



INCEPTION REPORT

Fortified Food Access Index



A Hyperlocal Dataset for
Assessment, Decision-Making,
and Monitoring

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Table of Contents

- Acronyms 3
- About Fraym 4
- Project Description 5
- Goals and Theory of Change 5
- Data Landscape Summary 7
- Literature Scoping Review 8
 - Availability 9
 - Affordability 10
 - Agency 11
 - Awareness 12
 - Other Indicators 13
 - Validation Measurement 13
- Methodology 14
- Appendix A 15

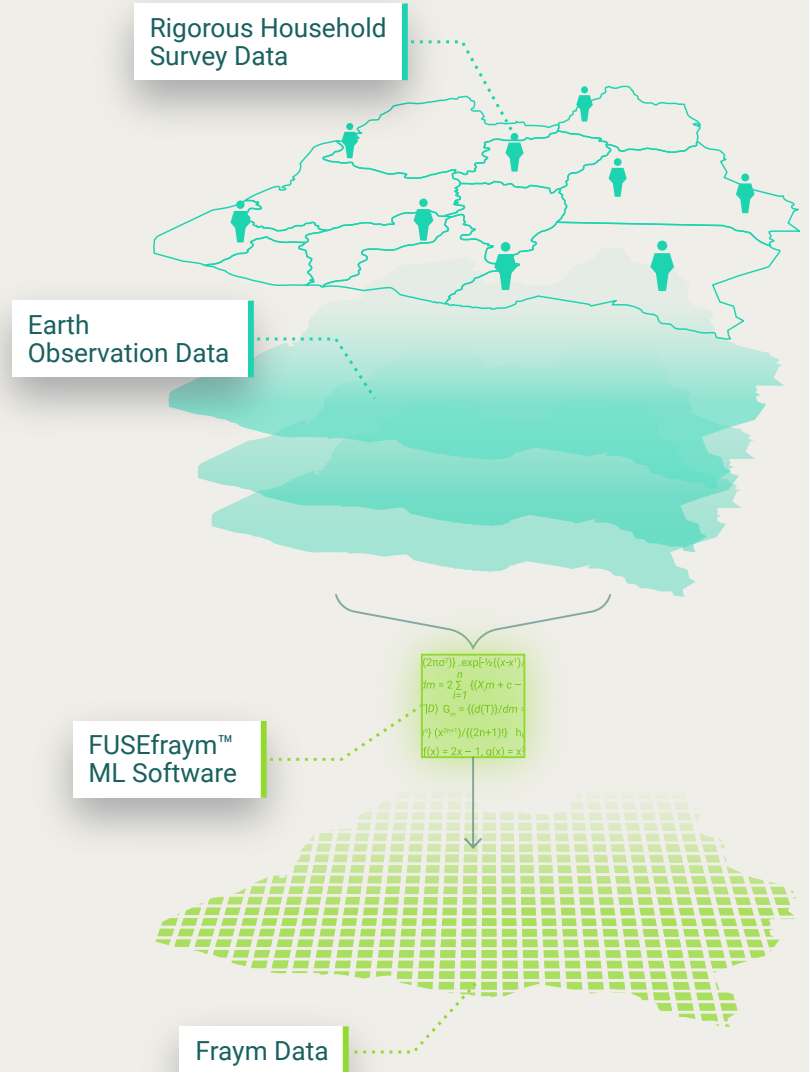
Acronyms

BMI	Body Mass Index
BOP	Bottom of the Pyramid
DHS	Demographic Health Survey
FACT	Fortification Assessment Coverage Toolkit
FAO	Food and Agriculture Organization
FCS	Food Consumption Score
FRAT	Fortification Rapid Assessment Tool
HAZ	Height-for-Age Z-score
HDDS	Household Dietary Diversity Score
HH	Household
ICDS	Integrated Child Development Services
IDD	Iodine Deficiency Disorder
IFPRI	International Food Policy Research Institute
LSFF	Large-scale Food Fortification
LSMS	Living Standards Measurement Survey
MICAH	MICronutrient and Health (MICAH) program
MiMI	Mapping and Modelling Inadequate Dietary Intake
ML	Machine Learning
NFCMS	National Food Consumption Micronutrient Survey
NFP	Nutrition Facts Panel
NNHS	National Nutrition and Health Survey
PAL	Programa de Apoyo Alimentario
POI	Point of Interest
VMNIS	Vitamin and Mineral Nutrition Information System
WEAI	Women's Empowerment in Agriculture Index
WFP	World Food Programme
WHO	World Health Organization
WHZ	Weight-for-Height Z-score

About Fraym

Fraym is a technology company with a mission to map humanity. Fraym data empowers development stakeholders to zoom-in on any community in the world and know what the people there look like, what they think, and how they behave.

Our machine learning (ML) powered software generates hundreds of key indicators about people's attributes, attitudes, and preferences down to the neighborhood level.



Organizations around the world use our location-based data to understand social and economic dynamics, design comprehensive programs, and monitor and evaluate investments that national statistics and polling data cannot reveal. Fraym has developed replicable and highly scalable methods to producing actionable and comparable data across any geography of interest. With Fraym data, policy makers, program managers, and development professionals can now select indicators relevant to their area of interest, create custom profiles, and analyze their target audience anywhere in the world. Fraym transforms household survey data into census-like spatial data across an entire country.

Fraym is the preeminent global provider of geospatial data for understanding population dynamics. Driven by our work with partners like the Bill and Melinda Gates Foundation, World Bank, African Development Bank, UNDP, and other global institutions, we now produce and deliver critical custom datasets for key policy and advocacy issues. These span categories such as equitable COVID-19 vaccine allocation, inclusive renewable energy access, inclusive economic recovery, and combatting misinformation. We are bringing this expertise to the question of the subnational reach and coverage of fortified foods.

Project Description

Inequitable nutrient adequacy reinforces the cycle of poverty, impedes women and children from reaching their potential, engenders preventable deaths, and undermines communities' development. Furthermore, conflict, climate change, continued effects of the COVID-19 pandemic, and rising food prices around the world are unlikely to affect communities and population groups uniformly—emphasizing the need for a precise understanding of household access to fortified foods to determine how to improve coverage in addressing malnutrition.

For the purposes of this project, **coverage** is defined as a *fortified food's presence in a household*. **Access** is the *household's capacity to acquire that fortified food*. Our hypothesis is that improving access will increase coverage, and we therefore use access as a proxy for coverage.

National and state-level data do not provide the spatial resolution needed to fully inform high-impact investment in nutrition. Fraym will fill this critical gap by developing a **Fortified Food Access Index** in three countries (Ethiopia, Nigeria, and India (2 states)) to identify hyperlocal variation in the current availability, affordability, agency, and awareness around fortified foods at the community level. To accomplish this, we will model key indicators from existing data sources and then augment existing measures with targeted, rapid data collection. The result will be a robust prototype that identifies subnational need for fortified food access. Components of the index will include: fortified food market availability and access; affordability; women's agency in household decision-making; and knowledge, preferences, and perceptions.

Goals and Theory of Change

PROBLEM STATEMENT: *Donors, program managers, implementing partners, and policymakers do not have an adequate measure of household level fortified food access.*

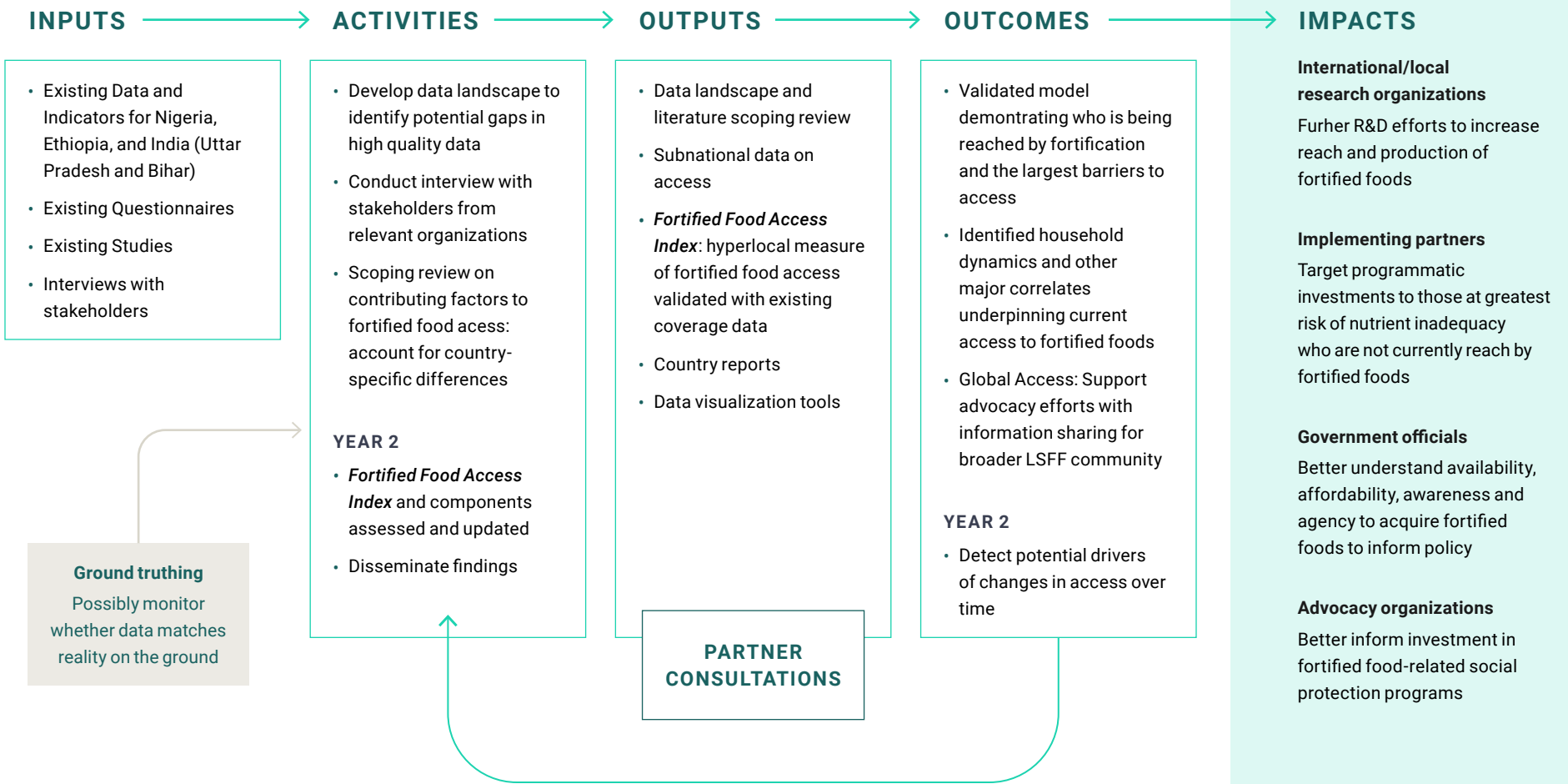
Fraym's vision for the Large Scale Food Fortification (LSFF) project is that by developing a measure of fortified food access to proxy for household coverage, we will be able to fill the existing gaps in understanding who is and, importantly, is not being reached by fortification and whether LSFF programming is reaching those who are most vulnerable. Our logic model (**Figure 1**) visually depicts how we will achieve this.

Our research questions are:

1. Can we adequately measure household access to fortified foods sub-nationally using advanced machine learning methods?
2. Does our access model accurately predict household food fortification coverage?
3. What are the drivers of the change in fortified food access over a two-year period?
4. Is there a mismatch between micronutrient deficient communities and their access to fortified foods in target countries?

FIGURE 1

Theory of Change



Data Landscape Summary

Fraym conducted a Data Landscape to identify data sources and questionnaires that were already available. From these sources, we will pull indicators to use in the **Fortified Food Access Index**, validate the index, and source themes for survey questions. Since we theorize that access predicts coverage, we intend to validate the index by assessing food fortification coverage along the coverage cascade, as well as other related measures of consumption. Further discussion on the validation approach, methods, and related definitions will be provided in the Literature Scoping Review section. We identified over 20 useful sources ranging from household datasets to market research studies. Many of the available geocoded data sources, like the Demographic and Health Surveys (DHS) and Living Standards Measurement Studies (LSMS), do not have variables directly related to fortified foods but can still be used as components of an index or for validation

There are several data sources that would be useful but are unfortunately unavailable—or are not nationally representative. For Nigeria, the *National Food Consumption Micronutrient Survey (NFCMS) 2021*, the *National Nutrition and Health Survey (NNHS 2018)*, the *2021 Multiple Indicator Cluster Survey*, and *World Food Programme (WFP) mVAM Monitoring* have data specific to fortified foods and nutrition that would be valuable; however, they are not yet available. There are also datasets related to the *Fortification Assessment Coverage Toolkit (FACT)* for the three countries—although each is limited to a specific country or region. Additionally, data from the *Fortification Rapid Assessment Tool (FRAT)* would be useful for the index development and validation, but data is not freely available.

For questionnaire design and model development, we will rely on numerous sources including: the *Fortification Assessment Coverage Toolkit (FACT)*, the *Fortification Rapid Assessment Tool (FRAT)*, the *International Food Policy Research Institute's (IFPRI) Women's Empowerment in Agriculture Index (WEAI)*, the *Food and Agriculture Organization's (FAO) Food Insecurity Experience Scale*, *World Food Programme's (WFP) Social and Behavior Change Communication, 24-hour and 7-day Dietary Recall and Food Frequency Questionnaires*, as well as several research papers and market research studies around fortified food access and consumption from countries around the world.

To the right is a list of data that will be useful as index components or output validation. Other datasets that may prove useful to our work are the *Global Fortification Data Exchange*, *WFP Hunger Map Live*, *Food Systems Dashboard*, *World Health Organization (WHO) Vitamin and Mineral Nutrition Information System (VMNIS) data*, and *FAO's Food Balance Sheet*. We are still exploring possible ways of integrating regulatory monitoring and market assessment data.

Demographic and Health Survey (DHS)

Index Components

Affordability	Socioeconomic status: wealth quintile, education levels
Agency	Sex of household head, women earning and controlling income
Awareness	Regular consumer of media

Index Validation

Biometric data	Stunting, wasting, Body Mass index (BMI), anemia
Nutrient Consumption	Food Consumption Score (FCS), Household Dietary Diversity Score (HDDS)

Living Standards Measurement Study (LSMS) /General Household Survey (GHS)

Index Components

Affordability	Food as a percent of total household's total spending
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Index Validation

Nutrient Consumption	Food Consumption Score (FCS), Household Dietary Diversity Score (HDDS)
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OpenStreetMap and Malaria Atlas Project

Malaria Atlas Project: Source for friction layer of walking and driving times

OpenStreetMap: Source of point of interest (POI) data on food markets

Index Components

Availability	Time to food market
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FAO's Food Insecurity Experience Scale

Index Components

Affordability	Relevant food insecurity experiences
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Literature Scoping Review

After combing through the Data Landscape to identify data gaps, we expanded our literature search to determine the factors associated with increased access to fortified foods. Some research was specifically related to fortified foods in the countries of interest—Nigeria, Ethiopia, and India.

In addition, our expanded review incorporated factors that influenced increased access to vitamins, minerals, and dietary diversity in other countries. Even though dietary diversity and food fortification are distinct and occasionally even opposing concepts¹, according to IFPRI, “dietary diversity is a *strong predictor of micronutrient adequacy and overall diet quality*”.²

Many factors predicting access to micronutrient-rich foods and dietary quality also influence fortified food access and consumption since they both require access to relatively larger and more integrated markets³ and at least an openness to consuming nutritional foods. For instance, in Nigeria, market constraints prevent people from accessing both nutrient-dense produce *and* fortified foods due to integration failures across supply chains and networks.⁴

Using themes that appeared in the literature and through discussions with partners and subject matter experts (SMEs), we identified the most likely indicators driving fortified food access and grouped them into the following four categories: Availability, Affordability, Agency, and Awareness. From these categories we developed a framework of indicators—which together provide a comprehensive and actionable measure of fortified food access. More detail on literature consulted by category can be found in [Appendix A](#).

1 <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0175952>

2 <https://www.ifpri.org/blog/dietary-diversity-and-biofortification>

3 <https://www.sciencedirect.com/science/article/pii/S2211912420301371>

4 <https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/3680>

Availability

Presence of fortified foods at a household's local food market or offered directly through a social program, combined with the household's capacity to access that market.⁵

LOGIC

When a fortified food is not sold at a local marketplace within a reasonable distance or provided through a social protection program, a household does not have access to it.

COMPOSITION OF THE MEASURE

Availability is broken down into the following categories:

- Presence in the market.
- Access to the market including travel time and type of market available.
- Social protection program involvement that provides in-kind support.

JUSTIFICATION

From an initial literature review on improving access to fortified foods, market access emerged as consistently being associated with improved dietary diversity. For example, in a study on production and dietary diversity in smallholder farm households in Indonesia, Kenya, Ethiopia, and Malawi, researchers found that reducing market distance by 10 kilometers has the same effect on dietary diversity as increasing farm production diversity by one additional crop or livestock species.⁶ Other studies on rural and smallholder households had similar findings—more market participation improves dietary diversity, whether in the form of closer markets, better road conditions, or raising cash incomes of smallholder households.^{7,8} More research is needed to extrapolate this improvement on dietary diversity to fortified food. However, the logic holds—the harder it is to get to a market that sells fortified foods, the less likely the household will be to purchase them.

One way to increase access for the most vulnerable, malnourished populations is to provide fortified food through in-kind social protection programs. The World Food Programme has initiatives to provide fortified foods directly to eligible participants. Globally in 2021, this involved the distribution of almost 1.5 million metric tons of fortified foods directly to vulnerable populations.⁹ In Telangana, India, a fortified take-home ration was available for caregivers of children 6-35 months old. A study conducted found that nearly everyone eligible had heard of the program and that 87% received the product—with 57% of children consuming the product regularly.¹⁰ Across all three countries of interest, food fortification mandates facilitate large-scale food fortification of common food vehicles, but supply chains and government programs deliver these products to those in need with varying success.

5 <https://www.gainhealth.org/sites/default/files/publications/documents/fact-manual.pdf>

6 <https://www.pnas.org/doi/10.1073/pnas.1510982112>

7 <https://agrifoodecon.springeropen.com/articles/10.1186/s40100-021-00190-8>

8 <https://www.sciencedirect.com/science/article/pii/S2211912420301395>

9 <https://www.wfp.org/publications/food-fortification>

10 <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0160814>

Affordability

Financial ability of a household to purchase the fortified version of a food vehicle.

Low affordability indicates that the financial costs to purchase fortified foods are high.

LOGIC

The more expensive a fortified food item is to purchase, the less accessible it will be to potential consumers, especially those at the bottom of the pyramid.

COMPOSITION OF THE MEASURE

Affordability is broken down into the following categories:

- Household socioeconomic status including overall wealth and education.
- Household's food security status.

JUSTIFICATION

The importance of affordability depends on a household's income, and wealthier households will be more likely to buy more expensive foods and a more diverse set of foods. In many different countries, including Ghana¹¹, Ethiopia¹², India¹³, and Bangladesh¹⁴, a household's income was an important factor in predicting whether they would have fortified foods in their home. Even in contexts with national, enforced mandates to fortify selected vehicles, the relative costs of fortified compared to unregulated (or black-market) unfortified options will also be relevant for marginalized populations. For instance, in Calcutta, 98% of packaged household salts were sufficiently iodized, compared to only 35% of the loose, unpackaged (presumably unregulated and locally produced) salts found in households.¹⁵

Another factor used to measure affordability especially as it relates to food purchasing decisions is the household's food security status. Food insecurity is inextricably linked to socioeconomic status—in a systematic review aimed to establish the prevalence of food insecurity and the related contributing factors in Sub-Saharan Africa, socio-economic factors such as low education, income, and wealth levels were all

consistently important in influencing food insecurity.¹⁶ Additionally, researchers have found a positive relationship between food insecurity and anemia risk, which is especially prevalent in infants and adult women.¹⁷ Food insecurity was also associated with undernourishment in Gambella, Ethiopia¹⁸ as well as lower dietary diversity in a study from Maharashtra, India.¹⁹ Food security's link to socioeconomic status and its association with nutritional deficiencies make it an important measure of affordability in being able to access fortified foods. Furthermore, our food insecurity indicators relate to the extent to which households compromise quality or variety in their diet due to lack of financial or other resources to acquire food.

Despite focusing on income and related variables, reviews have found that other factors might play critical roles. Factors such as income variability, income unpredictability, inter-temporal trade-offs, savings and savings practices, reallocation of current spending, perceived values of different foods, rationality in decision-making, and access to financial services and transfers can all affect food affordability.²⁰

11 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8292088/>

12 <https://pubmed.ncbi.nlm.nih.gov/29765978/>

13 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2965328/>

14 <https://www.cambridge.org/core/journals/public-health-nutrition/article/factors-associated-with-the-availability-of-iodized-salt-at-household-level-a-case-study-in-bangladesh/17580692A2007D6D5FE07C2C5590218D>

15 <https://pubmed.ncbi.nlm.nih.gov/11243088/>

16 <https://www.tandfonline.com/doi/abs/10.1080/21551197.2021.1988027>

17 <https://www.cambridge.org/core/journals/public-health-nutrition/article/food-insecurity-and-anaemia-risk-a-systematic-review-and-metaanalysis/EF80533493DA97E3B4D3434506AE5D92>

18 <https://www.hindawi.com/journals/aph/2018/1350195/>

19 <https://onlinelibrary.wiley.com/doi/full/10.1111/mcn.12447>

20 <https://www.gainhealth.org/sites/default/files/publications/documents/gain-working-paper-series-27-Conceptualising-and-assessing-food-affordability.pdf>

Agency

A household's capacity to purchase fortified foods in terms of intra-household decision-making dynamics and women's empowerment.

LOGIC

If household food purchasing decision-making is optimized and women are empowered to make nutritious food purchasing decisions for their families, then the household will have increased access to fortified foods.

COMPOSITION OF THE MEASURE

Agency consists of women's decision-making, including household decision-making power and economic empowerment.

JUSTIFICATION

A household's likelihood of purchasing fortified foods can depend on the household member who does the shopping and controls the purchasing decisions. For fortified foods consumption, one study in Zimbabwe showed statistically weak evidence that female headed households were more likely to adopt food fortification than their male counterparts, but those that did reduced the proportion of stunted children in their household much more than male headed households.²¹

However, a common theme throughout nutrition research is that women's agency and empowerment are associated with increased household nutrition and dietary diversity. For example, using the 2012-2013 World Bank General Household survey for Nigeria, researchers found an association between a modified empowerment index and dietary diversity. They found that households that are more "female-biased" in terms of share of females within the household and those that have female leadership tend to have more dietary diversity.²² Another study using household survey data from

Ethiopia, Kenya, Rwanda, Tanzania, and Uganda found that nutritional status of children in terms of height for age, weight for height, and maternal Body Mass Index (BMI) were all higher for places with higher rates of women's empowerment.²³ Additional studies are needed to assess whether this holds true for specifically fortified foods. However, women's agency not only influences purchasing decisions but also knowledge and willingness to pay. A study in Eldoret, Kenya found that women's willingness to pay was higher for fortified foods products after receiving information about their benefits.²⁴ Another paper from North Carolina found that women are significantly more likely to read nutrition labels when making food purchasing decisions.²⁵ The evidence suggests that putting food decisions in the hands of women in the household yields more nutritious, diverse diets.

21 <https://nutritionj.biomedcentral.com/articles/10.1186/s12937-020-00541-z>

22 <https://www.econstor.eu/handle/10419/149974>

23 <https://pubmed.ncbi.nlm.nih.gov/31993480/>

24 <https://journals.sagepub.com/doi/full/10.1177/0379572119876848#bibr29-0379572119876848>

25 <https://pubmed.ncbi.nlm.nih.gov/15746826/>

Awareness

Knowledge, preferences, and perceptions around fortified foods.

LOGIC

The more that people understand the nutritional value of fortified foods and feel positively about them, the more likely they will be to seek them out, purchase them, and consume them—even if they cost more.

COMPOSITION OF MEASURE

Awareness is broken down into the following categories:

- Knowledge about the nutritional value of fortified foods and how micronutrients are important for remaining healthy.
- Positive preferences and perceptions including brand awareness, purchasing preferences, and willingness to pay for fortified foods.

JUSTIFICATION

Awareness factors such as knowledge influence access to fortified foods from a demand perspective. Prior research demonstrates that these demand-side factors are important determinants in eventual fortified food purchasing and consumption. For example, awareness of folic acid was associated with increased intake of folic acid fortified flour among women of reproductive age in a study from the Morogoro region of Tanzania.²⁶ Another study in Greece found that a one point increase in an iron nutrition knowledge score was associated with 20% higher likelihood of consuming iron fortified foods more often.²⁷ Media campaigns can also influence purchases, as evidenced by a study from Australia that showed a significant increase in national iodized salt sales after a brief period of television and newspaper reports about the benefits of iodized salt.²⁸

Preferences and perceptions can also play a big role in awareness and demand for fortified foods. Evidence suggests people are willing to forego taste or texture if they are aware of the nutritional benefits of fortification. For example, a study in Giyani district, South Africa

found that participants were willing to accept yellow maize meal for nutritional reasons even though they did not reveal sensory preferences for yellow over white maize meal.²⁹ Additionally, a study from the US found that packaging information mattered for those making household food purchasing decisions,³⁰ while one in Nigeria found that the use of food product information is a determinant of consumption of packaged goods.³¹ If households have the prior knowledge to know what to look for in a product, they are more likely to seek it out.

The potential impact of fortified foods depends also on their willingness to pay more for the fortified versions. Fortunately, there is some preliminary evidence that willingness to pay may indeed be higher for fortified foods—especially if consumers have knowledge of its nutritional benefits. For example, in Kenya, consumers were willing to pay a 24% premium on fortified maize.³² Additionally, higher willingness to pay for fortified foods remains true for consumers at the Bottom of the Pyramid (BOP) in Kenya and Uganda.³³

26 <https://bmcnutr.biomedcentral.com/articles/10.1186/s40795-019-0324-5>

27 <https://www.sciencedirect.com/science/article/abs/pii/S0950329311000917>

28 <https://pubmed.ncbi.nlm.nih.gov/17639120/>

29 <https://www.tandfonline.com/doi/full/10.1080/0376835X.2011.570074>

30 <https://pubmed.ncbi.nlm.nih.gov/17142192/>

31 <https://journals.sagepub.com/doi/full/10.1177/0266666913489699>

32 <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1574-0862.2010.00466.x>

33 <https://www.sciencedirect.com/science/article/pii/S0306919219305627>

Other Indicators

Other categories initially considered were excluded after our literature review and conversations with partners and other nutrition experts revealed their irrelevance. Excluded categories consisted of crop availability (i.e., whether—and to what extent—a household grows food at home); biometric indicators such as stunting, wasting, or anemia levels; and baseline food consumption such as a Food Consumption Score (FCS) or a Dietary Diversity Score (HDDS). We initially hypothesized that if the household is in a region where a fortified crop is grown, they would be more likely to have access to it. Our research showed that, while this was occasionally true for rice and biofortified foods, it was not the case for other fortified products such as flours and oils which require additional processing. There is some evidence that higher smallholder farm production diversity contributes to overall dietary diversity but improving small farmers' access to markets is a more effective strategy to improve nutrition than promoting production diversity.³⁴ Additionally, biometric indicators, FCS, HDDS, and other food consumption indicators are generally intermediate indicators for access to food but do not accurately reflect the intake of fortified food. For instance, other factors may furthermore influence biometric indicators beyond food consumption, such as how anemia is also often associated with parasitic diseases like malaria and hookworm which induce chronic intestinal blood loss.³⁵ This highlights the limitations of using these scores to measure or assess fortified food intake, although previously collected data will be used for validation purposes.

Validation Measurement

Validating the access measure is a multi-stage, multi-pronged process that requires precise definitions of core nutritional concepts and their interrelationships, in addition to carefully constructed and executed data collection procedures. Our main measure, access, reflects a household's capability to buy or otherwise acquire fortified foods. By contrast, coverage reflects whether a household *actually* purchases or otherwise receives fortified foods through a targeted program. Access and coverage are related; access predicts coverage because the presence of one or more access barriers can manifest in a lack of coverage (i.e., the household would not own the fortified food).

Coverage itself is also an umbrella term, referring to a cascading set of products as they relate to different stages of the fortification process. There are food vehicles, fortifiable food vehicles, and fortified food vehicles. Food vehicles are foods that are selected for addition of a nutrient during normal processing and are usually staple foods that are widely consumed. Fortifiable food vehicles are amenable to fortification because they are made from raw materials processed on an industrial scale. Fortified food vehicles have had micronutrients actually added to them via the fortification process.³⁶ We are interested in household coverage of all three levels of this cascade in validating our index. We will collect coverage data through our questionnaire and plan to supplement this with existing data from *FACT surveys* or *National Food Consumption Micronutrient Surveys*.

We use coverage to validate our access metric, because we expect coverage to be highest in places where there are the fewest access barriers. In other words, coverage will be highest where the most important features of access are high and will reveal the extent to which our various access components matter for coverage. This can offer insights into potentially differential impacts of the four domains. For instance, we might find that high affordability and availability are sufficient for most households to purchase fortified foods, even if awareness is low, because few alternatives exist. The interplay between access subdomain scores thus has practical implications for food fortification advocacy and programming efforts.

³⁴ <https://www.pnas.org/doi/full/10.1073/pnas.1510982112>

³⁵ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3336930/#:~:text=Anaemia%20is%20often%20associated%20with,by%20chronic%20intestinal%20blood%20loss.>

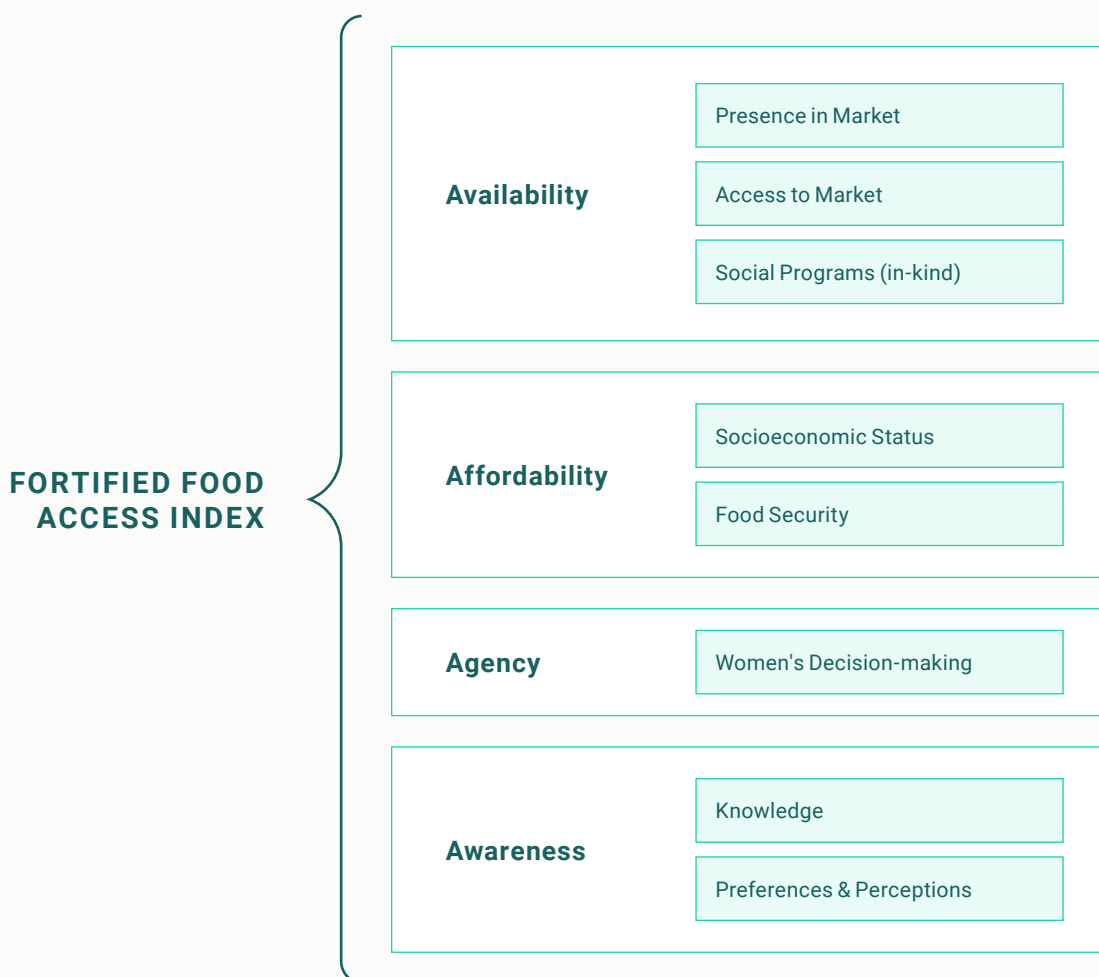
³⁶ <https://www.gainhealth.org/sites/default/files/publications/documents/fact-manual.pdf>

Methodology

Based on our Data Landscape and Literature Scoping, we arrived at the below index framework (Figure 2) that measures fortified food access based on Availability, Affordability, Agency, and Awareness. This **Fortified Food Access Index** will use access as a proxy measure of fortified food coverage. However, it is not meant to show actual consumption of fortified foods or whether the food vehicles are in compliance with regulated standards. **Consumption** requires that members of a household eat the fortified foods in the household and that everyone in the household is eating a sufficient amount. Food consumption surveys combined with data on micronutrient inadequacy are necessary to measure

consumption. We are unable to collect this granular data, but the WFP's Mapping and Modelling Inadequate Dietary Intake (MiMI) project can fill this gap. Even if households consume fortified foods, the micronutrient content may be below necessary **quality standards**. This requires working with millers and government institutions to help ensure compliance and make sure standards are always met. We are unable to collect this data, but organizations like TechnoServe can fill this gap. Together, these three distinct concepts would provide comprehensive information on the fortified food lifecycle.

FIGURE 2



APPENDIX A

Availability

SUB CATEGORY	TITLE	RELEVANT FINDING	LINK
Presence in Market	Availability of iodized table salt in the UK—is it likely to influence population iodine intake?	Iodized salt was only available in 42% of supermarkets—one of the reasons iodized household table salt would be unlikely to contribute meaningful amounts to UK iodine intake.	pubmed.ncbi.nlm.nih.gov/23324480/
Presence in Market	Body iodine status in school children and availability of iodized salt in Calcutta	Looked at success of Universal Salt Iodization (USI) program in India both at the retail and HH level. Packed salts were all iodized and the majority had iodine levels at or above standards. 77% of male children and 69% of female children had satisfactory urinary iodine levels confirming the success of the USI program with regard to the availability of iodized salt.	pubmed.ncbi.nlm.nih.gov/11243088/
Access to Market	Does market access improve dietary diversity and food security? Evidence from Southwestern Ethiopian smallholder coffee producers	Households located far from market centers consumed less diverse foods and spend less on food consumption than households located close to market centers. Greater market access encouraged smallholder HHs to rely on market purchases more than their own production to improve the diversity of HH consumption—one way to improve market access would be to expand rural road connectivity.	agrifoodecon.springeropen.com/articles/10.1186/s40100-021-00190-8
Access to Market	Does household participation in food markets increase dietary diversity? Evidence from rural Malawi	Examined the relationship between food market participation and household dietary diversity in rural Malawi. Households engaging more with food markets are more likely to have diversified diets and better nutrition.	sciencedirect.com/science/article/pii/S2211912420301395
Access to Market	Market Access, Production Diversity, and Diet Diversity: Evidence From India	Created dietary diversity score based on 24-hour and 7-day recall periods, measured HH market integration as monthly HH expenditure on key non-staple food groups, and measured production diversity. Market purchases of non-staples like pulses and dairy products were associated with significantly higher dietary diversity.	journals.sagepub.com/doi/10.1177/0379572120920061
Access to Market	Production diversity and dietary diversity in smallholder farm households	Looked at many factors that influence dietary diversity for small-scale subsistence farmers. Improving small farmers' access to markets seems to be a more effective strategy to improve nutrition than promoting production diversity on subsistence farms. Reducing market distance by 10km has the same effect on dietary diversity as increasing farm production diversity by one additional crop or livestock species.	pnas.org/doi/10.1073/pnas.1510982112

Availability, cont'd

Social Programs (in-kind)	High Coverage and Utilization of Fortified Take-Home Rations among Children 6–35 Months of Age Provided through the Integrated Child Development Services Program: Findings from a Cross-Sectional Survey in Telangana, India	The Integrated Child Development Services (ICDS) freely provides a fortified complementary food product, Bal Amrutham, as a take home ration. Nearly all had heard of Bal Amrutham and 86% received the product. More than half consumed the product regularly—provided target children with significant portions of required macro and micro nutrients. Two barriers to optimal coverage were found: the irregular supply of the product to the beneficiaries and the intra-household sharing of the product.	journals.plos.org/plosone/article?id=10.1371/journal.pone.0160814
Social Programs (in-kind)	Cash and In-Kind Transfers in Poor Rural Communities in Mexico Increase Household Fruit, Vegetable, and Micronutrient Consumption but Also Lead to Excess Energy Consumption	Looked at the impact of Programa de Apoyo Alimentario (PAL) (cash and in-kind transfer program) on energy and nutrient consumption of poor rural households in Mexico. One group given a food basket and one given an equal amount in cash. Energy consumption increased in treatment group of just cash and of food basket - although being given a food basket had the larger increase. For micronutrients, both groups improved with food basket group improving more overall.	academic.oup.com/jn/article/140/3/612/4600428
Social Programs (in-kind)	Comparing cash and food transfers: findings from a pilot project in Sri Lanka	WFP Sri Lanka ran a pilot cash transfer project for families affected by the 2004 tsunami. In areas where markets were functioning and accessible, cash transfer was more cost-effective and preferred. In areas where markets were less functional or accessible, food assistance was more cost-effective and preferred.	enonline.net/fex/30/comparingcashandfoodtransfers

Affordability

SUB CATEGORY	TITLE	RELEVANT FINDING	LINK
Socio-economic Status	Factors associated with the availability of iodized salt at household level: a case study in Bangladesh	Results show that 73% of HH salt samples were iodized to some extent although the level varied. HHs with young and educated HH heads had higher likelihood of iodized salt. Less likely to be found in poor and rural HHs.	cambridge.org/core/journals/public-health-nutrition/article/factors-associated-with-the-availability-of-iodized-salt-at-household-level-a-case-study-in-bangladesh/17580692A2007D6D5FE07C2C5590218D
Socio-economic Status	Factors Affecting the Presence of Adequately Iodized Salt at Home in Wolaita, Southern Ethiopia: Community Based Study	Revealed low levels of households having adequately iodized salt—need to increase the supply of iodized salt to eliminate iodine deficiency disorders (IDD). Rural residence, literacy, low income, unavailability, lack of awareness, unpackaged salt, exposing to sunlight, and cost, are factors associated with the absence of adequately iodized salt at home.	pubmed.ncbi.nlm.nih.gov/29765978/

Affordability, *cont'd*

Socio-economic Status	Limited Access to Iodized Salt among the Poor and Disadvantaged in North 24 Parganas District of West Bengal, India	Looked at who had access to iodized salt from the HH and market level. Consumption of adequately iodized salt was lower among rural residences, Muslims, and low monthly income. Those who heard and were aware of the risk of iodine deficiency disorders and the benefits were more likely to use iodized salt. Iodine content was higher in salt sold in sealed packets and stored on shelves.	ncbi.nlm.nih.gov/pmc/articles/PMC2965328/
Socio-economic Status	Income Level but Not Nutrition Knowledge Is Associated with Dietary Diversity of Rural Pregnant Women from Northern Ghana	Counterexample study: income level was a more significant predictor of dietary diversity than knowledge or attitudes in this study.	ncbi.nlm.nih.gov/pmc/articles/PMC8292088/
Food Security	Household Food Insecurity, Low Dietary Diversity, and Early Marriage Were Predictors for Undernutrition among Pregnant Women Residing in Gambella, Ethiopia	Pregnant women from food insecure households with low dietary diversity scores were much more likely to be undernourished. Food insecurity and the consumption of unbalanced nutrients are inextricably linked.	hindawi.com/journals/aph/2018/1350195/
Food Security	Household food insecurity and children's dietary diversity and nutrition in India. Evidence from the comprehensive nutrition survey in Maharashtra	Children from moderately food insecure and severely food insecure households are more likely to have lower dietary diversity scores which are also linked to malnutrition.	onlinelibrary.wiley.com/doi/full/10.1111/mcn.12447
Food Security	Food insecurity and anaemia risk: a systematic review and meta-analysis	There is an overall positive relationship between food insecurity (both mild and severe) and anemia risk. Food insecurity significantly increased the risk of anemia among infant/toddlers and adult women compared to other subgroups.	cambridge.org/core/journals/public-health-nutrition/article/food-insecurity-and-anaemia-risk-a-systematic-review-and-metaanalysis/EF80533493DA97E3B4D3434506AE5D92
Food Security	Prevalence and Factors Associated with Food Insecurity among Older Adults in Sub-Saharan Africa: A Systematic Review	In a systematic review of food security in Sub-Saharan Africa, socio-economic factors such as wealth, income, and education are consistent factors that influence food security.	tandfonline.com/doi/abs/10.1080/21551197.2021.1988027
All	Conceptualising and Assessing Food Affordability	Looks at affordability around income, social safety nets, or expenditures as well as less studied areas such as income variability, savings, reallocation of spending, perceived values of foods, and access to financial services	gainhealth.org/sites/default/files/publications/documents/gain-working-paper-series-27-Conceptualising-and-assessing-food-affordability.pdf

Agency

SUB CATEGORY	TITLE	RELEVANT FINDING	LINK
Women's Decision-making	The impact of food fortification on stunting in Zimbabwe: does gender of the household head matter?	Finds statistically weak evidence that female headed households are more likely to adopt food fortification than their male counterparts. Food fortification does reduce the proportion of stunted children in the household. In comparison to non-adopters, female headed households that adopt food fortification are more able to reduce the proportion of stunted children in their households than their male counterparts.	nutritionj.biomedcentral.com/articles/10.1186/s12937-020-00541-z
Women's Decision-making	Women Empowerment and Intra-household Dietary Diversity in Nigeria	Examined the relationship between empowerment (measured using "empowerment index") and household dietary diversity. Households that are female biased in terms of share of females within the HH and those that favor female leadership tend to have more dietary diversity	econstor.eu/handle/10419/149974
Women's Decision-making	Women's empowerment & child nutrition: The role of intrinsic agency	Nutritional status in terms of child heights for age (HAZ), child weight for height (WHZ), and maternal BMI were all higher for places with higher rates of women's empowerment.	pubmed.ncbi.nlm.nih.gov/31993480/
Women's Decision-making	A Review of Evidence on Gender Equality, Women's Empowerment, and Food Systems	Women's economic empowerment is also associated with a transition from traditional diets to more heavily processed foods, which can be counterbalanced by large-scale food fortification to ensure that more processed food items still sufficiently contribute to a nutritious, micronutrient-rich diet. When women control incomes, especially in the poorest households, it leads to a greater improvement in health, nutrition, and education compared to if those incomes are controlled by men	sc-fss2021.org/wp-content/uploads/2021/06/FSS_Brief_gender_equality.pdf
Women's Decision-making	Consumer Acceptance and Willingness to Pay for Instant Cereal Products With Food-to-Food Fortification in Eldoret, Kenya	Found that men's willingness to pay for fortification was less than women's.	journals.sagepub.com/doi/full/10.1177/0379572119876848#bibr29-0379572119876848
Women's Decision-making	Gender Equality and Food Security: Women's Empowerment as a Tool against Hunger	Establishes at a general level that women's agency and child nutritional status and health are related.	adb.org/sites/default/files/publication/30315/gender-equality-and-food-security.pdf
Women's Decision-making	Women's involvement in intra-household decision-making and infant and young child feeding practices in Central Asia	Positive association between a woman's decision-making power—a measure of her instrumental agency—and adherence to World Health Organization—recommended complementary feeding practices related to achieving minimum dietary diversity and minimum acceptable diet.	ifpri.org/publication/womens-involvement-intra-household-decision-making-and-infant-and-young-child-feeding

Awareness

SUB CATEGORY	TITLE	RELEVANT FINDING	LINK
Knowledge	Consumer awareness of food fortification in Kenya: The case of vitamin-A-fortified sugar	More than half of respondents were aware of fortified sugar—especially in urban settings. Only 26% were aware of the importance of Vitamin A in diet. Age of consumers, purchasing from supermarket, reading newspaper, dwelling place (urban or rural) as well as having a child below the age of five years, were the significant factors influencing consumers' awareness of fortified sugar.	repository.uonbi.ac.ke/handle/11295/81692
Knowledge	Awareness and factors associated with reported intake of folic acid-fortified flour among women of reproductive age in Ifakara, Morogoro region, Tanzania: a cross-sectional study	Tanzania adopted a mandatory fortification policy for commercially produced wheat and maize flour in 2011. Looked at factors influencing intake of folic acid-fortified flour. Independent factors associated with intake included being employed, having no children, or having 1-4 children, and folic acid awareness.	bmcnutr.biomedcentral.com/articles/10.1186/s40795-019-0324-5
Knowledge	Food Fortification: The Level of Awareness among Kenyan Consumers	Study on fortified food knowledge and consumption. 28% of participants were aware of term "food fortification". Greater knowledge associated with being female, education, many dependents, and formal employment.	hindawi.com/journals/jnme/2020/8486129/
Knowledge	Consumer perception and use of iron fortified foods is associated with their knowledge and understanding of nutritional issues	One point increase of overall nutrition knowledge score was associated with 4.3% higher likelihood that the consumer believes that iron fortified foods have a positive role in diet. One point increase of iron nutrition knowledge score was associated with 20% higher likelihood of consuming iron fortified foods more often.	sciencedirect.com/science/article/abs/pii/S0950329311000917
Knowledge	Can even minimal news coverage influence consumer health-related behaviour? A case study of iodized salt sales, Australia	Found significant increase in national iodized salt sales after a brief period of television and newspaper reports about the benefits of iodized salt. Even brief media exposure can influence health related decisions.	pubmed.ncbi.nlm.nih.gov/17639120/
Knowledge	Impacts of Caregivers' Nutrition Knowledge and Food Market Accessibility on Preschool Children's Dietary Diversity in Remote Communities in Southeast Nigeria	Knowledge gap on appropriate feeding practices amongst caregivers is correlated to lower dietary diversity (inclusive of lower nutritional uptake across certain foods) for preschool children	mdpi.com/2071-1050/11/6/1688
Preferences & Perceptions	Food nutrition label use is associated with demographic, behavioral, and psychosocial factors and dietary intake among African Americans in North Carolina	Nutrition label use was significantly higher among participants who were women, older, educated beyond high school, and obese.	pubmed.ncbi.nlm.nih.gov/15746826/
Preferences & Perceptions	Use of nutrition facts panels among adults who make household food purchasing decisions	Fifty-three percent of the sample reported using NFP information on a consistent basis. Females, those with more education, and those currently married were more likely to use NFP labels. The importance of knowledge in order to maintain healthy body weight was the only belief variable associated with use of NFP information.	pubmed.ncbi.nlm.nih.gov/17142192/

Awareness, *cont'd*

Preferences & Perceptions	Developing country consumers' acceptance of biofortified foods: a synthesis	Measured consumer acceptance in terms of sensory evaluation and economic valuation of biofortified varieties. Sensory differences must be accompanied by clear branding during marketing and promotion. Knowledge of nutritional value is important. Willing to pay more for biofortified varieties. Women buyers preferred international branding and international certification.	link.springer.com/article/10.1007/s12571-015-0464-7#citeas
Preferences & Perceptions	Consumer acceptability and perceptions of maize meal in Giyani, South Africa	Investigate the acceptability and perceptions of traditionally prepared maize meal porridge among Tsonga households. Participants were willing to accept yellow maize meal for nutritional reasons despite the fact they did not reveal sensory preferences for yellow over white maize meal.	tandfonline.com/doi/full/10.1080/0376835X.2011.570074
Preferences & Perceptions	The Potential to Improve Nutrition through the Use of Fortified Maize Flour in Schools in Uganda	Students were able to differentiate between some fortified foods by mouthfeel, aftertaste, aroma, thickness, taste. Parents and teachers require extra sensitization for appearance and taste of fortified foods. Cost, storage, and shelf-life are all barriers to access.	spring-nutrition.org/publications/reports/potential-improve-nutrition-through-use-fortified-maize-flour-schools-uganda
Preferences & Perceptions	Use of food product information in consumption decision among female workers in Nigerian state universities	If university employees are not using food product information on packaged foods, other less-educated citizens are most likely not either. Advocates for more awareness campaigns to increase interest and knowledge of fortified foods.	journals.sagepub.com/doi/full/10.1177/0266666913489699
Preferences & Perceptions	World Vision Malawi's MICronutrient and Health (MICA) Program	Goal was to improve the nutrition and health status of women and children through small scale fortification of maize at a select number of rural hammermills. Maize fortification was initially met with resistance by MICA beneficiaries. Many believed the premix contained poison or contraceptives and was a plot to limit family size. MICA staff countered these beliefs through radio, posters, role plays/drama, Q&A sessions, song, community role models/leaders, peer education, soccer sponsorships, taste testing, social marketing, etc.	wvi.org/sites/default/files/Small-Scale-Fortification-MICA-Malawi.pdf
Preferences & Perceptions	Estimating consumer willingness to pay for food quality with experimental auctions: the case of yellow versus fortified maize meal in Kenya	Consumer willingness to pay for yellow and fortified maize was compared in experimental auctions in three regions in Kenya. Consumers were willing to pay a 24% premium for fortified maize.	onlinelibrary.wiley.com/doi/abs/10.1111/j.1574-0862.2010.00466.x
Preferences & Perceptions	Are consumers at the base of the pyramid willing to pay for nutritious foods?	Looking at fortified foods WTP for Bottom of the Pyramid consumers. Results that BOP consumers are willing to pay a premium and that providing nutrition information, economic status of HH head, and presence of young children influence willingness to pay. Important results for BOP consumers showing that they still put a premium on more nutritious varieties if they are aware of them.	sciencedirect.com/science/article/pii/S0306919219305627



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