FOOD FORTIFICATION

THE 2008 UGANDA FOOD CONSUMPTION SURVEY

Determining the Dietary Patterns of Ugandan Women and Children

PHIL HARVEY
ZO RAMBELOSON
OMAR DARY

MAY 2010

USAID FROM THE AMERICAN PEOPLE
A2Z Micronutrients Sight Innovation
AED Ideas Changing Lives
gain Global Alliance for Improved Nutrition

This study was made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the terms of Cooperative Agreement No. GHS-A-00-05-00012-00, and by support from the Global Alliance for Improved Nutrition (GAIN) and the World Food Programme (WFP). The contents are the responsibility of the Academy for Educational Development (AED) and do not necessarily represent the views of USAID, the United States Government, WFP, or GAIN.

Recommended Citation:

Harvey, Phil, Zo Rambeloson and Omar Dary. *The 2008 Uganda Food Consumption Survey: Determining the Dietary Patterns of Ugandan Women and Children*. A2Z: The USAID Micronutrient and Child Blindness Project, AED, Washington D.C., 2010.

Copies of the Study can be obtained from:

A2Z: The USAID Micronutrient and Child Blindness Project
AED
1825 Connecticut Ave., NW
Washington D.C., 20009-5721
Tel: 202-884-8000
Fax: 202-884-8432
E-mail: a2z_info@aed.org
Website: www.a2zproject.org

Acknowledgments

We thank the authors, Phil Harvey, independent consultant, and Zo Rambeloson and Omar Dary, A2Z-AED, for their valuable contributions in the drafting of this report. We also wish to acknowledge the important contributions of the study's principle investigator, Associate Professor William Kyamuhangire, and co-investigators Professor Joyce Kikafunda and Dr. Archileo Kaaya, from Makerere University Department of Food Science and Technology. Their efforts went beyond the terms of their contract to organize and carry out the field work of this study. And as representatives of the institution responsible for the monitoring and evaluation component of the Ugandan National Food Fortification Program, they were able to provide valuable input regarding the fortification program, as well as realities and constraints on the ground in Uganda. We express our appreciation to the following individuals and institutions for their important contributions to the study: Abdelrahman Lubowa, collaborator nutrition, and Juliana Kalibbala, collaborator statistician from the Uganda Bureau of Statistics; Dr. Madraa Elizabeth, head, Department of Nutrition, Ministry of Health; Maureen Ndahura Uganda Ministry of Health program assistant/food fortification and other members of the National Working Group on Food Fortification; the staff of HarvestPlus/Uganda; Dr. Christine Holz, formerly of HarvestPlus; Martin Ahimbisibwe, nutritionist, World Food Program/Uganda; Louise Sserunjoji, Dr. Barbara Macdonald, and James Wirth, Global Alliance for Improved Nutrition (GAIN); Dr. Alfred Boyo, Ronald Afidra, Dr. Rolf Klemm, and other staff of A2Z-AED in Uganda and Washington DC; Jean Baker, AED, Dr. Ame Stormer, Veronica Lee, and Richard Semakula; Professor Rosalind Gibson, Department of Nutrition, University of Otago, New Zealand; Dr. Rafael Flores, program director, IMMPaCt-CDC, Dr. Anne Swindale, director, FANTA2-AED, and Dr. Alicia Carriquiry, Iowa State University. We also thank Joan Whelan, A2Z-AED, for her support with technical editing and writing on the final drafts, as well as Uganda Chartered Healthnet for providing the PDAs used in data collection.

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS 5

PREFACE 6

EXECUTIVE SUMMARY 7

I. INTRODUCTION AND METHODS 10
- Nutrition Situation in Uganda 10
- Food Fortification in Uganda 10
- Rationale for the study 11
- Objectives 12
- Institutional Partnerships 12

II. METHODS 13
- Study components 13
- Study Sample 13
- Ethical Review 15
- Data Collection 15
- Data Analysis 18
- Strengths and limitations of the study 21

III. RESULTS 22

Socioeconomic Characteristics and Dietary Intakes 22
- Description of the Sample 22
- Food Group Intakes 24
- Macronutrient Intakes 27
- Micronutrient Intakes 29
- Frequency of Consumption of Food Fortification Vehicles and the Amounts Consumed 30

Estimated Additional Intakes of Micronutrients through Mass Fortification 32
- Predicted Reduction in Inadequate Vitamin A Intake Due to Fortification 32
- Predicted Reduction in Inadequate Intakes of Micronutrients in Kampala due to Flour Fortification 34
- Prevalence of Usual Intakes Exceeding the Tolerable Upper Intake Level (ULs) after Fortification with Folic acid and Vitamin A (Retinol) 37

IV. DISCUSSION 38
- Key Findings and Conclusions 39
- Policy and Program Implications 433

V. REFERENCES 45

VI. ANNEXES 47
Annex 1: Districts of Uganda included in the survey, sampling size calculation, and sampling framework 47
Annex 2: Analyses that determine the risk of usual intakes being greater that the Upper Limits (ULs) of folic acid and retinol 51
Annex 3: DRI Values and Estimated Intakes of Micronutrients in Kampala (Kamp), and South-Western (S-W) and Northern (North) Regions of Uganda-2008 59
Annex 4: Detailed results of the projected impact of fortification on prevalences of inadequate intake, with standard deviations 61
Annex 5: Probability among true consumers of food vehicles to reach the Tolerable Upper Intake Level (UL) value of retinol 64
Annex 6: Nutrient intake from the diet (excluding breast-feeding) and additional micronutrient intakes from fortified food vehicles on children 6-23 months of age 65
Annex 7: Breastfeeding and Complementary Feeding Behaviors 68
Annex 8: Nutrient Details of behaviors related to purchase of fortified foods 75
Annex 9 – Uganda Food Consumption Survey Team 82

VII. SUPPLEMENTARY ANNEXES

These documents can be found on the Uganda Food Consumption Survey Supplementary Annexes CD

Supplementary Annex 1: Food Intake Recall Questionnaire

Supplementary Annex 2: Socio-Economic Survey Questionnaire

Supplementary Annex 3: Training Manual for Dietary Assessment and Slides

Supplementary Annex 4: Food Intake Tools and Protocols

1. Methods for Estimating Food Intake
2. Probes and Prompts for 24-hour Recall
3. Protocol for Preparing Respondents
4. Quality Checklist for Team Leaders
5. Standard Recipes
6. Photographs of Commonly Consumed Foods

ACRONYMS AND ABBREVIATIONS

AED	Academy for Educational Development
AI	Adequate Intake
CSPRO	Census and Survey Processing Program, United States Bureau of the Census
DQE	Data Quality Editor
DHS	Demographic and Health Survey
EA	Enumeration Area
EAR	Estimated Average Requirement
ECSA	Eastern, Central and Southern Africa Health Community
FAO	Food and Agricultural Organization
GAIN	Global Alliance for Improved Nutrition
IFA	Iron and Folic Acid
IFPRI	International Food Policy Research Institute
ISU	Iowa State University
IOM	Institute of Medicine
IYCF	Infant and Young Child Feeding
MFPE	Meat, Fish, Poultry, and Eggs
MMN	Multiple Micronutrients
MOH	Ministry of Health
NWGFF	Uganda National Working Group on Food Fortification
PDA	Personal Digital Assistant
PPS	Probability Proportional to Size
RE	Retinol Equivalent
RFS	Regional Field Supervisor
RNI	Recommended Nutrient Intake
S-W	South-Western region
UBOS	Uganda Bureau of Statistics
UDHS	Uganda Demographic and Health Survey
UL	Tolerable Upper Intake Level
UNHS	Uganda National Household Survey
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VAD	Vitamin A Deficiency
VAS	Vitamin A Supplementation
WFP	World Food Program
WHO	World Health Organization
WRA	Women of Reproductive Age

PREFACE

Undernutrition is one of the world's most serious but least addressed health problems. Undernutrition encompasses low weight-for-age (underweight), low height-for-age (stunting), low weight-for-height (wasting) and micronutrient malnutrition. Micronutrient deficiencies are due, in large part, to inadequate intakes of key vitamins and minerals; these can result from poor diet quality, including low mineral bioavailability in plant-based diets, as well as increased nutritional needs due to parasitism and infectious diseases. The human costs of these inadequate intakes are enormous and fall hardest on the very poor. In Uganda, more than one-third of children are underweight or stunted. Undernutrition interacts with repeated bouts of infectious disease, causing an estimated one third of preventable maternal and child deaths annually. Poor nutrition results in lost life opportunities. Undernutrition at an early age (minus 9 to 23 months) causes irreversible damage to intellectual and physical development, including neural tube defects. Undernutrition is preventable, and there is increasing evidence for and recognition of the exceptionally high development returns to a key number of direct interventions to address undernutrition, and of the importance of doing so to meet the Millennium Development Goals.

For decades, however, the lack of solid information on dietary patterns in most developing countries has been a barrier to designing and implementing comprehensive interventions to address nutritional deficiencies due to inadequate intake. Such has been the case in Uganda as well. The Uganda Food Consumption Survey was undertaken to help close this information gap.

The survey was first proposed in 2006, carried out in 2008, with data analysis completed in 2010. The survey was the product of an inter-institutional effort responding to needs expressed by the Ugandan National Working Group on Food Fortification (NWGFF), as well as international interest in closing the information gap in Uganda, and developing a viable model for global application. It is expected that the findings from this report will serve as a foundation for additional analysis and collaboration both within Uganda and beyond.

This report reflects the enormous effort of a large number of people as well as productive institutional and personal partnerships created to see this project through to completion. These efforts are recognized in the acknowledgments section.

EXECUTIVE SUMMARY

The Uganda Food Consumption Survey was undertaken to provide the critical body of evidence that policy makers and program designers need to make informed decisions about effective investments to reduce deficiencies of vitamins and minerals in Uganda. Such decisions will result in substantial contributions to efforts being made to assist Ugandans in achieving the Millennium Development Goals.

The survey itself was carried out in one urban and two rural regions of Uganda in 2008 to more fully characterize the dietary patterns of children 24-59 months of age and women of reproductive age (WRA) (15-49 years). The three regions included in the survey were purposefully selected, within each region, districts and then households were randomly selected in a two-stage process that provided samples representative of that region.

Food consumption was measured using the 24-hour recall method with duplicate measurements on a subset of the sample to allow estimation of usual intake. Measurement of food and nutrient intake is complex and prone to error (including respondent bias); therefore, great care was taken both in the field work and in analysis to provide accurate and valid data. Breastfeeding and complementary feeding practices were also surveyed for children 6-23 months.

The survey provides information enabling development of a baseline for strengthening the Ugandan National Food Fortification Program as well as other micronutrient interventions. The information presented is intended to assist Ugandan policy makers and program designers to select and tailor interventions designed to fit the specific contexts found in Uganda.

Summary of Results

Our findings confirm a substantial variation in usual food and micronutrient intake across regions of Uganda in 2008. Overall, we found inadequate intake levels for five vitamins and minerals critical to good health, development of social capital, and economic productivity in the three regions studied. As in many developing countries, the main micronutrient intake gaps identified were for the vitamins and minerals that would most often be supplied by foods of animal origin; these include vitamin A, vitamin B-12, iron, zinc, and calcium. These deficiencies in dietary patterns have important adverse consequences for Uganda.

In general, the diet in the rural South-West provided larger amounts of most nutrients, and thus the population there had the lowest prevalences of inadequate intakes. Despite higher overall levels of wealth in Kampala, mild inadequacies of B complex vitamins were found, such as B-1, B-2, niacin, and folate. This may well be due to the limited access urban inhabitants have to natural sources of these micronutrients and their reliance, instead, on products with low micronutrient density, such as refined flours, sugar and oil/fats. Dietary patterns in the North were restricted, to such an extreme that this population required food aid from the WFP. Inadequacies of vitamin B-2 and B-6, in addition to vitamin A, vitamin B-12, iron, zinc, and calcium, also affected this population.

The study results suggest that vitamin A could feasibly be delivered to a large proportion of the Ugandan population through the combined fortification of vegetable oil and sugar. Vitamin A fortified vegetable oil is already widely available, particularly in urban areas, while vitamin A fortification of sugar is currently under consideration. Incorporation of vitamin A into wheat flour would benefit the population of Kampala until sugar fortification is implemented. While fortification with vitamin A in a powdered form for use in wheat and sugar is significantly more expensive than vitamin A for fortification of oil, the public health benefits would justify the additional cost. Fortification of wheat flour with B-1, B-2, niacin, and folic acid at the current proposed levels appears sufficient to correct the inadequacies of these micronutrients in Kampala. At this time, wheat flour and its products are rarely used and consumed in rural Uganda.

However, even with all proposed mass fortification interventions in place, our model indicates that micronutrient gaps for iron, zinc and calcium would remain widespread. Biofortification is a potential intervention for improving intake of those micronutrients, but it could take years for biofortification programs to be fully operational and bring full benefits. Thus social programs based on targeted fortification or supplementation (daily or weekly) should be actively introduced and tested, or expanded to supply the required nutrients to vulnerable groups. These interventions should be considered in efforts to design integrated Ugandan food security policies and programs.

Policy and Program Implications

The findings re-affirm that inadequate intakes of vitamins and minerals are widespread in Uganda. There is compelling evidence that these inadequacies will impose an enormous cost to the nation in terms of health, education, and economic development. Consumption surveys, such as the one described in this report, provide information integral to the design and periodic adjustment of comprehensive nutrition interventions that meet the needs of the specific populations targeted. These findings, therefore, are meant to contribute to the further development of a comprehensive Ugandan approach to reducing undernutrition through its National Nutrition Policy and program implementation. The results of our study lead us to suggest the following actions:

1. Carry out a biomarker assessment for vitamin A (serum retinol and breast milk retinol), to be used as a baseline before the introduction of either wheat flour and/ sugar fortification. Such an assessment would also serve as evidence of the impact of the vegetable oil fortification already underway. Assessing serum zinc, folate, and B-12 levels as well would allow evidence-based changes to the fortification formula for wheat flour, which would have greatest relevance to the population of Kampala, where wheat flour and its products are widely consumed.

2. Implement and use the findings from a monitoring and evaluation (M&E) system to provide timely information to inform decisions about adjusting fortification programs and/or re-designing vitamin A supplementation (VAS) and other programs. Specifically, given the positive estimated impacts that we predict from the combined fortification of oil and sugar with vitamin A, the need for continuing with VAS of children and WRA should be reviewed periodically. Our results indicate that VAS should be continued in those regions with limited access to either fortified oil or sugar, and for treating malnutrition, xerophthalmia and measles throughout the country.

3. Further examine estimates of additional intake of vitamin A due to the combined consumption of fortified vegetable oil and sugar to ensure both fortified products can be consumed safely; to do so, fortification levels for sugar must take into account likely additional intake of vitamin A from fortified oil. Our estimates show that some pre-school age children from Kampala may be at risk of reaching intakes near the Tolerable Upper Intake Level (UL) value of vitamin A if these two interventions exist together. If both oil and sugar are fortified with vitamin A, it would be appropriate to start limiting the addition of vitamin A for other market-driven fortification, excepting for restoration in skim milk and establishing the equivalence of vegetable fats (i.e. margarine) to butter. Use of vitamin A in targeted fortification would depend on the specific needs of the groups aimed for this type of program.

4. Use the results of this study to review the current Ugandan fortification formula for wheat flour. It should be noted however that issues related to the micronutrient formula should be discussed in the context of the inter-country policies of the East, Central and Southern Africa Health Community (ECSA). For example, consider:
    a. Keeping the current levels of vitamin B-1, B-2, and niacin, because they seem appropriate for reducing the prevalence of inadequate intake of these micronutrients in the population of Kampala;

b. Eliminating vitamin B-6 from the formula because inadequate intakes were very low both in Kampala and in the rural South West. This nutrient should be incorporated as part of the other micronutrient interventions for the population of the North.
c. Increasing levels of vitamin B-12 and zinc[1];
d. If iron from NaFeEDTA is found compatible with wheat flour and the Ugandan products made with it at levels equal to or higher than 3.0 mg/100 g[2], consider using this instead of ferrous fumarate. The cost would be higher, but the corresponding benefits would be greater, an important factor of analysis for accepting a higher cost of fortification;
e. Reducing the folic acid content if serum folate levels are found to be high; and,
f. If sugar fortification is implemented, eliminating vitamin A from the formula for wheat.

5. Explore effective alternative interventions to iron fortification such as supplementation (single-nutrient formulations or multiple micronutrient [MMN] powders, weekly for adolescents and pre-pregnancy, daily for pregnant women), and reducing iron losses by de-worming children 1-5 years, school children, and pregnant women after the first trimester. Our results indicate that, regardless of the type of iron, the impact of mass fortification will be modest in reducing the very high prevalence of inadequate intakes of iron that were observed.

6. Review the likely causes of neural tube defects in relation to the level of folic acid being added into wheat flour. Our model suggests that a high prevalence of inadequate intake of vitamin B12 may be a more likely cause of neural tube defects in Uganda than folate deficiency. Our results show half the level of folic acid currently used would be adequate to eliminate inadequate folate intakes. On the other hand, current levels of folic acid fortification would lead to additional intakes below the current UL values for this substance.

7. Explore maize flour fortification as a targeted fortification program, as has been suggested by GAIN and WFP. This approach should allow flexibility so that it may be adapted to best reduce the estimated nutrient gaps that affect intended populations, including vitamin A.

8. Consider additional complementary interventions to mass fortification to address inadequate intakes of vitamins and minerals in the population groups and/or for the specific nutrients for which our results indicated the impact of mass fortification could be limited. For example:
   a. Use of selected nutrient-dense locally produced foods, agricultural/horticultural interventions including biofortification, low-cost fortified foods (targeted fortification), MMN powders, and other possible vehicles delivered as part of social programs;
   b. In rural areas, further strengthen implementation of nutrition education and counseling, supplementation, hygiene and sanitation, and other health interventions to prevent and treat common childhood infections. These interventions have been effectively delivered on a large scale through community nutrition programs that extend the reach of health care services beyond the health center.

[1] The appropriate levels could be modeled using the data collected in this study.
[2] A lower level would not have an additional benefit as compared with the current use of 4.0 mg Fe/100 g from ferrous fumarate.

I. INTRODUCTION AND METHODS

Nutrition Situation in Uganda

Uganda is among the developing countries suffering high levels of macro- and micronutrient deficiencies, particularly among young children, adolescents, and pregnant/lactating women. Undernutrition is endemic in many parts of the country and poses a serious threat to the well-being of many. It is responsible for, or associated with, 40% of all deaths occurring in children below the age of five. The most recent Uganda Demographic and Health Survey (UDHS), carried out in 2006, revealed that 38% of children under five were stunted, 6% wasted, and 16% underweight. In the case of women, the situation exemplifies the double-burden of malnutrition, with 12% (6% urban and 13% rural) underweight (BMI < 18.5), and 16% (34% urban and 13% rural) overweight or obese (BMI ≥ 25.0) (Uganda Bureau of Statistics [UBOS], 2007).

Anemia affects 73% of children 6-59 months of age, 49% of women of reproductive age, and 28% of 15-54 year old males (UBOS, 2007). Anemia prevalence was higher in 2006 than in 2000-2001. Although the etiological factors of anemia have not been determined, it is reasonable to assume that in Uganda, as in many developing countries, the primary causes are iron deficiency, as well as malaria and intestinal worms.

Based on the UDHS 2000-2001[3] 28% of children and 23% of women have serum retinol levels lower than 0.7 µmol/L, which is evidence of vitamin A deficiency (VAD). If the cut-off point of 1.05 µmol/L is used for women, the prevalence of VAD rises to 52% for WRA.

The Government of Uganda (GOU) recognizes the potential dangers of micronutrient malnutrition to the health and prosperity of its population and has adopted a multi-pronged strategy to combat the problem. These strategies include universal VAS for children 6-59 months of age and post-partum women, iron and folic acid (IFA) supplementation for pregnant women, food fortification, food diversification, nutrition education, and behavior change communication. New interventions such as biofortification are being tested in the country.

Food Fortification in Uganda

Mass fortification is defined as the addition of micronutrients to food commonly consumed by the general public, such as oil/fats, cereals, condiments, and milk. Fortification efforts started in Uganda with salt iodization when, in 1994, the country mandated that all imported salt be iodized. The effort was successful and by 2006, 96 percent of households were utilizing iodized salt (UBOS, 2007).

In 2001, Makerere University, with the support of USAID's MOST project, produced a food assessment report focused on vegetable oil and maize flour as potential vehicles for food fortification. In 2002, the National Working Group of Food Fortification (NWGFF) was constituted. In 2003, MOST funded a national survey of the food consumption patterns of vegetable oil, maize flour and sugar; this was conducted by the Department of Food Science and Technology, Makerere University. The study covered seven districts in the four regions of Uganda, but it did not estimate nutrient intakes. In 2004, the NWGFF facilitated the approval of fortification standards for oil, sugar, wheat and maize flour. These standards were modified in 2006 to come into alignment with fortification guidelines established for the ECSA region.

In 2004, the largest oil factory in Uganda began voluntary fortification; when a second oil factory also began fortification in 2005, the combined production covered 85% of the market. Also in 2005, two maize mills

---

[3] UDHS 2000-2001 was used due to questions regarding the methods used in UDHS 2006 to predict the prevalence of vitamin A deficiency, namely a specific monoclonal dot-blot test for immunological reaction of retinol binding protein (RBP) (Hix *et al.*, 2004), which does not have a quantitative linear association with serum retinol measured by HPLC. The UDHS 2000-2001 used a method that better approximates the results of by HPLC in serum samples (Craft *et al.*, 2000; Erhardt *et al.*, 2002).

started fortification with the support of MOST (Fiedler *et al.*, 2009). In 2007, the country obtained a GAIN grant to expand oil fortification and introduce wheat and maize flour fortification. Fortification of wheat flour is currently in the planning and implementation stage, and discussions are under way to expand maize flour fortification. Sugar fortification is still under discussion, although successful trials were undertaken in one mill in 2005.

Of the three main potential fortification vehicles, the cost of vitamin A fortification of oil is the lowest, followed by wheat and then sugar with the highest cost.[4] Therefore, the NGWFF decided that oil would be the main source of vitamin A, and that wheat flour and sugar would be considered complementary fortification vehicles.

From 2007 to 2008, three fortified food inspection rounds were carried out with the support of A2Z to test for compliance with fortification standards. Results from samples obtained at importation sites (salt), factories (oil), and retail stores (salt and oil) from all nine regions of the country, and 38 out of 68 districts revealed that, overall, fortified products were found to be compliant. Salt contained, on average, 53-55 mg iodine/kg, and almost all samples were fortified. Vegetable oil samples averaged between 22 and 31mg vitamin A/kg, and 90 percent of samples had vitamin A levels above 20 mg/Kg. Wheat flour samples were also tested to determine the intrinsic amount of iron in the unfortified product, as a reference baseline to be used when wheat flour fortification has been introduced. An average of 17 mg iron/kg and a range of 11 to 28 mg/kg were found for the unfortified, refined wheat flour (Ministry of Health, Uganda, 2009).

Rationale for the Study

Ideally, the design of food fortification programs should be based upon a clear understanding of the nutrient needs of the target groups in question. Similarly, the selection of food vehicles should be based on clear information about the proportions of the target groups that consume them (coverage) and the amounts in which they are consumed (intake). This helps to ensure that fortification interventions are designed so that those individuals who have inadequate intakes of vitamins and minerals will consume meaningful additional intakes of the needed nutrient through the fortification process. If food fortification is designed and implemented properly along with other micronutrient interventions, the additional intakes of nutrients will be large enough to correct the nutrient gaps.

While household income expenditure surveys and similar studies can be a valuable source of information on use and consumption of potential food fortification vehicles (Imhoff-Kunsch *et al.,* 2007), they shed little light on the micronutrient adequacy of the diet or correction of intake gaps. And while changes in micronutrient status estimated via biomarkers provides the strongest evidence to diagnose the need and determine the impact of nutrition interventions, the causal relationships will be strengthened through associations and correlations with changes in intake values. Food consumption surveys provide clear information on current micronutrient intakes, the magnitude of gaps between intakes and requirements and the potential correction of these gaps with different formulae used in the fortification program. Further, measuring change in micronutrient intakes before and after interventions provides the opportunity to correlate these changes in intake with changes in nutritional status as detected in biomarker surveys and so establish stronger causal evidence for the impacts of interventions.

Such information is especially important in the case of mass food fortification and biofortification where, unlike in supplementation or targeted fortification, micronutrient intake varies widely in the same population because the daily intake of the fortified foods varies enormously. Ideally, every country should have its own baseline, or at worst, access to information from neighboring countries where dietary practices might be similar.

[4] The cost of fortifying sugar was estimated at US$0.0072/kg for a vitamin A level of 10 mg/kg, while fortification of oil at 35 mg/kg has a cost of US$0.0048/L (Fiedler, Afidra and Dary, 2009). Fortification of wheat flour with vitamin A at 3 mg/kg has a cost of US$0.0016/kg.

Over the last decade, there have been considerable social, economic and demographic changes in Uganda impacting the food consumption patterns of both rural and urban populations. In response, periodic nationally representative food consumption surveys are critical to planning and implementation of effective nutrition interventions, including fortification.

While food consumption surveys offer a gold standard in obtaining important dietary intake data, they are both time and resource intensive. Priority should be given to developing alternate methods for the future of estimating the adequacy of micronutrient intake, particularly by WRA and pre-school children, groups considered the most vulnerable to micronutrient and general malnutrition. It is hoped that the release and dissemination of this report will facilitate discussions leading to the development of these methods.

Objectives

The Uganda Food Consumption Survey was conducted in 2008 to determine dietary patterns of Ugandan children 24-59 months, and WRA (15-49 years), in three regions of Uganda: Central/Kampala, South-West and North (see map in Annex 1).

Specifically, the study was undertaken to:

A. Serve as a baseline for strengthening Uganda's National Food Fortification Program
B. Estimate specific micronutrient gaps in diets so that formulation of the amounts of nutrients to be added in the fortification process will help meet those gaps without exceeding 'safe' levels.
C. Predict the contribution of fortifying different food vehicles to the adequacy of micronutrient intakes of different vulnerable segments of the Ugandan population
D. Develop a basis for targeting micronutrient supplementation to populations who are not likely to consume fortified foods in sufficient amounts to meet their requirements for micronutrients through fortification.

To achieve these objectives, this project measured the types and quantities of foods consumed by individuals in the target groups. The data was used to calculate the macro- and micronutrient intakes of the groups. The opportunity was also taken to also assess the knowledge and attitudes of caregivers toward foods rich in micronutrients, including fortified foods, as well as their breastfeeding and complementary feeding practices.[5] Detailed information on the food intake of infants and children 6-23 months of age was also collected in this survey to inform the design and evaluation of infant and young child feeding (IYCF) interventions for this key target group. Measuring breast milk intake was beyond the scope of the survey, thus it was not possible to calculate nutrient adequacies for this age group.

The information presented in this report provides a useful basis for predicting the potential additional intake of micronutrients through fortification interventions in these three regions of Uganda. It also provides findings designed to assist policy makers and program designers in selecting and tailoring nutritional interventions to best fit the context in which they will be implemented.

Institutional Partnerships

In 2006, HarvestPlus began developing a methodology to measure dietary intake for a food consumption survey. In 2007, it conducted a baseline survey in the Eastern region of Uganda in 2007 to measure the impact of increased availability and consumption of orange-fleshed sweet potatoes on maternal and child vitamin A status.

In support of the Ugandan NWGFF and with the financial support of USAID and GAIN, in 2006, A2Z began planning a food consumption survey in one rural (South-West) and one urban (Kampala) region of Uganda,

[5] Annexes 4 and 5 include the reports for these areas.

to determine the dietary patterns of Ugandan WRA and children. The study was designed to include the nutrient intake of the target populations and consumption of potential food fortification vehicles. The World Food Program (WFP) joined the initiative during the first months of activities, allowing implementation of the same survey in the Northern region of Uganda, where WFP was providing food aid to a substantial portion of the population.

Technical staff in food science and nutrition from Makerere University helped identify local food data bases to compile available information.

The presence of staff already trained by HarvestPlus in dietary surveys facilitated the implementation of this study. The data and conclusions from HarvestPlus' food consumption survey in Eastern Uganda will be incorporated with A2Z/GAIN's data and conclusions from the other three regions of Uganda, once the information collected in 2006 by HarvestPlus is analyzed following the same procedures that are described in this report.

II. METHODS

Study Components

The Uganda Food Consumption Survey consisted of a socio-economic and a food intake component, each consisting of a series of modules.

The socio-economic survey modules included:

- Background characteristics of WRA, including relationship to head of household, age, religion, marital status, education level and type of work of head of household.
- Household characteristics including material of floor, type of roof, source of and distance to drinking water, toilet facilities. These characteristics were then used to develop a wealth index proxy.
- Food production data especially food crops like maize and sweet potato, and livestock such as cattle, goats, sheep, and poultry.
- Household expenditure data on basic needs such as food, clothing, housing, and school fees.
- Breastfeeding status and complementary feeding practices for infants and young children 6 to 23 months and feeding practices for children 24 to 59 months.
- Knowledge and utilization of fortified foods.

The dietary intake modules included:

- 24-hour recall of food intake.
- Household food frequency and expenditure[6].
- Household consumption of oil, sugar, maize and wheat flour, as well as products made with flour.

Study Sample

The Uganda Food Consumption survey was designed as a cross-sectional study and collected data to provide separate estimates for three regions of Uganda. The three regions were selected purposefully and included: the Central Region (Kampala City Council) representing urban areas, and the South-West and North Regions representing rural areas. In the South-West and North, two districts were selected randomly from a roster of all constituent districts after removing those considered unsafe and/or too inaccessible.

[6] This information will be used later to assess these data as proxies for the deductions reached through the 24-hour recall of food intake.

The selected districts were:

- South-West: Bushenyi and Hoima Districts
- North: Kitgum and Lira Districts

Kampala district coincides with Kampala City Council, therefore it is the only district selected in the Central region. In Kampala district, two divisions were randomly selected, while in each survey district selected in the South-West and North, two sub-counties were randomly selected, for a total of two divisions in Kampala, and eight sub-counties, four each in the South-West and North.

The primary sampling unit for the survey was an enumeration area (EA), or cluster, as demarcated by the UBOS for the Uganda Population and Housing Census of 2002. The boundaries of EAs often coincide with village councils, the smallest administrative subdivision in Uganda, and constitute about 150 households.

A two-stage procedure was used to select the sample. In the first stage, the EAs for each sub-county were selected with a probability proportional to their size (PPS). In the second stage, households in each cluster were randomly selected based on a complete listing of households. Clusters with more than 150 households were first segmented, with households listed only for one randomly selected segment. Ahead of actual data collection, a team of community mobilizers was deployed to each survey region and they worked with local leaders to list all eligible households in each cluster or cluster segment. Households were eligible for inclusion in the study when at least one WRA (15-49 years) and a child 6-59 months resided in them. In each household, only one woman aged 15-49 years, one child from 24-59 months, and one child from 6-23 months were selected. In households where more than one woman and/or child in each age group lived, one woman and one child in each age group were selected randomly.

Calculating the sample size

A key objective of the survey was to establish a baseline for subsequent evaluation of the impact of fortification. We needed a sample of sufficient size to identify as statistically significant a change in intake of a micronutrient that would bring worthwhile benefit to public health that resulted from the implementation of the fortification program. The sample size was calculated to obtain region-level estimates of vitamin A intake among WRA. Vitamin A was chosen because it was already being used to fortify cooking oil, cooking oil was more widely consumed than other potential food vehicles such as wheat and maize flours, and more precise information on consumption of cooking oil was available (Uganda National Household Survey [UNHS] 2005-2006). The information available on the consumption of wheat flour and its products in Uganda was not sufficient to allow the assumptions needed to make a reliable sample size calculation using this vehicle. There was also insufficient data on maize flour, and moreover maize flour processing was extremely decentralized and as such the industry participating in the fortification program covered a very small proportion of the market.

For the purpose of calculating sample size, we assumed that the vitamin A intake of at least 50% (the most conservative estimate possible) of WRA was lower than the estimated average requirement (EAR) level and hence inadequate. Only people with inadequate intake of vitamin A would potentially benefit from fortifying cooking oil with vitamin A. Considering that 72% of the Ugandan population consumed cooking oil (UBOS, 2007), we estimated that 36% (0.72 x 0.5 = 0.36) of the population had the possibility of receiving some benefit from cooking oil fortification. From there, we hypothesized that fortification of cooking oil with vitamin A would be successful if the percentage of WRA with vitamin A intake lower than the EAR was reduced from 50% before fortification to 36% after its introduction (50 - 36 = 14).

Using the standard formula shown in Annex 2, the sample size for WRA was calculated to detect a change of 14 percentage points in vitamin A intakes. The initial value of (P1) was set 50 percent, the level of precision was set at 0.05 and the power was set at 0.84. The design effect was set at 2. For each region, the sample size was calculated to be 300 WRA (and hence 300 households). The average number of households per cluster was 12 households with a total of 25 clusters per survey region; i.e. 300 households per region, and 900 households for the survey across three regions. In addition, an extra cluster per region was selected to allow replacement of households for non-response or subject fatigue during the 24-hour recall survey. Thus a total of 312 (rounded at 320) households per region were required.

The number of children 24-59 months included in the survey in each region ranged from 166 in the South–West to 177 in the North. The smaller number of 166 was adequate to detect a change of 19 percentage points in the adequacy of vitamin A intake among these children, while the number of 177 was adequate to detect a change of 18 percentage points.

Table 1: Sample size of the 2008 Uganda Food Consumption Survey by category of target group and region

REGION	Urban Central Kampala		Rural Southern-Western		Rural with Food Aid Northern		TOTAL	
CATEGORY	Planned	Surveyed	Planned	Surveyed	Planned	Surveyed	Planned	Surveyed
Household	320	314*	320	322	320	321	960	957
Women 15-49 years-old	320	314*	320	322	320	321	960	957
Women with children 24-59 months	171	167	171	166	171	177	513	510
Women with children 6-23 months old	143	140	143	153	143	144	429	437

* In Kampala, 6 respondents refused to be interviewed during the 24-hour recall survey

Ethical Review

The survey protocol mandated procedures to ensure informed consent and maximize confidentiality. Participation of all respondents in the survey was strictly voluntary and there was no monetary or other compensation offered for participation. Measures were taken to assure the respect, dignity, and freedom of each individual participating in the data collection. Participation in the survey and each interview was completely voluntary and based on informed consent. Each individual agreeing to participate and who was able signed the consent form electronically on the personal digital assistant (PDA) screen held by the interviewer. Individuals who were not able to read or write provided a witnessed, oral consent. The information from the informed consent forms was not recorded with the survey data, but was maintained separately in an unassociated file. All interviews were conducted in private and the respondent's identity was not recorded. Each person was assigned a unique identification code.

Detailed survey protocols were approved by the relevant institutional ethical review boards. In Uganda, the protocols were approved by Uganda National Council for Science and Technology April 30, 2008 and in Washington DC by the AED/Research Integrity Department, January 5, 2008.

Data Collection

Socio-economic survey modules

The socio-economic data were collected using PDAs to reduce cost, time, and data entry errors. For all cases, the principal respondent (interviewee) was the reference woman aged 15-49 years who was most likely the principal woman of the house and main caregiver/mother for the reference child.

Quantitative dietary intake assessment
Questionnaires were based on the methods described by Gibson and Ferguson (2008). The multi-pass 24-hour recall method was used to estimate the intake of several nutrients. This method is considered valid and is the currently recommended 'state-of-the-science' for carrying out population-based food consumption surveys in developing countries.

A 24-hour recall questionnaire (example in Supplementary Annex 1) was developed specifically for the survey and was administered by trained fieldworkers. A training manual (Supplementary Annex 3) and a food intake booklet (Supplementary Annex 4) were developed and employed, as appropriate, for the administration of the questionnaire. The multiple pass 24-hour recall interviews were structured into four steps (passes) to maximize respondent recall of foods eaten. The first step, the 'quick list', involved respondents supplying a broad description of all food and beverage items, including snacks, consumed in the previous day, commencing with the food or drink taken immediately after they or the reference child woke up and ending with the last food or drink taken before going to sleep at night . In the second step, a detailed description of each food or beverage item on the quick list was ascertained through a series of questions and prompts (generated by interviewers) which were specific to each item. Respondents were asked to give information on the ingredients and preparation methods of mixed dishes. The third step was to estimate the amount of each food and beverage and their ingredients consumed. The final step was to review and check the recall responses in conjunction with food picture charts to clarify and confirm responses given about the previous day's intake.

All days of the week (including the weekend) were proportionately represented in interviews across the sampling units to negate any day-of-the week effects on dietary intakes.

The multiple-pass procedure allows for enhanced recollection of the various foods and beverages consumed, as well as improved estimation of portion sizes, by asking respondents to: (a) record all foods eaten by the reference child and themselves on food picture charts; (b) instead of eating from a "common plate" as is the norm, serve food to their reference child and themselves in individual bowls (c) estimate the quantities of main staple food items consumed using replicas of these staples, such as various porridges; e.g. *matooke*, *posho* and *atap* or *kalo*, to improve visual impression of the foods consumed.

Repeat dietary recalls were conducted on ten percent of the sampled households in each region on a non-consecutive day, to allow for an estimation of the distribution of usual nutrient intakes by the population, thereby reducing variation due to day-to-day (intra-individual) differences in intakes. (See *Calculation of usual intakes,* below)

All interviews (including the 24-hour dietary recalls) were conducted in the first language of the person being interviewed whenever possible. As such, the instruments were translated into local languages, Luganda (for Kampala), Runyakitara (South-West), and Luo (North). Enumerators were recruited to match this need.

Team composition and timing of data collection
One team was used to collect socioeconomic data (Annex 9) and another for dietary data because extensive additional training was required for the teams collecting dietary data. In each survey region two teams consisting of four interviewers were supervised by the regional field supervisor (RFS) and data quality editor (DQE). The RFS managed all field work, financial and logistics administration, and liaised with respondent communities. The DQE managed data quality control and coding.

The DQE downloaded socioeconomic data from the PDA at the end of each survey day. Each socio-economic and dietary team had a field coordinator who was directly responsible to the principal investigator. This coordinator oversaw overall data quality management, training, and re-training. A team of two community mobilizers worked in parallel and slightly ahead of the data collection teams to list and prepare households for the interviews. These mobilizers were first trained on how to select the households to participate in the survey in each EA. They were given maps similar to those used earlier during the UDHS 2006.

The interviews for all modules of the household survey took about two-three hours to complete. Each enumerator completed two household interviews per day allowing the two sub-teams in each region to complete16 interviews per day. Data collection took place in Kampala and the South-West over five months, beginning in May 2008 and ending in September 2008. The survey in the North took place in August and September of the same year.

Standardization of measurements across the survey
The survey standardized measurements by using standard training manuals, translating survey instruments into local languages (after teams agreed on the common phrasing), and standardizing other field tools including probe lists and measurement method lists to obtain descriptions of common dishes, their ingredients and portion sizes. DQEs also had standard quality check lists to guide survey tool checks. The National Field Coordinator in turn made field checks and re-trained as necessary to maintain a high level of consistency and accuracy.

Recruitment, training, and supervision of survey enumerators
Enumerators were recruited to match both the language and skill needs of the survey. The multi-pass 24-hour recall procedure also requires that enumerators have a reasonable education level to grasp the rigorous level of detail, and candidates with prior experience with the procedure were the first choice. The IFPRI/HarvestPlus Project referred enumerators from their recently completed baseline study and an earlier study by Urban Harvest/International Potato Center. The UBOS also referred former enumerators from the Uganda DHS and other surveys. Most enumerators were recent graduates in Food Science and Technology/Human Nutrition from Makerere National University.

The training was conducted at the Department of Food Science and Technology, Makerere University and lasted about 17 days to cover both the socio-economic and dietary intake studies, including pre-testing and review of survey instruments. Most candidates entered the training as enumerators after which those with management and leadership skills were identified and recruited as supervisors. Standardized manuals on relevant topics guided the training. A consultant provided PDA training. All training provided theory as well as practical application in the form of role plays, presentations, and field testing. The dietary intake training culminated in three days of pre-testing of the tools, and observation of and feedback to enumerators.
A pilot exercise was carried out in one urban and one non-urban cluster. The pilot incorporated validation of the questionnaires and interview techniques as well as the use of measurement equipment and sampling methodology. Once the pilot had been completed, the survey teams addressed any points that needed improvement prior to data collection.

Data entering, checking and cleaning
Dietary intake data were entered using an application from the Census and Survey Processing Program (CSPRO) version 3.3.002 (U.S. Bureau of the Census, 2007). A double-entry system was used to eliminate keying errors. Appropriate logic was written into the CSPRO program to enable data cleaning during data entry through range, consistency, and other logic verifications and checks. More intensive and thorough batch edits were carried out using Microsoft Access. Data quality tables were produced during the course of data collection and the results reviewed in consultation with the field teams for consistency and validation. Before entry, questionnaire batches were subjected to random manual scrutiny by quality control assistants to assess the consistency of the data collected.

Data Analysis

Portion sizes and recipe amounts in different measurement units were converted into grams by application of gram-weight conversion factors that were adapted from the work already done in Uganda by IFPRI/HarvestPlus. We also used HarvestPlus food composition database to calculate nutrient intakes. This composition table was constructed based on nutrient values from the United States Department of Agriculture (USDA) Nutrient Database for Standard Reference (2003), and was augmented with values from other food composition tables. New foods and new preparations that were documented in this study were added to the HarvestPlus food composition table.

Where necessary and possible, adjustments were made to the food composition values taken from other sources to consider any discrepancies in moisture content compared to that stated in the USDA database. When data were not available for foods in the cooked form, nutrient values were derived from dried or raw foods using adjustments for changes in yield and nutrient retention where appropriate, as described in Gibson and Ferguson (2008). Gram-weight conversions and nutrient calculations were done using syntax language written in SPSS Statistical Program version 15.

Calculation of nutrient intake

From the quantities of foods measured with the 24-hour recall instruments, we calculated intake of nutrients including energy, protein, fat, fiber, thiamin (B1), riboflavin (B2), niacin (B3), B6, folate (B9), B12, vitamin C, iron, zinc, and calcium. Vitamin A, from animal and plant sources, was expressed as retinol (retinol equivalents, based on the Food and Agriculture Organization (FAO) conversion factors (FAO/WHO, 2002). Adjustments were made to account for variance in bioavailability according to food source. Vitamin B-12, when supplied by liver, was reduced by one fourth because of the reduction in the proportion of the nutrient that is absorbed when it is consumed in large quantities. Iron and zinc supplied from meat, fish and poultry were considered twice as bioavailable as iron and zinc from vegetable sources. Overall, dietary iron and zinc were estimated at 5% bioavailability, based on the high presence of fiber and vegetable products in the diet. Algorithms to estimate the iron bioavailability with more precision were not used because intake of phytates was not measured. Although most of the vegetable oil consumed at the time of the survey was fortified with vitamin A (retinol), we included the additional intake of this vitamin only in the simulation analyses described below, i.e. the nutrient composition of vegetable oil was set at non-fortified values.

For modeling the impact of the consumption of fortified foods, folic acid was expressed in Dietary Folate Equivalents, with the assumption that synthetic folic acid has a 70% higher bioavailability than dietary folate. Iron supplied by NaFeEDTA was also estimated as doubly bioavailable compared with ferrous sulfate or ferrous fumarate. Bioavailability of the last two iron compounds was assumed to be similar to dietary iron.

Calculation of usual nutrient intakes and prevalence of inadequate intakes

In terms of designing and evaluating nutrition policies and programs, it is the usual intake of nutrients that is of central interest. Usual intake is calculated as the average intake over a long period of time and a large sample of the population. Direct observation, therefore, is difficult. Instead, the most accepted procedure is to measure actual daily intakes on a large sample of persons, and in addition, estimate the intra- (or within)-individual variation on a subsample of the large sample. This estimate is then used to adjust the actual intake distribution of the whole population, which is then considered the usual intake profile

In this study, calculation of usual intake from actual intake was done using the Iowa State University (ISU) method proposed by Nusser *et al.* (1996). This method adjusts daily intakes by removing the intra-individual variance from the variance of observed person-level mean intakes. The estimated usual nutrient intake distribution that results from implementation of the method has the correct mean, variance, and shape, and, in particular, allows reliable estimation of the prevalence of inadequate nutrient intake as described by Carriquiry (2003). In this study, the repeat dietary recalls conducted on ten percent of the sampled households in each region allowed for correction of the day-to-day intra-individual variance in nutrient intakes. Dr. Alicia Carriquiry, of ISU, undertook these calculations using PC-SIDE version 1.0 software.

An individual's intake of a nutrient was classified as inadequate using the WHO EAR cut-point method as described by Allen *et al.* (2006), that is, when the estimated usual intake of the individual was less than the corresponding EAR value for the age and sex of the individual.

This approach relies on the following assumptions: (a) intakes and requirements are independent; (b) the requirement distribution is symmetric around its mean; and, (c) the variance of requirements in the group is higher than the variance of usual intakes. Thus, the method cannot be applied to nutrients without an EAR (e.g., calcium), or to energy (because intakes are highly correlated with requirements which are in turn largely determined by energy expenditure) or to iron (because the distribution of requirements is not symmetric).

In order to obtain an estimate of the prevalence of inadequate calcium intake, we used the method proposed by Foote *et al.* (2004). This approach relies on the assumption that the adequate intake (AI[7]) is high enough that individuals with usual intakes above the AI are very likely to be meeting their requirements. What is more difficult to assess is the status of individuals with usual intakes below the AI. Foote and colleagues propose that usual intake below 25% of the AI is inadequate with probability 1, usual intake between 25% and 50% of the AI is inadequate with probability 0.75, usual intake between 50% and 75% of the AI is inadequate with probability 0.5 and finally, usual intake between 75% and 100% of the AI is inadequate with probability equal to 0.25. An approximated prevalence of inadequate calcium intake can then be computed as the weighted average of those probabilities, where the weights are given by the frequency of persons in the group with usual calcium intake in each of those categories.

We used the probability approach to estimate the adequacy of iron intake. This required that we compute the weighted average of the risks of inadequacy at each usual iron intake level. Tables with risk estimates are given in Institute of Medicine (IOM)(2000) but these were computed assuming a higher bio-availability of iron (15%) than what we assume is present in the diet of Ugandan children and women. We adapted the IOM tables to the case where bioavailability of dietary iron, given the high dietary content of fiber and phytate, is 5%.

Statistical analysis

Summary statistics along the study objectives and the various outcome variables were generated from data using SPSS Statistical Program version 15 and SAS version 9.2.

Simulating the impact of fortification

An individual's additional intake of a vitamin or a mineral resulting from fortification is determined by the amount of fortified food s/he consumes and the amount of the nutrient/s added during the fortification process remaining at the time the food is consumed. In simulating the impact of fortification on nutrient intake, we calculated each individual's additional consumption of each vitamin and mineral from fortification by multiplying the amount of each fortified food consumed by the amount of each micronutrient we estimated would remain in that food in the household, i.e. allowing for losses after the fortification process. The additional nutrient level added at the factory was based upon current Ugandan food fortification standards for each 100 g of fortified food consumed. Together with the assumptions about losses between production and consumption, the amounts of micronutrients used in our calculations are presented in Table 2.

[7] Adequate intake (AI) is a recommended intake value based on observed or experimentally determined approximations or estimates of nutrient intake by group or group of apparently healthy people that are assumed to be adequate. This value does not derive from EAR value.

Table 2. Amounts of micronutrients (mg/100 g food) added at the factory to current and potentially fortified foods, estimated percentages lost in transport and storage, and estimated amounts remaining in households in Uganda, 2008

Fortified Food/Micronutrient	Addition at Factory[§] (mg/100 g)	Estimated Losses (%)[¶]	Level in Household (mg/100 g)
Vegetable Oil			
Vitamin A	3.5	30	**2.5**
Sugar			
Vitamin A	1.0	30	**0.7**
Wheat Flour			
Vitamin A	0.3	20	**0.24**
Vitamin B-1	1.3	30	**0.91**
Vitamin B-2	0.7	15	**0.60**
Niacin	9.0	15	**7.7**
VitaminB-6	0.7	15	**0.6**
Folic Acid*	0.3	15	**0.43**
Vitamin B-12	0.0015	15	**0.0013**
Iron (as ferrous fumarate)	4.0	0	**4.0**
Zinc	5.0	0	**5.0**
Maize Flour			
Vitamin A	0.1	20	**0.08**
Vitamin B-1	0.5	30	**0.35**
Vitamin B-2	0.4	15	**0.34**
Niacin	4.0	15	**3.4**
VitaminB-6	0.0	0	**0.0**
Folic Acid*	0.1	15	**0.14**
Vitamin B-12	0.0005	15	**0.0004**
Iron (as NaFeEDTA)**	1.5	0	**3.0**
Zinc	4.0	0	**4.0**

[§] As specified in the current Ugandan standards for food fortification.
[¶] Usual losses due to packaging, food preparation, and storage as compiled from several sources.
* The contribution at homes has been multiplied by 1.7 to transform folic acid to Dietary Folate Equivalents.
** The contribution at homes has been multiplied by 2.0 to reflect higher iron bioavailability.

For this study, the potential benefit of fortification on the adequacy of nutrient intake of the populations of interest was described as reduction in the prevalence of inadequate intakes that results from the additional intakes of micronutrients from consuming fortified foods, as is recommended in the WHO/FAO fortification guidelines (Allen *et al.,* 2006). The prevalence of inadequate intake for most nutrients is defined as the proportion of the population with intake of that nutrient below the corresponding EAR. The proportions of populations with inadequate intake of calcium and iron were estimated using the probability approach as described before.

Estimating the probability of usual intake exceeding Tolerable Upper Intakes Levels (ULs)
PC-SIDE was used to implement the ISU method in estimating the probability of usual intake of folic acid and retinol exceeding the respective ULs. These analyses were performed by Dr Alicia Carriquiry. Her methods are summarized below and described in detail in Annex 2.

The ULs for folic acid for children 6-23 months, children 24-59 months and WRA, are 330, 338 and 1,000 μg/day as folic acid, respectively (Annex 5). The number of children consuming wheat and maize flours was quite low and therefore we combined them into a single age group. Because the UL is different in the two age groups of children, we used the smaller of the two UL values (300 µg/day as folic acid) in the model to be very conservative. That is, if we estimated the probability of exceeding the lower UL to be small, then among the older children, the probability of exceeding their own (higher) UL will be even smaller. To be highly conservative in this analysis, we considered the risk of excessive intakes only among those persons who consumed foods fortified with folic acid.

The ULs of retinol for children 24-59 months and WRA are 750 and 3,000 µg Retinol Equivalent (RE), respectively. Higher proportions of each age group consumed the food vehicles fortified with vitamin A; 65% (369 of 564), and 54% (564 of 1050) in the children and WRA, respectively. Thus we used the age appropriate ULs. As we did with folic acid, in order to be conservative, we considered the risk of excessive intakes only among persons consuming foods fortified with vitamin A.

Strengths and Limitations of the Study

Efforts to maintain high quality data included:

a) Working with appropriate Ugandan institutions to ensure both the ultimate ownership of the data from the survey, and that opportunities for capacity building provided in the design and implementation of the survey were exploited;
b) Employing rigorous sampling procedures in the three regions selected purposefully for the survey;
c) Using state-of-the-art methods both in collecting and analyzing the food consumption data (24-hour recall with duplicates, PDAs, and PC-Side software for estimating usual intakes carried out by the researcher who developed this methodology);
d) Engaging experienced interviewers with the language skills needed to allow respondents to focus on the recall task; and,
e) Providing sufficient training and supervision to ensure conscientious, high-quality field work, including specific attention to standardizing the procedures used to ask questions, and prompt for and code responses.

The survey also capitalized on the opportunity to include knowledge, attitudes and practices about IYCF, in the hopes that such data can be used in future studies, in particular to provide better understanding of the role of complementary foods for this group.

An ancillary product of the study was the production of a food database specific for Uganda. It was developed from the information collected by HarvestPlus in 2007, and expanded for those food items and recipes that did not appear in the HarvestPlus database. Nutrient composition for those foods was extracted from the composition tables of neighboring countries as well as from USDA information. As with any other food composition table, some discrepancies between the real nutrient composition of the foods and the recorded values for ingredients and recipes might exist. Thus, the process of converting measured food intake to estimated nutrient intake inevitably includes some error. However, by far, this is the most comprehensive database with specific application to the Ugandan diet and, in all likelihood, for the ECSA region as well.

Setting reasonable, logistically feasible objectives for this study required setting a number of limitations that are important to note:

- Collection of information occurred only for the months of May to September, and as a consequence, seasonal crops produced during the months from October to April will not be fully represented. Derived as it is from a seasonal product, estimation of the consumption of maize flour was affected; the timing of the survey coincided with a time of limited availability of maize.
- Specific data about the amount of food aid given to households in the North was not obtained, making it difficult to make inferences about the direct impact of the food aid programs because the

specific sources of commonly consumed foods could not be identified. Likewise, the origin of maize flour consumed, whether domestically or industrially produced, was not thoroughly identified.

- Because consumption of breast milk by children 6-23 months was not estimated, the intake data for this group is incomplete, and no deduction about adequacy of intakes could be made. Nevertheless, Annex 6 presents the nutrient intake through foods for this age group.

Finally, while all care was taken with the methods used in this survey to provide valid estimates of nutrient intakes, a study of this type should, ideally, analyze biomarker and nutrient intake results together. Biomarker studies are costly, however, and for many micronutrients, such as vitamin A, zinc, calcium, and others, biomarker studies may not be practical because no viable biomarker exists or because interpretation of the values are complicated due to infection and/or multiple nutritional deficiencies. Therefore, the assessment of intakes is a valuable approach to identifying the nutrients with the highest probability of inadequacy, as well as the age groups at highest risk of suffering the consequences of micronutrient deficiencies.

III. RESULTS

Socioeconomic Characteristics and Dietary Intakes

Description of the Sample

The sample of WRA was comprised mainly of wives or partners of male heads of household (over 75%) indicating that most respondents lived as couples. Kampala had more female-headed households (16%) than rural areas (South-West, 11%; North, 5%). Most female respondents in all regions ranged in age from 20 to 29 years, indicating a young population. The modal age group among respondents was 20–34 years. Few respondents were younger than 19 years (6%) or older than 45 years (5%). This population distribution conforms to DHS 2006 data.

Table 3: Description of the social and economic characteristics of respondents in the food consumption survey in Kampala, South-West, and North Uganda, 2008

REGION	Kampala		South-West		North	
	n=314	%	n= 322	%	n= 321	%
Relationship to head of household (HH)						
Female head of HH	49	16	34	11	14	5
Wife/partner of HH	239	76	274	85	292	91
Female relative of HH	17	5	14	4	14	5
House-girl (non-relative)	9	3	0	0	0	0
Age category (years)						
15-24	125	40	90	28	105	33
25-34	156	50	130	42	145	45
35-49	32	10	94	30	70	22
Marital status						
Married (+ single with co-habiting partner)	273	87	290	90	295	92
Single (+ widowed, separated, divorced)	41	13	33	10	27	8
Literate						
Yes	265	84	216	67	149	47
No	49	16	106	33	172	54
Highest level of schooling						
Informal	24	8	46	14	98	30
Primary school	123	39	214	66	181	57
Secondary school	146	46	46	14	13	4

REGION	Kampala		South-West		North	
	n=314	%	n= 322	%	n= 321	%
Post secondary	21	7	9	3	1	0
Don't know	1	0	8	3	28	9
Wealth Index[8]						
Lowest quintile	53	17	90	28	151	47
Second	3	1	71	22	103	32
Third	22	7	84	26	35	11
Fourth	63	20	74	23	32	10
Highest quintile	176	56	3	1	0	0
Partner employed	n= 271		n=289		n=294	
Yes	251	93	241	83	46	16
No	20	7	48	17	248	84
Partner's occupation	n=251		n=241		n=46	
Farmer	0	0	149	55	9	20
Trader	48	19	41	15	3	7
Civil servant	68	27	14	5	19	42
Other Privately employed	35	14	54	20	9	20
Other service	103	41	14	5	5	11
Respondent's occupation	n=111		n=162		n=15	
Farmer	0	0	112	69	3	19
Trader	43	39	8	5	4	25
Civil servant	3	3	10	6	1	6
Other privately employed	24	22	16	10	5	31
Artisan	1	1	0	0	0	0
Food service	13	12	3	2	2	13
Other service	26	23	15	9	1	6

Wealth was distributed unevenly in the three areas surveyed. In Kampala 76% of the sample were classified into the two highest quintiles of wealth, compared to 24% in the South-West and 10% in the North. At the other extreme, 17% of the respondents in Kampala were in the lowest quintile of wealth compared to 28% in the South-West and 47% in the North. These stark differences in wealth distribution are likely to be a major determinant of access to commercially produced fortified foods. The distribution of wealth in Kampala has a striking bimodal distribution not seen in the other regions. The 17% in the lowest quintile seem to represent a distinct group of very poor as very few of the sample were categorized into the 2nd and 3rd quintiles (1% and 7%, respectively). It is fair to say that the highest prevalence of inadequate nutrient intake in Kampala is likely found among the poorest, however, given their urban setting and consequent access to industrially-manufactured foods, they also have a strong chance of benefiting from food fortification.

[8] The wealth index was similar to that calculated by the Uganda Demographic and Health Survey (UBOS, 2006) and is based upon household assets and categorized for the entire sample.

Table 4: Numbers and percentages of children 24-59 months of age, by gender and age group, included in the food consumption survey in Kampala, South-West, and North Uganda, 2008

REGION	Kampala n=155		Southern-Western n=160		Northern n=163	
	n	%	n	%	n	%
Sex						
Males	77	50	73	46	78	48
Females	78	50	87	54	85	52
Age (months)						
24-35	72	46	74	46	79	48
36-47	50	32	61	38	45	28
48-59	33	21	25	16	39	24

Food Group Intakes

Figure 1 shows the mean intake of the main food groups eaten by WRA. Figure 2 presents the proportional contribution to the total energy intake for the same food groups. Consumption patterns of children 24-59 months are not shown, but are similar to those of the women.

Figure 1: Mean intake (in grams) by food group for women of reproductive age in Kampala, South-West, and North Uganda, 2008

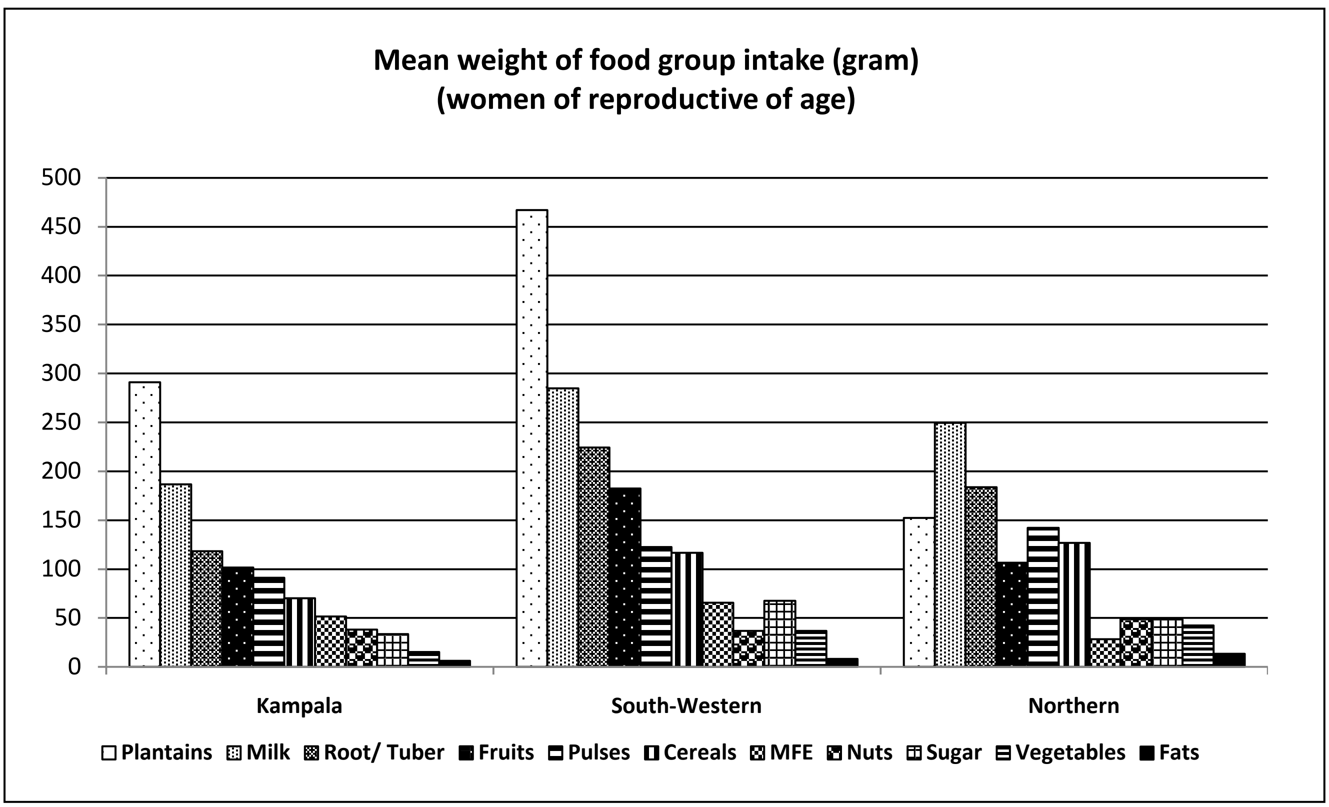
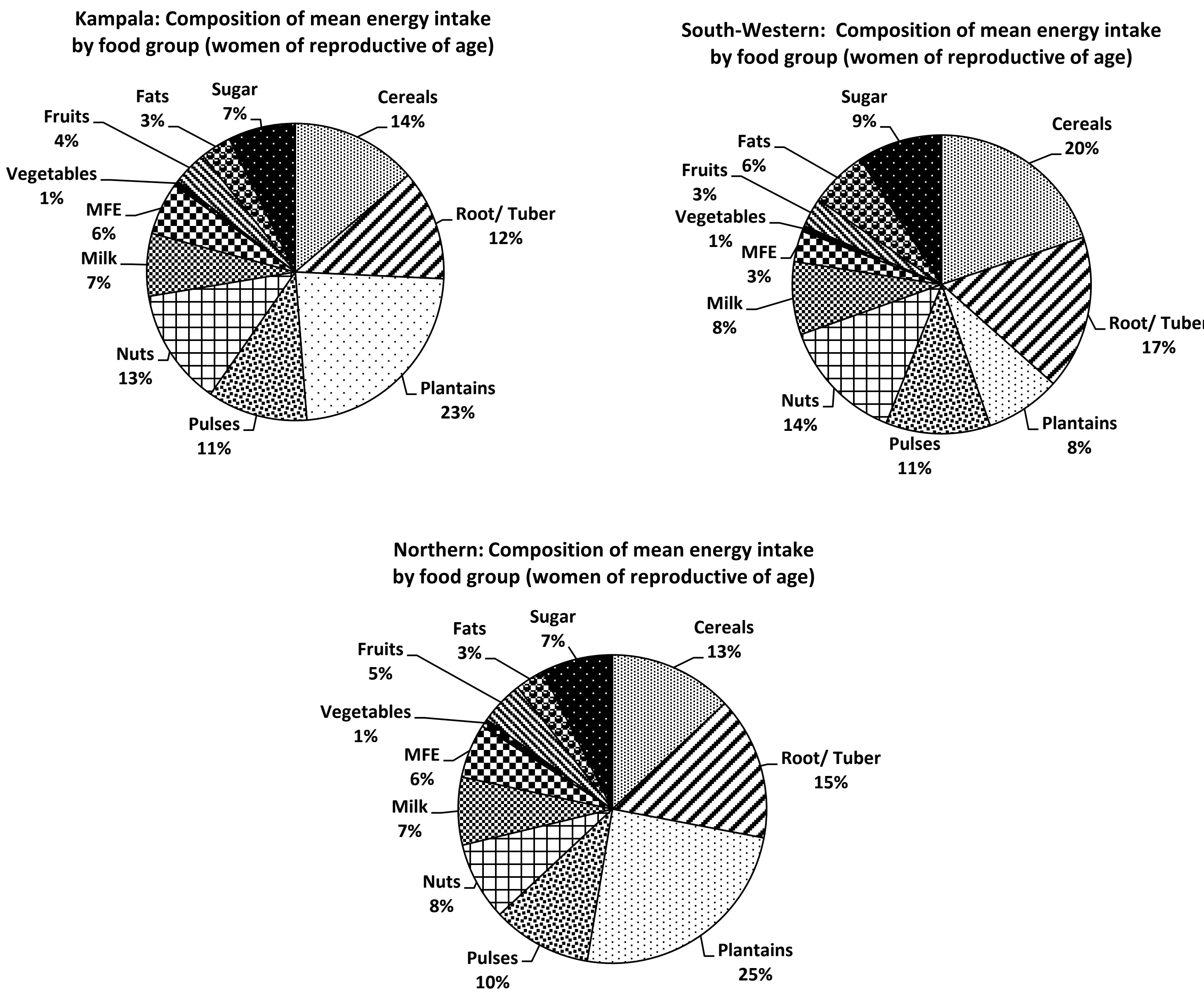


Figure 2. Contributions to energy intake by food groups for women of reproductive age in Kampala, South-West, and North Uganda, 2008



The Ugandan diet is predominantly vegetarian; only 11-13% of the energy is supplied by foods of animal origin. Most of the energy in the Ugandan diet during the period of the study (May to September) comes from plantains and roots or tubers (425 to 700 g/day).

The combined intake of pulses and nuts, which are good sources of protein and nutrients of the B complex, including folate, was relatively large (100-180 g/day), especially for the two rural communities. Consumption of sugar, oil/fat, and vegetables was modest, at approximately 20 to 60 g/day. Fruit intake (100-150 g/day) was also fair. As predicted, and typical for a poor developing country, intake of meat, fish, poultry and eggs (MFPE) was low (25-60 g/day), with this most pronounced in the North.

Milk is expressed as a fluid, which means that the mean daily intake of milk in the three regions of Uganda was a cup or less. However, in order to meet daily requirements for calcium delivered only from milk, a person should consume between 3 and 4 cups of milk per day depending on the age. Milk intake was lower in Kampala than in the two rural areas. Milk expressed in dry matter is approximately one tenth of the volume.

The dietary profile indicates that the energy and protein intake of the studied groups are likely to be adequate for Kampala and the South-West, whereas the North has disrupted access to agricultural land and the usual food supply to the extent that humanitarian food aid has been required. Second, a severe and extended drought began to severely impact the availability of locally produced food causing steep increases in food prices in 2008. These two factors resulted in the population's increased reliance on food aid from WFP, consisting of vegetable oils, pulses and cereals. The influence of food aid on the diet can be seen in the contribution of oil/fats to the total energy intake in the North at 6% versus 3% in the other regions, and that of cereals at 20% versus 13-14% in the other regions (Figure 2). Despite this food aid, however, the total amount of energy-supplying foods appears to be insufficient to satisfy the daily requirements of the population as a whole in the North (see below).

The dietary profile also indicates that the intakes of vitamin C, B-1, B-2, niacin, folate, and calcium (coming from plantain, pulses, nuts, fruits, and milk) appear to be larger in the rural areas than in Kampala. Whereas all regions have insufficient intake of micronutrients provided preferentially by MFPE; this includes vitamin A, vitamin B-12, iron, zinc, and calcium.

The consumption of cereals was much lower than expected (75-125 g/day). Table 5 shows the median, and mean plus standard deviation of the cereals most commonly consumed by WRA. Cereals included wheat flour and wheat products (bread, biscuits, chapatti, and others) particularly in Kampala, as well as maize grain, rice, millet, and sorghum.

Table 5a: Amounts of cereals consumed (g/day) by all women of reproductive age, described by both medians (50th percentiles) and means and standard deviations (SD), in Kampala, South-West, and North Uganda, 2008

Type of flour and products	Kampala n=314		South-West n=322		North n=321	
	Median*	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)
Total wheat flour equivalent consumption**	31.7	40.2 (46.1)	0.00	3.93 (17.5)	0.00	1.57 (9.40)
Total maize flour equivalent consumption**	0.00	53.4 (84.1)	0.00	16.1 (39.5)	0.00	30.5 (85.4)
Total rice consumption	0.00	37.4 (70.8)	0.00	10.7 (46.9)	0.00	2.25 (16.5)
Total maize grain consumption	0.00	34.7 (74.0)	0.00	99.2 (206)	0.00	106 (161)
Total sorghum consumption	0.00	0.11 (1.73)	0.00	0.45 (3.77)	54.0	115 (157)
Total millet consumption	0.00	0.00 (0.00)	0.00	0.10 (1.56)	0.00	0.18 (3.30)

* Other percentiles shown in Tables 11 and 12

** Total of flours and food products containing these flours

Table 5b: Amounts of cereals consumed (g/day) by women of reproductive age who consumed the cereals, described by both medians (50th percentile) and means and standard deviations (SD), in Kampala, South-West, and North Uganda, 2008

Type of flour and products	Kampala		South-West		North	
	Median	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)
Total wheat flour equivalent consumption*	n=198		n=24		n=12	
	58.3	63.6 (43.3)	35.3	52.5 (40.0)	35.6	41.9 (26.9)
Total maize flour equivalent consumption*	n=134		n=61		n=55	
	116	125 (87.4)	78.6	84.9 (48.7)	147	178 (129)
Total rice consumption	n=102		n=26		n=6	
	90.2	115 (80.7)	116	132 (108)	121	120 (19.5)
Total maize grain consumption	n=86		n=110		n=143	
	106	126 (91.7)	201	289 (262)	191	237 (164)
Total sorghum consumption	n=2		n=7		n=182	
	17.4	17.4 (18.4)	10.8	20.9 (16.1)	165	202 (161)
Total millet consumption	n=0		n=2		n=1	
			16.09	16.09 (16.29)	59.13	59.13 (0.00)

* Total of flours and food products containing these flours

The mean and median intake of various cereals and their flours are presented to allow comparison of the food patterns of Uganda women with equivalent data collected in other surveys. As expected, there was a strong divergence between the mean and the median (P50) intake of cereals consumed by WRA in Uganda (Tables 5a and 5b). This divergence is highlighted in Table 5a where the intake of all women, both cereal consumers and non-consumers together, is described. The mean, in particular, may be a misleading indicator of the consumption of a food in a population, first, because the consumption of that food is often highly skewed to the right (consumption is very high in a few individuals), while, also, many of the population consume nothing. The median, by itself is also a poor indicator of the consumption pattern, because this will be zero when fewer than 50% of the women consumed these foods. A more useful way of describing the consumption pattern of a potential vehicle for fortification and, hence, the likely impact it may have on micronutrient intake, is to describe the percentile distribution as is done below in Tables 11 and 12.

Macronutrient Intakes

Tables 6 and 7 summarize the distributions of macronutrient intakes for children 24-59 months and WRA, respectively. The data indicate substantial differences among the three regions, with energy intakes in the South-West substantially greater and with a wider distribution than those in Kampala and in the North. The shapes of the distributions of energy intakes in Kampala and the North are quite similar but with Kampala being about 100-200 kcals/day greater. The distribution of energy intakes in the South-West, on the other hand, is markedly skewed to the right. These observations may be explained by the higher energy expenditures required for farm work that was far more common among the sample in the South-West (69%) than in the other areas (0% in Kampala and 19% in North—see Table 3).

Refined foods were more prominent in the diet in Kampala than in the South-West or the North, and this is evident from the substantially lower fiber intakes there. This feature of the urban diet is more striking when fiber intakes are expressed per 100 Kcal. The reduction in fiber intake might also have implications for the intake of B complex vitamins, as well as some minerals. However, despite lower absolute intake, iron and zinc bioavailability may be higher in Kampala than in the two rural regions because of the lower level of fiber intake there. This fact also has implications for food fortification with these two minerals because, at similar levels of additional intake, the expected impact might be stronger in urban communities than in rural ones.

The intake of fiber in women in the North shows far less variation than in other regions, especially when expressed in relation to energy intake (P5 – P95 of 1.74 to 1.81, Table 6). This suggests that the overall diet there varies little, and consists more of whole grains and fewer other plant sources than in the other two regions.

Table 6: Usual nutrient intake distributions of energy, fat, protein, and fiber for children 24-59 months in Kampala, South-West (S-W), and North Uganda, 2008.

Macronutrient	Region	5th	10th	25th	50th	75th	90th	95th
Energy (kcal)	Kampala	786	896	1086	1315	1583	1881	2092
	S-W	996	1113	1323	1581	1863	2138	2312
	North	649	760	964	1215	1492	1762	1933
Fat (g)	Kampala	11.3	14.1	19.8	27.6	37.4	48.0	55.1
	S-W	11.9	14.0	18.3	23.9	30.4	37.1	41.4
	North	21.0	22.8	26.2	30.4	35.1	49.8	42.9
Protein (g)	Kampala	19.2	21.7	26.2	32.1	38.9	46.2	51.4
	S-W	17.7	21.0	27.4	36.0	46.5	57.6	65.2
	North	26.6	28.8	32.7	37.4	42.7	47.9	51.2
Fiber (g)	Kampala	5.8	7.2	9.8	13.4	17.9	23.1	26.9
	S-W	12.4	15.4	21.0	28.3	36.8	45.3	50.8
	North	9.7	11.6	15.5	20.6	26.8	33.4	37.8
Fiber (g/100 kcal)	Kampala	0.74	0.80	0.90	1.02	1.13	1.23	1.29
	S-W	1.25	1.38	1.59	1.79	1.98	2.12	2.20
	North	1.49	1.53	1.61	1.70	1.80	1.90	1.96

Nutrient requirements vary considerably by age and gender in younger children. The FAO/WHO/UNU (1985) estimated daily energy requirements, averaged for gender, for ages 24-36, 36-47, 48-59 months, are1360, 1500, and 1650 kcal/day, respectively. The mean of these requirements, assuming equal distribution across age groups, is 1492 kcal/day. Given that data presented in Table 6 are not weighted for age, and that the sample has greater numbers of younger children than older children, the estimates of 1315 and 1581 kcal/day in Kampala and the South-West seem reasonable, while energy intake for the North (1215 kcal/day) appears to be low.

Children 24-59 months old consuming less than 1000 kcal were probably deficient and this could be interpreted as a prevalence of inadequate energy intake of about 15% in Kampala, 5% in the South-West, and 25% in the North. Protein intake seems appropriate in all regions.

Table 7: Estimated usual nutrient intake distributions of energy, fat, protein and fiber for women of reproductive age (WRA) in Kampala, South-West (S-W), and North Uganda, 2008.

Macronutrient	Region	5th	10th	25th	50th	75th	90th	95th
Energy (kcal)	Kampala	1547	1700	1957	2256	2582	2920	3149
	S-W	1666	1892	2308	2826	3404	3977	4345
	North	1359	1507	1767	2074	2400	2708	2899
Fat (g)	Kampala	25.3	28.8	35.5	44.0	54.0	64.2	70.9
	S-W	10.3	13.5	20.9	62.3	48.3	65.8	77.6
	North	23.8	28.4	37.2	48.8	62.9	78.4	89.2
Protein (g)	Kampala	32.4	36.6	44.4	54.2	65.1	76.1	83.1
	S-W	31.3	37.4	49.3	65.4	84.9	106.0	119.0
	North	44.5	48.2	54.8	62.8	71.5	80.0	85.4
Fiber (g)	Kampala	16.2	18.7	23.3	29.1	35.9	42.7	47.2
	S-W	27.9	32.9	42.3	54.4	68.5	82.9	92.3
	North	23.7	26.4	31.1	36.8	42.9	48.8	52.5
Fiber (g/100 kcal)	Kampala	1.05	1.10	1.19	1.29	1.39	1.46	1.50
	S-W	1.67	1.74	1.83	1.92	2.01	2.08	2.12
	North	1.74	1.75	1.76	1.77	1.79	1.80	1.81

In the case of women (Table 7), the energy intake appears acceptable (between 1800 and 2800 kcal/day), except for individuals in the lowest quintiles of intake, and mainly in the North. As was the case with children, protein intake appears adequate.

Micronutrient Intakes

The percentile distributions of usual intake of vitamins and minerals are presented with the EAR and the Tolerable Upper Intake Level (UL[9]) reference values in Annex 4. Table 8 summarizes the prevalence of inadequate intake of the micronutrients assessed for the three regions of Uganda.

Table 8: Percentages of the populations with inadequate usual intake of micronutrients in Kampala, South-West (S-W), and North Uganda, 2008

Age	**Children 24-59 months old**			**Women of reproductive age**		
Region	**Kampala**	**S-W**	**North**	**Kampala**	**S-W**	**North**
Vitamin A	69	52	99	47	30	98
Vitamin B-1	18	1	2	20	3	6
Vitamin B-2	18	2	34	20	8	39
Niacin	13	2	6	11	7	13
Vitamin B-6	5	0	7	0	0	26
Folate	17	0	1	7	1	11
Vitamin B-12	32	65	94	64	97	100
Vitamin C	13	0	12	13	0	12
Iron	75	57	55	89	65	71
Zinc	82	78	74	36	33	18
Calcium	88	79	93	99	84	96

[9] UL, the Tolerable Upper Intake Level, is the highest average daily nutrient intake level unlikely to pose risk of adverse health effects to almost all (97.5%) apparently healthy individuals in an age- and sex-specific population group.

The prevalences of inadequate intake of the various vitamins and minerals vary widely, as do the prevalences among age groups and regions. However, in general, the dietary patterns were found to be highly inadequate for vitamin A, vitamin B-12, iron, zinc, and calcium, based on the dietary profile, which featured low levels of consumption of milk, meat, fish, and eggs. As compared to the other regions, the North showed the highest prevalence of inadequate intake for the two vitamins, corresponding to the limited availability of foods rich in vitamins A and B-12 in that region. On the other hand, inadequate intake of the minerals (iron, zinc, and calcium) were generally most prevalent in Kampala, and this is likely due to the population's reliance on refined foods rather than traditional sources of these nutrients, such as whole cereals, pulses, and other traditional and local plant foods. Nevertheless, the bioavailability of minerals may be higher in Kampala than in the rural areas due to the lower intake of fiber, a mineral-absorption inhibitor. Regardless, the prevalence of inadequate intake of these three minerals is high in the three regions surveyed.

Overall, with the exception of vitamin B-12, the rural South-West has a lower prevalence of inadequate intake of vitamins and minerals than the other two regions, despite the lower levels of wealth than in Kampala.

Kampala reported a higher prevalence of inadequate intake for vitamin B-1, vitamin B-2, niacin, vitamin B-6, and folate than the South-West; this is likely attributable to the switch from a traditional diet to a diet rich in refined flours, sugar and fats. The high prevalence of inadequate intake of vitamins B-2 and B-6 in the North can be attributed to the overall poor quality of the diet there.

In general, inadequate intake of vitamin C (main sources: banana plantain or *matooke*, guava, green cabbage, sweet potato, papaya and cassava root), niacin (main sources: fish carp or *mukene*, peanut, millet), folate (main sources: beans of several types, such as *nambale*, kidney and black beans, peanut, cowpea and avocado), and vitamin B6 (main sources: beans of several types, banana, sweet banana or *kisubi,* avocado, sweet potato, and cassava flour) are far less common.

The intake data show that the prevalence of inadequate intake of zinc is higher in children than in WRA. However, at the 95th percentile, intake of zinc approaches the current UL value for children (Annex 7). This anomalous situation implies that the UL value of zinc for children should be reviewed, because the separation between the UL and the EAR values is too narrow given dietary and metabolic realities. It seems that the UL values of zinc for children have been set too low, and perhaps an adjustment is required for the low bioavailability of this mineral in vegetarian diets. For this reason, we have not discussed further the apparently high intake of zinc in Uganda.

Regarding excessive intakes of vitamin A and calcium, it is clear that through dietary intake the Ugandan population is far from reaching current UL values (see Annex 4).

Frequency of Consumption of Food Fortification Vehicles and the Amounts Consumed

Tables 9 to 12 present the distributions (in percentiles) of usual intake of the four food vehicles being fortified or considered for mass fortification in Uganda: oil, sugar, wheat flour, and maize flour. Oil and sugar are the most widely consumed of these vehicles, but still only half or less of the rural population consumes them. In the North, vegetable oil is more commonly consumed than in the South-West, and in greater amounts than in either of the two other regions. Vegetable oil is a prominent component of the food aid package distributed by WFP.

At the time of this survey, wheat flour was, essentially, a food of urban communities. In Kampala, flour or flour-based products were consumed by about 75-90% of children 24-59 months and 50-75% of WRA. In contrast, in the rural areas, less than 25% of the population consumed wheat flour or its products.

The low levels of consumption of maize flour were an unexpected finding since maize is considered a staple in Uganda. This finding can be explained by the seasonality of maize consumption; the survey was undertaken immediately before the harvest, a time when maize is less available than it usually is.

Table 9: Estimated percentiles of usual consumption of vegetable oil (grams/day) by children 24-59 months and women of reproductive age in Kampala, South-West and North Uganda, 2008¶

Region	Age	P5	P10	P25	P50	P75	P90	P95
Kampala	Children	0.72	2.06	3.85	7.26	12.9	18.2	23.6
	WRA	-	1.30	4.99	10.60	18.2	27.3	35.4
South - West	Children	-	-	-	-	5.56	12.1	19.4
	WRA	-	-	-	-	5.64	16.0	21.0
North	Children	-	-	-	5.30	14.0	23.3	34.0
	WRA	-	-	-	-	22.3	40.6	49.0

¶ The highest percentile with an empty box denotes the proportion of the population that is not consuming the food.

Table 10: Estimated percentiles of usual consumption of sugar (grams/day) by children 24-59 months and women of reproductive age (WRA) in Kampala, South-West and North Uganda, 2008¶

Region	Age	P5	P10	P25	P50	P75	P90	P95
Kampala	Children	9.46	14.3	24.4	40.5	65.9	88.4	107.0
	WRA	9.76	19.4	34.0	57.1	86.1	122.0	143.0
South - West	Children	-	-	-	-	14.9	38.5	54.7
	WRA	-	-	-	-	21.3	55.6	82.7
North	Children	-	-	-	-	17.9	37.8	60.3
	WRA	-	-	-	-	24.2	51.1	67.2

¶ The highest percentile with an empty box denotes the proportion of the population that is not consuming the food.

Table 11: Estimated percentiles of usual consumption of wheat flour and its products (grams/day) by children 24-59 months and women of reproductive age (WRA) in Kampala, South-West, and North Uganda, 2008¶

Region	Age	P5	P10	P25	P50	P75	P90	P95
Kampala	Children	-	-	14.6	32.5	54.3	77.8	103.0
	WRA	-	-	-	30.6	63.7	99.9	130.0
South - West	Children	-	-	-	-	-	29.6	44.9
	WRA	-	-	-	-	-	-	32.5
North	Children	-	-	-	-	-	7.56	29.6
	WRA	-	-	-	-	-	16.1	38.9

¶ The highest percentile with an empty box denotes the proportion of the population that is not consuming the food.

Table 12: Estimated percentiles of usual consumption of maize flour and its products (grams/day) by children 24-59 months and women of reproductive age (WRA) in Kampala, South-West, and North Uganda, 2008¶

Region	Age	P5	P10	P25	P50	P75	P90	P95
Kampala	Children	-	-	-	-	50.4	89.1	125.0
	WRA	-	-	-	-	89.3	177.0	230.0
South - West	Children	-	-	-	-	-	41.6	77.1
	WRA	-	-	-	-	-	78.0	118.0
North	Children	-	-	-	-	-	57.4	118
	WRA	-	-	-	-	-	133.0	211.0

¶

The highest percentile with an empty box denotes the proportion of the population that is not consuming the food.

The data show that a higher proportion of the urban population in Kampala consumes these four foods, and consumes substantially more of them, than do the rural populations. Thus, the urban population will be the primary beneficiaries of food fortification in Uganda. Further, these data indicate that, at this time, the introduction of oil and sugar fortifications show potential for mass fortification for vitamin A as both foods are increasingly penetrating the rural markets.

While wheat flour is consumed primarily in Kampala (and probably other urban communities), it remains a viable vehicle for mass fortification for providing micronutrients that are inadequate in the diets of the urban population. These include not only some of the micronutrients with the widest and most severe prevalence of inadequate intake (vitamin A, vitamin B-12, iron, and zinc), but also B-complex vitamins (B-1, B-2, niacin, and folate).

The percentile distributions of consumption indicate an "abrupt start" to the consumption of wheat and maize flour at higher percentiles. For example, maize flour is consumed by 25% or less of the population, but those consuming it are consuming reasonable amounts. For example, in children 24-59 months, between 50% and 75% (75% to 90% rural areas) were not consuming any maize flour at the time of the survey, but among those who did consume this food, consumption levels were sufficient to provide enough of the added micronutrients to be useful from a public health point of view (P90 to P95 of 90 to 125 g/day in Kampala, 42 to 77 g/day in the South-West, and 57 to 118 g/day in the North). Therefore, between 50 to 100 g/day would be the amounts of maize flour needed to be consumed by this age group in an effective targeted-fortification program. In the case of WRA, the corresponding consumption values for using maize flour in targeted-fortification would be from 78 to 230 g/day. These estimations were based on the estimated the distribution of percentiles of intake and highlight the value of this presentation of results over the mean and median.

Estimated Additional Intakes of Micronutrients through Mass Fortification

The Ugandan fortification standards (shown in Table 2) were used to model the extent to which fortification of four food vehicles according to those standards would reduce the proportion of the population whose intake of micronutrients remains inadequate. Inadequate intake for most micronutrients was defined as below the EAR, while for calcium and iron the probability approach was used (see Methods).

Predicted Reduction in Inadequate Vitamin A Intake Due to Fortification

The predicted impact of fortification with vitamin A was considered separately from other vitamins and minerals because it is the only micronutrient that is added to commercially-produced wheat flour and oil in Uganda; it could also be added to sugar, as well as maize flour.

Table 13: The predicted prevalences (%) of inadequate intake of vitamin A for children 24-59 months and women of reproductive age (WRA) in the absence of and in the presence of fortification, in Kampala, South-West (S-W), and North Uganda, 2008

Age	Children 24-59 months			WRA		
Region	**Kampala**	**S-W**	**North**	**Kampala**	**S-W**	**North**
Diet alone*	69	52	99	47	30	98
Plus oil¶	20	28	56	6	17	45
Plus wheat flour	48	46	99	30	29	98
Plus wheat flour and oil	10	25	54	3	17	45
Plus sugar	6	31	90	2	19	87
Plus oil and sugar	**0**	**16**	**43**	**0**	**13**	**33**
Plus wheat flour, oil, and sugar	0	14	42	0	13	33
Plus maize flour	64	49	99	40	28	97
Plus wheat flour, oil, sugar, and maize flour	0	13	39	0	12	31

* Prevalences without fortification from Table 8.
¶ This is a closer approximation to the current situation in Uganda, because more than 85% of vegetable oil is already fortified with vitamin A.

Our estimations show that fortifying oil and sugar with vitamin A would have a dramatic impact in reducing the prevalence of inadequate intake of this vitamin in all three regions (highlighted in Table 13). The lowest reduction was in the North and highest in Kampala, corresponding to the proportions of the population consuming these foods. The percentage reductions due only to fortified oil ranged from 43% (from a prevalence of 99% to a prevalence of 56% for children in the North) to 87% (from a prevalence of 47% to 6% for WRA in Kampala). For sugar, percentage reductions ranged from 9% (from a prevalence of 99% to 90% for children in the North) to 96% (from a prevalence of 47% to 2% for women in Kampala).

Modeling the combined impact of fortification of both oil and sugar indicates that prevalence of inadequate intake of vitamin A for children 24-59 months and WRA would be corrected in Kampala (0% prevalence), while only 16% of children and 13% of WRA in the South-West, and 43% of children and 33% of WRA in the North would still have intake below the corresponding EAR values. A more detailed description of these data (including standard deviations) is presented in Annex 6.

Fortification of wheat flour with vitamin A would bring further benefits in the population of Kampala, but very modest benefits –if any- to the populations of the South-West and North. In the rural regions studied, products manufactured with wheat flour were consumed by few people and in small amounts. Therefore, in Kampala, in the absence of sugar fortification, wheat flour has an important complementary role to that of fortified oil which is already fortified. The prevalence of inadequate vitamin A intake would be reduced from 20% to 10% in children, and from 6% to 3% in women, i.e. a 50% reduction from the estimated prevalence of intake inadequacies using only fortified oil.

Mass fortification of maize flour with vitamin A would not cause an appreciable population-level reduction in the inadequate intake of this nutrient in any of the regions during the months that this survey was carried out (May to September), because this was the low season for this staple food. However, the pattern of consumption of maize flour described in this study might make it more appropriate for a fortification program targeted specifically to vulnerable groups.

Conclusions
Fortifying both vegetable oil and sugar is predicted to eliminate inadequate intake of vitamin A in children and women in Kampala and nearly so in the South-West. This finding suggests that if these two fortification programs are implemented effectively, there may be no need to continue with vitamin A supplementation (VAS) of children older than 24 months of age and of women after delivery in some parts of the country. It is important to note that despite the presence of both fortified oil and sugar, VAS should continue in the North and in any other localities where these two foods are not being consumed often and in reasonable amounts. The situation for children younger than 24 months of age is described in Annex 6.

Fortifying wheat flour with vitamin A would benefit the population of Kampala if sugar fortification is not occurring. However, if sugar fortification were introduced together with oil fortification, the elimination of vitamin A from fortified wheat flour should be considered. Our results suggest that the fortification of maize flour in Uganda should not be conceptualized as a vehicle for mass fortification but used for targeted fortification and/or market-driven fortification. As a vehicle for targeted fortification, maize flour should contain vitamin A, which is one of the micronutrients with the highest prevalence of inadequate intake in poor segments of the population (see the North in Table 8). In contrast, as a vehicle for market-driven fortification, the inclusion of vitamin A in maize flour should be prohibited if both oil and sugar are fortified with this vitamin.

A food vehicle can be considered a good source of the added micronutrient if it provides at least 20% of the estimated average requirement (EAR[10]) or 15% of the nutrient reference value (NRF[11]) (Allen *et al.*, 2007). Based on current fortification formulas, the minimum amounts that should be consumed daily to consider these fortified foods good sources of vitamin A (providing at least 20% of the EAR) are: 10 grams (2 teaspoons) of sugar, 2.5-3.0 grams (half teaspoon) of oil, and 25-30 grams (about one slice of bread of 40 grams) of wheat flour.

Predicted Reduction in Inadequate Intakes of Micronutrients in Kampala due to Flour Fortification

Our results from modeling the impacts of wheat and maize flour fortification are presented for Kampala only. The consumption of these foods and their products at the time of the survey in the rural South-West and North was too low to expect a useful public health impact in a mass fortification context. The changes in prevalence of inadequate intake of vitamin A associated with consumption of the fortified flours were described in the previous section.

---

[10] EAR, Estimated Average Requirement: It is the average (median) daily nutrient intake level estimated to meet the needs of half the healthy individuals in a particular age and gender group.

[11] NRV, Nutrient Reference Value: It is the dietary reference value defined by the Codex Alimentarius Commission with the aim of harmonizing the labeling of processed foods. It is a value applicable to all members of the family aged 3 years and over. These values are constantly reviewed based on advances in scientific knowledge, and they approximate the Recommended Nutrient Intake (RNI) of the adult males. The Recommended Nutrient Intake is the daily intake that meets the nutrient requirements of almost all apparently healthy individuals in an age- and sex-specific population group. It is set at the Estimated Average Requirement plus 2 standards deviations.

Table 14: The predicted prevalences (%) of inadequate micronutrient intake in the absence of and in the presence of fortification of all wheat and maize flours and their products in Kampala, 2008

Nutrient Added	**Age Groups**	
	24-59 months	**WRA**
Vitamin B-1		
Diet alone	18	20
Plus wheat flour	3	9
Plus maize flour	9	11
Plus both flours	2	5
Vitamin B-2		
Diet alone	18	20
Plus wheat flour	5	7
Plus maize flour	9	9
Plus both flours	2	3
Niacin		
Diet alone	13	11
Plus wheat flour	2	3
Plus maize flour	7	5
Plus both flours	1	2
Vitamin B-6 (not included in maize flour)		
Diet alone	5	0
Plus wheat flour	2	0
Folate (Folic acid = 3.0 mg/kg in wheat flour)		
Diet alone	17	7
Plus wheat flour	2	1
Plus maize flour	7	2
Plus both flours	1	0
Folate (Folic acid = 1.5 mg/kg in wheat flour)		
Diet alone	17	7
Plus wheat flour	4	1
Plus maize flour	7	2
Plus both flours	1	0
Vitamin B-12		
Diet alone	32	64
Plus wheat flour	3	41
Plus maize flour	21	54
Plus both flours	1	32
Iron (Ferrous fumarate in wheat flour, 5% bioavailability)		
Diet alone	75	89
Plus wheat flour	66	83
Plus maize flour	71	83

Nutrient Added	Age Groups	
	24-59 months	WRA
Plus both flours	61	76
Iron (NaFeEDTA in wheat flour, 10% bioavailability)		
Diet alone	75	89
Plus wheat flour	53	72
Plus maize flour	71	83
Plus both flours	48	65
Zinc		
Diet alone	82	36
Plus wheat flour	58	12
Plus maize flour	63	15
Plus both flours	39	7

Table 14 shows the estimated prevalences of inadequate intake in the absence of (diet alone) and in the presence of fortification of wheat and maize flours with seven vitamins and two minerals. Almost all wheat flour consumed in Uganda is processed commercially in a few large mills. On the other hand, most maize flour is produced either in the household or at small village mills. The data presented here are for all flours consumed, regardless of where it was processed, and therefore the values presented for maize flour are overestimated.

We have not highlighted the estimated changes in intake for the nutrients with relatively low prevalences of inadequate intake (e.g. B6 and vitamin C) as there seems to be little public health justification for adding them to foods. Inadequate intakes of vitamin B-6 occur among WRA in the North only, although this micronutrient is included in the current formula for fortified wheat flour.

Our overall observations from the analyses suggest that fortification of flours will provide a modest but still important contribution to overcoming micronutrient inadequacies, but only in urban Kampala (see Annex 8 and Table 14). It seems that both urban children (24-59 months of age) and WRA with inadequate intake of vitamins B-1, B-2, niacin, and folate consume products made with wheat flour, which, if fortified, would complement the amounts supplied by the diet, and, hence, move their intake above the corresponding EAR values. This finding justifies the incorporation of vitamins B-1, B-2 and niacin for restoration purposes in flour, i.e. to recover the micronutrient contents of the wheat grain that are lost during milling.

Our results show that reducing the fortification level of folic acid from 3.0 to 1.5 mg/kg would have little or no negative impact on the prevalence of inadequate folate intake for WRA, i.e., prevalence levels would stay roughly the same. However, it would be appropriate to measure the serum folate level of women in Kampala to determine if the amount of additional folic acid at the lower fortification level will be sufficient to prevent neural tube defects associated with folate deficiency (Dary 2009).

Our results suggest that increasing levels of vitamin B-12 and zinc in the fortification formula currently planned for wheat flour would improve the potential impact of wheat flour fortification in both children 24-59 months and WRA in Kampala. The incremental level of vitamin B-12 used in fortification is important for women because the prevalence of inadequacy remains high (41%) when modeled using the current fortification level in Uganda's fortification standards. B-12 deficiency has also been associated with the occurrence of neural tube defects (Molloy *et al.*, 2009) and, it seems, in Uganda, vitamin B-12 deficiency might constitute a more important risk for these birth defects than folate deficiency does.

The situation with iron deserves special consideration both because iron deficiency is so common and its consequences carry such adverse affects. Fortifying wheat flour with ferrous fumarate (5% bioavailability) reduced the prevalence of inadequate intake, but the prevalence remained high: 66% for children and 83% for WRA; i.e. reductions of only 12% and 7% from the original values, respectively. Doubling the bioavailability of iron by using NaFeEDTA instead of the ferrous fumarate increases the proportion of individuals predicted to reach estimated adequate intake levels of iron, and the prevalence of inadequate intake is reduced to 53% in children and 72% in women; i.e. reductions of 29% and 19% from the original values, respectively. These results suggest that, although improvement in the iron status would occur, they would still be insufficient and, therefore, it is important to begin identifying measures complementary to flour fortification to deliver bioavailable iron to the population, including Kampala. The decision to switch from ferrous fumarate to NaFeEDTA should be made after information on sensorial compatibility between the iron fortificant and wheat flour and its products is collected and discussed, along with analysis and acceptance of the additional cost that will be incurred by industry and the Ugandan government.

Prevalence of Usual Intakes Exceeding the Tolerable Upper Intake Level (ULs) after Fortification with Folic acid and Vitamin A (Retinol)

In the context of food fortification in Uganda, folic acid and vitamin A (retinol) require special consideration because excessive intakes could have adverse effects. The other micronutrients have large safety ranges (see Annex 3) for comparing the UL values with the intakes of other micronutrients).

For folic acid, the analysis was restricted only to the added folic acid, without considering dietary folate. In the age groups and regions studied, given the levels of fortification and the pattern of consumption of the food vehicles, we estimated the probability that usual intake of folic acid would exceed the UL was zero, i.e. fortification with folic acid in Uganda does not approaches its current UL value. This value has been established for healthy individuals living in healthy environments. Furthermore, because our analysis included only those who consumed foods fortified with folic acid, these intake estimates are higher than those we would have obtained had we included all individuals. In summary for folic acid, in Uganda, there is no risk of exceeding ULs even at the higher of the two levels of fortification that were modeled, mainly because the consumption of wheat flour is low. This calculation should be done when folic is added into maize flour as part of targeted fortification programs.

For vitamin A, the model only took into consideration the pre-formed vitamin A (retinol) intake from the diet and fortified foods. The probabilities of intake of retinol being above the corresponding UL values are presented in Table 16 and in Annex 5.

Table 16: Predicted proportion (%) of children 24-59 months and women of reproductive age (WRA), among those consuming oil, sugar, and/or wheat flour fortified with vitamin A, whose usual retinol intake would exceed the Tolerable Upper Intake Levels if foods were fortified, in three regions of Uganda, 2008

Region	Age	Oil	Sugar	Wheat Flour	Oil + Wheat Flour	Oil + Sugar	Oil + Sugar + Wheat Flour
Kampala	24-59 months	9.4	18.1	4.9	15.4	48.2	69.9
	WRA	0.0	0.1	0.0	0.0	0.1	0.3
South-West	24-59 months	0.0	0.0	0.0	0.3	2.0	4.5
	WRA	0.0	0.0	0.0	0.0	0.0	0.0
North	24-59 months	5.4	2.4	0.0	6.9	16.9	21.8
	WRA	0.0	0.0	0.0	0.0	0.0	0.0

The data show that women had no risk of excessive intakes of vitamin A (retinol) when fortification is considered together with the vitamin A already in the diet; this was true even in the most extreme case in which all current and potential vehicles were fortified. However, for children 24-59 months, our simulation shows that some would be at risk of excessive intakes regardless of the vehicle fortified. This risk appears mainly related to the proposed sugar fortification (vitamin A fortification level of 1.0 mg/100 g); suggesting that the proposed fortification formula for sugar should be reviewed to take into account the amount of this nutrient already supplied through vegetable oil, and, at the same time, to ensure the combination of both fortified foods remains at safe levels. Furthermore and as stated before, once sugar is fortified, the inclusion of vitamin A in wheat flour should be suspended.

It is important to clarify two points in relation to the UL for vitamin A. The UL values are defined as the "highest level of daily nutrient intake that is likely to pose no risk of adverse health effects for almost all individuals" and thus intakes reaching these values are considered neither dangerous nor toxic. ULs have been calculated very conservatively by dividing levels that may prompt health concern using an uncertainty factor, which was five in the case of vitamin A. Thus, the UL values presented here should be interpreted as an intake of reference that is undesirable to reach, and above which the probability of adverse effects may start to appear. The UL is not a level of toxicity.

If vitamin A fortification of sugar is fully implemented as a complement to vitamin A fortification of oil, VAS policy will require review. VAS should be maintained for those localities with little access to both vegetable oil and sugar, and for treating malnutrition, xerophthalmia, or measles throughout the country regardless of the presence of mass fortification.

Furthermore, once vegetable oil and sugar are fortified with vitamin A, the addition of this nutrient to other foods (other than restoration of vitamin A in skimmed milk, or equivalence of the nutritional value of butter by vegetable fats) should be restricted. Nevertheless, vitamin A may still appear in the fortification formula of maize flour and similar foods if they are used in targeted fortification, at levels that correct the vitamin A inadequacy of the treated populations.

IV. DISCUSSION

The 2008 Uganda food consumption survey was undertaken to provide the information needed by the Ugandan NWGFF, policy makers, and program designers and evaluators to make informed decisions about sound investments to reduce inadequate intake of vitamins and minerals in Uganda and so aid in achieving the Millennium Development Goals.

Dietary behaviors are known to be complex, and measuring individual nutrient intakes with acceptable validity and reliability is difficult, time-consuming, relatively expensive, and prone to a number of errors. Nevertheless, the authors believe that the findings presented in this report are of high quality and represent an accurate description of dietary patterns in Kampala, the South-West and the North of Uganda in 2008. The information collected provides a strong foundation to guide discussions for further developing nutrition policy and intervention design. These data will be combined with those collected by HarvestPlus in the Eastern region of the country to provide a more comprehensive description of dietary patterns in Uganda in 2008.

Both urban and rural areas were included in the survey and the report highlights important differences in the dietary patterns for each area. The majority of the population in Uganda is rural and likely relies upon home food production for the bulk of their food requirements. Access to goods, including food, and services are more difficult in rural areas, and it is important to determine the likely impact of fortification programs in these areas. Urban areas are also very important because of their large and growing populations,[12] and because they rely heavily on processed foods to meet their nutritional requirements. Thus understanding food consumption patterns in both urban and rural communities is critically important for future nutrition and public health programs.

There is much variation among rural populations throughout the world. This report has described the diet in two rural populations, one of which was confronted with a humanitarian emergency and was dependent on food aid. Unfortunately, the numbers of people facing humanitarian emergencies is increasing throughout the world and so we hope that the description of individual nutrient intake in the North of Uganda, and how mass fortification might impact on this, will provide useful insights for those responsible for designing humanitarian assistance. The differences in diets of the three areas described in this report highlight the well known, but too often ignored, requirement to design interventions in ways that fit the specific contexts of targeted populations.

Key Findings and Conclusions

Seven key findings and conclusions emerging from our analyses are described below. The potential policy and program implications that the authors see in these findings are then summarized.

1. ***There was substantial variation across regions in Uganda in usual food and micronutrient intake in 2008.*** The varied dietary patterns across the three regions resulted in different levels in the prevalence of inadequate intake of the eight vitamins and three minerals we assessed (Table 8). The main inadequacies in all areas studied, as in many developing countries, were those linked to limited consumption of foods from animal sources, i.e., vitamin A, vitamin B-12, iron, zinc, and calcium. Inadequate intakes were least common for folate, vitamin B-6, and vitamin C for all age groups.

   Overall, the diet in the rural South-West provided larger amounts of most nutrients than the diets of other regions, including urban Kampala, and thus this region had the lowest prevalences of inadequate intake. Despite higher overall levels of wealth in Kampala, mild deficiencies of B-complex vitamins were found: B-1, B-2, niacin and folate. This may well be due to the limited access urban inhabitants have to natural sources of these micronutrients and, instead, their consumption of products with low micronutrient density, such as refined flours, sugar and oil/fats. This was not the case in the South-West where the diet is less reliant on refined foods. The range of dietary patterns in the North was restricted, a result of the humanitarian situation requiring WFP to provide food aid. In this special

[12] While less than 3% of the population resided in urban areas of Uganda in 1950, in 2000 more than 12% did. By 2050, the urban population in Uganda is projected to be more than one-third of the total population. *Source*: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2006 Revision* and *World Urbanization Prospects: The 2007 Revision*, **http://esa.un.org/unup**, Friday, May 07, 2010; 10:06:59 AM.

situation, other dietary inadequacies that are not generally considered in emergency feeding situations might also be important, e.g., vitamin B-2 and vitamin B-6.

We also noted variation within regions indicating the existence of groups with special needs that policy makers need to be aware of and perhaps to plan interventions for. For example, about one in five of the sample in Kampala formed a distinctly poor group. The dietary patterns of this group were likely worse than the remainder of the urban sample. Supporting this observation, the proportion of children 24-59 months with energy intake likely to be deficient was higher in Kampala than in the South-West (15% vs. 5%). Meanwhile, in the North, 25% of children in this age group were found likely to have insufficient energy intake (Table 7).

2. ***Mass fortification clearly has the potential for important beneficial public health impact in Uganda.*** Commonly consumed foods, such as staples and condiments, make practical vehicles to supply micronutrients limited in the local diet. This practice is known as mass fortification because it reaches a large part of the population, even without awareness building or behavior change, because the foods fortified are commonly consumed independent of the fortification process. The potential benefit of this strategy depends on the amount of food consumed and the fortification level, which, in combination, determine the additional intake of micronutrients by vulnerable populations.

   There are three factors limiting the degree to which fortification levels can be adjusted in response to the consumption levels of the food vehicle: 1) foods cannot be fortified beyond a level at which those individuals who consume large amounts may reach the UL values; 2) there must be technological compatibility between the fortificant (source of the micronutrient) and the food matrix; and, 3) high levels of fortification can increase costs of the food and this creates a disincentive for the food industry to observe food fortification standards (Allen *et al.*, 2006).

   Using the methods that are recommended by WHO (Allen *et al*., 2006) for "usual intakes", we predicted the impact of mass fortification in Uganda for each nutrient. We simulated the prevalences of inadequate intake before and after the additional intake of the nutrient due to the consumption of fortified foods, using the fortification formula currently being used for oil, or as proposed in Uganda for the other three vehicles. Given the variation in consumption of the four 'candidate' food fortification vehicles that are currently, or proposed to be, fortified in Uganda (Tables 9 to 12), it is not surprising that the predicted impact of fortification varied substantially by age group, by region, and by nutrient (Tables 13 and 14). In general, the impact of mass fortification of the four vehicles considered here was greater in urban than in rural areas. These findings result directly from the urban groups consuming commercially-processed foods more commonly and consuming them in greater quantities, than rural groups do.

3. ***Vegetable oil and sugar were identified as suitable fortification vehicles for the whole country.*** The proportion of the population consuming vegetable oil and sugar, and the amounts being consumed, make these two foods suitable candidates for mass fortification. Our modeling predicted that the combination of both fortification interventions would reduce to nearly zero the prevalence of inadequate intake of vitamin A for Kampala and the South-West, and greatly reduce the prevalence in the North. This finding suggests that once these two foods are appropriately fortified, VAS could be focused on those areas with little access to these two foods (such as the North) and for treating cases of malnutrition, xerophthalmia, and measles throughout the country, regardless of the presence of vegetable oil and sugar fortification.

   The modeled impacts of food fortification indicate that the prevalence of vitamin A intake has likely already been halved in Uganda due to the current oil fortification program; confirmation of the improvement of vitamin A status using suitable biomarkers (serum retinol and breast milk retinol) is a logical next step to pursue. The analysis of likely future excessive intakes due to the combined consumption of fortified vegetable oil and sugar by children 24-59 months (the only group to reach intakes around the UL value of vitamin A) suggests that the current proposed level of fortification for sugar should be examined in order to take account of the substantial impact of consuming fortified vegetable oil and to assure the safe use of both interventions for the entire population.

4. ***Multiple fortification of wheat flour is an appropriate intervention for the population of Kampala.*** Our results suggest wheat flour and their products were mainly consumed in Kampala and, in all likelihood, other urban settings, but only a small proportion of the rural population was consuming this food. Despite this geographical limitation, the multiple fortification of wheat flour with 7 vitamins and 2 minerals appears to be a good practice. Prevalence of inadequate intake of vitamin B-1, B-2, B-6, niacin, and folate would be reduced significantly for children 24-59 months and WRA in Kampala.

   The presence of vitamin A in wheat flour would have the potential to further reduce by half the prevalence of inadequate intake that remains after factoring in the already fortified vegetable oil. Nevertheless, if sugar is also fortified with vitamin A, this micronutrient should be removed from the fortification formula for wheat flour, both because it would be unnecessary but also to avoid providing excessive intakes to some individuals in the population.

   The expected benefits from fortified wheat flour in the reduction of prevalence of inadequate intake of vitamin B-12 and zinc would improve if the fortification levels of these two micronutrients were increased from current Ugandan specifications. Likewise, switching the iron source from ferrous fumarate to NaFeEDTA would also enhance the potential impact of fortified wheat flour if it is feasible to add the latter at the same fortification level as ferrous fumarate. Therefore, it is important to determine the iron content from NaFeEDTA that is technologically compatible with fortified wheat flour and its uses in Uganda. If the feasible levels of iron from NaFeEDTA were at least 75% of the current level proposed for ferrous fumarate (4.0 mg/100 g), this change should be considered. The additional cost of switching to NaFeEDTA should also be analyzed based on the potential benefits and comparing different intervention alternatives.

   Our models also indicated that currently recommended fortification levels of folic acid may be decreased due to a large supply of folate from the usual diet; however, it is advised that this decision be confirmed with determination of serum folate levels to assure that these are consistent with levels needed not only for good nutritional status, but also for the prevention of neural tube defects (Dary, 2009). In countries such as Uganda, greater attention should be given to vitamin B-12 status for the prevention of neural tube defects (Molloy *et al.*, 2009). The current level of folic acid in the wheat flour standard was found to pose no threat of reaching the current UL value for this substance in healthy populations and environments.

5. ***Maize flour was identified as a viable fortification vehicle for targeted fortification.*** This study confirms that availability of maize flour is seasonal. During the period of our study from May to September, the availability of maize flour was low in all studied locations. This seasonal pattern of consumption, compounded by the fact that maize flour is milled in hundreds of small operations widely dispersed across the country, suggests that it is not a good candidate for mass fortification in Uganda. However, maize flour might still be considered suitable for targeted fortification, such as that being considered by GAIN and WFP, to reach specific and defined vulnerable groups, such as school-age children, refugees or during emergencies. The fortification formulation should be one that fits with the nutritional needs of the designated groups, and this might include vitamin A. However, it should be noted that addition of vitamin A in market-driven fortification of maize flour should be limited if both vegetable oil and sugar are fortified with this vitamin

6. ***Complementary measures are needed to provide additional iron and zinc population-wide, as well as other key micronutrients to rural communities.*** Despite the inclusion of zinc and iron in wheat flour, our calculations indicate that the prevalence of inadequate intake of these minerals would still be serious in Uganda, irrespective of whether the iron comes from ferrous fumarate or from NaFeEDTA. Therefore, iron supplementation directed to pregnant and lactating women, children, and adolescents should be continued and strengthened nationwide. Mechanisms for delivering these two minerals plus vitamin B-12 to rural communities are also needed. For example, there is growing evidence for the effectiveness of programs based on MMN powders for children, and daily or weekly supplements for WRA and pregnant women; the feasibility and effectiveness of these programs should be assessed in Uganda.

7. ***Calcium deserves special consideration.*** Although this mineral is not strictly a micronutrient, low intakes constitute a serious health problem in populations of many countries, including Uganda. Calcium has a central role in structural functions involving the skeleton and for regulatory functions involving the transmission of electrical and chemical stimuli, blood clotting, and enzyme activity. Calcium deficiency is associated with blood pressure problems in pregnancy and this may have severe adverse effects for both mother and unborn child. Fortification with calcium is technically difficult and expensive because relatively large amounts are needed, and this may also cause changes to the texture and taste of foods. Calcium supplementation in pregnancy has been shown to substantially reduce the risk of pre-eclampsia and maternal death or serious morbidity.

   Calcium supplementation programs present operational challenges because, again, the amount of the mineral required makes it difficult to combine with other vitamins and minerals, and further, calcium interferes with the absorption of other minerals such as iron and zinc. Operational research is needed to find ways to incorporate calcium supplementation for pregnant women into a high quality antenatal care package. Interventions to deliver calcium are rare, difficult and expensive, but if the problem exists it should be addressed. Between 79-99% of children 24-59 months and WRA in the Uganda study areas were found to have inadequate intake of calcium.

8. ***Fortification formulas should respond to local needs and conditions***. Our findings confirm the importance of designing nutrition programs, including fortification, to best fit the context in which they will be implemented. The nutritional needs of one country are different from those of others, and needs can vary significantly even in the same country. The conditions of production and consumption of the potential food fortification vehicles vary widely as well. In Uganda, we confirmed that, as in many developing countries, the main inadequacies in micronutrient intake were those supplied by food from animal sources, i.e. vitamin A, vitamin B-12, iron, zinc, and calcium. It would be feasible to deliver vitamin A to wide sectors of the Ugandan population through the combined vitamin A fortification of vegetable oil and either sugar or wheat. As stated above, vitamin A fortification of wheat flour would bring benefits primarily to urban residents. Vitamin B-12, iron and zinc could also be supplied through fortified wheat flour. However, the need for additional iron, zinc, and calcium remains, particularly in rural areas. Biofortification holds great promise as an intervention to improve the intake of those micronutrients in the rural populations; however, it seems unlikely at this time biofortification would be implemented on a sufficient scale in the coming years to address this problem in a timely way. Therefore, social programs based on targeted-fortified products, MMN powders, and traditional supplements (daily or weekly) should be actively promoted and tested, and considered as integral components of food security policies and programs.

   In the case of Uganda, mild inadequate intake of vitamin B-1, B-2, B-6, niacin and folate in the urban population can be easily corrected adding relatively small amounts of these micronutrients to refined wheat flour. It appears that inadequacies of these micronutrients are associated with the consumption of a Westernized diet, rich in refined cereals, sugar and fats and oils, but without the consumption of micronutrient dense foods coming from animal sources. Therefore, refined flours produced by formal food industries should incorporate those micronutrients, at least at levels found in the natural grains, as part of industry good manufacturing practices.

Policy and Program Implications

Our findings re-affirm that inadequate intake of vitamins and minerals is widespread in Uganda. There is compelling evidence that these inadequacies will impose an enormous cost to the nation in terms of health, education, and economic development. These findings are meant to contribute to the further development of a comprehensive Ugandan approach to reducing undernutrition through its National Nutrition Policy and program implementation. Consumption surveys, such as the one described in this report, provide information integral to the design and periodic adjustment of comprehensive nutrition interventions that meet the needs of the specific populations targeted. The results of our study lead us to suggest the following actions for policy and program development and refinement in Uganda:

1. Carry out a biomarker assessment for vitamin A (serum retinol and breast milk retinol), to be used as a baseline before the introduction of sugar (and wheat flour) fortification. This assessment could provide evidence of the impact of vegetable oil fortification already underway, and also provide the opportunity to test serum zinc, folate, and B-12 levels to support changes in the fortification formula for wheat flour. The latter determinations would be applicable only to Kampala, where wheat flour and its products are widely consumed already.

2. Implement and use the findings from an M&E system to provide timely information to inform decisions about adjusting fortification programs and/or re-designing VAS and other programs. Specifically, given the positive estimated impacts that we predict from the combined fortification of oil and sugar with vitamin A, the need for continuing with VAS of children and WRA should be reviewed periodically. Our results indicate that VAS should be continued in those regions with limited access to either fortified oil or sugar, and for treating malnutrition, xerophthalmia and measles throughout the country.

3. Further examine estimates of additional intake of vitamin A due to the combined consumption of fortified vegetable oil and sugar to ensure both fortified products can be consumed safely; to do so, fortification levels for sugar must take into account likely additional intake of vitamin A from fortified oil,. Our estimates show that some pre-school age children from Kampala may be at risk of reaching intakes near the Tolerable Upper Intake Level (UL) value of vitamin A if these two interventions exist together. If both oil and sugar are fortified with vitamin A, it would be appropriate to start limiting the addition of vitamin A for other market-driven fortification, excepting for restoration in skim milk and establishing the equivalence of vegetable fats (i.e. margarine) to butter. Use of vitamin A in targeted fortification would depend on the specific needs of the groups aimed for this type of program.

4. Use the results of this study to review the current Ugandan fortification formula for wheat flour. It should be noted however that issues related to the micronutrient formula should be discussed in the context of the inter-country policies of ECSA. For example, consider:
    a. Keeping the current levels of vitamin B-1, B-2, and niacin, because they seem appropriate for reducing the prevalence of inadequate intake of these micronutrients in the population of Kampala;
    b. Eliminating vitamin B-6 from the formula because inadequate intakes were very low both in Kampala and in the rural South West. This nutrient should be incorporated as part of other micronutrient interventions for the population of the North.
    c. Increasing levels of vitamin B-12 and zinc;[13]

[13] The appropriate levels could be modeled using the data collected in this study.

d. If iron from NaFeEDTA is found compatible with wheat flour and the Ugandan products made with it at levels equal to or higher than 3.0 mg/100 g[14], consider using this instead of ferrous fumarate. The cost would be higher, but the corresponding benefits would be greater, an important factor of analysis for accepting a higher cost of fortification;
e. Reducing the folic acid content if serum folate levels are found to be high; and,
f. If sugar fortification is implemented, removing vitamin A from the formula for wheat.

5. Explore effective alternative interventions to iron fortification such as supplementation (single-nutrient formulations or multiple micronutrient [MMN] powders, weekly for adolescents and pre-pregnancy, daily for pregnant women), and reducing iron losses by de-worming children 1-5 years, school children, and pregnant women after the first trimester. Our results indicate that, regardless of the type of iron, the impact of mass fortification will be modest in reducing the very high prevalence of inadequate intakes of iron that were observed.

6. Review the likely causes of neural tube defects in relation to the level of folic acid being added into wheat flour. Our model suggests that a high prevalence of inadequate intake of vitamin B12 may be a more likely cause of neural tube defects in Uganda than folate deficiency. Our results show half the level of folic acid currently used would be adequate to eliminate inadequate folate intakes. On the other hand, current levels of folic acid fortification would lead to additional intakes below the current UL values for this substance.

7. Explore maize flour fortification as a targeted fortification program, as has been suggested by GAIN and WFP. This approach should allow flexibility so that it may be adapted to best reduce the estimated nutrient gaps that affect intended populations, including vitamin A.

8. Consider additional complementary interventions to mass fortification to address inadequate intakes of vitamins and minerals in the population groups and/or for the specific nutrients for which our results indicated the impact of mass fortification could be limited. For example:
   a. Use of selected nutrient-dense locally produced foods, agricultural/horticultural interventions including biofortification, low-cost fortified foods (targeted fortification), MMN powders, and other possible vehicles delivered as part of social programs;
   b. In rural areas, further strengthen implementation of nutrition education and counseling, supplementation, hygiene and sanitation, and other health interventions to prevent and treat common childhood infections. These interventions have been effectively delivered on a large scale through community nutrition programs that extend the reach of health care services beyond the health center.

In summary, the authors believe that food consumption surveys, such as the one described in this report, serve important purposes. We hope that the results, deductions and implications for policy constitute a worthy return on the investments made. We recommend that consumption surveys be repeated periodically (e.g., every ten years) to not only of estimate additional intake through multiple micronutrient interventions (biofortification, food fortification, and supplementation), but also to track the evolution of diet quality, especially in light of urbanization and the rapid social changes it brings. The progress and development of any country depends on the health and productivity its human assets. More importantly, each human being has the right to fulfill the maximum expression of his/her inherited potential.

---

[14] A lower level would not have an additional benefit as compared with the current use of 4.0 mg Fe/100 g from ferrous fumarate.

V. REFERENCES

Allen A, de Benoist B, Dary O, Hurrell R (Eds). 2006. *Guidelines on Food Fortification with Micronutrients.* World Health Organization, Geneva, Switzerland.

Carriquiry AL. Estimating the usual intake distributions of nutrients and foods. *J Nutr* 2003; 133:601-608.

Craft NE, Haitema T, Brindle LK, Yamini S, Humphrey JH, West KP. Retinol analysis in dried blood spots by HPLC. *J Nutr* 2000; **130**:882-885.

Dary O. Nutritional Interpretation of Folic Acid Interventions. *Nutr Rev* 2009; 67:235-244.

Erhardt JG, Craft NE, Heinrich F, Biesaiski HK. Rapid and simple measurement of retinol in human dried whole blood spots. *J Nutr* 2002; **132**:318-321.

FAO/WHO, 2002. Vitamin A. In: *Human Vitamin and Mineral Requirements. Report of a Joint FAO/WHO Expert Consultation.* FAO, Rome; pp 87-107.

FAO/WHO/UNU. *Energy and protein requirements.* World health Organization Technical Report Series 724, 1985. http://www.fao.org/docrep/003/AA040E/AA040E07.htm#ch6.3

Fiedler J, Afidra R, Dary O. 2009. *Fortification of vegetable oil and sugar in Uganda: Progress, Issues, Costs and Prospects.* A2Z: The USAID Micronutrient and Child Blindness Project / AED, Washington DC and Kampala .

Foote JA, Murphy SP, Wilkens LR, Basiotis PP, Carlson A. Dietary variety increases the probability of nutrient adequacy among adults. *J Nutr* 2004; **134**:1779-1785.

Gibson RS, Ferguson, EL. 2008. *An interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries.* HarvestPlus Technical Monograph 8. Washington, DC and Cali: International Food Policy Research Institute (IFPRI) and International Center for Tropical Agriculture (CIAT).

Hix J, Martinez C, Buchanan I, Morgan J, Tam M, Shankar A. Development of a rapid enzyme immunoassay for the detection of retinol-binding protein. *Am J Clin Nutr* 2004; **79**:93-98.

Imhoff-Kunsch B, Flores R, Dary O, Martorell R, Wheat flour fortification is unlikely to benefit the neediest in Guatemala. *J Nutr* 2007;**137**:1017-1022.

Ministry of Health of Uganda, Food Fortification Program. 2009. *Quality of Fortified Foods in Uganda, 2007-2008.* A2Z: The USAID Micronutrient and Child Blindness Project / AED, Washington DC and Kampala.

Molloy AM, Kirke PN, Troendle JF, Burke H, Sutton M, Brody LC, Scott JM, Mills JL. Maternal vitamin B12 status and risk of neural tube defects in a population with high neural tube defect prevalence and no folic Acid fortification. *Pediatrics* 2009; **123**:917-23.

Nusser SM, Carriquiry AL, Dodd KW, Fuller WA. A semiparametric approach to estimating usual nutrient intake distributions. *J Amer Stat Assoc* 1996; **91**:1440-1449.

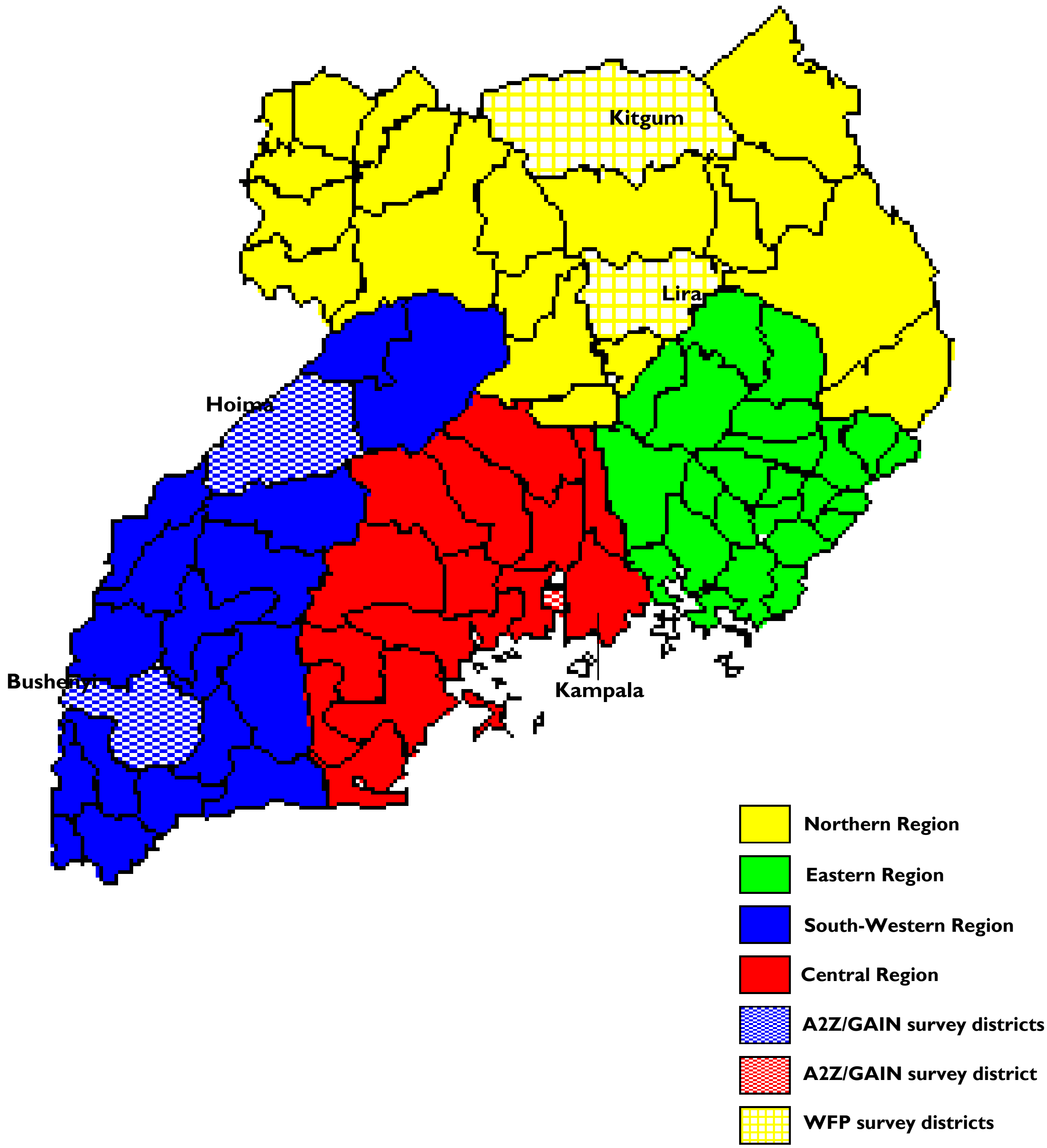
UBOS (Uganda Bureau of Statistics), Macro International, 2002. *Uganda Demographic and Health Survey, 2000-2001*. Kampala, Uganda, and Calverton, Maryland, USA; UBOS and Macro International Inc

UBOS (Uganda Bureau of Statistics), Macro International, 2007. *Uganda Demographic and health Survey, 2006*. Kampala, Uganda, and Calverton, Maryland, USA; UBOS and Macro International Inc

VI. ANNEXES

Annex 1: Districts of Uganda included in the survey, sampling size calculation, and sampling framework

Food Consumption Survey: District MAP



Sample size calculation

The sample size was fixed using the formula below to obtain region level estimates on various vitamin A reduction strategy components:

$$n = D\frac{\left[\sqrt{2P(1-P)}Z_{1-\alpha} + \sqrt{P_1(1-P_1)+P_2(1-P_2)}Z_{1-\beta}\right]^2}{\Delta^2}$$

Where:

D = design effect
P1 = the estimated proportion at the time of the first survey
P2 = the proportion at some future date such that the quantity (P2 - P1) is the size of the magnitude of change it is desired to be able to detect
P = (P1 + P2) / 2
$Z1\text{-}\alpha$ = the z-score corresponding to the desired probability in order to be able to conclude that an observed change of size (P2 - P1) would not have occurred by chance; and
$Z1\text{-}\beta$ = the z-score corresponding to the desired degree of confidence in order to be certain of detecting a change of size (P2 - P1) if one actually occurred.
$\alpha = 0.05$ ($Z1\text{-}\alpha = 1.65$) $\beta=0.20$ ($Z1\text{-}\beta=0.84$)
$\Delta = |P1 - P2|$

Sampling procedure

Region selection
The Uganda Food Consumption survey was designed as a cross-sectional study and collected data to provide separate estimates for three regions of Uganda. The three regions were selected purposefully and included: the Central Region (Kampala City Council) representing urban areas, and the South-West and North Regions representing rural areas.

District selection
In the South-Western and Northern regions, two districts were selected randomly from a roster of all constituent districts after removing those considered unsafe and/or too inaccessible.
Kampala district coincides with Kampala City Council, therefore it is the only district selected in the Central region.

Sub County and Sub Division selection
In Kampala district, two divisions were randomly selected, while in each survey district selected in the South-West and North; two sub-counties were randomly selected, for a total of two divisions in Kampala, and eight sub-counties, four each in the South-West and North.

Cluster selection
In each selected sub county, EAs or clusters or villages (PSUs) were selected using Probability proportional to size methods using a sampling interval obtained by dividing the total cumulative population of the sub county by the total number of villages or clusters. A quick count was carried out in each village or cluster, by using the census data population, to provide the information needed to divide large village or cluster or to regroup small village or cluster into a number of segments, assuming approximately 150 households per segment. Then sub county maps were used to arrange villages in serpentine order according to their location from north to south within the sub county. All villages or clusters were listed in one column, their corresponding population in another column and the cumulative population in yet another column. The first cluster or village to be included in the survey was randomly selected using random numbers selected

between 1 and the maximum number in the sampling interval. The remaining clusters were selected by adding the sampling interval to the cumulative population of villages.

Additional clusters or villages were also preselected for provision in case the desired number of target groups was not met.

Individual woman of reproductive of age, children from 6-23 months old and children from 24-59 months old selection

For each village or cluster, a quick count of targeted households was done**.** Ahead of actual data collection, a team of community mobilizers deployed to each survey region and worked with local leaders to list all households in each cluster or cluster segment and screen out non-eligible ones. All eligible households were listed in one column, and each household was given a number in another column. The households to be included in the survey were randomly selected using random numbers selected between 1 and the total number of households in the village or cluster.

In each household, only one woman aged 15-49 years, one child from 24-59 months, and one child from 6-23 months were selected. In households where more than one woman and/or child in each age group lived, one woman and one child in each age group were selected randomly. For each target group, the numbers in birth order were written on separate papers and only one was chosen randomly.

The summary of sampling is presented in the table on the following page.

SUMMARY of Uganda Food Consumption Survey SAMPLING FRAME

Region	Sampling universe	First area of selection (random method)			Second area of selection (random method)			Third area of selection (PPS method)		Fourth area of selection (random method)	
		Level	Number	Name	Level	Number	Name	Level	Number	Level	Number
Central	Kampala City Council = Kampala District = Kampala County	District*	**1**	a- Kampala	Division	**2**	a- Kawempe	Village = EA = Cluster	25	Household or women	160
							b- Nakawa				154
South-Western	All Districts	District	**2**	a- Busheyni District	Sub County	**2**	a- Kyabugimbi	Village = EA = Cluster	25	Household or women	102
							b- Kashenshero				69
				b- Hoima District	Sub County	**2**	a- Buanika				82
							b- Kabwoya				69
Northern	All Districts	District	**2**	a- Kitgum District	Sub County	**2**	a- Labongo Amida	Village = EA = Cluster	25	Household or women	82
							b- Palabek Gem				65
				b- Lira District	Sub County	**2**	a- Amach				102
							b- Okwang				72

Annex 2: Analyses that determine the risk of usual intakes being greater that the Upper Limits (ULs) of folic acid and retinol

Consumption of Folic Acid

Folic acid, the artificial form of the nutrient folate, is consumed only through the fortification of wheat and maize flour *produced commercially*. If no wheat or maize flour (not produced in the home) is consumed, then the consumption of folic acid is zero.

Probability of consumption of vehicles for folic acid fortification

Out of a total of 1,902 individuals in three age groups and across three regions, only 573 (or 30%) consumed wheat flour on at least one survey day. Consumption of maize flour was even lower; only 539 (or 28%) of the individuals consumed maize flour on at least one day. The overlap between persons who consumed maize flour and wheat flour was large; the majority of individuals did not consume either wheat or maize flour on any survey day.

We grouped individuals into two socio-economic groups as follows: persons with income in the bottom three quintiles were included in one socio-economic stratum. The other socio-economic stratum included persons with income in the top two quintiles. We constructed a binary variable that takes on the value 1 if the person consumed at least some wheat flour on one survey occasion and took on the value 0 otherwise. We proceeded in a similar manner for maize flour.

A logistic regression model with age, region and SES stratum plus all possible two-way interactions between those three variables was fitted to the two binary response variables. We found that the only interaction that was statistically significant in at least one of the two analyses was the interaction between age group and region. Thus, we re-fitted the model but this time including only the main effects of age, SES stratum and region and the two-way interaction between region and age.

Results from these two logistic regression analyses are shown below.

Table A2-1: Probability of consumption of wheat flour on at least one survey day

Effect	DF	Wald Chi-Square	Pr> ChiSq
Region	2	330.4895	<.0001
Age	2	29.8365	<.0001
Ses	1	3.8868	0.0487
Region*Age	4	16.7748	0.0021

Table A2-2: Probability of consumption of maize flour on at least one survey day

Effect	DF	Wald Chi-Square	Pr> ChiSq
Region	2	59.1103	<.0001
Age	2	0.5378	0.7642
Ses	1	3.1701	0.0750
Region*Age	4	3.8624	0.4250

We find that age, region, SES stratum and the interaction between region and age are all highly significant effects when the probability of consumption of wheat flour is the response variable. In the case of maize flour, there are no significant differences between age groups or between age groups within regions, and the effect of SES stratum is only marginally significant. There are, however, significant differences between regions.

To more easily understand the effect of these factors we computed the average predicted probabilities of consumption of wheat or maize flour for each possible combination of region, age group and SES stratum. Results are presented in Figures 2-1 and 2-2 for wheat and maize flour, respectively.

Figure A2-1: Mean probability of consumption of wheat flour. Blue lines correspond to Region 1. Red and cyan lines correspond to Regions 2 and 3 respectively. In all regions, the dotted line denotes the consumption probabilities for higher SES.

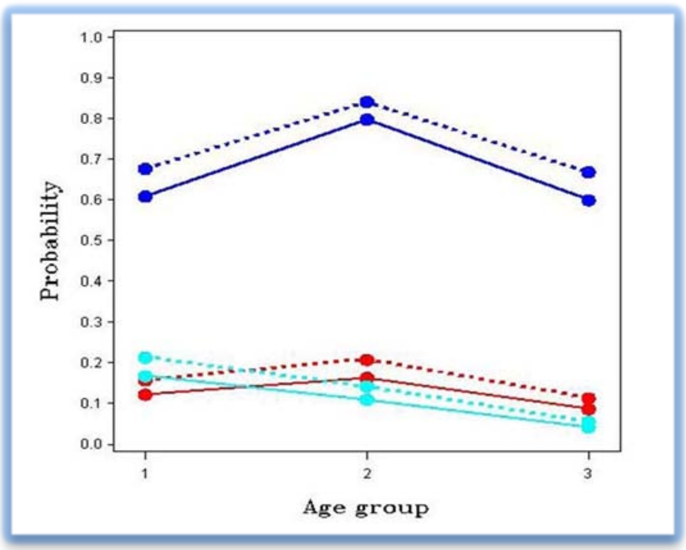


Figure A2-2: Mean probability of consumption of maize flour. Blue lines correspond to Region 1. Red and cyan lines correspond to Regions 2 and 3 respectively. In all regions, the dotted line denotes the consumption probabilities for higher SES.

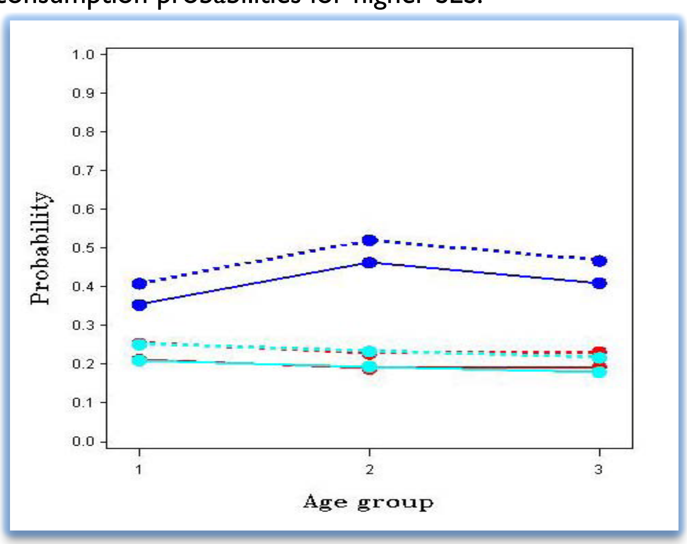


Figure 6-2 clearly shows that there is no effect of age or of SES status (and a very small effect of region) on the probability that a person will consume maize flour containing folic acid.

Conditional usual intake distributions of folic acid by age and region

A question of interest is whether the usual consumption of folic acid among persons who actually do consume the vehicles is likely to be excessive, i.e., has a non-negligible probability of exceeding the UL for folic acid.

To estimate the probability of usual intake of folic acid exceeding the UL for each of the age groups, we used PC-SIDE to implement the ISU method. The number of children in age groups 1 and 2 with positive consumption of the vehicles and a replicate observation was quite low and therefore we grouped all children of age groups 1 and 2 into a single age group. Because the UL is different in the two age groups we used the smaller of the two values (510 mg). That is, if we estimate the probability of exceeding the lower UL to be small, then among the older children, the probability of exceeding their own (higher) UL will be even smaller.

Tables 2-3 and 2-4 below show selected percentiles of the estimated usual intake distributions for the two new age groups (aggregated groups 1 and 2 and the old group 3) and the three regions for folic acid consumed from wheat flour and folic acid consumed from maize flour, respectively.

Note that in all cases we estimate that the probability that usual intake of folic acid will exceed the UL given the fortification amounts and the pattern of consumption of the vehicles is zero. Note as well that this conditional estimate is higher than what we would have obtained had we not conditioned the analyses on just the subset of the sample persons with positive vehicle consumption.

Table A2-3: Selected percentiles of usual intake distributions of folic acid from wheat flour

```
============================================================
Subpopulation variable RA = 112   -- Region 1, ages 1 and 2
ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE
  Mean            102.68
  Variance        1645.57
  Std. Dev.       40.566
  Skewness        0.80991
  Fourth Moment   4.0000

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES
  Probability   Percentile   Std. Error
    0.050          44          14.3
    0.100          55          12.5
    0.250          75          7.63
    0.500          98          4.45
    0.750          126         10.9
    0.900          156         21.7
    0.950          176         30.0

  CDF Values for Usual Intakes
    Value  Prob. Below  Prob. Above  Std. Error
     510     1.000        0.0000      ********
============================================================
```

Nutrient Faw (not weighted).

Subpopulation variable RA --- 13 Region 1, age 3
ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE

Mean	156.50
Variance	3176.46
Std. Dev.	56.360
Skewness	0.88824
Fourth Moment	4.0000

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES

Probability	Percentile	Std. Error
0.050	84	20.50
0.100	93	16.40
0.250	113	13.90
0.500	149	8.27
0.750	189	19.20
0.900	231	53.10
0.950	263	69.90

CDF Values for Usual Intakes

Value	Prob. Below	Prob. Above	Std. Error
1700	1.000	0.0000	********

==

Nutrient Faw (not weighted).
Subpopulation variable RA = 212

ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE

Mean	97.197
Variance	2292.380
Std. Dev.	47.879
Skewness	1.1616
Fourth Moment	4.0000

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES

Probability	Percentile	Std. Error
0.050	36	39.9
0.100	45	36.8
0.250	63	26.2
0.500	89	11.8
0.750	122	44.5
0.900	161	100.0
0.950	188	144.0

CDF Values for Usual Intakes

Value	Prob. Below	Prob. Above	Std. Error
510	1.000	0.0000	********

==

Nutrient Faw (not weighted).
Subpopulation variable RA = 23

Could not get this to run under any set of reasonable assumptions. Results ought to be very similar to those obtained for RA=33.
===

Nutrient Faw (not weighted).
Subpopulation variable RA = 312

ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE

Mean	77.494
Variance	1304.86
Std. Dev.	36.123
Skewness	1.0106
Fourth Moment	3.0000

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES

Probability	Percentile	Std. Error
0.050	30	174.
0.100	37	158.
0.250	51	107.
0.500	72	20.6
0.750	97	169.
0.900	126	384.
0.950	145	546.

CDF Values for Usual Intakes

Value	Prob. Below	Prob. Above	Std. Error
510	1.000	0.0000	********

===

Nutrient Faw (not weighted).
Subpopulation variable RA = 33

ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE

Mean	104.10
Variance	1235.01
Std. Dev.	35.143
Skewness	0.76116
Fourth Moment	3.0000

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES

Probability	Percentile	Std. Error
0.050	55	27.4
0.100	63	24.9
0.250	79	19.5
0.500	100	16.5
0.750	125	27.4
0.900	151	47.6
0.950	168	63.4

CDF Values for Usual Intakes

Value	Prob. Below	Prob. Above	Std. Error
1700	1.000	0.0000	********

==

Table A2-4: Selected percentiles of the usual intake distribution of folic acid from maize flour

==

Subpopulation variable RA = 112

ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE

Mean	45.079
Variance	355.027
Std. Dev.	18.842

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES

Probability	Percentile	Std. Error
0.050	20	7.77
0.100	24	7.02
0.250	32	4.96
0.500	42	2.71
0.750	55	7.87
0.900	70	16.90
0.950	80	23.80

CDF Values for Usual Intakes

Value	Prob. Below	Prob. Above	Std. Error
510	1.000	0.0000	********

==

Subpopulation variable RA = 13

ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE

Mean	106.70
Variance	1550.88
Std. Dev.	39.381

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES

Probability	Percentile	Std. Error
0.050	52	8.40
0.100	60	7.92
0.250	78	6.74
0.500	101	6.07
0.750	130	9.91
0.900	160	16.2
0.950	179	20.8

CDF Values for Usual Intakes

Value	Prob. Below	Prob. Above	Std. Error
1700	1.000	0.0000	********

==

Subpopulation variable RA = 212

```
ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE
  Mean           39.607
  Variance      291.865
  Std. Dev.      17.084

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES
  Probability   Percentile   Std. Error
     0.050          17         12.2
     0.100          20         11.0
     0.250          27          7.66
     0.500          37          3.59
     0.750          49         12.0
     0.900          62         26.1
     0.950          71         36.9

  CDF Values for Usual Intakes
     Value  Prob. Below  Prob. Above  Std. Error
      510     1.000       0.0000    ********
============================================================
Subpopulation variable RA = 23

ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE
  Mean           68.948
  Variance      446.688
  Std. Dev.      21.135

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES
  Probability   Percentile   Std. Error
     0.050          38         12.8
     0.100          43         11.0
     0.250          54          7.43
     0.500          67          4.72
     0.750          82          9.64
     0.900          97         17.90
     0.950         107         23.70

  CDF Values for Usual Intakes
     Value  Prob. Below  Prob. Above  Std. Error
     1700     1.000       0.0000    ********
============================================================
Subpopulation variable RA = 312

Cannot get this group to run except under unreasonably strong assumptions.
============================================================
Subpopulation variable RA = 33

ESTIMATED MOMENTS FOR USUAL INTAKES IN ORIGINAL SCALE
  Mean          137.19
  Variance     3257.81
```

Std. Dev. 57.077

ESTIMATED PERCENTILE VALUES FOR USUAL INTAKES

Probability	Percentile	Std. Error
0.050	58	21.2
0.100	72	19.0
0.250	97	14.5
0.500	130	12.5
0.750	169	21.3
0.900	211	39.4
0.950	242	53.9

CDF Values for Usual Intakes

Value	Prob. Below	Prob. Above	Std. Error
1700	1.000	0.0000	********

Annex 3: DRI Values and Estimated Intakes of Micronutrients in Kampala (Kamp), and South-Western (S-W) and Northern (North) Regions of Uganda-2008

Table A3-1: EAR and UL values and estimated percentiles of the usual nutrient intake distributions without fortification for children 24-59 months old in Kampala, South-West (S-W), and North Uganda, 2008.

Micronutrient	EAR	Region	5th	10th	25th	50th	75th	90th	95th	UL
Vitamin A (RE) (µg)	304	Kamp	113	133	176	243	341	468	568	750*
		S-W	128	156	214	299	413	549	652	
		North	8.46	12.9	24.8	47.7	87.7	148	201	
Vit B-1 (Thiamin)(mg)	0.5	Kamp	0.42	0.46	0.55	0.65	0.75	0.86	0.93	NA
		S-W	0.58	0.66	0.81	0.98	1.18	1.38	1.53	
		North	0.70	0.74	0.82	0.91	1.02	1.11	1.17	
Vit B-2 (Riboflavin) (mg)	0.5	Kamp	0.33	0.41	0.56	0.77	1.06	1.45	1.76	NA
		S-W	0.56	0.63	0.78	0.98	1.20	1.41	1.54	
		North	0.29	0.34	0.45	0.60	0.82	1.08	1.27	
Niacin (mg)	5.4	Kamp	4.14	4.89	6.32	8.16	10.3	12.5	13.9	NA
		S-W	6.09	6.82	8.17	9.87	11.8	13.8	15.0	
		North	3.83	4.71	6.48	8.95	12.0	15.4	17.7	
Vitamin B-6 (mg)	0.5	Kamp	0.50	0.62	0.83	1.10	1.44	1.85	2.15	NA
		S-W	1.48	1.65	1.95	2.32	2.72	3.12	3.37	
		North	0.46	0.56	0.75	0.99	1.27	1.56	1.74	
Folate (DFE) (µg)	167	Kamp	125	147	188	274	307	374	419	595*
		S-W	239	265	313	373	440	508	552	
		North	192	210	244	285	330	375	404	
Vitamin B-12 (µg)	0.8	Kamp	0.265	0.367	0.628	1.14	2.10	3.83	5.58	NA
		S-W	0.103	0.147	0.258	0.465	0.797	1.24	1.59	
		North	0.051	0.072	0.132	0.261	0.525	0.997	1.47	
Vitamin C (mg)	25	Kamp	16.0	22.0	34.5	52.9	77.1	105	125	525
		S-W	115	124	139	158	178	198	211	
		North	17.9	22.8	33.0	47.9	67.1	88.5	103	
Iron (mg)	5.1§	Kamp	3.57	4.39	5.85	7.69	10.2	13.6	16.5	40
		S-W	8.27	8.85	9.88	11.2	12.6	14.2	15.2	
		North	7.79	8.52	9.54	11.6	13.5	15.5	16.8	
Zinc (mg)	7.5§	Kamp	1.92	2.49	3.54	4.89	6.70	9.17	11.2	10**
		S-W	3.46	3.91	4.78	5.92	7.26	8.66	9.60	
		North	3.50	4.01	4.96	6.18	7.57	8.98	9.90	
Calcium (mg)	459ω	Kamp	96.4	122	177	257	364	486	573	2,500
		S-W	205	234	288	358	441	527	590	
		North	142	163	205	265	341	428	492	

* UL for vitamin A is specific for retinol, and for folate is specific for folic acid. However, the intake values in the table include pro-carotenoids of vitamin A and dietary folate, respectively.

** These are the UL values for zinc, which are apparently too low for a vegetarian diet.

§ For low bioavailability diet (5%).

ω AI value

Table A3-2: EAR and UL values and estimated percentiles of the usual nutrient intake distributions without fortification for women of reproductive age in Kampala, South-West (S-W) and North Uganda, 2008.

Micronutrient	EAR§	Region	5th	10th	25th	50th	75th	90th	95th	UL
Vitamin A (RE) (µg)	357	Kamp	148	182	255	373	556	822	1053	3,000*
		S-W	133	183	297	283	751	1081	1326	
		North	14.8	21.1	36.8	65.1	114	190	259	
Vit B-1 (Thiamin)(mg)	0.9	Kamp	0.65	0.74	0.91	1.11	1.33	1.58	1.74	NA
		S-W	0.89	1.05	1.34	1.74	2.23	2.74	3.08	
		North	1.29	1.34	1.43	1.53	1.64	1.74	1.80	
Vit B-2 (Riboflavin) (mg)	0.9	Kamp	0.58	0.68	0.87	1.15	1.49	1.87	2.14	NA
		S-W	0.69	0.84	1.13	1.52	2.00	2.50	2.84	
		North	0.60	0.68	0.83	1.05	1.33	1.65	1.89	
Niacin (mg)	10.8	Kamp	8.00	9.28	11.7	14.8	18.4	22.0	24.4	NA
		S-W	9.73	11.1	13.8	17.3	21.3	25.4	28.1	
		North	10.4	11.5	13.5	16.1	19.0	22.0	23.9	
Vitamin B-6 (mg)	1.1	Kamp	1.83	1.98	2.24	2.55	2.87	3.18	3.33	NA
		S-W	2.05	2.43	3.16	4.14	5.29	6.50	7.30	
		North	0.57	0.73	1.08	1.57	2.15	2.70	3.02	
Folate (DFE) (µg)	320	Kamp	300	329	382	446	516	584	627	1,700*
		S-W	353	408	510	639	782	943	1052	
		North	291	325	387	466	556	646	706	
Vitamin B-12 (µg)	2.0	Kamp	0.396	0.565	1.01	1.89	3.53	6.25	8.83	NA
		S-W	0.121	0.174	0.314	0.591	1.09	1.84	2.50	
		North	0.089	0.119	0.191	0.327	0.578	0.994	1.39	
Vitamin C (mg)	35	Kamp	48.6	61.0	85.0	116	152	188	211	2,000
		S-W	113	134	176	232	299	369	416	
		North	19.2	26.4	42.8	69.8	109	157	191	
Iron (mg)	26.5§	Kamp	8.38	9.52	11.71	14.60	18.05	21.70	24.16	45
		S-W	11.61	13.15	16.08	19.92	24.46	29.23	32.42	
		North	10.36	11.86	14.76	18.60	23.20	28.06	31.34	
Zinc (mg)	8.2§	Kamp	7.41	7.75	8.33	9.04	9.79	10.5	11.0	45**
		S-W	4.45	5.42	7.37	10.1	13.4	17.0	19.5	
		North	6.84	7.49	8.65	10.1	11.6	13.1	14.1	
Calcium (mg)	833§	Kamp	147	174	228	306	411	534	625	3,000
		S-W	184	236	344	504	711	946	1111	
		North	196	230	299	399	532	688	802	

* UL for vitamin A is specific for retinol, and for folate is specific for folic acid. However, the intake values in the table include pro-carotenoids of vitamin A and dietary folate, respectively.

** These are the UL values for zinc, which are apparently too low for a vegetarian diet.

§ For low bioavailability diet (5%).

Annex 4: Detailed results of the projected impact of fortification on prevalences of inadequate intake, with standard deviations

Table A4-1: The prevalences of inadequate in the presence of and in the absence of fortification of sugar, oil, wheat and maize flour with vitamin A, with standard deviations, in children 24-59 months and women of reproductive age (WRA), Kampala, South-West (S-W) and North Uganda, 2008.

Age	**24-59 months**			**WRA**		
Region	**Kamp % (SD)**	**S-W % (SD)**	**North % (SD)**	**Kamp % (SD)**	**S-W % (SD)**	**North % (SD)**
Diet alone	68.6 (14.7)	52.0 (5.43)	99.5 (1.97)	47.4 (4.28)	29.9 (7.27)	98.2 (3.86)
Plus wheat flour	47.9 (6.03)	46.2 (5.80)	99.0 (3.69)	30.2 (10.9)	29.2 (7.05)	98.1 (4.09)
Plus oil	19.9 (20.1)	28.0 (19.5)	56.5 (5.45)	5.9 (11.7)	17.1 (9.50)	45.1 (3.44)
Plus wheat flour & oil	9.7 (18.2)	25.2 (20.7)	54.4 (5.22)	3.2 (8.17)	17.0 (9.02)	44.8 (3.45)
Plus sugar	6.24 (18.0)	31.0 (14.9)	90.5 (12.8)	1.7 (4.99)	19.2 (7.34)	87.3 (13.9)
Plus oil & sugar	0.5 (3.30)	16.0 (21.1)	42.7 (5.43)	0 (NA)	13.4 (6.65)	33.4 (5.13)
Plus wheat & oil & sugar	0.2 (1.60)	14.3 (20.4)	41.2 (5.85)	0 (NA)	13.2 (6.22)	33.2 (5.19)
Plus maize flour	63.6 (12.3)	49.4 (5.30)	99.4 (2.80)	40.1 (6.06)	27.7 (7.63)	97.5 (5.32)
Plus wheat & oil & sugar & maize	0.2 (1.22)	13.3 (20.2)	39.5 (6.22)	0 (NA)	12.3 (6.09)	31.4 (5.50)

Table A4-2: The prevalences of inadequate micronutrient intake in the presence of and in the absence of fortification of wheat and maize flours, children 24-59 months and women of reproductive age (WRA), in Kampala, South-West (S-W) and North Uganda, 2008

Age	**24-59 months**			**WRA**		
Region	**Kamp % (SD)**	**S-W % (SD)**	**North % (SD)**	**Kamp % (SD)**	**S-W % (SD)**	**North % (SD)**
Vitamin B-1						
Diet only	17.8 (20.1)	0.7 (2.85)	2.0 (11.0)	19.8 (18.1)	2.8 (2.79)	5.8 (10.5)
+ wheat flour	3.44 (10.0)	0.5 (2.02)	2.0 (9.46)	8.9 (15.7)	2.5 (2.61)	5.8 (9.70)
+ maize flour	8.9 (17.0)	0.5 (2.13)	1.6 (8.50)	11.5 (14.1)	2.3 (2.49)	4.4 (8.80)
+ both flours	1.7 (6.22)	0.3 (1.38)	1.6 (7.61)	4.9 (9.56)	2.2 (2.32)	4.4 (8.26)
Vitamin B-2						
Diet only	18.4 (6.29)	2.4 (5.15)	33.8 (6.92)	20.3 (21.10)	8.1 (3.83)	38.9 (6.16)
+ wheat flour	4.6 (5.00)	1.4 (3.98)	29.9 (8.39)	6.6 (14.1)	7.7 (3.81)	37.9 (6.34)
+ maize flour	8.8 (7.62)	1.4 (3.99)	27.0 (8.82)	9.2 (17.5)	6.9 (3.49)	28.8 (12.0)
+ both flours	1.8 (3.64)	1.0 (3.13)	21.8 (12.1)	3.4 (8.80)	6.7 (3.40)	28.3 (11.60)
Niacin						
Diet only	13.5 (12.5)	2.3 (6.15)	6.4 (21.4)	10.9 (23.3)	7.0 (6.43)	13.2 (13.9)
+ wheat flour	2.4 (6.25)	1.1 (4.24)	4.8 (19.8)	3.4 (12.1)	6.7 (6.13)	13.1 (13.2)
+ maize flour	7.4 (11.4)	0.6 (3.60)	4.0 (18.1)	5.2 (12.53)	5.8 (5.97)	8.7 (14.1)
+ both flours	1.3 (4.13)	0.3 (2.17)	3.5 (16.8)	2.0 (6.19)	5.8 (5.58)	8.6 (13.7)
Vitamin B-6						
Diet only	4.9 (5.57)	0 (NA)	6.8 (10.9)	0 (NA)	0.3 (0.37)	26.4 (5.01)
+ wheat flour	1.6 (2.70)	0 (NA)	6.8 (8.18)	0 (NA)	0.2 (0.34)	26.0 (4.88)
Folate (Folic Acid = 3.0 mg/kg in wheat flour)						
Diet only	16.6 (10.3)	0.2 (1.95)	1.5 (14.3)	7.0 (25.3)	1.5 (3.16)	10.8 (14.8)
+ wheat flour	2.3 (4.40)	0.1 (0.82)	0 (NA)	0.9 (5.40)	1.2 (2.84)	11.7 (11.2)
+ maize flour	7.04 (11.6)	0 (NA)	4.16 (13.8)	2.2 (13.7)	1.3 (2.67)	7.6 (13.2)

+ both flours	0.6 (2.50)	0 (NA)	0.1 (2.70)	0.3 (2.44)	1.1 (2.42)	8.2 (11.5)
Folate (Folic Acid = 1.5 mg/kg in wheat flour)						
+ wheat flour	4.25 (6.82)	0.2 (1.34)	0.6 (9.92)	1.4 (9.32)	1.3 (2.94)	11.4 (13.1)
+ maize flour	7.04 (11.6)	0 (NA)	4.16 (13.8)	2.2 (13.7)	1.3 (2.67)	7.6 (13.2)
+ both flours	0.8 (3.93)	0.00 (NA)	3.9 (14.0	0.4 (3.75)	1.2 (2.50)	8.0 (12.1)
Vitamin B-12						
Diet only	31.8 (15.6)	65.4 (44.5)	94.4 (41.4)	63.7 (13.1)	96.6 (7.61)	99.8 (2.44)
+ wheat flour	3.3 (13.80)	50.8 (9.03)	91.5 (57.4)	41.5 (7.24)	95.2 (8.32)	99.8 (3.38)
+ maize flour	20.7 (23.6)	58.3 (17.5)	94.2 (58.9)	53.9 (5.26)	95.4 (8.10)	99.6 (4.69)
+ both flours	1.5 (8.58)	44.5 (13.3)	84.9 (48.9)	31.9 (11.1)	94.1 (8.53)	99.6 (4.96)
Iron (Ferrous fumarate in wheat flour)						
Diet only	74.7 (3.23)	57.5 (2.67)	55.1 (4.33)	89.3 (9.12)	64.9 (5.55)	70.9 (7.14)
+ wheat flour	66.1 (2.2)	56.1 (8.54)	54.2 (3.14)	83.5 (7.92)	64.2 (9.6)	70.5 (6.18)
+ maize flour	70.8 (8.33)	55.7 (4.67)	52.9 (4.75)	83.5 (7.33)	62.8 (4.51)	67.1 (5.45)
+ both flours	61.5 (9.61)	54.0 (4.80)	51.9 (4.62)	76.5 (10.7)	62.1 (3.92)	66.8 (4.81)
Iron (NaFeEDTA in wheat flour)						
+ wheat flour (10)	53.2 (3.28)	53.3 (3.25)	52.9 (3.4)	72.4 (4.32)	63.3 (6.66)	70.1 (7.1)
+ maize flour	70.8 (8.33)	55.7 (4.67)	52.9 (4.75)	83.5 (7.33)	62.8 (4.51)	67.1 (5.45)
+ both flours (10)	48.5 (4.68)	51.7 (2.88)	50.6 (2.55)	64.9 (9.76)	61.3 (5.27)	66.3 (5.75)
Zinc						
Diet only	81.6 (5.09)	78.3 (12.90)	74.0 (14.0)	36.4 (20.9)	32.7 (3.35)	18.3 (23.4)
+ wheat flour	57.7 (4.23)	71.7 (10.3)	69.6 (10.4)	12.3 (29.5)	31.7 (3.41)	18.0 (18.5)
+ maize flour	63.4 (4.70)	73.0 (10.6)	70.1 (10.0)	14.7 (33.0)	31.9 (3.39)	18.0 (19.2)
+ both flours	39.1 (45.3)	67.0 (9.69)	68.0 (13.1)	7.1 (18.7)	31.1 (3.56)	18.0 (15.2)

Annex 5: Probability among true consumers of food vehicles to reach the Tolerable Upper Intake Level (UL) value of retinol

Methods used are described in detail in Annex 2.

Table A5-1: Probability among those who consume sugar, oil, and/or wheat flour fortified with vitamin A, that retinol intake exceeds the Tolerable Upper Intake Level **(**UL), in children 24-59 months and women of reproductive age (WRA) , in Kampala, South-West (S-W) and North Uganda, 2008

Age	Region	Sugar % (SD)	Oil % (SD)	Wheat Flour % (SD)	Sugar+Oil % (SD)	Oil+Wheat Flour	All
Children 24-59 months	Kamp	18.1 (36.8)	9.4 (29.3)	4.9 (22.2)	48.2 (7.85)	15.4 (30.0)	69.9 (28.8)
	S-W	0.0 (NA)	0.0 (NA)	0.0 (NA)	2.0 (8.68)	0.3 (2.03)	4.5 (11.0)
	North	2.4 (63.4)	5.4 (35.5)	0.0 (NA)	16.9 (20.0)	6.9 (26.6)	21.8 (26.2)
WRA	Kamp	0.1 (1.02)	0.0 (NA)	0.0 (NA)	0.1 (1.80)	0.0 (NA)	0.3 (3.00)
	S-W	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)
	North	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)

Annex 6: Nutrient intake from the diet (excluding breast-feeding) and additional micronutrient intakes from fortified food vehicles on children 6-23 months of age

This annex summarizes the data about nutrient intake through foods, and the estimated additional intakes of micronutrients coming from fortified food vehicles for children 6-23 months of age. It is important to note that these nutrient intakes are underestimated because they do not include nutrients provided by breast milk.

Table A6-1: Percentiles of usual nutrient intake distributions, excluding breastmilk, of energy, fat, protein, and fiber for children 6-23 months in Kampala (Kamp), South-West (S-W) and North Uganda, 2008.

Macronutrient	Region	5th	10th	25th	50th	75th	90th	95th
Energy (kcal)	Kamp	305	396	568	787	1035	1282	1439
	S-W	224	307	487	757	1111	1789	1510
	North	139	207	358	583	870	1183	1396
Fat (g)	Kamp	4.02	5.99	10.5	17.6	27.4	38.6	46.5
	S-W	4.56	5.66	7.97	11.3	15.8	20.8	24.3
	North	4.72	6.15	9.18	13.7	19.4	25.9	30.4
Protein (g)	Kamp	6.09	8.59	13.6	20.2	27.9	35.7	40.8
	S-W	5.61	7.51	11.7	18.2	27.1	37.6	45.2
	North	4.29	6.25	10.6	17.2	25.7	35.0	41.3
Fiber (g)	Kamp	2.80	3.60	5.21	7.39	9.97	12.6	14.4
	S-W	3.62	4.97	8.07	13.1	20.5	36.3	29.5
	North	3.18	4.28	6.63	10.1	14.5	19.4	22.8

Note: Estimates do not include consumption of breast milk and thus underestimate energy, fat and protein intakes

Table A6-2: Percentiles of the usual nutrient intake distributions, excluding breastmilk, for children 6-23 months old in Kampala (Kamp), South-West (S-W) and North Uganda 2008.

Micronutrient	EAR	Region	5th	10th	25th	50th	75th	90th	95th	UL
Vitamin A (RE) (µg)	286	Kamp	11.4	21.9	50.4	99.5	168	246	300	600*
		S-W	20.7	32.0	62.1	121	219	359	473	
		North	19.3	22.8	29.8	39.7	52.3	66.4	76.4	
Vit B-1 (Thiamin)(mg)	0.3	Kamp	0.15	0.19	0.27	0.38	0.52	0.67	0.76	NA
		S-W	0.12	0.17	0.29	0.47	0.72	1.03	1.25	
		North	0.15	0.20	0.29	0.42	0.58	0.75	0.86	
Vit B-2 (Riboflavin) (mg)	0.4	Kamp	0.19	0.25	0.40	0.61	0.88	1.19	1.39	NA
		S-W	0.14	0.19	0.30	0.48	0.71	0.98	1.17	
		North	0.20	0.23	0.30	0.40	0.53	0.67	0.77	
Niacin (mg)	3.8	Kamp	2.29	2.72	3.58	4.73	6.14	7.64	8.65	NA
		S-W	1.35	1.86	2.98	4.70	6.98	9.59	11.4	
		North	0.75	1.18	2.21	3.85	6.05	8.55	10.3	
Vitamin B-6 (mg)	0.4	Kamp	0.28	0.35	0.48	0.65	0.84	1.03	1.16	NA
		S-W	0.24	0.36	0.63	1.07	1.67	2.39	2.90	
		North	0.08	0.12	0.22	0.39	0.63	0.94	1.17	
Folate (DFE) (µg)	92	Kamp	49.9	64.0	92.8	133	183	236	273	510*
		S-W	49.1	66.0	105	168	259	374	460	
		North	63.5	77.6	106	145	193	245	280	
Vitamin B-12 (µg)	0.7	Kamp	0.211	0.284	0.499	0.712	1.08	1.53	1.82	NA
		S-W	0.064	0.086	0.138	0.231	0.384	0.604	0.790	
		North	0.050	0.066	0.103	0.165	0.261	0.388	0.490	

Vitamin C (mg)	25	Kamp	6.11	8.93	15.4	25.4	38.8	53.9	64.5	400
		S-W	16.7	23.9	40.3	65.2	98.2	135	161	
		North	5.57	7.75	13.0	22.3	37.8	60.9	80.8	
Iron (mg)	6.4[§]	Kamp	1.18	1.64	2.69	4.30	6.30	9.55	14.0	40
		S-W	1.39	1.95	3.20	5.17	7.88	11.1	13.4	
		North	1.15	1.71	3.02	5.09	7.92	11.2	13.5	
Zinc (mg)	7.0[§]	Kamp	0.88	1.25	2.04	3.24	4.80	6.55	7.76	7**
		S-W	0.80	1.11	1.80	2.88	4.33	6.03	7.24	
		North	0.73	1.03	1.70	2.72	4.06	5.55	6.58	
Calcium (mg)	375 [ω]	Kamp	61.1	88.2	151	251	389	550	655	2,500
		S-W	38.4	55.1	94.9	163	262	387	482	
		North	49.7	63.0	91.0	134	190	256	302	

* UL for vitamin A is specific for retinol, and for folate is specific for folic acid. However, the intake values in the table include pro-carotenoids of vitamin A and dietary folate, respectively.

** These are the UL values for zinc, which are apparently too low for a vegetarian diet.

§ For low bioavailability diet (5%). For iron, the Adequate Intake (AI) instead of the EAR value is used because this age group does not have EAR value for this nutrient.

[ω] AI value

Table A6-3: Estimated percentiles of usual consumption of vegetable oil in grams/day by children 6-23 months in Kampala, South-West and North Uganda, 2008

Age	Region	P5	P10	P25	P50	P75	P90	P95
Children 6-23 m	Kampala		0.06	1.16	3.21	6.23	12.1	13.9
	South-West					1.37	4.87	7.51
	North				2.9	6.67	14.1	19.6

Table A6-4: Estimated percentiles of usual consumption of sugar in grams/day by children 6-23 months in Kampala, South-West, and North Uganda, 2008

Age	Region	P5	P10	P25	P50	P75	P90	P95
Children 6-23 m	Kampala	4.48	9.46	17.9	31.3	50.2	69.9	91.5
	South-West					8.96	22.5	35.8
	North					18.2	41.2	47.5

Table A6-5: Estimated percentiles of usual consumption of wheat flour and its products in grams/day by children 6-23 months in Kampala, South-West, and North Uganda, 2008

Age	Region	P5	P10	P25	P50	P75	P90	P95
Children 6-23 m	Kampala				6.4	31.7	58.5	69.3
	South-West						5.42	17.8
	North						16.1	38.9

Table A6-6: Estimated percentiles of usual consumption of maize flour and its products in grams/day by children 6-23 months in Kampala, South-West, and North Uganda, 2008

Age	Region	P5	P10	P25	P50	P75	P90	P95
Children 6-23 m	Kampala					27.0	50.5	68.7
	South-West						29.1	51.9
	Northern						46.7	77.2

Generally, mass fortification will have limited impact in infants and young children simply because the majority of them do not consume sufficient quantity of the fortified staples and condiments to consume sufficient of the added nutrients. The exception to this rule is vitamin A fortified sugar and oil, and therefore a proportion of the additional vitamin A is supplied through this means, either by direct consumption or through the mother's milk.[15] It would be important to assess the total intake of vitamin A in this age group, mainly those from Kampala. Here, it would also be needed to add the amounts provided by VAS.

[15] Ross JS and Harvey PWJ. The contribution of breastfeeding to infant vitamin A nutrition: A simulation Model. Bulletin of World Health Organization 2003;81(2):80-86.

Annex 7: Breastfeeding and Complementary Feeding Behaviors

Tables A7-1 presents the distributions of gender and age in the 6-23 months old children. Distributions were relatively even across the three regions.

Table A7-1: Numbers and percentages of children 6-23 months surveyed in Kampala, South-West and North Uganda, 2008

REGION	Kampala 158		Southern-West 162		North 158	
	n	%	n	%	n	%
Sex						
Males	83	53%	86	52%	81	51%
Females	72	48%	76	48%	77	49%
Age (months)						
6-8	39	25%	28	17%	25	16%
9-11	16	10%	28	17%	25	16%
12-17	52	33%	56	35%	47	30%
18-23	51	32%	50	31%	61	39%

Breastfeeding status of children 6 – 23 months

Almost all (94%-99%) infants and children 6-23 months in the three regions surveyed were breastfed at some time. More than half (57%-81%) were still breastfeeding at the time of the interview. These results indicate that breastfeeding remains a very important source of nutrition through 24 months.

Table A7-2: Breastfeeding of children aged 6-23 months in Kampala, South-West and North Uganda, 2008

REGION	Kampala 158		South-West 162		North 158	
	n	%	n	%	n	%
Ever breastfed	150	95%	161	99%	148	94%
Never breastfed	5	3%	1	1%	4	3%
Missing value	3	2%	0	0%	6	4%
Still breastfeeding	90	57%	122	75%	128	81%
Not breastfeeding	60	38%	39	24%	22	14%
Missing value	8	5%	1	1%	8	5%

Feeding practices among children 6 – 23 months

Kampala region had the highest distribution of mothers introducing food before six months (31%) compared to 16% in the South-West region and to 27% in the Northern region. South-West region had the highest (28%) distribution of mothers introducing food after the recommended six months of age compared to 18 percent in Kampala and the Northern regions.

Table A7-3: Age at which foods other than breast milk were first introduced to children aged 6-23 months in Kampala, South-West and North Uganda, 2008

REGION	Kampala		South-West		North	
	150		161		148	
	n	%	n	%	n	%
Before 6 months	47	31%	25	16%	40	27%
At about 6 months	68	45%	86	53%	81	55%
After 6 months	29	19%	45	28%	27	18%
Don't know	6	6%	5	3%	0	0%

Mothers reported giving a variety of 'first foods' to infants, with the greatest variety in the South-West region with 8 foods identified by more than 10% of respondents. Across the three regions, goat or cow milk was the most common food identified, most likely because they were used a) to mix with other foods to provide a more liquid consistency, and b) as breast milk substitutes or to supplement breast milk. Along with goat or cow milk, the most common first foods were Irish potato in Kampala, matoke (cooking banana) in South-West, and commercial rice cereal in the North. Notably, the use of commercial formula was uncommon in Kampala (8%), minimal (1%) in the North and absent in the South-West.

Table A7-4: Types of foods first fed to children aged 6-23 months in Kampala, South-West and North Uganda, 2008

REGION	Kampala		South-West		Northern	
	150		161		148	
	n	%	n	%	n	%
Potato (Irish)	82	55%	38	24%	0	0%
Milk (goat or cow)	76	51%	76	47%	37	25%
Matooke (banana)	33	22%	114	71%	13	9%
Porridge (sorghum flour)	13	9%	21	13%	19	13%
Commercial baby formula	12	8%	0	0%	1	1%
Porridge (millet flour)	9	6%	16	10%	1	1%
Sweet potato	8	5%	67	42%	17	12%
Porridge (maize flour homegrown)	6	4%	20	12%	15	10%
Commercial rice cereal	5	3%	20	12%	47	32%
Biscuits/cookies	5	3%	14	9%	14	10%
Porridge (maize flour purchased)	2	1%	0	0%	0	0%

A variety of processed or snack foods were reported as being given to the child 'now'. The foods that were most frequently given to young children were bread, doughnuts, biscuits and pancakes. Bread in Kampala (64%) and biscuits in the North region (69%) were the processed foods that were consumed substantially more than any other in those regions. In the South-West, the four common processed foods identified above were consumed more evenly (28-37%).

Table A7-5: Processed foods given to child aged 6-23 months in Kampala, South-West and North Uganda, 2008

REGION	Kampala		South-West		North	
	158		162		158	
	n	%	n	%	n	%
Bread	100	64%	64	37%	47	30%
Doughnut	61	39%	52	32%	58	37%
Biscuits	57	36%	45	28%	109	69%
Pancake	50	32%	55	34%	50	32%
Cake	43	27%	16	10%	0	0%
Cookies	10	6%	1	1%	0	0%

Infant and young child feeding practice in last 24 hours

Figure A11-1 shows the percentage of breastfed, as well as non-breastfed children 6-23 months old who received solid/semi-solid foods at least the minimum number of per day according to their respective age group (see Box 1).

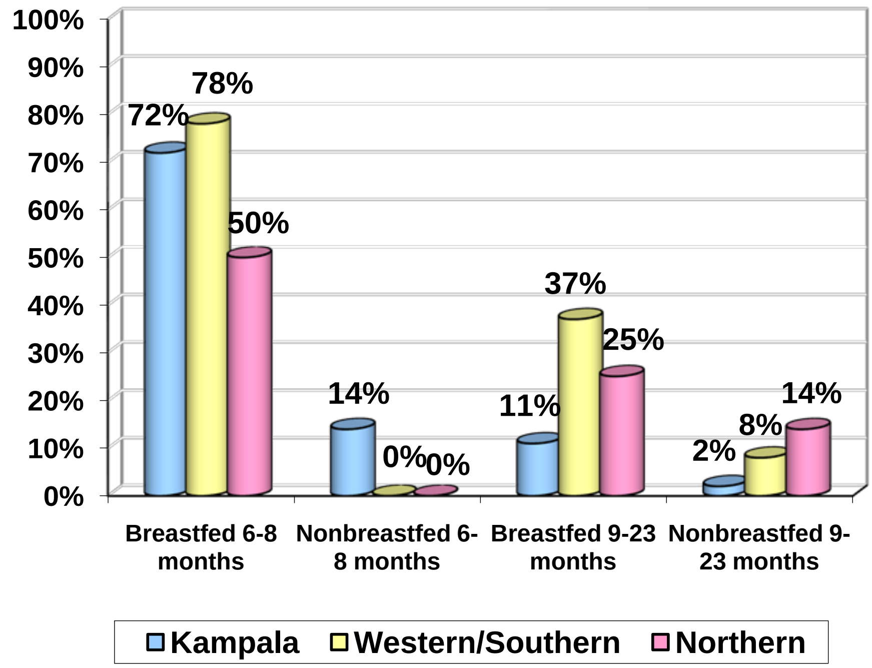
Box1: Components of infant and young child feeding practices indicator*

<table>
<tr><th rowspan="2">Components included</th><th colspan="4">Scoring</th></tr>
<tr><th colspan="2">Breastfed</th><th colspan="2">Non-breastfed</th></tr>
<tr><td rowspan="2">Breastfed or fed appropriate breast milk substitutes</td><td colspan="2">Continued breastfeeding</td><td colspan="2">Fed other milk, dairy products, or infant formula</td></tr>
<tr><td colspan="2">Yes = 1</td><td colspan="2">No = 0
Yes = 1</td></tr>
<tr><td>Fed (solid/semi-solid foods) minimum number of times per day</td><td>6-8 months
0-1 = 0
2 or more = 1</td><td>9-23 months
0-2 = 0
3 or more = 1</td><td>6-8 months
0-3 = 0
4 or more = 1</td><td>12-23 months
0-3 = 0
4 or more = 1</td></tr>
<tr><td>Fed minimum number of food groups</td><td colspan="2">3 or more food groups</td><td colspan="2">4 or more food groups</td></tr>
</table>

*WHO. Indicators for assessing infant and young child feeding practices - Part I: Definitions. Conclusions of a consensus meeting held 6–8 November 2007 in Washington D.C., USA. WHO, UNICEF, USAID, AED, UCDAVIS, IFPRI, 2008

Among breastfed children, more than 70% of children from 6-8 months received solid/semi-solid foods at least the minimum number of times recommended by WHO in Kampala and in the South-Western regions, while in the Northern region only 50% were fed with the frequency recommended (Figure A7-1). The frequency of feeding children 9-23 months of age was low overall, but particularly in Kampala (11%). Among non-breastfed children, not one child from 6-8 months of age fed with the recommended frequency in the South-West and Northern regions, while 14% were fed at the recommended frequency in Kampala. Among children from 9-23 months, few were fed with the recommended frequency with the lowest numbers being reported in Kampala.

Figure A7-1: Proportions of children aged 6-8 (left) and 9-23 months (right) fed solid/semi-solid foods at least the minimum number of times per day by age and breastfeeding status in Kampala, South-West, and North Uganda, 2008



The percentages of children receiving the diversity of foods that is recommended by WHO (see Box 1) are shown in Figure A7-2. The diversity of foods being fed to young children was greatest in Kampala. No non-breast children 6-8 months received at least the recommended minimum number of food groups per day in the South-West and the Northern regions. Diversity was better overall in older children. Even among children not receiving any breast milk, more than 25% in all regions received the recommended number of food groups.

Figure A7- 2: Proportions of children aged 6-23 months receiving at least the minimum number of food groups per day by age and breastfeeding status in Kampala, South-West (S-W) and North Uganda, 2008

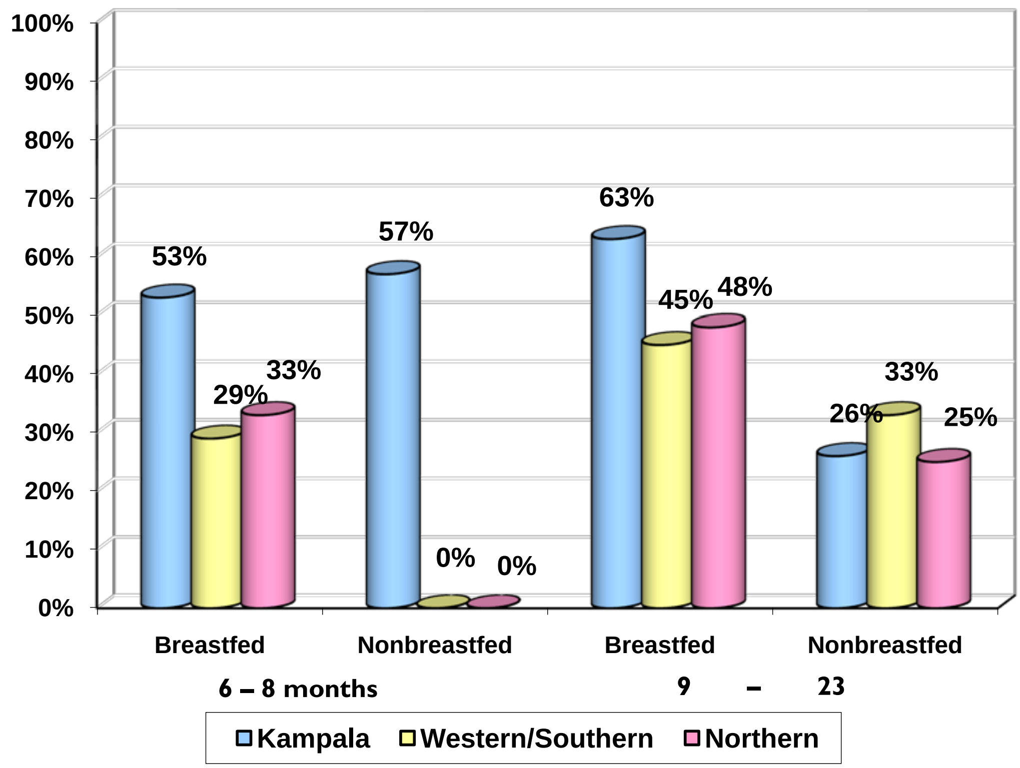
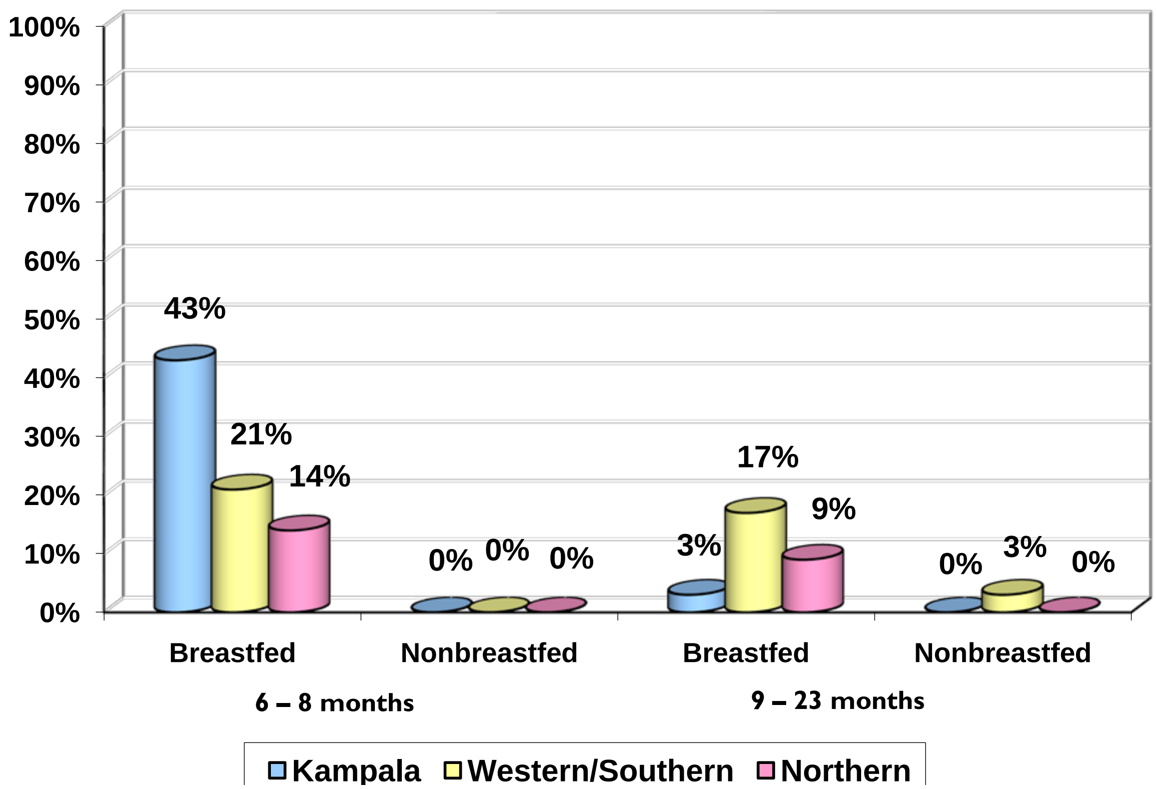


Figure A7-3 presents the proportions of children receiving the "WHO minimum acceptable diet" which combines the frequency and diversity of complementary feeding (see Box 1). Among breast fed infants 6-8 months old, the proportion in Kampala was higher (43%) than in the South-West (21%) or the Northern region (14%). Among children 9-23 months old, the South-West had the highest proportion (17%) fed according to WHO recommendations with those in Kampala (3%) and the Northern region (9%), being less than 10%.

Figure A7-3: Proportions of children aged 6-23 months receiving a minimum acceptable diet per day by age and breastfeeding status in Kampala, South-West, and North Uganda, 2008



Perceptions of lactating mothers about the quantity of food they eat

The mothers of children 6-23 months were asked about the quantity of food they ate while they were breastfeeding compared to the quantity of food they are at other times (Table A7-6). Fewer than half of women in all three regions consumed more food during lactation and in the Northern region; almost one quarter reported eating less food.

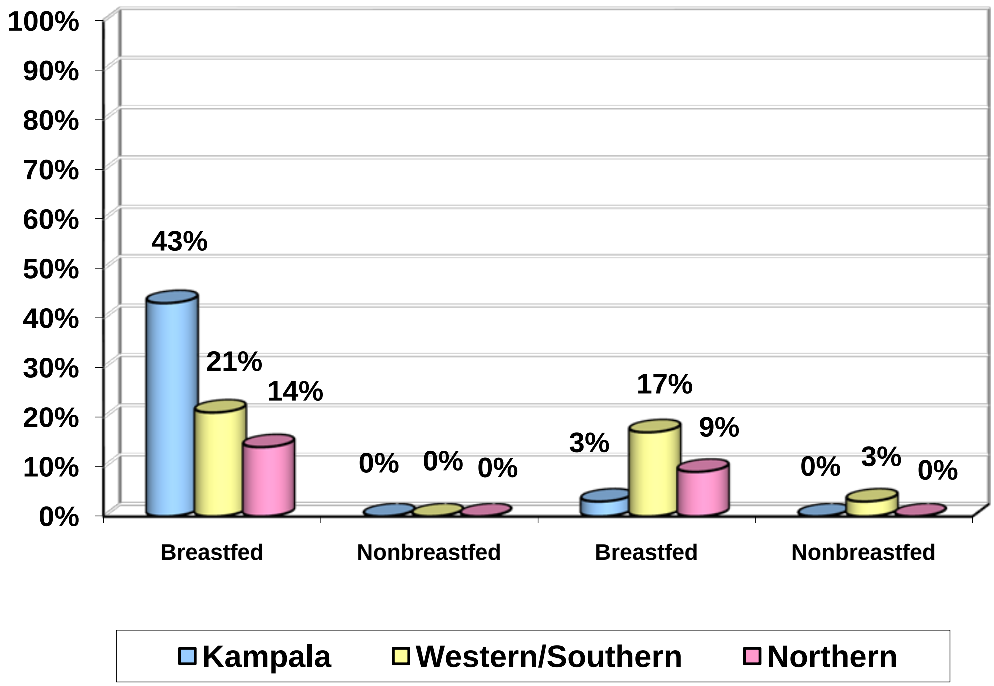
Table A7-6: Percentages of mothers by perceived amount of food eaten during lactation by region

REGION	Kampala		South-West		Northern	
	90		122		128	
	n	%	n	%	n	%
Less	7	8%	4	3%	30	24%
Same	46	51%	54	45%	45	35%
More	36	40%	56	46%	53	41%
Don’t know	1	1%	8	6%	0	0%

Infant and young child feeding behaviors by components of WHO recommendations

Figure A7-4 shows the percent of children from 6-23 months old who were fed according to each component of infant and young child feeding practices. Overall, less than 15% of children received a minimum acceptable diet per day; about two of five children received at least the minimum number of food groups per day. Kampala region had the lowest distribution of children receiving at least the minimum number of solid/semi-solid food per day (20%), compare to 36% in the South-West region and 28% in the Northern region.

Figure A7-4: Percent of children 6-23 months old by components of infant and young child feeding practices and region



Annex 8: Nutrient Details of behaviors related to purchase of fortified foods

This annex has been added to show the current knowledge and appreciation of the food fortification programs in Uganda, and for being used as reference for any social marketing component of this program.

Knowledge of fortified foods

It was important to find out whether respondents had knowledge about fortified foods. The National Working Group for Food Fortification was formed and external financial and technical support was sought. The oil industries made a corporate commitment to contribute to public health through voluntary oil fortification with Vitamin A. A social marketing strategy was developed in 2004-5, and a fortification logo developed. Some activities were carried out, but those were discontinued at the end of 2005. Therefore, by 2008 there was not any social marketing program in the country, and a new one has not been launched yet.

Table A8-1 presents the knowledge about fortified foods among households by region and residence. In all regions, about 90% of the respondents had not heard about fortified foods. Among respondents who had heard about fortified foods, very few had seen the fortification logo (16% in Kampala, 7% in the South-West). In the Northern region, no one reported having seen the fortification logo.

Table A8-1: Knowledge of fortified foods among households in three regions of Uganda, 2008

REGION	Kampala		South-West		Northern	
	N = 305		N = 319		N = 320	
	n	%	n	%	n	%
Ever heard about fortified food						
Yes	50	16%	22	7%	20	6%
No	255	84%	297	93%	300	94%
Of those who had heard about fortification, Ever seen the logo of fortified food						
Yes	4	8%	3	15%	0	0%
No	46	92%	19	95%	20	100%

In all regions, respondents who had heard about fortified foods reported that they had heard of them either from the radio or health workers.

Oil

In all regions, the choice of brand of oil used depended on its availability in the local market and/or personal preference. Very few reported the health benefits for the family, the taste and the packaging of the oil. No household complains about the bad smell of oil. “Given as relief aid” was reported mostly in the Northern region (24%).

Table A8-2: Reasons for choice of brand of oil/fat used by household in Kampala, South-West and North Uganda, 2008

REGION	Kampala		South-West		North	
	N = 299		N = 212		N = 306	
	n	%	n	%	n	%
Reason						
Most common choice available	132	44%	56	26%	141	46%
Prefer it	75	25%	85	40%	43	14%
No special reason	48	16%	29	14%	8	3%
Cheapest	18	6%	28	13%	3	1%
It has vitamins, minerals/better for health of family	5	2%	4	2%	0	0%
Given as a relief aid	2	1%	0	0%	72	24%
Has nice taste	4	1%	3	1%	0	0%
Package attractive	4	1%	0	0%	0	0%
Has no bad smell	0	0%	0	0%	1	0%
Other	4	1%	2	1%	1	0%

Among households that buy oil, the expenditure on oil at a time by the majority of urban households ranged from Sh. 50 to 75,000 with a median of Sh. 300 and mean of Sh. 1821. In rural areas, the expenditure ranged from Sh. 100 to 12,000 with a median of Sh. 700 and mean of Sh. 1202.

Table A8-2: Expenditure on fat/oil purchased at a time by region, in Kampala, South-West and North Uganda, 2008

REGION	Kampala	South-West	North
	N = 297	N = 211	N = 135
Minimum	50	100	100
Maximum	75,000	12,000	12,000
Mean (SD)	1,821 (6,780)	1,290 (1,565)	1,066 (1,714)
Median	300	700	650

Table A8-3: Respondent's perception of the price of oil/fat and frequency of purchase by region in Kampala, South-West, and North Uganda, 2008

REGION	Kampala		South-West		Northern	
	N = 290		N = 210		N = 135	
	n	%	n	%	n	%
Price perception (among those who buy)						
Expensive	219	76%	170	81%	127	94%
Reasonable	67	23%	35	17%	1	1%
Cheap	4	1%	5	2%	7	5%
	N = 299		N = 209		N = 294	
Frequency of purchase/get oil/fat (among those who use oil)						
Daily	133	45%	22	11%	19	6%
3-6 times a week	59	20%	19	9%	26	9%
1-2 times a week	65	22%	93	44%	82	28%
2-3 times a month	13	4%	27	13%	13	4%
Once a month or less	22	7%	43	21%	149	51%
Other	6	2%	3	1%	3	1%
Don't know	0	0%	2	1%	2	1%

The container in which oil/ fat is stored, its characteristics and how it is kept are important in maintaining the quality of oil. In all regions, most respondents (> 70%) indicated that the oil was stored in translucent plastic containers. From the factories, the oil is produced in opaque containers, which means that it is transferred into transparent bottles or bags for the traders. The majority of households (> 89%) in all regions indicated that they keep the container closed. In the Northern region, most households (54%) reported that the oil container was stored on the floor. While in Kampala and the South-West regions the oil storage container was on a shelf, table or other open space in 69 percent and 58 percent of the households, respectively. Only 20 percent of households in all regions indicated that the container is stored in a cupboard or other closed space, which is a good practice.

Table A8-4: Type and status of oil container, storage and conditions at household by region in Kampala, South-West, and North Uganda, 2008

REGION	Kampala		South-West		North	
	N = 298		N = 208		N = 304	
	n	%	n	%	n	%
Type of container						
Plastic container	228	76%	146	69%	276	91%
Glass container	41	14%	28	13%	8	3%
Kaveera (Polythene bag)	16	5%	16	8%	4	1%
Calabash	0	0%	12	6%	0	0%
Aluminum	2	1%	1	1%	9	3%
Refused	2	1%	5	2%	0	0%
Other	9	3%	2	1%	7	2%
Status of the container	n=274		n=187		n=293	
Light enough to see through, but not clear	206	75%	75	40%	217	74%
Too dark to see through	40	15%	86	46%	71	24%
Clear	28	10%	26	14%	5	2%
How container is kept	n=274		n=187		n=293	
Closed	248	90%	167	89%	282	96%
Open	26	10%	20	11%	11	4%
How the container is stored	n=274		n=187		n=293	
On a shelf, table or other open space	190	69%	108	58%	85	29%
On the floor	18	7%	41	22%	158	54%
In a cupboard or other closed space	66	24%	37	19%	50	17%

Most households use oil/fat to stir fry their food. This was reported by 98 percent of the respondents in Kampala, 78 percent by those in South-West and 62 percent in the Northern regions. Respondents in all regions reported using oil to deep-fry cassava, pancakes and doughnuts while others indicated that they add the oil when boiling food or after food has been prepared. Those who add oil or fat after food has been prepared were mostly found in the South-West region (13%) possibly because they use the locally made butter/ghee and, this is added to hot food after it has been prepared.

Table A8-5: Use oil/fat during cooking at household by region in Kampala, South-West and North Uganda, 2008

REGION	Kampala		South-West		North	
	N = 299		N = 212		N = 306	
	n	%	n	%	n	%
Oil/fat use						
Stir fry	292	98%	164	78%	191	62%
Deep fry	24	8%	25	12%	2	1%
Add when boiling food	46	15%	20	9%	43	14%
Add to food after prepared	4	1%	27	13%	89	29%
Other	1	1%	13	6%	0	0%

The majority in all regions indicated that they never have leftover oil or fat. This is most likely because most households do not deep fry but stir fry in which all the oil/fat is incorporated in the dish.

Table A8-6: Percentage of respondents reporting having left over oil/fat after frying food by region in Kampala, South-West and North Uganda, 2008

REGION	Kampala		South-West		North	
	N = 299		N = 212		N = 168	
	n	%	n	%	n	%
How often have leftovers						
Never	246	83%	155	73%	216	70%
Sometimes	29	10%	14	7%	2	1%
Often	8	3%	2	1%	1	0%
Always	7	2%	26	12%	83	27%
Rarely	7	2%	15	7%	4	2%

Sugar
The minimum amount of money reported paid for the quantity of refined sugar commonly bought was 100 shillings in the South-West region while the maximum was 15000 in Kampala. The average expenditure on sugar varied from 922 shillings in the Northern region for a half kilo, to 1589 shillings in Kampala for a kilo of refined sugar.

Table A8-7: Expenditure on refined sugar purchased at a time in Kampala, South-West and North Uganda, 2008

REGION	Kampala	South-West	North
	N = 303	N = 182	N = 202
Minimum	300	100	200
Maximum	15,000	6,000	6,000
Mean (SD)	1,589 (1,361)	1,457 (778)	922 (774)
Median	1,600	1,200	825

Generally, many respondents indicated that refined sugar is expensive. More than 90 percent of the respondents in the rural regions indicated that the refined sugar was expensive, while in Kampala, a slightly lower proportion (73%) indicated that the refined sugar was expensive. A fairly good proportion of respondents in Kampala (26%) indicated that the price used to buy refined sugar was affordable.
The majority of the households purchase refined sugar 1 to 2 times a week, although in Kampala, a quarter of them reported purchasing refined sugar 3 to 6 times a week possibly because many buy small quantities.

Table A8-8: Respondent's perception of the price of refined sugar and frequency of purchase in Kampala, South-West, North Uganda, 2008

REGION	Kampala		South-West		Northern	
	n = 303		n = 183		n = 202	
	n	%	n	%	n	%
Price perception						
Expensive	223	73%	164	89%	190	94%
Reasonable	79	26%	18	10%	5	2%
Cheap	1	1%	1	1%	7	4%
Frequency of purchase of refined sugar	n=305		n=189		n=204	
Daily	43	14%	1	1%	5	3%
3-6 times a week	83	27%	8	4%	17	8%
1-2 times a week	156	51%	104	55%	118	58%
2-3 times a month	15	5%	30	16%	36	17%
Once a month or less	7	2%	38	20%	27	13%
Other	1	1%	5	3%	0	0%
Don't know	0	0%	3	1%	1	1%

Refined sugar was reported to be used in various ways. In all regions, most respondents used the refined sugar for hot drinks like tea and coffee, and for porridge. Adding sugar to cold drinks like juice was mainly reported in Kampala (57%) and rarely in the Northern region (14%).

Table A8-9: Uses of refined sugar by households by region in Kampala, South-West, and North Uganda, 2008

REGION	Kampala		South-West		North	
	N = 305		N = 189		N = 204	
	n	%	n	%	n	%
Common use of sugar						
Add to tea, coffee or other hot drinks	305	100%	182	96%	167	82%
Add to porridge	273	90%	131	69%	126	62%
Add to juice or other cold drinks	173	57%	52	28%	29	14%
Bake cakes, bread or other foods, including fried foods	3	1%	1	1%	4	2%
Add to fruits or vegetables	5	2%	0	0%	0	0%

Maize flour

Table A8-10: Expenditures on maize flour purchased at one time by region in Kampala, South-West and North Uganda, 2008

REGION	Kampala	South-West	North
	N = 287	N = 203	N = 127
Minimum	200	250	200
Maximum	50,000	40,000	20,000
Mean (SD)	1,978 (5,321)	2,477 (4,784)	1,825 (2,533)
Median	900	1,200	1,000

Most respondents reported that the maize flour is expensive although in Kampala, 78 percent reported that the price is affordable. In Kampala and the South-West region where maize flour is mainly bought from shops, the majority indicated that they buy it 1 to 2 times a week while in the Northern region where maize flour is given as a relief; the majority gets it once a month or less.

Table A8-11: Respondent's perception of the price of maize flour and frequency of purchase by region in Kampala, South-West, and North Uganda, 2008

REGION	Kampala		South-West		North	
	N=287		N=215		N=130	
	n	%	n	%	n	%
Price perception						
Expensive	225	78%	182	85%	121	93%
Reasonable	61	21%	20	9%	5	4%
Cheap	1	1%	13	6%	4	3%
Frequency of purchase of sugar	N=291		N=234		N=219	
Daily	56	19%	6	2%	1	1%
3-6 times a week	72	25%	20	9%	8	4%
1-2 times a week	121	41%	99	43%	56	25%
2-3 times a month	21	7%	33	14%	36	16%
Once a month or less	17	6%	52	22%	103	47%
Other	3	1%	15	6%	13	6%
Don't know	1	1%	9	4%	2	1%

Annex 9 – Uganda Food Consumption Survey Team

Technical Committee

Prof. William Kyamuhangire	Principle Investigator
Prof. Joyce Kikafunda	Co-investigator
Dr. Archileo Kaaya	Co-investigator
Mrs. Juliana Kalibbala	Collaborator Statistician
Mr. Abdelrahman Lubowa	Collaborator Nutrition
Mr. Zo Rambeloson	A2Z-AED

Data collection team

Mrs. Sarah Kisakye	Regional Field Supervisor
Mr. Lukwago Fred Branny	Regional Field Supervisor
Mrs. Elizabeth Kyomugisha	Regional Field Supervisor
Mrs. Munirah Mbabazi	Regional Field Supervisor
Mrs. Joweria Nambooze	Data Quality Editor
Mrs. Florence Turyashameirirwe	Data Quality Editor
Mrs. Caroline Nambafu	Data Quality Editor
Mrs. Sophie Nansereko	Data Quality Editor
Mrs. Clementina Nyaketcho	Investigator
Mrs. Maureen Naggayi	Investigator
Mrs. Peace Nakitto	Investigator
Mrs. Katusiime Clare	Investigator
Mrs. Kansiime Noel	Investigator
Mrs. Katureebe Shilla	Investigator
Mrs. Dusabe Daphine	Investigator
Mrs. Kihembo Prudence	Investigator