MINIMUM NUTRITION DATASET FOR AGRICULTURE: VALIDATION OF A SURVEY INSTRUMENT TO MEASURE DIETARY DIVERSITY IN MAHARASHTRA AND TELANGANA

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To Whomsoever It May Concern

This is to certify that this project report **"Minimum Nutrition Dataset for Agriculture: Validation of a Survey Instrument to Measure Dietary Diversity in Maharashtra and Telangana"** is a bonafide record of work done by **Mr. Nathaniel Alex Córdova, Mr. Christian DiRado-Owens, Ms. Kathryn Merckel, Mr. Andrew Pike and Ms. Amrita Rao** under my supervision and submitted to International Crop Research Institute for the Semi-Arid Tropics, (ICRISAT), Patancheru, Telangana, India.

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DECLARATION

We do hereby declare that this paper entitled "**Minimum Nutrition Dataset for Agriculture: Validation of a survey instrument to measure dietary diversity in Maharashtra and Telangana"** is an original and independent record of project work undertaken by us under the supervision of **Dr. M.C.S. Bantilan at Markets, Institutions, and Policies, International Crops Research Institute for Semi Arid Tropics (ICRISAT), Patancheru, India**, during the period of our internship through the Tata-Cornell Agriculture and Nutrition Initiative (TCi).

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Respectfully,
The TCi Intern Team

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ABSTRACT

As part of a joint collaboration between the Tata-Cornell Agriculture and Nutrition Initiative (TCi) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), a survey instrument was designed to capture the most essential dietary information at both the individual and household levels and to be integrated into existing agricultural surveys. The instrument, one module of a larger Minimum Nutrition Dataset for Agriculture (MNDA), was developed and pilot tested to collect individual and household level dietary diversity scores in four villages in Maharashtra and Telangana. Focus group discussions were held to better understand and contextualize the results of individual surveys. 142 women between the ages of 18 and 45 responsible for household cooking were interviewed about their own consumption and that of their families. The validity of the tool was then assessed by comparing the scores generated by the MNDA to those collected and calculated by ICRISAT's intensive nutrition survey. Informal market visits were also conducted at three markets serving the four study villages to contextualize the food supply in the local region, as well as to gather qualitative data regarding market actors, infrastructure, and market development. It was found that in evaluating dietary diversity of the woman, a three-day recall using the MNDA survey was most similar to the intensive nutrition survey, while for measuring household dietary diversity, a 24-hour recall yielded the most similar results. For both women and household dietary diversity, the length of recall made a significant difference in the results. After comparing the dietary diversity scores generated by the MNDA to those of the intensive nutrition survey, it was concluded that the survey design and general methodology could be adapted to many different populations. The MNDA shows promise but further research into the results is necessary to examine the efficacy of the tool in measuring dietary diversity.

Keywords: *Dietary diversity, recall period, Tata-Cornell Initiative, ICRISAT, consumption, market, nutrition*

INTRODUCTION AND BACKGROUND

I. Tata-Cornell Agriculture and Nutrition Initiative and ICRISAT

The Tata-Cornell Agriculture and Nutrition Initiative (TCi) is a long-term research project 'focusing on the design and evaluation of innovative interventions linking agriculture, food systems, human nutrition, and poverty in India (Cornell University, 2014). Founded in 2013 with a generous gift from the Tata Education and Development Trust, TCi has partnered with organizations across India to 'reduce rural childhood stunting and safeguard cognitive and physical development' (Cornell University, 2014). TCi collects data regarding issues of agriculture, health, and nutrition. Most recently, TCi has partnered with the Markets, Institutions, and Policies Program of the International Crops Research Institute for the Semi-Arid Tropics in the summer of 2014 to further this goal.

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a member of the Consortium Group of International Agricultural Research (CGIAR), based outside of Hyderabad, India (ICRISAT, 2014a). The organization conducts research with the aim of improving the lives and livelihoods of smallholder farmers in semi-arid tropical regions of the world, notably through a strategy of inclusive market-oriented development (ICRISAT, 2014a).

In order to accomplish this, ICRISAT operates a variety of research programs involving hybrid crops and genomics, markets and policy development, and nutrition, to name a few (ICRISAT, 2014a). Recently, a forum looking to understand gender relations was launched (ICRISAT, 2014a). A key element of this work at ICRISAT has been intensive longitudinal data collection, most notably through the Village Level Study project, widely considered to be the golden standard of agronomic and socioeconomic data collection.

II. Village Level Study and the VDSA

In the mid 1970s, ICRISAT launched a data collection effort in six rural villages in the Indian states of Maharashtra and Telangana. This interdisciplinary effort, known as the Village Level Study (VLS), captured a multitude of information relating to technological adaptation and on-farm productivity, socioeconomic status and household consumption, labor and employment, as

well as dietary diversity and nutrition. Though this initial data collection came to an end, the study resumed post-2001, and additional villages and regions were added to the sample.

In 2009, this work was expanded through the launch of the 'Village Dynamics in South Asia' (VDSA) project funded by the Bill and Melinda Gates Foundation. The project, which aims to break the cycle of hunger and poverty of small farmers in South Asia, includes the launch of an intensive nutrition survey (ICRISAT, 2014b) This information captured over a period of 30 years, provides a wealth of information surrounding rural livelihoods as well as village dynamics and the changes that have occurred in these regions on both macro and micro economic levels (ICRISAT, 2014b).

III. The Minimum Nutrition Dataset for Agriculture: Why the VLS villages?

TCi has launched an ambitious project with its partners titled the 'Minimum Nutrition Dataset for Agriculture' (MNDA). The primary aim of the MNDA is to 'gather consensus on the most essential nutrition metrics for inclusion into current and future longitudinal agriculture surveys (Ricketts, 2014). The current iteration of the MNDA consists of several modules:

- Module 1: Anthropometry/clinical nutrition indicators
- Module 2: Biochemical markers
- Module 3: Household-level and market-level dietary diversity and quality scoring (household food access)
- Module 4: Metrics around intra-household allocation (individual food access)
- Module 5: Early childhood care in the first 1,000 days of life

After consultation with on the ground partners in India, a decision was made to pilot the household-level and market-level dietary diversity module during the summer of 2014.

This module would be piloted by a team of TCi intern researchers in collaboration with ICRISAT staff and field investigators (Ricketts, 2014). Due to the extensive information collected during the Village Level Study, it was decided that the dietary diversity module would be implemented in four of these villages: Aurepalle and Dokur in Telangana, and Kinkhed and

Kanzara in Maharashtra. By piloting the dietary diversity module in the VLS villages, the TCi team would not only be able to validate the MNDA methodology through a comparison with intensive nutrition data, but also would be able to further investigate the links between agriculture and nutrition (Ricketts, 2014)

The Sample Villages

Dokur and Aurepalle, Mahabubnagar District - Telangana

Dokur is situated 125 kilometers south of Hyderabad (Rama Krishna et al., 2011). In 2010, the village had approximately 3,000 residents and 545 households (Rama Krishna et al., 2011). The population of the village belongs to five caste groups and 24 individual castes in the village (Rama Krishna et al., 2011). Agriculture has been the primary occupation in the past, however many families have diversified their occupations to include non-farm labor, a significant proportion of which involves migration to urban regions for employment (Rama Krishna et al., 2011). The primary agricultural crops grown in the village are rice, castor, pigeon pea during *Kharif* (rainy season) and groundnut and rice during *Rabi* (spring season) (Rama Krishna et al., 2011). Infrastructure has improved in the village with electricity in 1962, as well as streetlights and a concrete road running through the village center (Rama Krishna et al., 2011). Water is obtained through bore wells stored in tanks that are distributed through a number of private taps and public distribution points (Rama Krishna et al., 2011). The road connecting the village to the nearest highway, however, is not cemented (Rama Krishna et al., 2011).

Aurepalle is located about 60 kilometers south of Hyderabad (Reddy et al., 2011). The village has close to 5,000 residents, and close to 1000 households (Reddy et al., 2011). These households fall into four caste groups, with 23 individual castes present in the village (Reddy et al., 2011). Agriculture is still the central occupation of more than half of village residents (Reddy et al., 2011). Emphasis is placed on commodity crops in the area, with cotton and rice accounting for the majority of production during *Kharif*, and rice and groundnut during *Rabi* (Reddy et al., 2011). The village was also electrified in 1962, with a tarred road running to Amangal, the nearest town that connects to Hyderabad (Reddy et al., 2011). Drinking water is available through multiple tanks that utilize the Krishna river as a source (Reddy et al., 2011).

Kanzara and Kinkhed, Akola District – Maharashtra

Kanzara is located in the Akola District of Maharashtra, approximately 600 kilometers from the state capital Mumbai, and 528 km away from ICRISAT in Patancheru, Telangana (Dhumale et al., 2011). It is 50 kilometers from Akola, and nine kilometers away from Murtizapur, the nearest 'market town' (Dhumale et al., 2011). The population of the village is just over 1,400 individuals, with approximately 300 households (Dhumale et al., 2011). 13 castes have a presence in the village (Dhumale et al., 2011). Agriculture is the primary occupation, responsible for upwards of 85% of income (Dhumale et al., 2011). During *Kharif* the majority of hectares are dedicated to soybean production (Dhumale et al., 2011). Kanzara was electrified in 1964, with more than 90% of households having access (Dhumale et al., 2011). Tar roads connect the village, with buildings typically built out of brick and concrete (Dhumale et al., 2011). Bore wells are utilized, but there is also the presence of government taps receiving water from an overhead tank (Dhumale et al., 2011).

Kinkhed is also located in Akola district, located 12 kilometers south of Murtijapur (Likhitkar, 2011). It is a small village with a population of 876 across 189 households (Likhitkar, 2011). There are 12 castes represented in the village (Likhitkar, 2011). Much of the population is landless, and agricultural labor is provided by close to 40% of all households amongst other income diversification strategies including migration to larger towns like Murtijapur (Likhitkar, 2011). Agriculturally, soybeans are the primary crop grown in the region, followed by Bt cotton, sorghum during *Kharif,* and wheat in *Rabi* (Likhitkar, 2011). In terms of infrastructure, the village is improving, although much work is necessary. Only 20% of the households have toilets, and 30% of households have drinking water taps (Likhitkar, 2011). During rain shortages, water is acquired through the use of uncovered wells (Likhitkar, 2011). Tarred roads connect the village to the highway, which is only two kilometers away (Likhitkar, 2011).

REVIEW OF LITERATURE

I. Linking agriculture and nutrition

Agriculture is important in food production and as a primary form of employment. It plays a crucial role in determining food availability and access, dietary diversity, and nutrition (Gillespie et al., 2012). Proper nutrition, in turn, affects agricultural productivity (Gillespie et al., 2012). Despite this link, agricultural initiatives often fail to collect nutritional information (Gillespie et al. 2012). The intent of the Minimum Nutrition Dataset for Agriculture (MNDA) is to design a survey tool that gathers sufficient data to track basic individual and household nutritional status and that can be easily integrated into existing agricultural surveys (Ricketts, 2014)

"The Agriculture-Nutrition Disconnect in India: What do we know?"
S. Gillespie, J. Harris, & S. Kadiyala

Despite rapid economic growth, India still grapples with high rates of malnutrition (Gillespie et al. 2012). Little has been done to establish a concept of malnutrition that goes beyond consuming a dearth of calories (Gillespie et al. 2012). Agriculture employs more than 50 percent of the labor force in India and has the capacity to improve availability of and access to diverse foods (Gillespie et al. 2012). For this reason, agriculture plays a vital role not only in nutrition, but also in the economy as a whole (Gillespie et al. 2012). A conceptual framework for understanding the factors that influence nutrition produced by the United Nations Children's Fund (UNICEF) in 1990 highlighted the importance of looking at food when trying to understand nutritional status (Gillespie et al. 2012). Using the UNICEF framework as a guide, this paper defines seven pathways linking agriculture and nutrition and reviews current evidence on the validity of these linkages (Gillespie et al. 2012). The seven pathways linking agriculture and nutrition are:

1) Agriculture as a source of food – crops cultivated by the household being consumed (Gillespie et al. 2012).
2) Agriculture as a source of income – wages for agricultural laborers or earnings from sale of food produced (Gillespie et al. 2012).

3) Policies and food prices – food prices affected by a variety of supply and demand factors, in turn affecting the way foods are bought, sold, and consumed (Gillespie et al. 2012).
4) How income from agriculture is spent – whether or not non-food expenditures include nutrition related activities, such as healthcare and education (Gillespie et al. 2012).
5) Women's socioeconomic status – a woman's decision-making capabilities and autonomy
6) Women's care – ability to manage feeding and health of young children (Gillespie et al. 2012).
7) Women's own nutritional status – when agricultural work energy expenditure exceeds intake or dietary diversity is compromised (Gillespie et al. 2012).

This paper serves as an evidence base for the TANDI initiative – Tackling the Agriculture-Nutrition Disconnect in India initiative, and emphasizes the need for more data connecting agriculture to nutrition (Gillespie et al. 2012).

"Households' Dietary Diversity, Farm Income, and Technical Efficiency Correlates: Empirical Evidence from Small-scale Farming Households in Nigeria"
M. Adewumi & J. Animashaun

This study examines the relationship among households' efficiency, farm income, and dietary diversity in the state of Kwara, Nigeria. While a negative relationship between technical efficiency and households' farm income and dietary diversity were shown, a strong positive relationship between farm income and household dietary diversity was found (Adewumi & Animashaun, 2014). Enhancing agricultural productivity, therefore, may not have much of an effect on farm income and nutritional status (Adewumi & Animashaun, 2014). This could be because there exists a "lack of efficient processing and market facilities that would enable farmers [to] optimally utilize the benefits of increased output resulting from productivity gains" (Adewumi & Animashaun, 2014). That is, they are unable to effectively process and sell much more than what they are selling now. The study recommends that policy be directed at making it easier for farmers to reap benefits from increased output and to focus attention on increasing farm income when looking to increase food security and dietary diversity (Adewumi & Animashaun, 2014).

II. What can dietary diversity tell us about nutritional status?

Dietary diversity is a valuable measure of nutritional status in terms of nutrient access and food security (Ruel, 2002). Individual level dietary diversity analysis is predictive of nutrient adequacy, while household level dietary diversity analysis is predictive of household food security and overall socioeconomic status.

"Is Dietary Diversity an Indicator of Food Security or Dietary Quality? A Review of Measurement Issues and Research Needs"
M.T. Ruel

Dietary diversity is one component of nutrition, and there is a need to make sense of its association with nutrient adequacy and food security. Dietary diversity is measured by counting the number of different food groups consumed during a fixed time period, called a reference period (Ruel, 2002). There are multiple methods to measure dietary diversity, making it difficult to compare results among various studies (Ruel, 2002).

That being said, research on dietary diversity in developing countries has shown a positive relationship between individual dietary diversity and nutrient adequacy (Ruel, 2002). Analysis of household-level dietary diversity is strongly associated with household food security, as measured by per capita consumption and energy availability (Ruel, 2002).

One study in Mali showed that individual dietary diversity is in fact related to nutrient adequacy (Hatloy et al., 1998). Two types of diversity scores were established: a food variety score, which is a count of the number of foods consumed, and a dietary diversity score, which is based on eight food groups. The researchers then measured the dietary diversity of respondents with an average age of 36 months (Hatloy et al., 1998). The study displayed that the dietary diversity score based on food groups was a stronger determinant of nutrient adequacy than the score based on food variety (Hatloy et al., 1998). Increasing food groups rather than the number of individual foods had a greater impact on nutrition (Hatloy et al., 1998).

Two years later, using data from Mali, a study was conducted to test the association between dietary diversity and socioeconomic status (Hatloy et al., 2000). Researchers used the same two

aforementioned measures of dietary diversity, but this time for the *household* rather than the individual (Hatloy et al., 2000). Socioeconomic status was assessed based on the number of household assets. The study showed that dietary diversity increases with socioeconomic status, with great disparity in dietary diversity between urban and rural areas (Hatloy et al., 2000).

The answer to the question posed in the title of this paper, therefore, is that individual level dietary diversity is predictive of nutrient adequacy, while household level dietary diversity is predictive of household food security and overall socioeconomic status (Ruel, 2002). The paper recommends that more research be undertaken on using dietary diversity as a measurement tool for learning about nutrition (Ruel, 2002).

"Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso"

M. Savy, Y. Martin-Prével, P. Sawadogo, Y. Kameli, & F. Delpeuch

Conducted in a rural area of Burkina Faso, the purpose of this study was to assign dietary diversity scores to individual women and to assess the relationship between dietary diversity and overall nutritional status of the woman (Savy et al., 2005). A 24-hour recall was conducted to capture both a food variety score and a dietary diversity score (Savy et al., 2005). Certain anthropometric measures - body mass index and mid-upper arm circumference - were evaluated to assess overall nutritional status (Savy et al., 2005). A clear relationship was shown between both the food variety score and the dietary diversity score with the measured nutritional indices, showing that dietary diversity can be used to assess the overall dietary quality of women living in this context (Savy et al., 2005).

METHODS

I. Developing Survey Instrument

The aim of the dietary diversity module was to capture both a household-level score identifying household access and an individual score identifying a woman's nutritional status. In order to obtain rapid data on individual and household dietary diversity in a way that could be later adapted for use in multiple contexts, four main choices were made: a) who in the family to interview, b) how long of a recall period to use, c) whether or not to include foods consumed in small quantities, and d) how to disaggregate mixed dishes.

Because both individual and household dietary diversity were important to capture in a rapid, easily administered survey, the woman responsible for cooking in the household was chosen as the respondent. This woman, who was defined as being between 18 and 45 years old, would not only be able to recall what she ate herself, but also be able to relate what she cooked for the other members of her family, serving as a proxy for household consumption. Everything the woman consumed was included in her individual level dietary diversity score and in the household level score. Anything additional consumed by the family that was not consumed by the woman was also included in the household level score.

When deciding on a reference period, the accuracy of responses had to be considered against capturing the breadth of different foods consumed in the household. The possibility that 24 hours alone might be insufficient to capture the variety of foods eaten by the individual and the household was a concern. A study conducted by Drewnowski, et al. (1997) shows that the number of different foods consumed increases with time but plateaus at 15 days. The greatest increase in number of different foods consumed is between days one and three (Drewnowski et al., 1997). A three-day recall period was decided on, further supported by a recent review on operationalizing dietary diversity (Ruel, 2003).

It has been determined that for women of reproductive age, dietary diversity scores were better at capturing micronutrient adequacy of the diet when quantities of less than one tablespoon were

not included (Arimond et al., 2010). Foods consumed in quantities less than one tablespoon were therefore not included in the dietary diversity analysis.

The issue of disaggregating mixed dishes was tackled in two ways: holding focus group discussions and asking the respondent for the main ingredients in each dish. According to the FAO Guidelines for measuring household and individual dietary diversity, a survey team should organize a series of community meetings with key informants in each survey locality to add food items, refine food groups, and gather information about ingredients used in common mixed dishes (Kennedy et al., 2010). The focus group discussions - one mixed-gender and one female-only in each village – proved particularly helpful in providing information about common mixed dishes consumed, in addition to information about respondents and household dynamics. This information helped prepare us to probe respondents for specific ingredients and helped validate the responses they gave when relating the ingredients they used while cooking.

II. Focus Group Discussions

To crosscheck the assumptions made in designing the household surveys and to become more familiar with local communities, a set of focus group discussions (FGDs) was conducted. The main goals of holding a set of focus group discussions were a) to validate food groups by gathering specific food items for later categorization into appropriate groupings, b) to become familiar with local dishes to inform what ingredients should be probed for in the household surveys, c) to confirm the findings about common foods reported in the household surveys, d) to validate the use of women ages 18-45 with primary cooking responsibilities as the household dietary proxy, and e) to test the assumptions regarding meal times, dietary and consumption norms, cooking responsibilities, food sources, and food items consumed on special days or under special circumstances.

The team of investigators was broken up into three categories during the focus group discussions. One investigator was chosen to be the moderator who would facilitate the discussion by asking questions and ensuring that all participants were given the opportunity to speak. This role was filled by the in-country research supervisor who was familiar with the local customs and language. A second grouping of investigators was designated as translators who had an in-depth

understanding of both the languages spoken in the community. Lastly, the investigators designated to record the FGD took notes. In addition, each focus group discussion was captured on a voice recorder for later validation. Across the villages, the focus group discussions took on average one hour to complete.

The focus group discussion began by asking questions about meal times and the frequency of cooking across households. This allowed the investigator to link probing mechanisms with corresponding meal times to help the respondent recall the different food items consumed over a three day period. The investigator then probed for the common foods or mixed dishes eaten throughout the day according to meal times, and what ingredients compose the mixed dishes reported. In the case where a respondent may forget to report a common ingredient when describing a mixed dish, this becomes particularly important. For example, if ingredients "A," "B," and "C" go into mixed dish "X," and the respondent reports having included "A" and "C" but not "B" in the dish, the interviewer can confirm whether the respondent purposely omitted ingredient "B" or simply forgot to include it in his/her response.

The investigator then asked questions about cooking responsibilities in order to validate the assumptions about who is cooking, and if he or she can be used as a proxy for household level dietary information. Next, the investigator asked about food distribution and dietary differences within the households. This included meal preference, whether or not families eat the same foods, whether or not families eat together, how often foods are eaten outside the home, and if so, who eats, and what kinds of foods are eaten.

Additionally, to understand the relationship between household level diets and market availability and access, the investigator asked about the sources from which food is bought or accessed. This question was used to inform the source system used in linking reported food items to common places in which they are accessed. Lastly, the investigator asked questions regarding the cultural norms around food consumption during special events or circumstances. This included weddings, festivals, fasting days, during pregnancy or while breastfeeding, and for children under the age of five. With this information, investigators were better able to probe in the individual survey for key dishes and food items in case a respondent's consumption pattern is

affected by one or more of the special circumstances listed above during the three-day recall period.

The focus group discussions were held in neutral, mutually agreed upon locations selected by key informants and in-village investigators. The purpose of this was to avoid confrontation or potential exclusion of certain groups. The focus group discussions were also held at convenient times based on the local context and work hours to facilitate sufficient participation. As evidence of the importance of time and space neutrality in choosing a venue, one village in Telangana, Dokur, required an additional focus group discussion because members of the 'scheduled caste' were not allowed to enter the chosen locale. We thus held another discussion with members of the SC colony to ensure that we could hear voices from all different backgrounds and statuses in the community.

Photo 1. Field investigators and interviewers (top) conduct a women's focus group discussion. Photo credit: Ms. K. Kavitha

III. Administering the Survey in the Field

Before entering the field, investigators were comprehensively informed of the purpose of the study and trained on how to ask questions and probe for answers. The training was also an important period in which interviewers could get to know investigators and develop a rapport.

The efficacy of the survey was dependent on productive communication between the interviewer and field investigator. This required the investigator to understand the purpose and methodology of the instrument and accurately and impartially relay questions and responses. It was therefore crucial that the investigators read and spoke English proficiently.

There was an opportunity for discussion and practice in the form of role-playing—this was particularly important as it highlighted potential miscommunications and mistakes that might occur, such as other household members trying to answer questions. It was also necessary to ask investigators to translate all information that might help contextualize dietary diversity, and not just the meal ingredients and their sources. For example, one respondent bought pigeon pea from the market, but only because the PDS was out of stock.

Before administering the survey, the investigators explained local customs and greetings, which helped make households feel at ease during the interview. At the start of each interview, a consent form was read that explained who we were, the purpose of our research, and that all information was confidential. The information captured was double-checked with the respondent at the end of each recall day. Although the survey is designed to be easily administered by investigators that are not experts in nutrition and local diets, it was advantageous that our investigators were knowledgeable about food preparation, local ingredient names, and food groups. This helped them probe for ingredients and effectively capture information. After the interview, the methods and results were discussed with the investigator to identify ways to improve the process.

Photo 2. Field enumerator (far left) and interviewer (center) discuss the respondent's (far right) diet. Photo credit Ms. K. Kavitha.

IV. Entering Data

Data was input using Excel Version 14. Data entry was verified through use of spot-checking. Creating a list of all food ingredients encountered in the surveys was the first step. to All team members contributed to this list, which was checked to be both comprehensive and non-repetitive. In cases of food items with local names, a suitable English name was found using the "Index of Foodstuffs" in the book *Nutritive Value of Indian Foods* as well as with consultation of experts familiar with local diets (Goplan et al. ,1976).

For mixed dishes, the major ingredients were recorded as reported in the interview. For commercial foods of which the ingredients were not reported in the interview, ingredients were obtained through online searches. For example, Kurkure is a popular processed snack food with the major ingredient being corn. Each ingredient in this masterlist was then assigned to a food group based on the recommendations of the FAO report *Guidelines for Measuring Household*

and Individual Dietary Diversity (Kennedy, Ballard, & Dop, 2011). It should be noted that in the case of 'vitamin A rich vegetables,' no foods on the list met the requirements and so the category was not included in the data entry.

After sorting the ingredients alphabetically and by food group, they were transferred into a spreadsheet template that would add up the number of ingredients eaten by each respondent in each category, and then a total dietary diversity score for both the woman's and the household's one-day and three-day recalls was calculated. The MNDA survey was conducted using a three-day recall, with a one-day (24-hour) recall obtained post-interview by considering only the foods reported in the first day of recall. The first day of recall was that which was one day prior to the day of the interview, and was recalled first in the interview, thus not being biased by any recall of other previous days. These are referred to throughout analysis as the MNDA 3 Day and the MNDA 24hrs.

The Woman's Dietary Diversity Score (WDDS) is tailored to measure micronutrient adequacy of the diet, giving less weight to, or excluding, less micronutrient dense food groups such as white roots and tubers, cereals, and non-vitamin A rich fruits and vegetables (Kennedy, Ballard, & Dop, 2011). More weight is given to food groups rich in iron, vitamin A, and other micronutrients; these include dark green leafy vegetables, organ meats, eggs, legumes, nuts, seeds, and dairy (Kennedy, Ballard, & Dop, 2011). The score for the WDDS ranges from 0 to 9, with 9 being the most diverse diet possible (Kennedy, Ballard, & Dop, 2011). The Household Dietary Diversity Score (HDDS) indicates household access to foods, and includes items that are not necessarily nutrient rich, such as sweets, condiments and beverages, and aggregates fruits and vegetables regardless of vitamin A content (Kennedy, Ballard, & Dop, 2011) The HDDS score ranges from 0 to 12 (Kennedy, Ballard, & Dop, 2011).

DATA ANALYSIS

I. Tests and Hypotheses

Three hypotheses were developed to analyze our data. The first was to test the validity of our survey tool by comparing the results of the MNDA 24hrs and the VLS 2014 surveys. The null hypothesis was that the MNDA 24hrs would collect similar information as the intensive VLS nutrition module. The second was to compare the 24-hour and three-day recall periods of the MNDA surveys. The null hypothesis was that the MNDA 24hrs would collect similar information as the MNDA 3 Day. The third and final hypothesis was to test the validity of both the recall periods and survey tools by comparing the results of the MNDA 3 Day and the VLS 2014. The null hypothesis was that the MNDA 3 Day would collect similar information as the VLS nutrition module.

II. Selection, characteristics and limitations of baseline dataset

The VLS is a suitable measure of dietary diversity because of its intensive data collection process that captures portion size and all ingredients, no matter how small the quantity used. HDDS and WDDS in both the VLS and MNDA are calculated according to FAO guidelines. Therefore, the less intensive methods of the MNDA could be validated through a comparison of the results. It was important to select one VLS dataset as a baseline to simplify and focus analysis. The 2014 VLS nutrition module was selected because it was the most recent and complete dataset.

The VLS 2014 module was conducted in February through April 2014, while the MNDA survey was conducted in July 2014. This was a limitation to our data, as seasonality is a confounding variable in analysis. Ideally a baseline dataset from the same time period would be selected. Another potential limitation is that although HDDS is calculated in both datasets according to FAO guidelines regarding food groups, the scores themselves are calculated in different ways. In the MNDA, the woman's raw score (the sum of all food groups eaten, out of 15) is found, and then additional food consumed by the household are added to calculate HDDS. In the VLS, however, a raw score is calculated for each individual, and then foods are grouped to calculate an

Individual Dietary Diversity Score (IDDS) using the same formula as the HDDS. The combined IDDS are then averaged to calculate an HDDS.

III. Analysis of the data

Stata version 12 SE was used to analyze the data. In our analysis, three observations with missing data from the VLS 2014 were dropped. Near the end of our analysis, we identified four additional observations that had been dropped but should have been included. Post-tests indicated no significant difference to our results because of these dropped observations. Hence, out of 142 interviews, 135 observations were used in analysis.

Using a detailed summary in Stata, the mean, standard deviation, skewedness, and kurtosis were calculated for both the HDDS and WDDS of the VLS 2014, MNDA 24hrs, and MNDA 3 Day. Histograms were generated to further describe the data (see Appendix). In the WDDS, it was found that the VLS 2014 and MNDA 3 Day were normally distributed, but that the MNDA 24hrs was positively skewed. In the HDDS, it was found that the VLS 2014, MNDA 24hrs, and MNDA 3 Day were negatively skewed.

TABLE 1. WOMEN'S DIETARY DIVERSITY SCORE AS CAPTURED BY THE ICRISAT 2014 VILLAGE LEVEL STUDY AND MINIMUM NUTRITION DATASET FOR AGRICULTURE 2014 PILOT

Survey	VLS 2014	MNDA 24hrs	MNDA 3 Day
Mean±S.D.	5.26±.83	4.36±1.05	5.36±1.11
Variance	0.686	1.097	1.239
Skewdness	-0.281	0.432**	0.094
Kurtosis	2.668	3.838*	2.761

*sktest indicates significant difference from normality at the level p<.10
**significant at p<.05
***significant at p<.01

TABLE 2. HOUSEHOLD DIETARY DIVERSITY SCORE AS CAPTURED BY THE ICRISAT 2014 VILLAGE LEVEL STUDY AND MINIMUM NUTRITION DATASET FOR AGRICULTURE 2014 PILOT

Survey	2014 VLS	MNDA 1 Day	MNDA 3 Day
Mean±S.D.	8.03±1.00	8.04±1.05	9.30±1.04
Variance	1.007	1.112	1.089
Skewdness	-0.81***	-0.908***	-0.688***
Kurtosis	3.316	4.694***	6.781***

*sktest indicates significant difference from normality at the level p<.10
**significant at p<.05
***significant at p<.01

IV. Results

Hypothesis 1

The first hypothesis to be tested was that of the tool validation. The null hypothesis was that the means of the scores of the MNDA 24hrs and of the VLS survey (also a 24hrs recall) are the same. To reject or fail to reject this hypothesis would indicate the validity of the MNDA tool, using the same recall period as the VLS, to collect similar dietary diversity information. This relationship was examined for both the WDDS and HDDS results. A paired t-test was run to test for any differences in the mean. The results for the t-test of the first hypothesis for the WDDS and the HDDS are found in Tables 3 and 4 respectively.

TABLE 3. PAIRED T-TEST COMPARING MEANS OF THE WOMEN'S DIETARY DIVERSITY SCORES OF THE MINIMUM NUTRITION DATASET FOR AGRICULTURE 24HR RECALL AND THE ICRISAT VILLAGE LEVEL STUDY 2014

Variable	n=	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
MNDA 24hrs	135	4.356	0.0907	1.054	4.176	4.535
VLS 2014	135	5.269	0.0721	0.837	5.117	5.402
Difference	135	-0.904	0.122	1.419	-1.145	-0.662
mean(diff) = mean(WDDS_1DP_24hrs- INS_WDDS_2014)						*t = -7.4006*
Ho: mean(diff) = 0						*Degrees of freedom=134*
Ha: mean(diff) < 0		Ha: mean(diff) != 0			Ha: mean(diff) > 0	
Pr(T < t) = 0.0000		*Pr(|T| > |t|) = 0.0000*			*Pr(T > t) = 1.0000*	

It was found through the paired t-test that for the WDDS, there is a significant difference between the means of the MNDA 24hrs and the VLS 2014, t(134) = -7.40, $p < .001$, with the VLS 2014 having a higher mean. For the WDDS the null hypothesis of the surveys collecting similar information is rejected. In comparing the distribution and spread of the two sets of results, a two-sample variance-comparison test revealed that the variances are significantly different (p=.008). The VLS 2014 WDDS distribution is not significantly different from normal in skewedness nor kurtosis as reported above, whereas the MNDA is significantly different from normal in respect to both skewedness (p=.03) and kurtosis (p=.06).

TABLE 4. PAIRED T-TEST COMPARING MEANS OF THE HOUSEHOLD DIETARY DIVERSITY SCORES OF THE MINIMUM NUTRITION DATASET FOR AGRICULTURE 24HR RECALL AND THE ICRISAT VILLAGE LEVEL STUDY 2014

Variable	n=	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
MNDA 24hrs	135	8.044	0.089	1.036	7.868	8.221
VLS 2014	135	8.019	0.087	1.011	7.847	8.191
Difference	135	0.0252	0.114	1.326	-0.201	0.251
mean(diff) = mean(HDDS_1DP_24hrs- INS_HDDS_2014)						*t = 0.2205*
Ho: mean(diff) = 0						*Degrees of freedom=134*
Ha: mean(diff) < 0		Ha:mean(diff) != 0			Ha: mean(diff) > 0	
Pr(T < t) = 0.5871		*Pr(|T| > |t|) = 0.8258*			*Pr(T > t) = 0.4129*	

The HDDS, however, tells a different story. It was found that for the HDDS, there is not a significant difference between the means of the MNDA 24hrs and the VLS 2014, t(134) = 0.22, p=.826. We fail to reject the null hypothesis that the means of the two surveys are equal. Furthermore, a two-sample variance-comparison test found that the variances of the two distributions are not significantly different (p=.782). Neither of the distributions is significantly similar to a normal distribution, as reported above.

Hypothesis 2

The next test was to compare the results obtained using different recall periods. In order to test the differences in recall period, paired t-tests were run on the MNDA 24hrs and the MNDA 3-day for both the WDDS and the HDDS. The results of these t-tests are found in Tables 5 and 6 respectively.

TABLE 5. PAIRED T-TEST MNDA THE WOMEN'S DIETARY DIVERSITY SCORES OF THE MINIMUM NUTRITION DATASET FOR AGRICULTURE 24HR AND 3 DAY RECALLS

Variable	n=	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
MNDA 24hrs	135	4.356	0.091	1.054	4.176	4.535
MNDA 3 Day	135	5.356	0.095	1.109	5.167	5.544
Difference	135	-1	0.088	1.0221	-1.174	-0.826
mean(diff) = mean(WDDS_1DP_24hrs- WDDS_total_3day)						*t = -11.3672*
Ho: mean(diff) = 0						*Degrees of freedom = 134*
Ha: mean(diff) < 0		Ha: mean(diff) != 0			Ha: mean(diff) > 0	
Pr(T < t) = 0.0000		*Pr(|T| > |t|) = 0.000*			*Pr(T > t) = 1.0000*	

In the paired t-test comparison of means for the 24hr and three-day recall for the MNDA, a significant difference was found, t(134) = -11.37, p < .001, with the MNDA 3 Day having a higher mean. For the WDDS portion of the MNDA survey, we reject the null hypothesis of the different recall periods collecting similar information. In comparing the distribution and spread of the results of the different recall periods, a two-sample variance-comparison test revealed that the variances are not significantly different (p=.556). For the WDDS, the 24-hour recall is significantly different from normal in skewedness (p=.034) and in kurtosis (p=.056) as reported above, whereas the WDDS of the MNDA 3 Day is not significantly

different from normal in respect to skewedness nor kurtosis.

TABLE 6. PAIRED T-TEST OF THE HOUSEHOLD DIETARY DIVERSITY SCORES OF THE MINIMUM NUTRITION DATASET FOR AGRICULTURE 24HR AND 3 DAY RECALLS

Variable	n=	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
MNDA 24hrs	135	8.044	0.089	1.036	7.868	8.220
MNDA 3 Day	135	9.311	0.090	1.040	9.134	9.488
Difference	135	-1.267	0.086	1.009	-1.438	-1.094
mean(diff) = mean(HDDS_1DP_24hrs - HDDS_total_3days)						*t = -14.5873*
Ho: mean(diff) = 0						*Degrees of freedom = 134*
Ha: mean(diff) < 0		Ha: mean(diff) != 0			Ha: mean(diff) > 0	
Pr(T < t) = 0.0000		*Pr(|T| > |t|) = 0.0000*			*Pr(T > t) = 1.0000*	

Similarly, the paired t-test comparison of means for the one-day and three-day recall for the HDDS finds a significant difference, t(134) = -14.59, $p < .001$, with the MNDA 3 Day having a higher mean. Thus, for the HDDS portion of the MNDA survey, we reject the null hypothesis of the different recall periods collecting similar information. Using a two-sample variance-comparison test to examine the distribution of the results found that the variances are not significantly different (p=.962). For the HDDS, both the 24-hour and the three-day recall have distributions significantly different from normal in both kurtosis (p<.001 both) and skewedness (24hr: p<.001, 3 Day: p=.002).

Hypothesis 3

The third and final test of the MNDA survey against the baseline of the VLS 2014 survey is a validation of both the tool as well as the recall period. Comparing these two variables (survey tool, recall period) together means an increased risk of error, but for the purposes of pilot testing it will provide valuable information regardless. The null hypothesis for the third test is that the MNDA 3 Day recall and the VLS 2014 collect similar information. The results of the paired t-tests for the WDDS and the HDDS are shown in Tables 7 and 8 respectively.

TABLE 7. PAIRED T-TEST OF THE WOMEN'S DIETARY DIVERSITY SCORES OF THE MINIMUM NUTRITION DATASET FOR AGRICULTURE 3 DAY RECALL AND THE ICRISAT VILLAGE LEVEL STUDY 2014

Variable	n=	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
MNDA 3 Day	135	5.356	0.095	1.109	5.167	5.544
VLS 2014	135	5.259	0.072	0.837	5.117	5.402
Difference	135	0.096	0.119	1.387	-0.140	0.332

mean(diff) = mean(WDDS_total_3day - INS_WDDS_2014) *t = 0.8067*

Ho: mean(diff) = 0 *Degrees of freedom = 134*

Ha: mean(diff) < 0	Ha: mean(diff) != 0	Ha: mean(diff) > 0
Pr(T < t) = 0.7894	*Pr(|T| > |t|) =0.4212*	*Pr(T > t) = 0.2106*

The paired t-test comparison of means for the WDDS of the MNDA 3 Day and the VLS 2014 finds no significant difference, t(134) = 0.807, p = .421. For this third test of the WDDS, we fail to reject the null hypothesis that the MNDA 3 Day collects similar information as the VLS 2014 survey. In comparing the distribution and spread of the results of the different recall periods, a two-sample variance-comparison test revealed that the variances are significantly different (p=.001). Despite the difference in variance, both the MNDA 3 Day and the VLS 2014 WDDS results display a normal distribution for both skewedness and kurtosis.

TABLE 8. PAIRED T-TEST OF THE HOUSEHOLD DIETARY DIVERSITY SCORES OF THE MINIMUM NUTRITION DATASET FOR AGRICULTURE 3 DAY RECALL AND THE ICRISAT VILLAGE LEVEL STUDY 2014

Variable	n=	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
MNDA 3 Day	135	9.311	0.090	1.040	9.134	9.488
VLS 2014	135	8.019	0.087	1.011	7.847	8.191
Difference	135	1.292	0.111	1.286	1.073	1.510

mean(diff) = mean(HDDS_total_3days - INS_HDDS_2014) *t = 11.6714*

Ho: mean(diff) = 0 *Degrees of freedom = 134*

Ha: mean(diff) < 0	Ha: mean(diff) != 0	Ha: mean(diff) > 0
Pr(T < t) = 1.0000	*Pr(|T| > |t|)= 0.0000*	*Pr(T > t) = 0.0000*

It was found through the paired t-test that for the HDDS, there is a significant difference between the means of the MNDA 3 Day and the VLS 2014, $t(134) = 11.671$, $p < .001$, with the MNDA 3 Day having a higher mean. Thus, for the HDDS, we reject the null hypothesis of the MNDA 3 Day collecting similar information as the VLS 2014. In comparing the distribution and spread of the two sets of results, a two-sample variance-comparison test revealed that the variances are not significantly different (p=.745). The distribution of the MNDA 3 Day is significantly different from normal for both skewedness (p=.002) and kurtosis (p<.001) whereas the VLS 2014 HDDS distribution is only significantly different from normal in skewedness (p<.001).

DISCUSSION

Based on these results, the MNDA survey of dietary diversity shows promise in collecting accurate information as to the dietary diversity of both women and households. The largest and most relevant non-significant differences were found in the comparison of the MNDA WDDS 3 Day recall with the VLS WDDS 2014, and the comparison of the MNDA HDDS 24hrs recall with the VLS HDDS 2014. Given this disagreement in recall periods, we cannot advise as to which recall period would yield results most similar to the VLS 2014 baseline. The similarities, however, do warrant further exploration into the differences between the MNDA and the VLS surveys, as well as the limitations of the MNDA. Despite the significance of difference between some portions of the MNDA with the VLS 2014, it must also be kept in mind that for both the WDDS and the HDDS, at least one recall period was found to be not significantly different with the VLS 2014, a fact in favor of the validity of the MNDA to collect similar information as the VLS 2014.

In finding no significant difference between the MNDA 24hrs HDDS and the VLS 2014 HDDS, the methods by which these scores are calculated must be taken into account. In this discussion, raw score refers to the consumed food groups out of the fifteen total before the WDDS and HDDS were calculated as outlined in the MNDA methodology. Given this methodology, WDDS is always lower than or equal to the woman's raw score. HDDS, however, is calculated differently for the MNDA and the VLS. The VLS HDDS is calculated by obtaining an individual dietary diversity score (IDDS) out of 12 for each member of the household, then averaging all of the IDDS together. The MNDA, however, measures HDDS by adding additional food groups consumed by the family onto the raw diversity score of the interviewed woman, and calculating the HDDS from the raw total. Therefore, the design of the MNDA stipulates that HDDS must be the same or greater than the woman's raw score, and thus greater than the WDDS. The VLS makes no such stipulation.

We believe that this difference in calculation has far ranging impacts on the HDDS as reported by the VLS. The first of these is that it may result in overall lower HDD scores in the population observed. This is because in the VLS model, regardless of the woman's raw score, if other family members score lower than the woman, the composite HDDS will be lower than the

woman's score. In the MNDA model, lower individual scores in the family do not cause an overall lowering of the HDDS, and the minimum household raw score is the woman's raw score. In cases where the family members consume more foods groups than the woman, the VLS method would calculate a higher HDDS score that is theoretically also captured in the MNDA method. This may account for the significantly higher HDDS scores reported by the MNDA than the VLS 2014.

Another likely effect of the composite VLS HDDS is that outlying individual scores are mediated by being averaged with other scores. The MNDA contains no such mediating effect, and we did indeed notice a greater range for the sets of scores collected by the MNDA than the VLS. Because the HDDS is dependent on a woman recalling foods that other people consumed, we assumed that the HDDS would be an underestimation. Given that our three-day recall produces significantly higher HDDS scores than the VLS 2014, we must either reconsider our assumption or question the validity of using the VLS 2014 as a baseline for the HDDS portion of the MNDA survey based on the difference in score calculation.

The finding that the comparisons of the MNDA 3 Day and the MNDA 24hr revealed significant differences in the means contributes towards the ongoing discussion of the importance of recall period in determining valuable dietary diversity information. The two distributions for the HDDS exhibited similar negative skewedness and high kurtosis, whereas the WDDS distributions both had slightly positive skewedness. Although we did not conduct extensive analysis to prove the similarities of these distributions, in general we can conclude that the change in shape from the 24hr to the 3 Day recall change very little as the recall period increases, particularly for the HDDS. This would indicate that even though the mean is increasing significantly for both the WDDS and the HDDS, it is doing so in a uniform manner across the distribution, which would prove to be very useful knowledge in adjusting for differences between instruments created using different recall periods.

As discussed in the results section, the WDDS section of the MNDA 3 Day captures similar dietary diversity scores to the WDDS of the VLS 2014, but the WDDS portion of the MNDA 24hrs does not. We think that this may be because the VLS is intensive and captures all

ingredients, regardless of quantity, and thus greater diversity. The lighter probing of the MNDA requires three days to capture similar diversity. Alternatively, it could be due to other differences in methodology, such as the way in which fasting is captured. The MNDA 24hrs captures fasting and includes fasting days as part of the survey.

There are also a number of factors that were not taken into account in this analysis. The first of these is the similarity of information between the MNDA and VLS 2014 at the village level. A preliminary breakdown of the means, standard deviations, and t-test comparisons to the VLS 2014 data by village can be found in the appendix. In addition, the MNDA survey collected information on fasting, market days, and pregnancy and breastfeeding. These factors may affect the diversity of diets for the woman, and may reveal some differences in methodology that would explain the similarity of the MNDA 3 Day recall WDDS but not the 24hr recall with the VLS 2014.

LIMITATIONS

In this section, the limitations of this study will be outlined. The decision to have a reference period of three days instead of 24 hours sometimes resulted in women finding it difficult to remember what they or their families had eaten. It was not always possible to interview the respondent alone, and other family members sometimes intervened with their own responses or corrections to the responses of the primary respondent. It is also possible that some of the respondents were over-reporting what they consumed because of shame at lack of access to certain foods or guilt at not providing their children with perceived adequate diets. Caste divisions within the villages sometimes required us to make special provisions for members of the scheduled caste to have separate meeting places.

Out-migration can confound the use of a single proxy to measure household-level dietary diversity. During the data collection process in Dokur, for example, two respondents had just returned to the village the previous day after living for an extended period of time in Hyderabad as a way to earn supplementary income. These two women met all of the selection requirements, but logically could not be a true proxy for the household because they would neither be eating nor cooking the same foods as the rest of the family who remained in the village. More importantly, they would not know what was being cooked or consumed in the household during their time spent away. When asked who assumes the household cooking responsibilities when the women and/or men are away, most informants reported that cooking responsibilities fall to the eldest child, often no more than twelve years of age. The presence of migration in any population is something to consider when using a woman as a proxy for her household's consumption. Meals eaten outside the home by other family members such as midday meals at school, for example, were also difficult for the woman to report on.

Additionally, some of the respondents were fasting, either as part of weekly routine or because of Ramadan, while their families were eating full meals. This proved challenging, because the additional food consumed by the family was often quite extensive and there was limited space on the survey form for recording this information. Food consumed in relatively small quantities—for example pickle, lime consumed with tobacco, and cilantro—were not consistently included in the collection and analysis. This is a potential limitation of the design because while consumed in

very small quantities, these foods could prove important to capturing the dietary diversity of a household if consumed frequently throughout the day.

Some words for foods reported in Marathi or Telegu were difficult to later translate as they had obscure or no translation in English, making classifying these foods demanding. All foods obtained from sources other than the primary five sources were grouped into "Other" sources, limiting the resolution of the source code data. For example, because both were coded as being from source code "6," there would be no way to distinguish sorghum procured as a gift or sorghum procured as an in-kind wage.

MARKET-LEVEL ASSESSMENT FOR THE MNDA

I. Market Survey Methodology

Markets play a critical role in supporting dietary diversity, providing opportunities for smallholder farmers to sell their products and earn income, as well as maintaining vital nutrition pathways and food security for local households (Marocchino, 2009). At the launch of the Minimum Nutrition Dataset for Agriculture (MNDA), a market assessment was considered to be a critical piece of the data collection process, particularly with regards to observing market supply and the context surrounding dietary diversity in the study villages. An instrument was developed by the TCi and ICRISAT teams in the hope of conducting this assessment to be included in the MNDA to collect information about the critical role that markets play in the respective study districts.

This Market Level Dietary Diversity module was designed to capture characteristics of the respective market, such as an estimate of total vendors participating during the market day, the frequency of the market (market schedule), the location of the market, as well as the distance to the nearest village, city, or town. Food items along with their various food groups were listed, with space to 'tick' a box if the item was present and being sold in the market. There was also room available for anecdotal observations to be recorded. While the team believed that an understanding of local markets and their relationship to dietary diversity (and the context) was critical, there was general consensus that implementing the tool in its current iteration (simply cataloguing available foods) would not capture sufficient information to warrant expending valuable research capacity at large retail markets.

Rather, a decision was made to undertake informal market visits to capture anecdotal and qualitative information. It was our belief that this qualitative data collection would fulfill the purpose of the initial market level assessment tool. Lists of available products were also collected for comparison purposes to the dietary diversity data, as well as to assess whether collecting information on food availability at the market could shed further light on dietary diversity. Brief, informal, semi-structured interviews were also conducted with market representatives when possible, through the facilitation of ICRISAT staffers and field translators

during the visits to collect data regarding barriers to entry, market infrastructure, and market management (Marocchino, 2009).

II. Market Assessment Results

TCi and ICRISAT researchers visited three markets during the data collection period. In Telangana, the Dokur team visited the Deverkadra market, while the team in Aurepalle visited the Amangal market. In the Maharashtra villages both teams visited the Murtijapur market. Visits were conducted on the weekly market day. In Maharashtra, semi-structured interviews were conducted with a representative from the Agricultural Produce Marketing Committee (APMC), as well as an agent overseeing the vegetable market. All markets that were visited were retail markets, however wholesale and assembly activity was observed. Both Amangal and Murtijapur also contained APMC markets, and there was an increased presence of wholesalers and traders in the area (Chimalwar & Tabhane, 2004).

Aurepalle/Dokur

The markets that served the villages of Aurepalle and Dokur were both retail in nature, but also included wholesale market functions. For example, a sizable amount of neem collection and aggregation was observed as well as a large livestock market. Retailers were primarily selling fruits and vegetables. Non-vegetarian options were also visible, including items such as mutton and chicken. Market infrastructure was relatively developed, with concrete roads, electrification, and available storage space. Many vendors also had physical building space to store leftover products.

Kinkhed and Kanzara

TCi and ICRISAT researchers also visited the Murtijapur weekly market, which serves both of the study villages in Maharashtra. It was a large retail market, with an extensive non-vegetarian section, as well as vegetables, prepared foods, spices, and cereals and pulses. There was minimal physical infrastructure, although some spaces were covered. Most vendors were situated under temporary shelters consisting of tents or tarps.

At this market, a brief semi-structured interview was conducted with an agent managing the market. The market was predominantly a direct-to-consumer outlet, however trader activity was evident, with storage facilities (although minimal) for larger firms retailing products. The agent reported that the vendors each paid 10-15 rupees per day to sell their product, and that the retailers came from the surrounding 25 villages. The agent also mentioned that there was price regulation occurring, with minimum prices being set for each product.

We also managed to interview the general of the APMC in Murtijapur. This meeting was quite informative as he described the wholesaling process through the APMC. Though this certainly has an impact on on-farm production and diversity, the secretary could tell us very little about the local retail markets and their dynamics.

III. Household Survey Results and Market Supply

Amangal Market-Aurepalle Village

The residents of Aurepalle frequently visited the Amangal Market, mainly to purchase specialty items such as fruit and oils, predominantly groundnut. Prices for these commodities are cheaper at the weekly market due to increased competition. The market was approximately ten kilometers from the village, and many members of the community attended when large purchases were necessary or if attending to other business in the town. For example, if a family attended the market to purchase oil, they would purchase large amounts so they would not need to return frequently.

Deverkadra Market

In Dokur, many of the items that were captured as being consumed in the household were procured from the market. Being just seven kilometers from Dokur, Deverkadra market was easily accessible. The main exceptions to this were rice, which was procured from the Public Distribution System and households' own farms, and milk, which was purchased primarily from local village vendors. Some of the large farm families also consumed vegetables from their own farm, including tomatoes, onions, and tamarind. From our observations, it seemed that the Deverkadra market served as the primary source of food for village households.

Murtijapur -Maharashtra

The Murtijapur market, serving both Kinkhed and Kanzara, also represented the diets of the local respondents. Here, the role of the market as the primary source of food procurement was particularly emphasized compared to the villages in Telangana. Due to the late rains, the majority of people in the village stated that they were consuming fruits and vegetables, as well as non-veg products acquired at this market on a regular basis.

Across Villages

The graph below shows food item consumption that was captured during the implementation of the household dietary diversity assessment. The data provides key insights into consumption of various products in the study states. Most notably, close to 70% of vegetables and over 50% of the fruits were purchased from the same market. It is also important to note that a significant amount of activity is occurring through 'local vendors.' This category consists of local retailers and traders, as well as village shops typically associated with processed and packaged goods. Across all villages significant purchasing activities in regards to oils, non-vegetarian options, and dairy products occurred through these outlets, and the retailing of fruits and vegetables by these actors at the village level should warrant further investigation.

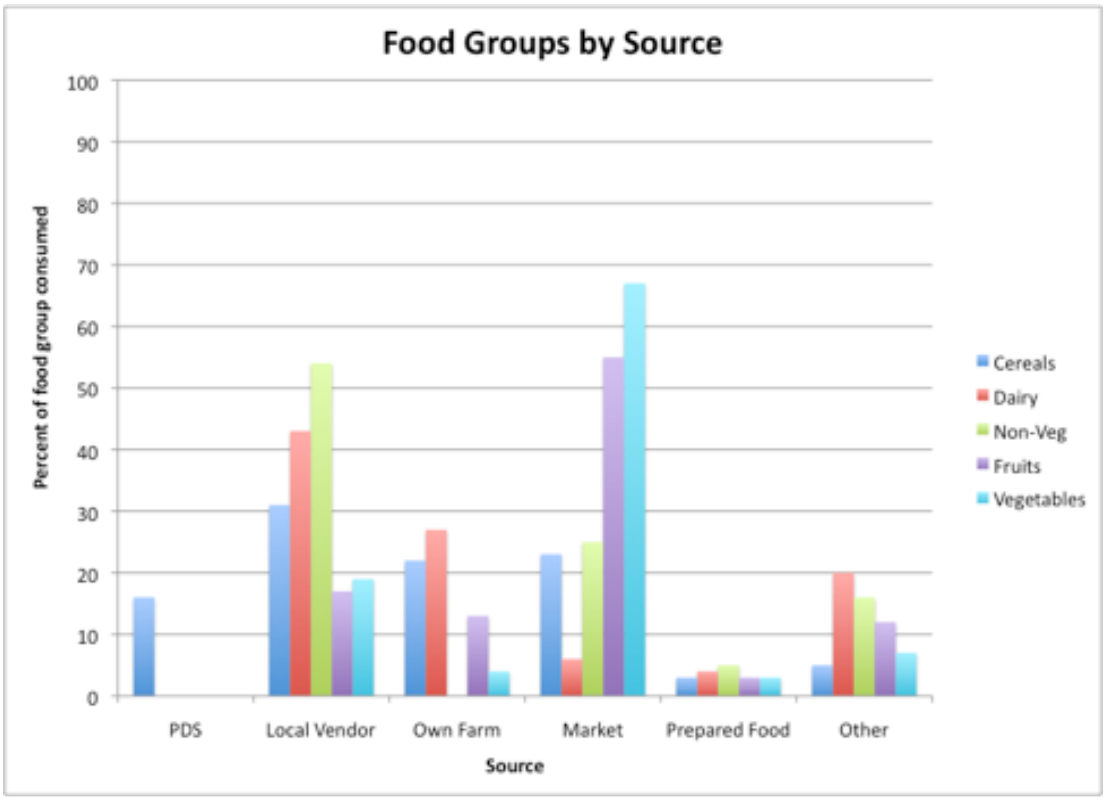

Figure 1. Histogram of five major food groups and where they are procured from as recorded in dietary diversity surveys of Aurepalle, Dokur, Kanzara, and Kinkhed 2014

IV. Markets' Role in Supporting Dietary Diversity in Study Villages

Markets in both regions adequately represented the diets of the survey respondents in all of the villages. Whether the villagers were utilizing these sources as their primary means of acquiring food, however, is questionable. In Kinkhed and Kanzara, it quickly became evident that the majority of residents were utilizing the market frequently to maintain their preferential diets (Chung, 1998). It appears that though these families prefer to eat a diverse diet, this proved difficult due to environmental conditions during the study period; the market fulfills this demand for increased diet diversity in the region.

While the markets in both regions generally reflected the commonly consumed household food items, the question of unreported foods remains. In both Maharashtra and Telangana, respondents mentioned that foraging of leafy green vegetables and mushrooms, and hunting of wild game commonly took place. From qualitative observations, we found that non-vegetarian

items such as rabbit and wild boar were consumed in some areas. Rabbit appeared during data collection in a few households but wild boar did not, and neither item was found being sold in any of the markets visited.

V. Market Level Dietary Diversity Module in the MNDA

While we believe that a market level assessment is indeed valuable in collecting information regarding the local food supply, market development, and infrastructure in a given area, we have come to the conclusion that the market level assessment tool in its current iteration does not provide insights into the complex relationships between markets, nutrition, and dietary diversity.

We strongly believe that the implementation of an assessment tool to primarily target market-based interventions is appropriate, but the dietary diversity instrument piloted during this project provides sufficient detail regarding household consumption patterns and sources of food. With further expansion and refining of source codes, an accurate representation of local food supply may be captured. If the dietary diversity indicators are included in future agricultural surveys, strong links can still be made between on-farm production and diversity, as well as household consumption and nutrition.

We do believe that the continued research and development of a market assessment tool has the potential to contribute to further understanding of dietary diversity. Including and integrating market visits with the dietary diversity instrument can provide further information about the links between market actors, grading and food safety, general market dynamics, the presence of prepared food vendors, and long term trends in market development. The development of concrete market level indicators and measures should be prioritized for future use in this module.

VII. Future Research Priorities

Further research should be conducted on vegetable value chains in the region as well as on village level marketing and trade. Respondents routinely described the presence of local vendors entering villages and selling various fruits, vegetables, and even non-vegetarian products. According to our survey results, the residents of Aurepalle also purchased a significant share of their vegetables from local village shops—shops that are typically associated with the selling of

packaged and processed goods. The representative of the APMC also mentioned that about 70% of the food (cereals and pulses) in the Maharashtra region went through the government regulated marketing committee, but had little information on the remaining 30%. A better understanding of vegetable supply, farm production, and trader/farmer relationships on a village level should be considered a high priority in the future.

GENERALIZABILITY AND CONCLUSIONS

To restate the purpose of our research, we sought to design and validate a survey instrument capable of capturing the most essential dietary information at both the individual and household levels, and which can be easily integrated into existing agricultural surveys. After piloting the survey instruments and making preliminary comparisons of the MNDA dietary diversity scores with those of the intensive nutrition survey for the same households, we conclude that this survey design and general methodology can be adapted to many different populations. The use of the focus group discussions proves an informative step in preparing the investigators for household surveying and for contextualizing the responses. Additionally, these survey instruments are designed with a simple framework that can effectively be used by investigators from all disciplines, with or without a background in nutrition.

Designating women ages 18-45 with primary cooking responsibilities as household proxies appears to be a relatively successful method of capturing household dietary diversity via a single interview, but requires further validation. Whether the potential validity of using this kind of proxy is a result of the designated sample age/sex or the role as the primary household-cook should be addressed in contexts where they do not align. Village and household-level context-specific variables such as migration and shared cooking responsibilities should be extracted in the focus group discussions and considered when designating a single proxy to measure household-level dietary diversity.

With regards to integrating our module into existing surveys, the MNDA shows promise but further research into our results is necessary to examine the efficacy of the tool in measuring dietary diversity. In the near future, we will be seeking to control for seasonality as a potentially confounding variable by comparing the MNDA data to the next round of intensive nutrition survey data completed within the same relative timeframe. By doing so, we hope to be able to make more concrete conclusions about the efficacy of the dietary diversity module of the MNDA in measuring dietary diversity.

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APPENDIX

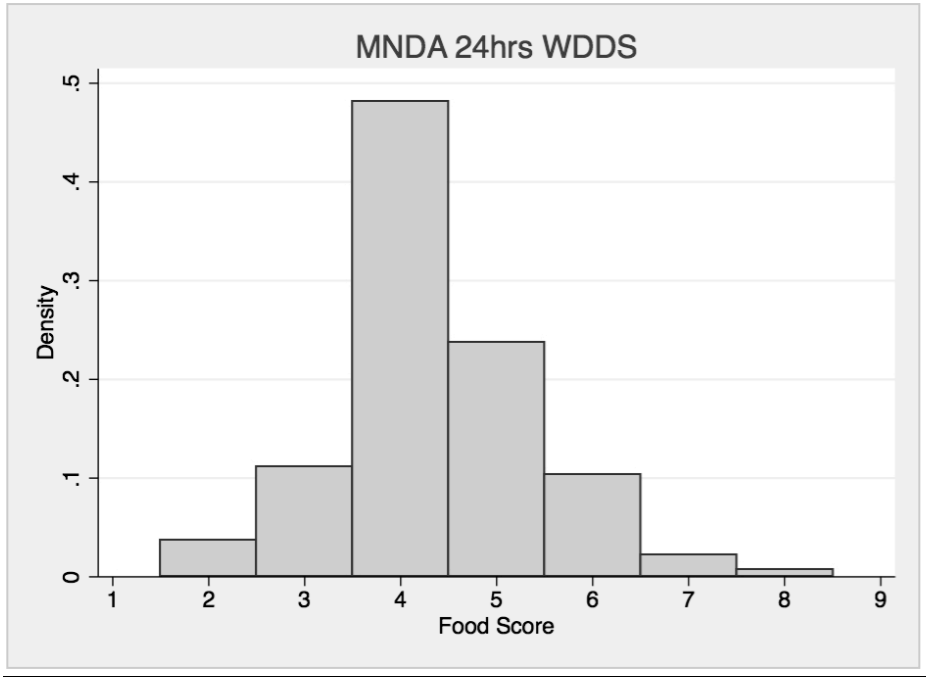

Figure 2. Histogram of the Women's Dietary Diversity Scores as captured by the 24-hour recall of the Minimum Nutrition Dataset for Agriculture 2014 pilot

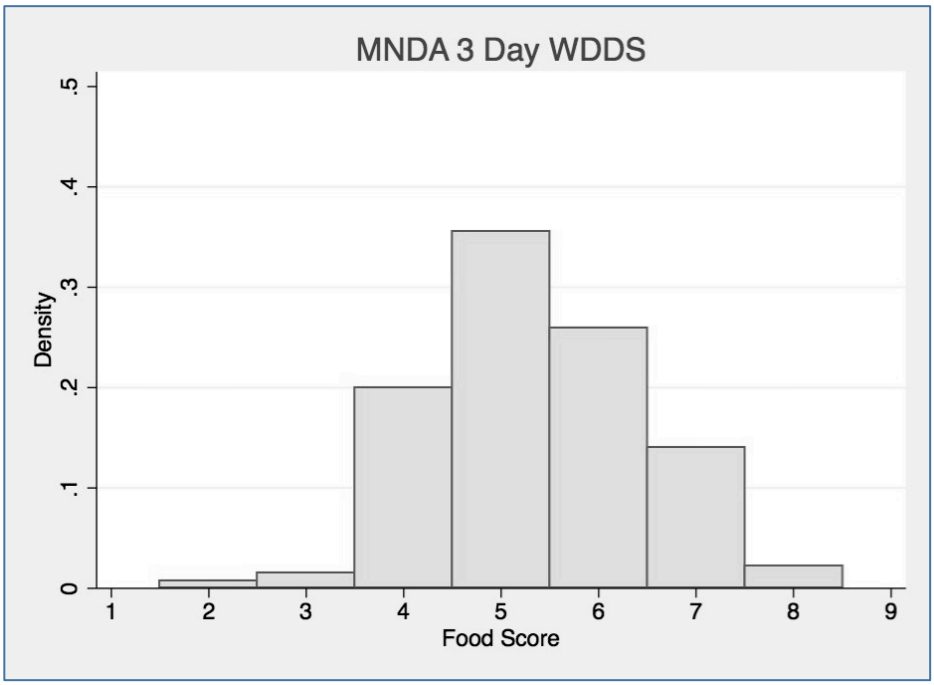

Figure 3. Histogram of the Women's Dietary Diversity Scores as captured by the three-day recall of the Minimum Nutrition Dataset for Agriculture 2014 pilot

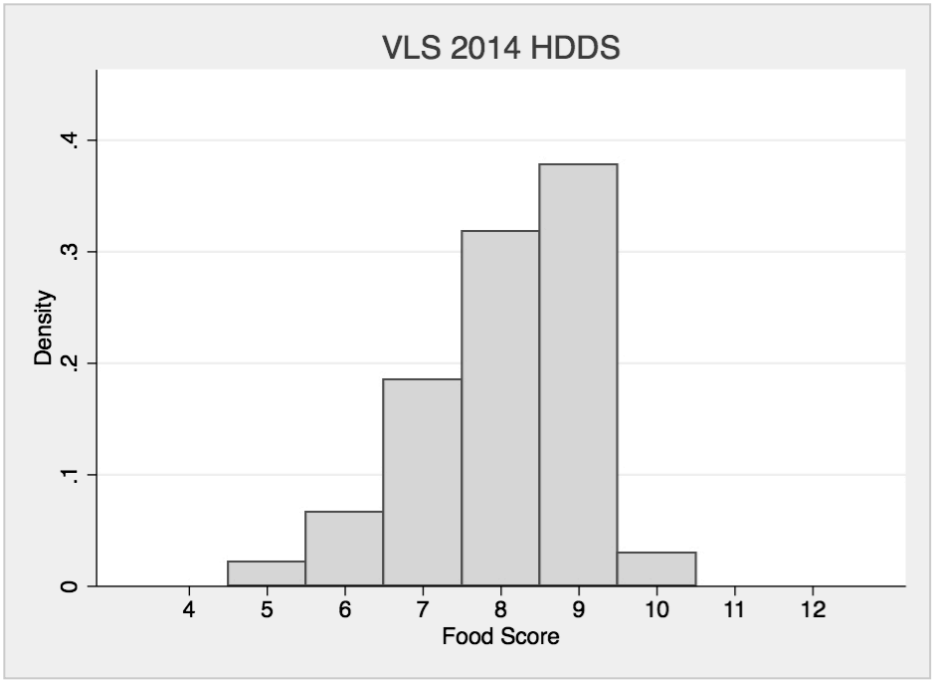

Figure 4. Histogram of Household Dietary Diversity Scores as captured by the ICRISAT 2014 Village Level Study

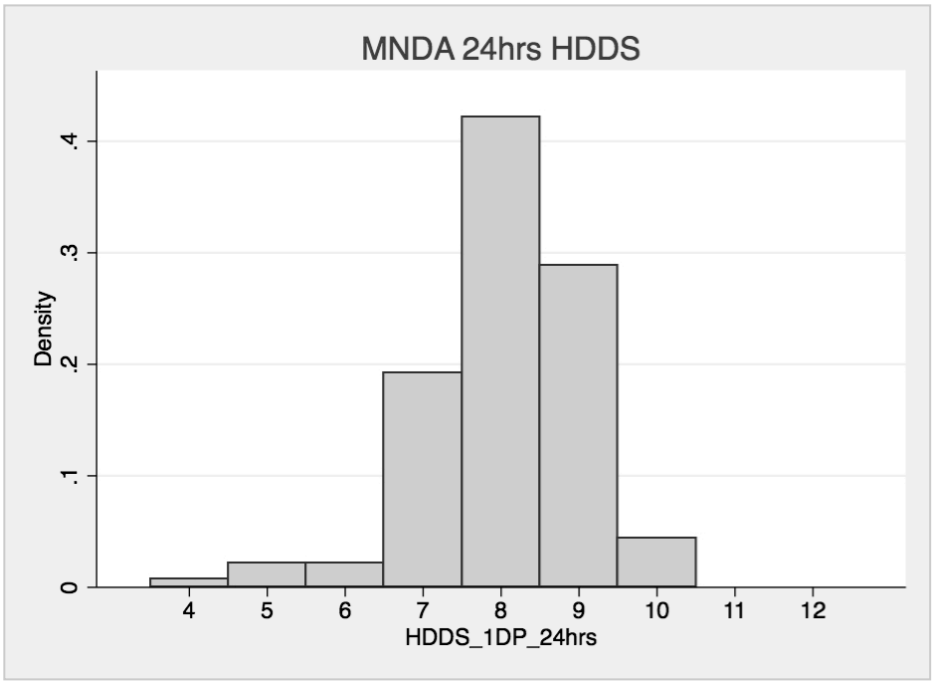

Figure 5. Histogram of the Household Dietary Diversity Scores as captured by the 24-hour recall of the Minimum Nutrition Dataset for Agriculture 2014 pilot

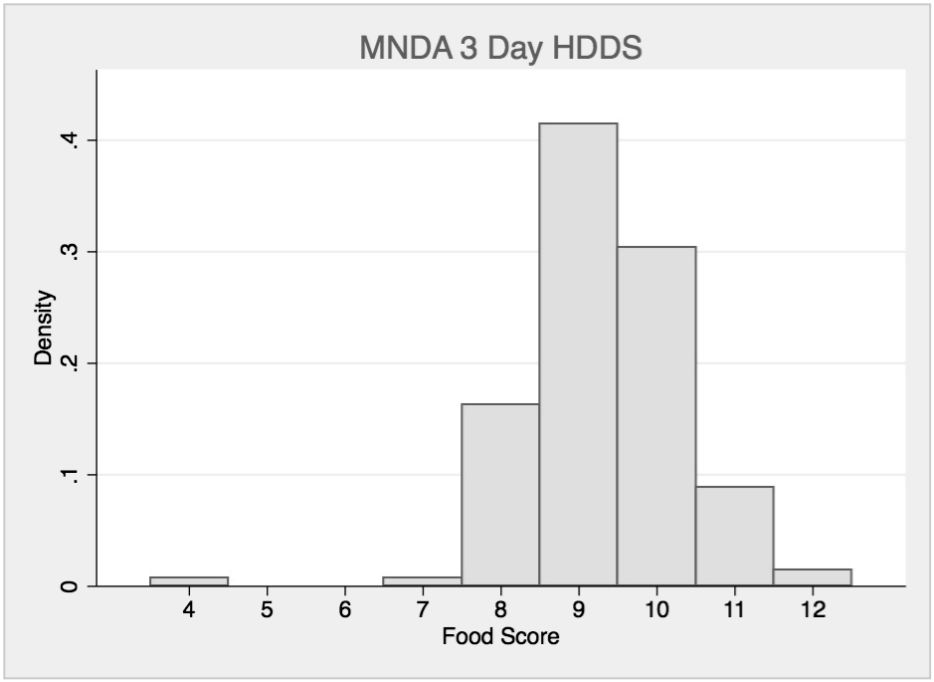

Figure 7. Histogram of the Household Dietary Diversity Scores as captured by the three-day recall of the Minimum Nutrition Dataset for Agriculture 2014 pilot

Table 9. Means, Standard Deviations, and T-Test Means Comparisons of Women's Dietary Diversity Scores by Village

	MNDA WDDS (3 Day Recall)	MNDA WDDS (24hrs Recall)	2014 VLS WDDS (24hrs Recall)
Aurepalle (n=38)	5.32±.83 [.89]	4.36±1.02	5.28±.94
Dokur (n=28)	5.50±.80 [1.00]	4.39±1.20	5.5±1.23
Kanzara (n=46)	5.17±1.06 [.91]	4.09±.96	5.18±.72
Kinkhed (n=30)	5.57±1.07 [.14]	4.73±.98 [.15]	5.13±.86
All villages (n=142)	5.36±1.11 [0.36]	4.36±1.05	5.26±.83

[ ] indicates p-value for significance of difference with 2014 VLS WDDS if not listed, $p<0.005$

Table 10. Means, Standard Deviations, and T-Test Means Comparisons of Household Dietary Diversity Scores by Village

	MNDA HDDS (3 Day Recall)	MNDA HDDS (24hrs Recall)	2014 VLS HDDS (24hrs Recall)
Aurepalle (n=38)	9.05±1.27	7.63±1.36 [.04]	7.12±1.01
Dokur (n=28)	9.39±1.13	7.82±.86 [.70]	7.73±.92
Kanzara (n=46)	9.37±.83	8.30±.84 [.03]	8.64±.42
Kinkhed (n=30)	9.40±.93	8.33±.88 [.65]	8.44±.82
All villages (n=142)	9.30±1.04	8.04±1.05 [.78]	8.03±1.00

[ ] indicates p-value for significance of difference with 2014 VLS HDDS if not listed, $p<0.005$

Table 11. Snapshot statistics of MNDA survey implementation

Snapshot Statistics	
Time Spent in the Field (June 30th - July 12th)	2 weeks
Total # of HH Surveys Conducted	142
Avg. Time for HH Surveys	27 minutes
Total # of FGDs Conducted	9
Total # of Informal Market Surveys	3

Figure 8. MNDA Survey document (cover page and first day of recall)

Minimum Nutrition Dataset for Agriculture (MNDA): Dietary Diversity Module

Tata-Cornell Agriculture for Nutrition Initiative (TCi) / ICRISAT

INSTRUCTIONS

Ensure that:

(1) You are speaking with a women between 18-45

(2) You are speaking with the woman responsible for the household cooking

(3) That you've properly identified the correct respondent for the record link (compare and validate member with the appropriate Village HH Master List (!) Orally confirm name.

(4) Start a timer to accurately record the time taken to complete.

VILLAGE NAME

TIME START INTERVIEW			**TIME END INTERVIEW**		

RESPONDENT NAME	**AGE**	DATE OF INTERVIEW		
		DAY	MONTH	YEAR
				2014

VLS HOUSEHOLD NUMBER: | | | | | | | | | | | |

VLS INDIVIDUAL NUMBER: | | |

IS THIS WOMAN:

- ☐ Pregnant? (check if yes)
- ☐ Brestfeeding? (check if yes)

YESTERDAY (1 Day Ago)

PROMPT Tell us about what the first thing YOU ate…	**Upon Rising (4-9am)**		**Mid Morning (9am-12pm)**		**Afternoon (12pm-4pm)**		**Late Afternoon Through Evening (4pm-4am)**	
☐ Visited Market ☐ Special day (festival, wedding, etc., do not check for market day). ☐ Respondent was fasting on this day	Food (write in)	Source*	Food (write in)	Source*	Food (write in)	Source*	Food (write in)	Source*

PROMPT **DID MEMBERS OF YOUR FAMILY EAT ANYTHING ADDITIONAL?**	☐ I don't know ☐ At this time, NO. ☐ YES. They also ate:		☐ I don't know ☐ At this time, NO. ☐ YES. They also ate:		☐ I don't know ☐ At this time, NO. ☐ YES. They also ate:		☐ I don't know ☐ At this time, NO. ☐ YES. They also ate:	

PROMPT **Response**	Yesterday, did you CONSUME any food outside the home? For example, sweets or snacks like chips, puff rice, or biscuits? ☐ 1 = YES 2= NO	If you have children 5 or younger, did they consume (or were they given money to purchase) snacks or food to be eaten outside the home? For example, sweets or snacks like chips, puff rice, or biscuits? ☐ 1 = YES 3= NO KIDS <5 2= NO 4= I DON'T KNOW

*Code List for Food Source

1= Public Distribution System (PDS) *4=Market*

2= Local Vendors and Shops *5= Prepared food*

3= Own farm/Foraged *6= Other (cooked food sourced from government program, given as a gift, offered as payment)*