough money to buy again and not being able to afford to buy *adequate* food, but only 33.2% had ever actually run out of food because of lack of money. Indeed, before totally running out of food, it appears more common (40.7%) to adopt a coping strategy such as eating the same type of food for several days consecutively, decreasing, thus, food quality instead of food quantity. Also in **Brazil** the worrying feeling about hunger is widespread, where 85% of the households earning less than the minimum monthly wage respond positively to the relative questionnaire item, against 25% of those earning more than 4 times the minimum monthly wage (Pérez-Escamilla et al., 2004), showing a strong link between poverty and food insecurity (see the next section). Despite the high prevalence of households experiencing such uncertainty, only 60% have actually run out of food before having enough money to buy more food. Such difference appears, as in the Indonesian case, due to the strategies put in place by households, which, before being completely without food, prefer to cut on food variety and quality (80%).

While the worry dimension is rarely accompanied in the questionnaires by frequency of occurrence questions, Frongillo and Nanama (2006) adopt the HFSSM scale in **Burkina Faso** in order to investigate whether lacking food has stress effects, such as insomnia, and how often during the week. Results show that during the pre-harvest seasons 92.3% (in 2001) and 87% (in 2003) of respondents affirm to have insomnia due to food uncertainty and for more than 3 nights per week. The authors ask also whether this worry feeling makes respondents loosing weight, but it is not clear whether such question was linked by the interviewees to the scarcity of food rather than to psychological stress.

Melgar-Quiñonez et al. (2006) implement an adapted version of the HFSSM scale in selected rural and urban areas of **Bolivia, Burkina Faso and the Philippines**. Uncertainty about food is the least severe food security item, with almost 80% of households reporting it in Burkina Faso and Bolivia and almost 60% in the Philippines (Food and Nutritional Technical Assistance project, 2004). Checking the internal validity of the scale, the authors find too high infit and outfit statistics in Bolivia, while they are in a good range for the two other case studies.

In contrast to the previous studies, worrying about running out of food is not the least severe aspect of being food insecure according to other studies. In **Theran** Mohammadi et al. (2011) adopt the HFIAS scale and show that other food quality-related aspects are more common among insecure households, such as "being unable to eat preferred foods" and "eat just a few kinds of foods". In particular, households moderately food insecure report uncertainty feelings at the fourth place (out of nine items in an increasing severity scale), those mildly insecure at the third place and those severely food insecure at the second place.

Also in the **Dominican Republic** worrying about food is not the most common reported item. Even though higher percentages are found by Bezuneh et al. (2008) (86.4% of the 110 random selected households indicate an uncertainty condition in 2003), food quality items are more often affirmed: 92.7% of households cannot afford to eat balanced

meals, 88.2% relies on only few kinds of low-cost food to feed the children and the same share cant feed the children a balanced meal, showing that coping strategies affecting children are not so rare in this context. In addition, the authors administrated a question about "La comida que se compró no fue suficiente, porque no se tenía dinero para comprar más durante las últimas 4 semanas"[1], which captures, together with the previous one, an anxiety that the budget or food supply is inadequate. Checking the internal validation of the scale adopted in the Dominican Republic, they find that the uncertainty item presents slightly too high infit values, going against the equal item discrimination assumption of the Rasch model.

Furthermore, Coates et al. (2006b), by adapting the HFSSM scale at a sample of 581 households in **Bangladesh**, finds that uncertainty and worry about food appear to be the $8^{th}$ item reported out of 24 (25.7% of households affirm it) in terms of food security, after lacking different types of food and eating less food. This brings the authors to highlight the importance of local context features when adapting the HFSSM scale and interpreting the results. Estimating the items internal validity, they find that only the Rash test of Differential Item Functioning rejected the psychological component validity (meaning that it is not valid across subgroups with different demographic and geographic characteristics), while it is considered adequate by the fit-statistics and qualitative assessment (based on panel experts and respondent debriefings). Hence, the authors are keen to defend the validity of such component, saying that the Rasch assessment actually describes a statistical reality not enough reflective of the household food insecurity condition. Doubts on the statistical adequacy of items related to the psychological component have been expressed also by Melgar-Quiñonez et al. (2010). By comparing **Colombia, Mexico and Guatemala**, they find that the uncertainty item presents too high infit statistics for Colombia and Mexico, meaning that such item was probably capturing another dimension than the one of food insecurity.

Similarly, Coates et al. (2006a) show that in **Bangladesh** households report more often "eating less quality food" and "smaller amount of food". In particular, worrying about food appears to be a more usual condition among households presenting severe food insecurity, while mild insecure ones lack more diet variety/quality and uncertainty feelings are rarer, as in Mohammadi et al. (2011).

When worrying about food is found to be characteristic of the severely food insecure households (and not a common aspect of mild insecure ones), it might be a signal of a wider anxiety, given that such extreme condition is also link to other types of deprivation which are likely to have a stress effect on the individuals. This might explain why in the validation of the HFSSM and HFIAS scales by Deitchler et al. (2010), Coates et al. (2006b), Melgar-Quiñonez et al. (2006), Melgar-Quiñonez et al. (2010) and Bezuneh et al. (2008) the psychological component appeared to be capturing other dimensions than only the food security one.

[1] A similar percentage affirmatively responded to this question, 83.6%.

The psychological component is investigated also in Mexico (Melgar-Quiñonez et al., 2005) and in Mozambique (FAO, 2008), although no data about the single items' response rates and severity score is given. By contrast, Hackett et al. (2007), Alvarez et al. (2006), Frongillo et al. (2003) have dropped the psychological component, as suggested by Deitchler et al. (2010) in their assessment of the HFIAS scale.

**Social acceptability.** Together with the psychological component, the introduction of a social acceptability aspect, which looks at cultural norms and perceptions affecting the food insecurity condition, is the main innovative aspect of the experiential approach, as compared to the unidimensional indicators. In the United States Radimer et al. (1990) found that whether lack of food quantity, variety or feelings of worrying were an actual problem, it was "influenced by whether the household food was acquired in socially acceptable ways, such as with income or food stamps, but not through charity" (Radimer et al., 1990, p. 1545). The questionnaire items proposed by Radimer et al. (1990) to investigate such condition were "I worry about where the next day's food is going to come from", "I can't afford to eat the way I should" and "I cannot afford to feed my child(ren) the way I think I should".

The aim of this component is mainly to shed light on the means by which households procure food. However, ask respondents about whether they do something unacceptable might be very indelicate, hence, given its highly sensitiveness, there is no study explicitly investigating whether households had to eat unacceptable food or had to acquiring it through unacceptable ways (Coates et al., 2006a). Thus, the concept of food social acceptability is usually either suppressed or included implicitly in scale items about food quality.

Yet, investigating such dimension allows to have an in-depth understanding of the food insecurity conditions and of the decision-making process for adopting context-specific coping measures. Cultural norms are fundamental in choosing the type of coping strategies to put in place, thus, making certain initiatives justifiable only in extreme conditions. For instance, in Indonesia selling assets is more socially acceptable than borrowing food or money, since borrowing is typically done by the poor (Studdert et al., 2001). In contrast, among Muslims accepting meat donations and charitable contributions during the *Kurbani Eid* festivity is a common practice (Coates et al., 2006b). The fact that children being hungry for a whole day and night is almost always the less frequently reported item is in line with the idea that it is socially unacceptable to starve children, thus, making adults prefer to sacrifice their food to the children (Radimer et al., 1990, Welch et al., 1998, Maxwell, 1995, Lorenzana and Mercado, 2002, Coates et al., 2003, Coates et al., 2006a, Gulliford et al., 2006 and Hackett et al., 2007).

For all these reasons, the perception of being not conform to cultural norms has been, so far, investigated by few studies, which have tried to reformulate it in different ways. For

instance, Welch et al. (1998) find that in Russia many women cannot afford to eat *the way they should* (70.8% versus 22.6% in the United States); in Indonesia 76.9% of households worry of not being able to afford *adequate* food (Studdert et al., 2001); in Burkina Faso 33.3% of households declared to have eaten food they *did not want to eat* because there was not enough food at home (Frongillo and Nanama, 2006); in Haiti 13.1% of households affirmed that they did things they would have preferred not to do, such as begging or sending children to work, in order to get food (Pérez-Escamilla et al., 2009).

As already noted, due to the high sensitivity of such theme and to the difficulty in finding an appropriate phrasing for investigating it and understanding the coping strategies related to it, the HFIAS and the ELCSA have dropped the social acceptability component and has rather inserted it in the food quality dimension, for instance in terms of food variety (Coates et al., 2007 and Comité Cientifico de la ELCSA, 2012). For instance, Coates et al. (2006b) in validating an adapted version of the HFSSM scale in Bangladesh look at a wide range of the acceptability dimension items[2]. In order to make all households able to respond to such questions, the ones not universally applicable (such as those addressing religious practices), indicating coping strategies inaccessible due to constraints (such as getting a loan or accessing the market for selling assets) or entailing abstract concepts (such as trade-offs and preferences when facing a budget constraint) were eliminated[3].

Due to the cultural specificity of what can be considered as socially acceptable, it is difficult to find an appropriate type of items that can be universally valid and applicable. Hence, scales that aim at being cross-cultural prefer to drop it. However, it might still be relevant and applicable in studies intending to investigate local characteristics of food security and the rationale of coping strategies addressing, like the ones conducted by Welch et al. (1998), Studdert et al. (2001), Frongillo and Nanama (2006) and Pérez-Escamilla et al. (2009).

**Food quality.** The dimension of quality highlights aspects about food access that enrich the analysis of food insecurity by looking at measures such as food diversity and healthy diet, knowing that a diet rich in a variety of macro and micro-nutrients is essential for good health. It has initially been introduced by Radimer et al. (1990) in terms of "food unsuitability" (i.e. not being able to buy the quality and kinds of food considered appropriate), translating it at the individual level as "diet inadequacy". Items proposed to investigate such condition are: "Can you afford to eat properly?", "I cannot give my child(ren) a balanced meal because I cannot afford that" and "I cannot afford to feed my child(ren) the way I think I should". In the current literature, items relating to food

[2] They are: "borrowed money from local moneylender", "tool food on credit", "borrowed food from relatives or neighbours", "borrowed food to serve guests", "had to seek charity meat during Eid", "received or sought charitable contributions", "not purchase something else to buy food" and "sold or mortgaged things for food".

[3] In the end, in the Bangladesh case questions about the social acceptability dimension were limited to getting food loans from shops or friends. However, the authors do not explain why the items remaining still pertain to the credit market.

quality often contain the wording "less varied/same food", "less preferred food", "foods that make you healthy", "healthy and nutritious food", "balanced meal".

Such variety of specifications is due to the different understanding of food quality and variety encountered in different contexts. Preferred and healthy food varies according to tastes, habits and local conditions. For instance, the term "balanced meal" has appeared to be of not unique interpretation in Latin America, where it has been replaced by "healthy and varied diet" (Pérez-Escamilla et al., 2004 and Pérez-Escamilla et al., 2007) and also among Hispanics immigrants in the United States (Coates, 2004). Similarly, also in Indonesia that term has been translated by "healthy food" (Studdert et al., 2001). Relevant problems of translating specific concepts emerged in the case of the adaptation of the HFIAS scale to a Kenyan and Malagasy sample (Mwangi and Mbera, 2006 and Deitchler et al., 2010).

Households cutting on food quality/variety are considered as "insecure households without hunger" and in the HFSSM and HFIAS scales food quality-related items are usually the ones less severe, hence reported more often by households: food insecure households prefer to renounce to some diet variety before having to cut on meals quantity or frequency. For example, in **Brazil** *the same amount* of households worrying about running out of food (more than 80% among poor ones, 70% of those just above the minimum wage, almost 60% of those with 3-4 times the minimum wage and less than 30% those earning more than 4 times the minimum wage) affirms running out of money in order to have a healthy and varied diet, consuming just a few foods and being unable to offer children a healthy and varied diet (although this last item presents a lower percentage as compared to the first one for the wealthier households), while much fewer cut on the size of meals (no more than 50% of the poor ones, and less than 10% of the wealthiest ones) (Pérez-Escamilla et al., 2004).

Cutting on food variety appears to be widespread also in the **Dominican Republic** (Bezuneh et al., 2008), where 92.7% of the sampled households affirm to be unable to afford a balanced meal for adults and for children (88.2%). Children seem to be less involved in coping strategies in the case of **Indonesia** (Studdert et al., 2001) where 76.9% of households worry about not being able to buy *adequate* food: the main strategies are to reduce *diet variety* (40.7%), by eating the same type of food for several days consecutively, and also reducing *quantity* (30.8%), while only 19% report not being able to afford a balanced meal for children. Decreasing the food quality of children seems a sign of higher hunger severity also in the Haitian case study. Indeed, more households are unable to eat healthy foods (72%) than to provide children with healthy foods (56.2%). In addition, slightly more respondents affirmed eating the same foods almost every day (64.7%) than children do (61.4%) (Pérez-Escamilla et al., 2009).

As in Indonesia, also in **Bangladesh** renouncing to food quality and variety appears to be the most common response to food insecurity: in a sample where 97% of households is reported to have some level of food insecurity (from moderate to very high), 90% of

households declare to not being able to afford eating rich food (*Bahlo Mondo*, such as meat, more than 70% do not eat household snacks (while only 40% does not buy children snacks) or fish (Coates et al., 2006b).

Looking at pre/post-harvest seasons gives interesting insights about the temporary aspects of food insecurity. In the case of **Burkina Faso** (Frongillo and Nanama, 2006), the mean insecurity score is higher in pre-harvest than post-harvest seasons and the amount of people that eats until satisfied is half less in pre-harvest (35.7% in 2001 and 48.8% in 2002) as compared to post-harvest season (85.5% in 2002 and 84.7% in 2003). Similarly, the need to buy cereals strongly decreases in the post season (13.7% and 12.1% in the two years) with respect to the hungry season (78% and 58%) when it seems that, in order to face the higher food expenses, households sell their small ruminants (42% and 28% in 2001 and 2002), receive remittances (23.5% and 20.5%) and start income-generating activities (11.2% and 28%).

Lower percentages[4] about cutting on food variety and quality in food insecure households are found in Trinidad and Tobago (Gulliford et al., 2006), Russia (Welch et al., 1998), Venezuela (Lorenzana and Mercado, 2002), Iran (Mohammadi et al., 2011) and Mozambique (FAO, 2008).

In **Trinidad and Tobago** 44% of households cannot afford balanced meals for adults and 36% for children, while 38% gives children few kinds of cheap food. Similar percentages are found in **Russia**, where almost 60% of the interviewed women declared cannot affording to eat properly, while less than half of them (25%) is unable to feed children a balanced meal and slightly more (30%) the way they think they should.

In **Venezuela** Lorenzana and Mercado (2002) do not provide data about children and adults separately, but find that 38% of very poor and 29% of poor households buy less indispensable food for children in 1998, being this the main coping strategy adopted. By looking at different severity levels of food insecure households in Tehran, Mohammadi et al. (2011) find that severely food insecure households mainly declare themselves to be unable to eat preferred foods (31%) and to worry about food (23%) and to eat just a few kinds of food (20.3%). Moderately food insecure ones report also cutting on food quality, by eating food they really do not want to eat (21.2%), followed by being unable to eat preferred foods and eating only few kinds of food (each item affirmed by 19.8%).

The prevalence of low dietary diversity (i.e. eating less than 4 food groups) appears quite relevant in **Mozambique**, around 30% in the randomly selected sample (FAO, 2008). In addition, diet composition seems to vary a lot between the pre and post harvest season, however due to a natural catastrophe occurring in one of the two sampled communities, no clear pattern can be identified. In the one heavily hit by droughts and floods prior the harvest time there has been a high drop of legumes, fruits and fish consumption (in

[4] A caveat should be made in comparing different studies conducted at local level, due to different samples (sometimes on purpose with over-representation of low income and deprived households and low heterogeneity among them), different scales and questions adopted.

particular among food insecure households) and an increase of tuber, sugar and coffee consumption in the post-harvest season. While in the other community, not affected by the natural disaster, the consumption of legumes and meat increased together with tubers, sugar and coffee and no drop occurred in the consumption of fish, while fruit declined a lot.

In conclusion, current evidence shows that in all case studies households prefer to cut on diet diversity than on food quantity and children appear to be quite protected by the implementation of such quality reduction, with the exceptions of Haiti and Dominican Republic. Hence, including questions about food quality and variety (for instance with a Household Dietary Diversity Score) both for adults and children, if possible differentiating according to harvest seasons, helps to shade light on coping strategies adopted by food insecure households, giving important insights for targeted policies aiming at improve food security.

**Food quantity.** The amount of foods, the size of meals and the frequency of meals are the main aspects describing the dimension of food quantity and a respondent is considered to be food insecure if those aspects are limited exclusively due to budget constraint[5]. In particular, households cutting on food quantity are defined "Insecure households with hunger", which denotes the moderately and severely insecure ones.

Radimer et al. (1990) identify such dimension in their interviews by asking respondents about "How often are you hungry, but you do not eat because you cannot afford enough food?", "Do you eat less than you think you should because you do not have enough money for food?", "My child(ren) is/are not eating enough because I just cannot afford enough food" and "I know my child(ren) is/are hungry sometimes but I just cannot afford more food". Generally, items concerning food quantity contain wording (ordered according to increasing severity) such as "enough/lack of food", "eating less/until satisfied", "cut size of meals", "skip meals", "do not eat the whole day", "went to bed hungry".

Similarly to food quality items, also for the food quantity ones several interpretation and translation problems raised when applying the HFSSM and HFIAS scales around the world. For example, the concepts of "smaller" and "fewer", "meal portion" and "meal frequency" were difficult to distinguish in Malawi and Zimbabwe (Deitchler et al., 2010).

The households affirming items of food quantity are usually the ones more severely food insecure and, it is often assumed, the ones cutting children food are in the most extreme conditions. However, while such assumption is usually validated by the literature with regard to food quality-related strategies (see the above discussion), there is still a mix

[5] The only exception is the investigation conducted in the Pacific island of Vanuatu, where the researcher decided that, since more than 75% of the population are subsistence farmers, the focus on the lack of money as a reason for not consuming/accessing food was inadequate. Hence, all the questions of the HFSSM adapted scale related to food production and purchasing capacity (Renzaho, 2006).

evidence when it comes to food quantity-related strategies, showing that maternal buffering is not universal and homogeneous across cultures. For instance, Coates et al. (2003) report that studies looking at intra-household food allocation affirm that in countries such as China and Myanmar a "contributions rule" is the main criteria for distributing food: individuals contributing the most are the ones receiving the highest food shares. Also Renzaho (2006) reports that in the Pacific island of Vanuatu breadwinners are fed first and in case of food shortage they are the last to be affected, at the expense of household children. Hence, children occasionally skipping meals might be one of the several forms of adjustment put in place by the household in order to guaranteeing the survival of all the members.

Evidence that households prefer to cut first on adults' meals and then on children's meals comes from **Russia** (Welch et al., 1998), where mothers report more often being hungry (11.9%) than their children (2.8%) and are more likely to eat less (28.2%) than their children (15.2%). Similarly, in **Venezuela** (Lorenzana and Mercado, 2002) both poor and very poor households present a higher percentage of adults declaring to reduce the frequency (13% and 31%) and the amounts of meals (13% and 30%) and to go to sleep hungry (5% and 15%) than decreasing the frequency of children's meals (2% and 16%), their amounts (2% and 8%) and to let them going to sleep hungry (1% and 5%).

In **Trinidad and Tobago** coping strategies appear to mainly involve adults' sacrifice: 20% of them report skipping meals (against 9% of children), 21% eat less (against 10% of children) and are more likely to be hungry (23% against 10% of children) (Gulliford et al., 2006). In addition, adults appear to buffer children[6] against food insecurity also in the **Dominican Republic**. While it is quite common for both children and adults to not eat enough (79.6% and 81.8%, respectively), adults are more likely to cut size or skip meals [7] (75.5%) than children (cut size of meals 66.7%, skip meals 60.2%) and to be hungry (72.7% vs 61.3%) (Bezuneh et al., 2008). The same results are found in **Ecuador**, where Hackett et al. (2007)[8] show that quite often children and adults eat less, but skipping meals and not eating for a whole day concerns more often adults than children.

In contrast, a case study from **Haiti** (Pérez-Escamilla et al., 2009) shows that coping strategies about food quantity might actually directly address children as often as adults. Indeed, 77.8% of the mothers interviewed report that their children eat less food because there is not enough, against 70.8% of adults, and that almost as many children as adults felt hungry but did not eat because there was not enough food (56.2% and 58.8%, respectively).

Some countries present strategies buffering children food insecurity together with other strategies hitting all members (more or less) equally. Pérez-Escamilla et al. (2004) find that

[6] In this case children are aged below 15 years old, while usually in the HFSSM, HFIAS and ELCSA household members up to 17 years old are defined "children".

[7] Unfortunately the two conditions are merged in the same question for adults, while for children they are separated.

[8] Affirmative item responses percentages are not reported.

among poor[9] households in the city of Campinas in **Brazil** more than 50% of adults and children report reducing the size of meals or skipping it totally[10] and almost 50% of adults and children eat less than they should because of lack of food. Instead, many more adults than children go hungry (30% against less than 20%) and spend a whole day without eating (20% and none). Furthermore, in **Ecuador** (Hackett et al., 2007) diminishing the number of children's meals is much rarer than adults skipping meals, while reducing the amount of food concerns the same percentages of adults and children. Finally, in **Indonesia** (Studdert et al., 2001), parents prefer to feed children with less food (24.4%) rather than decreasing their diet variety (19%), while they more often eat the same food (40.7%) rather than eating less than they want to (30.8%). Quite interestingly, cutting the amount of food concerns almost equally children and adults (24.4% and 30.8%, respectively).

Several studies do not include questions about children, due to the fact that sometimes the rate of responses were very low for food quantity items concerning children, or because respondents found it difficult to answer the questions on behalf of all the household's children, given their different ages and needs, or some other times it was not the mother to be interviewed but the male household head, which is supposed to know less about child feeding practices (Coates, 2004). Even in adults scales alone food quantity items are reported less often than quality and uncertainty items, being characteristic of the more severe food insecure households.

In **Bangladesh** (Coates et al., 2006b) the most common strategy for dealing with food insecurity is eating less food (37.3%, much more than worrying about food (25.7%)), less squared meals (23.2%) and skipping meals (17.3%). Quite surprisingly, running out of food is more common than taking a loan at a shop food (15.7% and 13.3%), while relying on closer networks is more common (21% take a loan from friends). Pretty rarely a working adult will skip a meal (8.4%) and almost never go a whole day without eating (0.7%).

By comparing two communities in **Mozambique** in the pre and post-harvest periods in 2006-2007, it appears that the both managed to decrease the severe food insecurity prevalence of households, but Chibabava, the one hit by a natural catastrophe before the harvest period, decreased it less than Gondola. For instance, households skipping meals for a whole day went from 67% to 53% in the former, while in the latter they moved from 42% to 20%. Similarly, in terms of Body Mass Index, the amount of adults with less than 18.5 decreased from 10.9% to 7.3% in Chibabava, and from 10.9% to 5.2% in Gondola (Comité Cientifico de la ELCSA, 2012).

Another studying exploiting the panel dimension and the harvest seasons, is the one conducted in North **Burkina Faso** by Frongillo and Nanama (2006), which find that

[9] Poor households are those earning less than the minimum wage. Similar patterns, but with lower percentages, are, however, found among households in the sample earning the minimum wage or more.

[10] Unfortunately the two items were merged into one question, making it impossible to know which of the two components contributed most at the positive answers.

the daily food ration from the collective store is reduced (since the last harvest) by 73% of households in the pre-harvest season, but only by 29% in the post-harvest period. Similarly, the amount of respondents reporting having decreased the number of daily meals drastically drops from 65.1% to 25% across the two seasons. A more in-depth analysis might assess households' resilience from one period to the other and identify those that are chronically and temporary insecure, in order to address specific policies for avoiding severe food insecurity in times preceding the harvest.

Testing the HFIAS scale in **Tehran**, Mohammadi et al. (2011) finds that, among the coping strategies concerning food quantity reduction, adults are likely to cut on meals' size as well as on their frequency[11], while almost none passes a whole day and night without eating.

It is difficult to derive a unique conclusion about intra-household food allocation when we look at the coping strategies put in place with respect to cutting food quantity. While children seem to be less affected than adults by the *quality* reduction, a different patterns appear when looking at *quantity* reductions. On the one hand it is evident that both adults and children experience not only food insecurity in terms of reduced diet quality and variety, but also in terms of actual quantities eaten. However, on the other hand, the extent to which reducing meals' size or frequencies is due to preferences, buffering behaviours or contribution rules is hard to say.

# 7 Relation between multidimensional and unidimensional measures of food security

There is a lack of evidence about the causal link between per capita food expenditures and food insecurity (as defined by the multidimensional scales) with few studies showing only a negative correlation[1]. If increased income might have a positive effect on expenditures, however the impacts of those on food security conditions are not yet clearly assessed. For instance, Melgar-Quiñonez et al. (2006) find a negative correlation between food insecurity and daily per capita food expenditure (-0.39 in Bolivia, -0.15 in Burkina Faso and -0.27 in the Philippines)[2], with secure households having a significant higher expenditures than the insecure ones, but, when looking at different levels of insecurity, only in Bolivia moderately food insecure households present significant higher expenditures than severely insecure ones, while in the Philippines and in Burkina Faso there is

[11] Among severely insecure respondents in both cases reported by 6.8%; among moderately insecure "cut meal size" is reported by 9.5% and "eat fewer meals" by 5.4%; for mildly insecure "cut meal size" is reported by 9.6% and "eat fewer meals" by 5.3%

[1] In this regard, a decrease/increase is difficult to interpret, being aware of the fact that more insecure households devote a higher share to food expenditures, but not always present a lower amount of food expenditures than secure households (Melgar-Quiñonez et al., 2006)

[2] Similarly, when looking at the continuous food insecurity variable, for each increasing point in the food insecurity score, total daily per capita food expenditures are significantly lower in Bolivia (-0.54) and in the Philippines (-1.96) but are not statistically significantly lower in Burkina Faso.

no statistically significant difference. By estimating an ANOVA model, the difference in daily per capita food expenditures between secure and insecure households is significant, but the difference between the moderately and severely groups is not. Also in Indonesia, during the 1998 crisis, food secure households have slightly higher total food expenditures (34,000 Rupiah) than insecure ones (30,000 rupiah), but no difference among different levels of severity are detected in the Indonesian sample (Studdert et al., 2001).

The choice of the variable for expressing food expenditures leads to different results. Alvarez et al. (2006) shows that when considering annualized food expenditures per capita there is no correlation with food insecurity, while when looking at daily per capita dimensions the correlation is significant (-0.5 in Bangladesh and -0.32 in Uganda).

With respect to socio-economic status, the causal relation between increased income and food security is not yet assessed in the literature, where only a positive correlation so far has been found between the income level and the food security score, where food insecure households have almost always a statistically significant lower income than food secure ones (Melgar-Quiñonez et al., 2008; Gulliford et al., 2006; Pérez-Escamilla et al., 2004; for women's income Bezuneh et al., 2008; Frongillo and Nanama, 2006; Fiszbein and Giovagnoli, 2004; Lorenzana and Mercado, 2002; Welch et al., 1998; Oh and Hong, 2003; Mohammadi et al., 2011; for household dietary diversity Hoddinott and Yohannes, 2002). In this regard, in Bangladesh, when taking into account the poverty line, 92% of the poor households were classified as moderately or severely food insecure, with the highest incidence of poverty being among the moderately ones (52.6%). Similarly, in Uganda 84% of the poor households were classified as moderately or severely food insecure, with the highest incidence of poverty being, instead, among severely insecure ones (Alvarez et al., 2006). Insecure households appear to be poorer and to spend less on food also in Iran (Mohammadi et al., 2011) and in Burkina Faso during the pre-harvest season (Frongillo and Nanama, 2006). Hypothesis of a positive impact of income on food security represent a relevant future research path. Further research has to be conducted whether, with an increased household production and income, the diet patterns change, and/or are more diversified, more nutritious, if there is a different food allocation within the households, and an income effect such that more expensive foods are preferred (see Grainer and Mitra (1995)).

So far the literature has not examined the effects of a variation in income on food quality and variety, limiting the analysis to the description of the different food groups consumed by households according to their level of food insecurity. The only study that manages to exploit an exogenous change of income is the one by Studdert et al. (2001), which uses a sample of 1440 households randomly selected in Java during the Indonesian crisis and interviewed about their current and previous year expenditures[3]. Food expenditures increase for all households, but increase less for secure ones (17%, from 34,000

[3] The recall of expenditure levels is considered by the authors as reliable, when comparing the collected information with official data on price variation.

to 51,000 *rupiah*) than for insecure ones (14%, from 30,000 to 44,000 *rupiah*), probably due to the high inflation rate occurred in Indonesia during the crisis, when the consumer price index rose from 29% to 138%. They find that households more often decreased the frequency of meals, rather than the quantity of food intake, and undertook compromises in the diet composition that were divergent from the cultural norms and expectations for diet[4]. The impact on food stores is not yet clear when income decreases: on the one hand farmers reported increasing them and not selling any more their products, on the other hand people were de-cumulating them and selling everything they could. Storing food might be only a short-term strategy, its efficacy depending on the type of food and the storing conditions.

There is still a lack of evidence about the impacts of exogenous changes in household's resources on other unidimensional measures, such as micronutrient deficiency levels, dietary intakes and anthropometric indicators, on which there are still mix results about their correlation with food insecurity. Mean intakes of vitamin C and A are higher and those of carbohydrate and thiamin are lower in food secure households as compared to insecure ones, while there is no difference in terms of energy and protein intakes in Iran (Mohammadi et al., 2011). In contrast, once adjusting for household welfare status, monthly income, children's gender and age and caretaker's characteristics, in Korea food insecure children are heavier than food secure and nutrient intakes were the highest among insecure children, because their diet quality was extremely poor mainly made of low-cost and quality food (Oh and Hong, 2003).

Diet quality appears relevant also in Haiti, where, after controlling for child body mass index severe households food insecurity was still associated with malaria risk (while child anthropometrics were not): since BMI reflects energy intake, the food security dimension associated with the risk of contracting malaria pertains to food quality(Pérez-Escamilla et al., 2009). Adult's BMI is also negatively associated with food insecurity in Burkina Faso during the pre-harvest season, while child anthropometrics and women's mid-upper arm circumference are not (Frongillo and Nanama, 2006). In contrast, in Mozambique women's BMI is not associated with food insecurity (FAO, 2008). Evaluating the long-term effect of a health, nutritional and agriculture project in the Pacific islands of Vanuatu, Renzaho (2006) find that five years after the end of the project, the treated island population was more food secure than the inhabitants of the control island, and children were less stunting and underweight (i.e. presented higher Height-for-Age and Weight-for-Age), while no difference was found in terms of wasting (Weight-for-Height), given that both children's height and weight were statistically higher in the treated island. Similarly, in Antioquia (Colombia) food insecure households present the higher percentage of stunting and underweight children[5]. In addition, household food insecurity appears also signifi-

[4] Rice, fish and meat were substituted by tofu, corn or cassava, making the diet not corresponding any more to cultural and tastes preferences.

[5] Cautious must be made in interpreting the results since one half of the sample (n=1299) was lost in the model because of missing item responses.

cantly associated with illness (child parasites, respiratory infections, diarrhea) (Hackett et al., 2008).

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FOODSECURE
FOR POLICIES THAT MATTER

## The FOODSECURE project in a nutshell

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| Title | FOODSECURE – Exploring the future of global food and nutrition security |
| Funding scheme | 7th framework program, theme Socioeconomic sciences and the humanities |
| Type of project | Large-scale collaborative research project |
| Project Coordinator | Hans van Meijl (LEI Wageningen UR) |
| Scientific Coordinator | Joachim von Braun (ZEF, Center for Development Research, University of Bonn) |
| Duration | 2012 - 2017 (60 months) |

**Short description**

In the future, excessively high food prices may frequently reoccur, with severe impact on the poor and vulnerable. Given the long lead time of the social and technological solutions for a more stable food system, a long-term policy framework on global food and nutrition security is urgently needed.

The general objective of the FOODSECURE project is to design effective and sustainable strategies for assessing and addressing the challenges of food and nutrition security.

FOODSECURE provides a set of analytical instruments to experiment, analyse, and coordinate the effects of short and long term policies related to achieving food security.

FOODSECURE impact lies in the knowledge base to support EU policy makers and other stakeholders in the design of consistent, coherent, long-term policy strategies for improving food and nutrition security.

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|---|---|
| EU Contribution | € 8 million |
| Research team | 19 partners from 13 countries |

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