

Food, Agriculture and Nutrition: Successful Integration



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IMPROVED NUTRITION

**Cognitive &
Physical
Development**

**Increased Human Capital
(health, education,
longevity, productivity)**

**Poverty
Reduction**

ECONOMIC GROWTH

**Improved food
systems,
markets and
health systems**



Malnutrition and National Development

- Malnutrition affects national development in 2 ways: (*Khan, 1984*)
 - Individual losses in productivity lead to reductions in national productivity
 - Increased demands on social services counter economic productivity gains

- Estimates of economic losses from malnutrition:
 - For human productivity, **10-15%**
 - For GDP, **5-10%**
 - For children's disability-adjusted life years, **20-25%**
(*WHO, 2000*)

Do “Food-Based Nutrition Solutions” work? How?



Expensive and difficult to prove efficacy resulting in donor skepticism, but it does work...



Field-Based Case Studies

- ❑ Animal Source Foods (Davis, UCLA, Nairobi & Hawaii)
 - Direct intervention supports correlational data
- ❑ Bio-fortified rice (IRRI, Cornell, Penn State)
 - Small additions of a nutrient can lead to improved nutritional status
- ❑ Orange-flesh sweet potato (CIP, IFPRI, MSU, World Vision, Helen Keller) – Low, Arimond and others)
 - Integrated approach – production, education and marketing



Role of Animal Source Foods to Improve Dietary Quality, Growth and Development of Kenyan School Children

Investigators

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UCLA

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U of Hawaii

Lindsay H. Allen

UC Davis



Background to Kenya-Embu Project

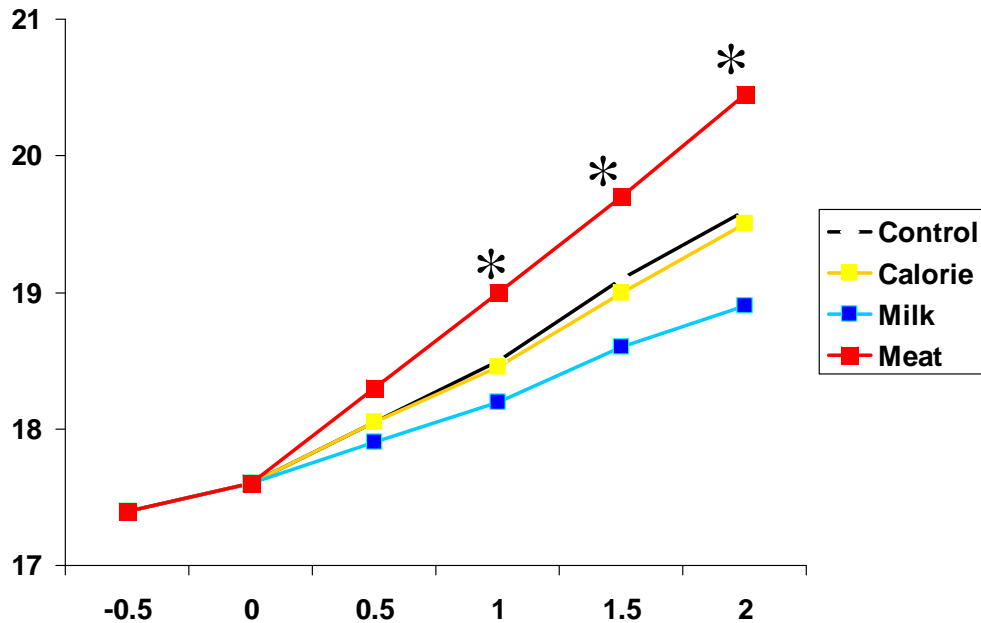
- ❑ Previously Nutrition-CRSP in Embu.
- ❑ 30% stunted.
- ❑ Protein and amino acid intake adequate, energy low if drought.
- ❑ 30-90% prevalence of micronutrient deficiencies.
- ❑ ASF intake correlated with growth, cognitive performance, activity.
- ❑ Meat & milk intake very low (<1% energy).
- ❑ **PURPOSE:** Intervention project to test causal effects of ASF on child development.

School Snacks, 2 years

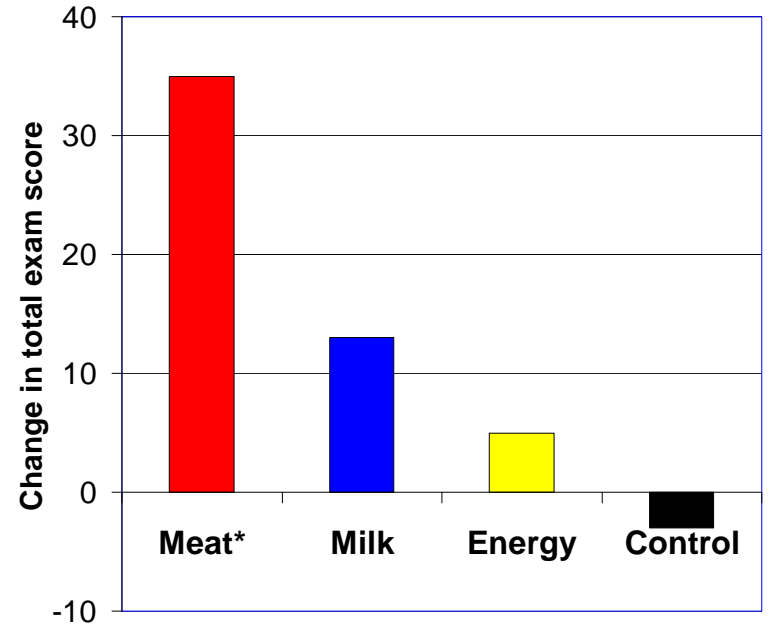
- ❑ **Energy:** 250 kcal from githeri (maize and beans) + oil
- ❑ **Meat:** 250 kcal from githeri + 60-80 g beef.
- ❑ **Milk:** 250 kcal from githeri + cup of milk.
- ❑ **No intervention:** (goat given after study).
- ❑ Total energy intakes similar, and mean energy & protein intakes were adequate in all groups.
- ❑ Randomized, 3 schools/group, $n=554$.



Raven's Scores and Exam Results



Raven's Test



End of semester exam results

Behavior during play

Compared to all other groups, the

MEAT GROUP

- Had greatest increase in % time spent at high activity levels, and least % time in low activity.
- Were more talkative, playful – and “disruptive”.
- Spent more % time in leadership and taking initiative.



Results

- **Meat supplementation improved:**
 - cognitive performance (Raven's, math)
 - physical activity
 - initiative and leadership behaviors
 - arm muscle mass
 - school test scores
- **Milk supplementation improved:**
 - linear growth of stunted children
- **Milk and meat supplementation improved:**
 - vitamin B-12 status



Bio-Fortified Rice

- Research at IRRI, Los Banos, Philippines
- 32% of Filipino women are anemic and 40% are iron deficient
- Women eat ~ 500 g cooked rice/day
- Newly developed (non-GMO) rice variety meets local consumer tastes and has higher iron content than most varieties after milling, polishing and cooking

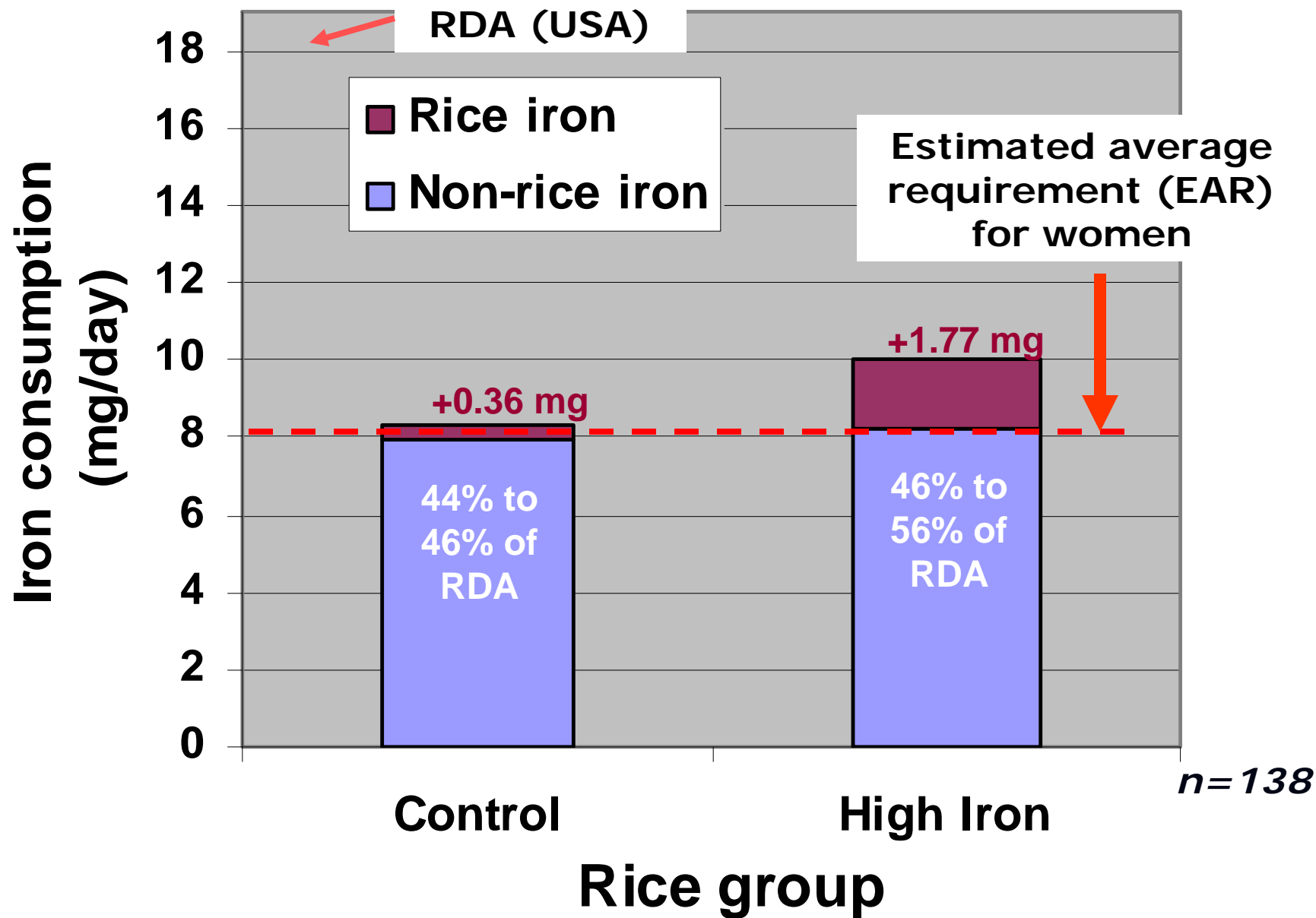


Study Design

- Two treatments – high and low iron rice, 9 months
- Random assignment, double-blinded
- Iron status assessed 3 times
- Careful control and standardization of rice preparation
- Measured intake of rice and rest of diet 3 days every 2 weeks
- 192 sisters from 10 convents



Dietary source of iron during 9 month feeding trial in Philippine women



Conclusions

- Iron from biofortified rice increased daily iron intake by 20% for iron-poor diets (<50% of RDA).
- Adding 1.77 mg/d of dietary iron from biofortified rice increased the % of women who met requirements from 50% to 70%.
- Consuming biofortified rice increased plasma ferritin and total body iron of non-anemic women.
 - Greater ferritin response was seen in the most iron depleted subjects
 - Positive relationship between amount of iron from rice and change in body iron
- Further dietary iron from meat or biofortified rice? More than twice as much total iron in the Kenyan meat than in the biofortified rice and meat has higher bioavailability. Which is a better approach? Both?

Orange-fleshed sweet potatoes and child nutrition in rural Mozambique: Impacts and challenges



*Jan Low – International Potato Centre (CIP), Principal Investigator
Mary Arimond - International Food Policy Research Institute (IFPRI),*

Towards Sustainable Nutrition Improvement (TSNI) Project: Implementing partners



**World Vision
Mozambique**



**Michigan State
University**



**Helen Keller
International**



**Nutrition Division:
Ministry of Health**

**Southern Africa Root
Crops Research
Network & National
Institute for
Agronomic
Investigation**



Poverty reflected in nutritional status and mortality

Focus children (4-38 mo) at baseline

More than half were stunted (HAZ < -2.0)

¼ with observable signs of malnutrition

¼ with very low hemoglobin (< 7.0 g/dl)

~ half had low serum retinol (< 0.70 µmol/L)

> half ill in last 2 wk

One in five women underweight (BMI < 18.5 kg/m²)

Half of the women had lost a child < 5 yr

Why agriculture for nutrition?

Why a food-based approach?

Need:

High levels of Vitamin A deficiency & food insecurity

Limited health infrastructure

Limited purchase of foods by HH (potential vehicles for commercial fortification)

Enabled by:

Positive orientation towards food production-based approach in Ministry of Health/Nutrition

Informed & positive view of integrated approach among implementing partners

Very good “candidate” crop

Identifying crops to impact nutrition

Agronomic/agricultural considerations

Suited to conditions

Timing

Social/economic consequences of introducing or promoting crop

Shifts in labor – amount, timing, and whose

Shifts in control of resources w/in HH or community

Likely to be sold or kept for home consumption?

Where does it fit in the diet?

Will it fill existing nutrient gap(s)?

Acceptability

Ease of preparation

What is displaced?

Why Orange Fleshed Sweet Potato?

Produced by ~ 2/3 of HHs – but not 1° staple

More drought-resistant than other staples

Vegetatively propagated; plant over broad range of time

“Women’s crop”

Less labor intensive

Cheap (vs nutrient-dense “high-value” crops)

Very high in carotenoids (breeding for higher)

Easily accepted by young children

Good source of energy

Easy to prepare; most likely to displace cassava

Considered by farmers as good food security crop

Evidence of efficacy* at reasonable level of intake

* Van Jaarsveld et al., AJCN 2005; 81:1080-7.

Project model: 3 necessary & linked pathways

**Create demand
for OFSP through
knowledge**

*Group education,
social marketing to
increase demand and
change child feeding
practices*

**Provide access to
 β -carotene-rich
OFSP varieties**

*Ag extension to
improve agronomic,
storage practices*

**Ensure sustained
adoption through
market development**

*Link farmers to traders
to increase income,
area under production,
develop processed
products*

**...towards sustainable increases in young child
vitamin A intakes & serum retinol**

Pathway 1: Provide access to β -carotene-rich OFSP varieties

*Multiplication and
distribution of vines*



*Varietal trials with farmers'
groups, including taste tests*

Pathway 2: Create demand (and behavior change) through knowledge

Multiple channels:

Group nutrition education sessions
based on formative research/recipe
trials

Community theater

Radio spots

Visible presence/advertising at local
markets

**“O doce que dá saúde”
(the sweet that gives health)**



Group nutrition education

Methods:

Visual

(posters, pictures,
flipcharts)

Interactive

(songs, role play,
recipe trials, games)



Education topics

Undernutrition

The 4 food groups

**Importance of vitamin A &
vitamin A-rich foods**

Recipe trials using OFSP

Breastfeeding

Complementary feeding

Care during pregnancy

Hygiene practices



**A series of concrete messages (“give OFSP every day”
“young children should eat at all three main meals”)**

Pathway 3: Ensure *sustained* adoption/use through market development

Market promotion and commercialization:

Contracted trader trained to
maintain records

Linked via extension agents to
farmers' groups

Introduced grades and standards

Product development:
“golden bread”, OFSP juice



Main research question & study design

Can a food-based, integrated agriculture-nutrition intervention, with OFSP as key “entry point”, lead to sustainable improvement in young child nutrient intake and serum retinol?

**Quasi-experimental, prospective (longitudinal) w control
Followed HH through 2 agricultural cycles
3 districts purposively selected (2 interv.; 1 control)
W/in districts villages stratified by distance to services
& selected pps
HH with young children (4-38 mo baseline) eligible**

Survey research: topics and objectives

Topics:

Socioeconomic & demographic characteristics

Agricultural production, yield, labor use

Parents' nutrition knowledge

Food frequency (one week food group recall)

HH level consumption and ind. level 24-hr dietary recall

Morbidity, anthropometry

Biochemical indicators: Serum retinol & acute phase proteins

Objectives:

Establish baseline comparability

Characterize intermediate outcomes in pathway to impact

Measure impact on young child serum retinol

Intermediate outcomes in pathway to impact



Production and sale
Parental nutrition knowledge
Young child feeding practices, eg.:
Maintaining breastfeeding (18-23 mo)
Children having 3 meals

Frequency of OFSP consumption
Intakes of energy, vitamin A
Also protein, B vitamins, vitamin C, iron

2004: OFSP cheapest source of vitamin A in local markets at \$0.01 / 700 RAE



Intermediate outcomes: Production/sale

	Intervention (n=498)	Control (n=243)	P-value ^a
% producing OFSP 2002	5	0	0.24
% producing OFSP 2004	90	11	<0.001
% selling any SP 2004	30	13	<0.001

~~^aP-value for Pearson's χ^2 and Mann-Whitney U test~~

Intervention HHs increased plot sizes from 33 to 359 m² in yr 2

Intermediate outcomes: Child feeding

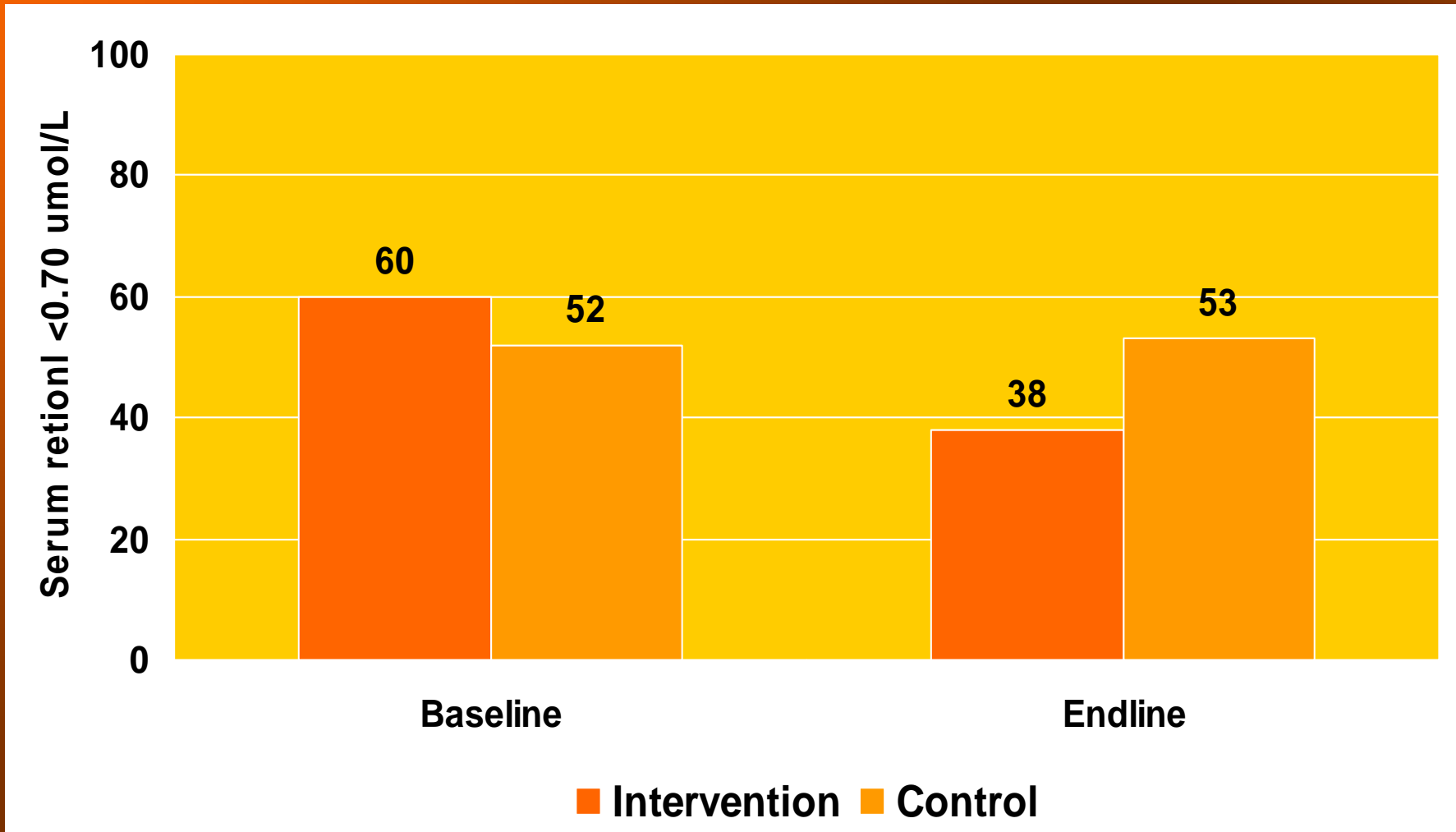
All indicators for 2004	OFSP (n=498)	Control (n=243)	P-value ^a
% breastfed (18-23 mo)	51	26	< 0.01
% of infants 6-11.9 mo fed at 3 main meals ^b	49	17	< 0.01
% who had OFSP 3+ days prev wk ^c	55	8	<0.001
Focus child ^c vitamin A intake (median, RAE)	426	56	<0.001

^aP-value for Pearson's X^2 and Mann-Whitney U test

^bDifferences also positive and significant for other age groups

^cFocus children were 21-56 mo at last 24-hr recall

Differences in prevalence of low serum retinol^a



^a Excludes children with elevated CRP (> 5 mg/L), indicating infection

How can we learn from integrated projects?

A specific, integrated package can produce results in one context and at one scale BUT

In community everything that can vary will vary

In how many different situations do we need to demonstrate impact?

What is sufficient “proof of concept” in community settings?

What kinds of processes/outcomes/impacts should we document?

Background:

Donor skepticism

Mixed results from weak studies in past

Yet strong designs are very difficult and expensive, and are still embedded in context

Low, J.W., M. Arimond, N. Osman , B. Cunguara , F. Zano, D. Tschirley

A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations among young children in rural Mozambique. *Journal of Nutrition* 2007 137: 1320-1327.

Ensuring supply of and creating demand for a biofortified crop with a visible trait: Lessons learned from the introduction of orange-fleshed sweet potato in drought-prone areas of Mozambique. *Food and Nutrition Bulletin* 2007 28(2): S258-S270.

Seeking Sustainable Health Improvements Using Biofortified Orange-fleshed Sweet Potato in Drought-Prone Areas of Central Mozambique. *Low-External Input and Sustainable Agriculture (LEISA) Magazine*, forthcoming.

<http://www.aec.msu.edu/fs2/tsni/index.htm>

Successful Nutrition-Ag. Projects



Successful Projects

Don't focus on WHAT worked (specific mix of activities) but on WHY

Ex: Why did OFSP work in Mozambique?

1. Appropriate crop (not primary staple, but has desirable agronomic characteristics)
2. Integrated theory and practice and based on knowledge/science
3. Strong partnerships and good leadership
4. Extension effective and adequately funded; good outreach
5. Farmer participation in all aspects of project (even varietal trials)
6. Communication and problem-solving

Teamwork in Potosi, Bolivia



Flexibility Essential

- ❑ No silver bullets/one size does not fit all
 - Agriculture is context-specific with huge annual variation
 - ❑ Coefficient of variation of rainfall in semi-arid areas often approaches 100%
 - Soils, rainfall, and crop pests all vary considerably



Traps

- ❑ Micronutrient: Diets deficient in micronutrients impair cognitive development of children
- ❑ Economic: ~75% of poor Africans (<\$1/day) are in rural areas and ~80% of them earn most of their livelihoods from agriculture
 - Many studies show agricultural development “jump starts” economic development
- ❑ Soil Fertility: Staple monocultures deplete soil fertility unless fertilizer is affordable (8 kg/year in Africa)
 - Fertilizer applied at affordable levels does not pay for itself
- ❑ Cognitive, economic and environmental poverty traps can be addressed through agricultural interventions
 - Crop diversity (including animals) affects diet adequacy and can reduce soil degradation increasing crop yields and incomes

Not just a pretty flower



One of the biggest causes of food insecurity in Africa