

THE DEMAND FOR BIOFORTIFIED FOODS: REFLECTIONS ON SOME EXPERIMENTAL EVIDENCE

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OUTLINE

- + What is biofortification?
- + Analyzing the impact of an agricultural intervention on public health
- + Analyzing consumer acceptance of biofortified foods

OBJECTIVE

- + Feedback on research in progress
- + Present research to identify areas of potential collaboration

WHAT IS BIOFORTIFICATION?

Potentially, a public health intervention to ameliorate micronutrient malnutrition. The objective of biofortification is to develop micronutrient-dense staple crops using the best traditional breeding practices and modern biotechnology to achieve provitamin A, iron, and zinc concentrations that can have measurable effects on nutritional status.

= "Agricultural technology for public health"

Premise: poor rural households typically rely on staples; cannot afford diversified diets rich in micronutrients

RESEARCH IS INTERDISCIPLINARY

Involving:

- × **Plant breeders** to screen germplasm for high micronutrient content and to cross them into locally-adapted varieties.
- × **Nutritionists** to set micronutrient target levels, establish proof of concept that elevated crop micronutrient levels do positively impact human health.
- × **Product development and dissemination specialists** to deliver finished products to target populations.
- × **Economists** to determine target countries, evaluate cost effectiveness, consumer acceptance, assess ex-post impact.

SCHEDULE OF PRODUCT RELEASES BY H+

Crop	Nutrients	Release Year of Initial Lines*
Sweetpotato	Pro-vitamin A	2007
Bean	Iron, Zinc	2010
Pearl Millet	Iron, Zinc	2011
Rice	Zinc, Iron	2012
Maize	Pro-vitamin A	2011
Wheat	Zinc, Iron	2013
Cassava	Pro-vitamin A	2014

* Approved for release by national governments after 2-3 years of testing

THREE KEY QUESTIONS FOR BIOFORTIFICATION

1. Is there enough variation in germplasm to increase micronutrient content without sacrificing yields?

Answer: Yes, for some nutrients

2. Will there be an impact on nutritional status? At what cost?

Answer:

Efficacy: Yes, under controlled conditions, (vitamin A sweetpotato, iron rice)

Effectiveness: Underway for sweetpotato (this seminar)

KEY QUESTIONS....

- Can we get consumers (not just farmers) to accept the new, healthier, food? How important is a nutrition message to ensure widespread consumption? (Presupposes agronomic acceptability)

Answer: Willingness-to-pay studies (this seminar)

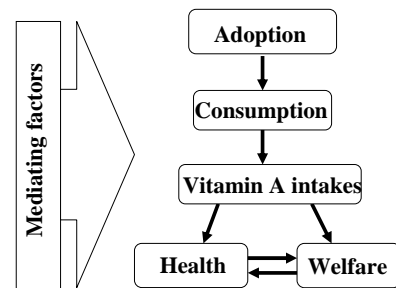
EFFECTIVENESS STUDIES (IMPACT ASSESSMENT)

- ✦ **Crop: Provitamins A 'Orange' sweetpotato**
- ✦ **Countries: Uganda, Mozambique**
- ✦ **Studies led by HarvestPlus**

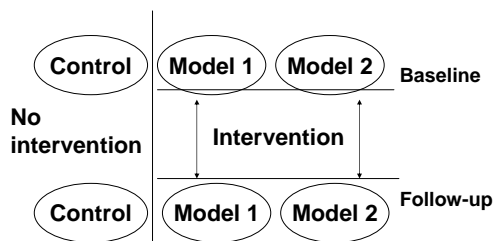
IMPLEMENTATION FRAMEWORK

Model 1	Model 2	Control
Intensive seed system and nutrition communication = high cost, high impact	Scaled back seed system & nutrition communication = moderate cost, moderate impact	

IMPACT INDICATORS



EVALUATION: PROSPECTIVE RANDOMIZED DESIGN, DIFFERENCE IN DIFFERENCES "THE GOLD STANDARD"

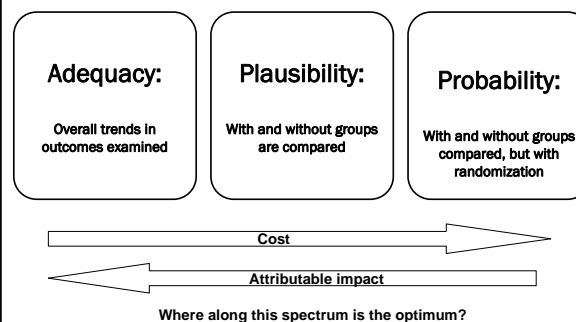


NO RESULTS YET....BUT SEVERAL QUESTIONS

Is the gold standard really gold? Or is it a bronze standard? (apologies to Richard Berk)

- ✘ Limitations of randomization as *it is implemented*
- ✘ Concerns over the use of RCT even in the clinical literature
- ✘ Does not illuminate pathways to impact—feature that distinguishes social sciences from the medical sciences
- ✘ More impact assessments coming up as product releases draw closer—Rwanda, India

FRAMEWORK FOR EVALUATING IMPACT



Source: Adapted from Vittora, Habicht

SOURCES AND ACKNOWLEDGEMENTS

UGANDA

- ✘ Dan Gilligan, Alan deBrauw, Alicia Carriquiry, Cornelia Loechl, Ricardo Labarta, Christine Hotz and J.V. Meenakshi "Reaching End Users with OSP Evaluation: Baseline Report for Uganda" 2008, IFPRI, mimeo
- ✘ NARO, CIP, VEDCO, FADEP, CHDC

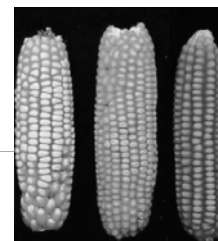
MOZAMBIQUE

- ✘ Alan deBrauw, Dan Gilligan, Mary Arimond, Cornelia Loechl, Ricardo Labarta, Christine Hotz, and J.V. Meenakshi "Reaching End Users with OSP Evaluation: Baseline Report for Mozambique" 2007, IFPRI, mimeo
- ✘ World Vision, Helen Keller International, CIP

ANALYSING WILLINGNESS TO PAY FOR BIOFORTIFIED CROPS



Orange sweetpotato

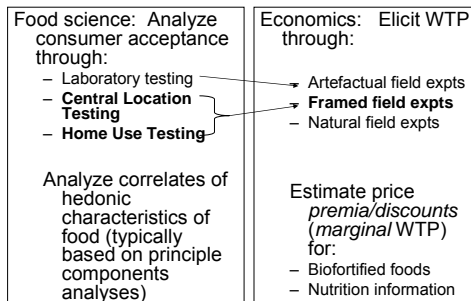


Orange maize

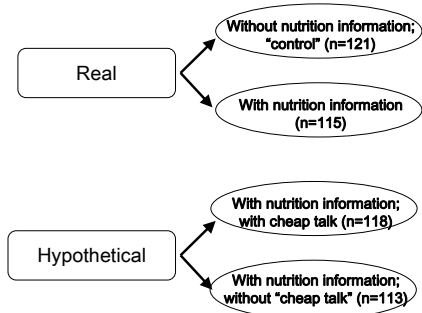
CONSUMER ACCEPTANCE OF ORANGE SWEETPOTATO IN UGANDA: QUESTIONS

- + What price are consumers willing to pay for orange sweetpotato? What is premium/discount for the 'orangeness' relative to white?
- + What is the impact of nutrition information on the prices consumers are willing to pay for OFSP?
- + Can this price be assessed in hypothetical setting (will it yield the same answers as in a real context)?
 - ✘ Hypothetical
 - ✘ Hypothetical with cheap talk

APPROACH: COMBINE METHODS FROM FOOD SCIENCE AND ECONOMICS

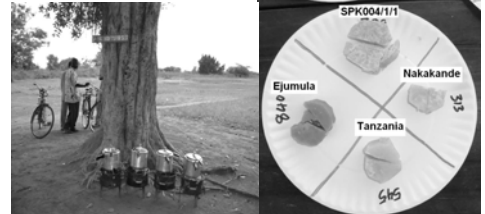


UGANDA: EXPERIMENTAL DESIGN



UGANDA: THE FOUR SWEETPOTATO VARIETIES

- + White ("Nakakande")
- + Yellow ("Tanzania")
- + Orange ("SPK004/1/1")
- + Deep orange ("Ejumula")



METHODS

Random allocation of participants to treatment arms

Consumer acceptance examination: each participant was provided with cooked samples of the four varieties and asked to rank on a 9-point hedonic scale by (a) taste, (b) appearance, and (c) overall acceptability

Nutrition information: For three arms of the survey, participants told about nutritional benefits of OSP; told that darker the color the more the vitamin A content

Participation fee: Participants in the two real arms of the survey given the equivalent of the maximum price of sweetpotato so they would not be out of pocket

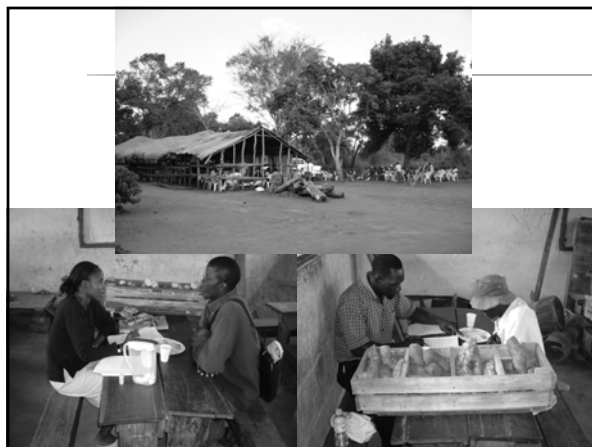
Choice (posted price) experiment: Fractional factorial design with four prices

CHOICE EXPERIMENT STRUCTURE

Each participant asked, given a set of prices, which of the four varieties of sweetpotato they would buy, including a 'none of the above' choice.

Random draw to determine binding scenario

Scenario	White (Nakakande)	Yellow (Tanzania)	Orange (SPK004/1/1)	Deep Orange (Ejumula)	None of the above
1	500	300	1000	800	
...					
17	300	300	300	300	



ESTIMATION METHOD

The utility U that the i th consumer derives from choosing alternative j consists of two components—a systematic component V and a random component:

$$U_{ij} = V_{ij} + \varepsilon_{ij}$$

This means that the probability that the choice Y made by the i th consumer is alternative j is given by:

$$P(Y_i = j) = P(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik})$$

V in turn depends on prices of the alternatives and various respondent-specific characteristics:

$$V_{ij} = b_j + \sum_{k=1}^5 a_{jk} P_{ik} + c'_i X_i + \varepsilon_{ij}$$

- ✘ Respondent-specific variables include
 - + Taste scores of each variety
 - + Income
 - + Household size and composition
 - + Prior exposure to information on Vitamin A deficiency
 - + Gender
 - + ...
- ✘ Estimation using a universal logit specification
- ✘ Point estimates of the willingness to pay can then be calculated (as a ratio of coefficients)
- ✘ Standard errors obtained by bootstrapping
- ✘ Estimation using a universal logit specification

RESULTS ON WTP (UGS/KG)

	Real, without information	Real, with nutrition information	Hypothetical, with no cheap talk	Hypothetical, with cheap talk
White	237	250	331	274
Yellow	168	123	574	392
Orange	189	221	631	394
Deep orange	232	357	750	553

UGANDA: SOME ANSWERS

What happens with no information?

- ✘ Price of white \approx Price of deep orange. But price of yellow and price of orange is lower than those for white

What happens with nutrition information?

- ✘ Increases the price consumers are willing to pay for orange and deep orange varieties, but not for the yellow. Also, both the yellow and orange varieties continue to suffer a price discount relative to the white
- ✘ The premium for deep orange varieties is 43%

UGANDA: SOME ANSWERS

Making real versus hypothetical choices

- ✘ Eliciting prices under a hypothetical scenario, even using a 'cheap talk' script results in higher prices than those elicited under a real scenario.
- ✘ The upward bias is not substantial for white varieties (because of experience?) but is substantial for the new varieties. Hypothetical prices for new varieties nearly twice that as real prices.
- ✘ This would appear to be true for the estimated premia/discounts as well

SOME IMPLICATIONS, AND NEW QUESTIONS

- ✘ Deep orange will do fine—it can compete with white even in the absence of nutrition information, but nutrition information does translate into a premium for the orange varieties. The orange is not a great favorite among consumers.
- ✘ Better to stay with real products rather than hypothetical scenarios
- ✘ The way that nutrition information is transmitted may matter—may not be a good idea to use enumerators. Premia are too high to be credible
- ✘ Experience with the product may also matter—some novelty value effects cannot be ruled out
- ✘ Preference reversals not uncommon—what does this imply?



Orange
Maize
in
Zambia

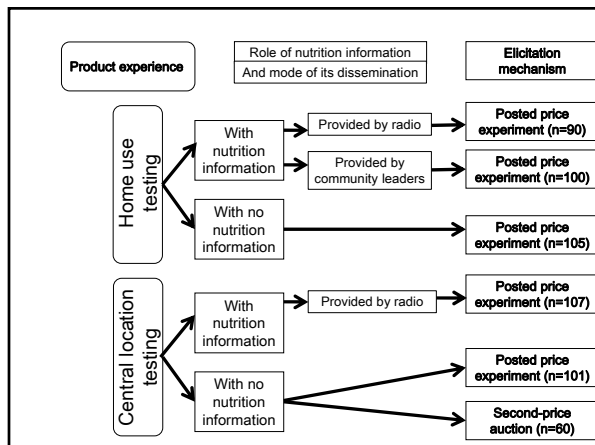
ORANGE MAIZE IN ZAMBIA

“Baggage” of yellow maize
 Distributed as food aid; associated stigma of food for bad times
 Bred in the US for use as cattle feed
 Deep price discounts, certainly for urban consumers—up to 33%
 Price discounts necessary to induce a switch to yellow maize—lower discounts necessary for the poor as compared to the rich

Therefore: “orange” **not** “yellow” **nor** “golden” maize.

CONSUMER ACCEPTANCE OF ORANGE MAIZE IN ZAMBIA: QUESTIONS

- What is the willingness to pay for orange maize? Without messages on nutritional benefits, will orange maize command a discount or premium relative to white maize?
- What is the impact of nutrition information *and the way it is communicated*, on the price of orange maize?
- How different are estimated prices between central location testing and home use testing? Is the additional expense involved in home use testing worthwhile?
- What difference does the elicitation mechanism make?



- ✘ Two provinces—Central and Eastern purposively selected.
- ✘ Multi-stage sampling of districts, blocks, villages and small-scale farmers for a total of 30 villages (randomly allocated to two treatments and control) and 10 households per village for HUT
- ✘ Exclusive focus on rural areas and on small-scale farm households
- ✘ Households randomly allocated and given sequentially three types of maize and asked to cook according to usual household recipes
- ✘ Remaining steps similar to those in Uganda

THE SECOND PRICE AUCTION—BDM

- ✘ BDM: Respondent makes a bid for **orange maize**. Enumerator makes a random draw from a distribution (uniform[a,b] where the support is determined by the range of posted price experiment)
- ✘ The transaction takes place at the lower of the two prices (respondent’s bid and random draw)
- ✘ Respondents given a participation fee (just as for the posted price experiment)
- ✘ Respondent told how the question works, why it is in their interest to bid their true valuation, a “dry run” to ensure that mechanism is understood

Orange maize grown out at Zambia Agricultural Research Institute; approximately 2 tons harvested

Yellow and white maize purchased in-country

Milling (by hammermills, not commercial mills) undertaken by Zambian National Institute of Scientific and Industrial Research

Radio messages by Zambia National Broadcasting Corporation

Community leaders—camp officers



ZAMBIA: PRELIMINARY RESULTS

- ✘ 'Orangeness': With no nutrition information, orange maize has a premium over white maize of over 60%. Perceived as distinct from yellow maize. No substantial difference between CLT and HUT
- ✘ Home Use Testing vs Central Location Testing: HUT results in *higher* premium for orange maize than CLT. Endowment effect appears to outweigh the wearing-off of the novelty effect

ZAMBIA: PRELIMINARY RESULTS

- ✘ 'Impact of nutrition information by radio: Estimated premia for radio (for orange maize) about 20 percent. No substantial difference between CLT and HUT
- ✘ Impact of nutrition information through community leaders (for orange maize, HUT): no substantial difference between premia created by radio and community leaders
- ✘ Point estimates from the BDM auctions are of the same order of magnitude as those from the posted price experiment

HOWEVER.... MORE QUESTIONS

How credible are these premia? While these are in line with studies for developed countries (organic foods, gmo), in the developing country context are these realistic? For most of these households, the product is salient, and accounts for a significant share of household expenditures. Will a 40-50% premium really be realized?

What is the impact of increment in posted price experiments on the magnitude of estimated premia?

How to capture novelty value? HUT does take care of this to a certain degree, but is 2 days enough? Short of lengthening the time consumers spend with a product, are there other methods to control for this?

QUESTIONS

How to separate income effects from participation fee/endowment effects? Money vs product endowment & loss aversion. Would a larger endowment have resulted in different premia? What does this imply?

Participation fee: Evidence of truncation at the participation fee in the second price auction. Most US settings, participation fee is about 30X to 40X of mean bid. Here fee is 2X of mean bid but close to the daily wage.

QUESTIONS

Choice of elicitation mechanism: substantial literature comparing across auction mechanisms (random nth price, kth price, BDM—see Lusk, Shogren) which suggests elicitation mechanism matters. Which to choose?

But not much literature on impact of distribution choice on optimal bidding strategies

QUESTIONS

Also limited literature comparing choice experiments with auctions

How to interpret WARP violations? Typical solutions—reduce choice set, block subsets of choices—only sidestep the issue

Might a bounded rationality type of approach better model how consumers make decisions?

Bottom line: Do methods need to be redefined / refined for **rural** developing country contexts? Research in this area likely to expand both in Asia and Africa

SOURCES AND ACKNOWLEDGEMENTS

Uganda:

- ✦ Shyamal Chowdhury, J.V. Meenakshi, Keith Tomlins and Constance Owori, "Are Consumers in Developing Countries Willing to Pay more for Micronutrient Dense Biofortified Foods? Evidence from a Field Experiment in Uganda" HarvestPlus Working paper 3, 2008.
- ✦ NARO, CIP

Zambia:

- ✦ J.V. Meenakshi, Victor Manyong, Abhijit Banerji, Precious Hamukwala and Keith Tomlins, "The Impact of Product Experience and Product Information on Willingness to Pay for Orange Maize in Rural Zambia" In process
- ✦ UNZA, NISIR, ZARI, CIMMYT, IITA