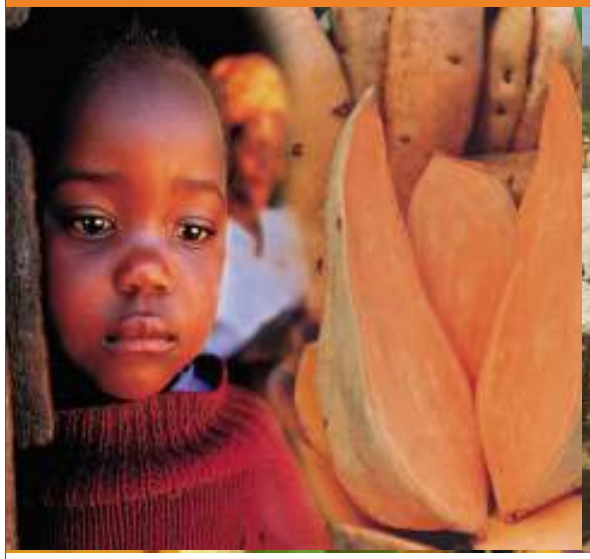




Developing Effective Delivery Systems for Biofortified Crops: Lessons Learned in Achieving Economic, Nutrition, and Health Goals in Sub-Saharan Africa

(The Importance of Questioning Conventional Wisdom)

Jan Low

CIIFAD Seminar Series, Cornell University

1 September 2010

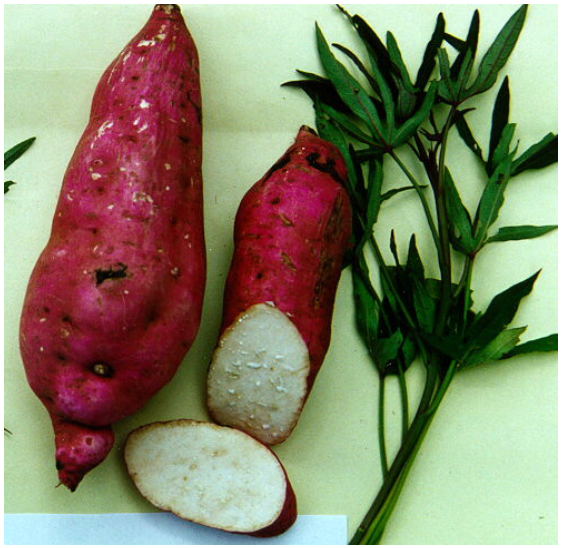
Overview: Biofortification in the Context of Food Security & Nutrition

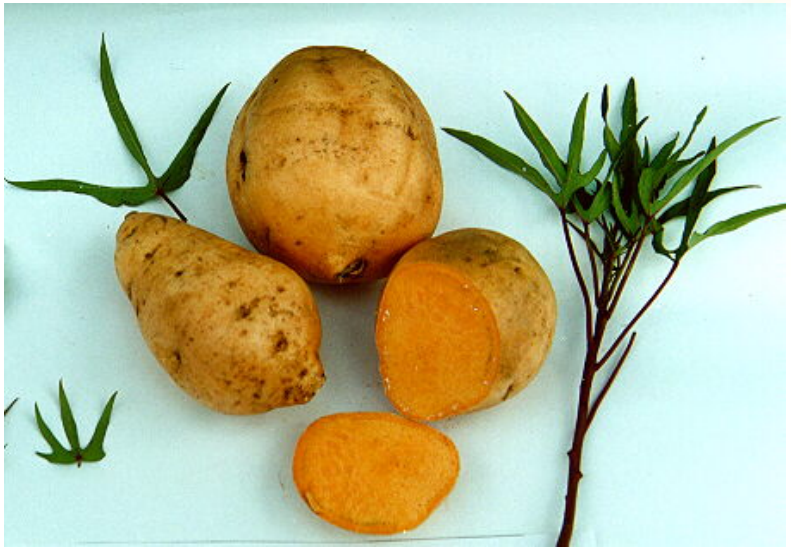
- Food security: assuring sufficient access to food through own production or purchase –quantity vs quality??
- Biofortification: enhancing the micronutrient content of food staples
  - builds on consistent & large amount of intake of staples
  - low recurrent costs once varieties are developed & distributed

Can biofortification succeed?

- Can nutrient levels be increased to high enough levels?
- Will the extra nutrients be absorbed at sufficient levels to improve status?
- Will farmers adopt and will consumers eat in sufficient quantities?

Orange-fleshed Sweetpotato: The Model for Biofortified Crops with a Visible Trait





- Most varieties in SSA white-fleshed: marginal change
- Assumed visible trait would be a barrier to adoption
- Review history of how the evidence base has been built to date and key lessons learned during past 15 years

- Higher yielding
- Rich in Beta-Carotene
- Earlier maturing

A Few Sweetpotato Facts

- Grows from sea level to 2300 meters
- Produces on marginal soils (3-12 t/ha)
- Yet responds dramatically to favorable conditions (40-60 t/ha)
- Flexible harvesting and planting times
- Dual purpose use: roots & vines
- Women dominate in its production
- As population density increases, per capita consumption increases (.75 correlation in 17 target countries)
- Vegetatively propagated



Highest energy & potential Vitamin A output among major African food crops

Crop[a]	Average Tropical Yield (Tons/Ha)	Vitamin A per hectare (RAE[c]/ha)	Mean Growth Period (Days)	Edible Energy (MJ/ha/day)
Sweetpotato[d]	7	0 to 175 million	140	194
Cassava[d]	9	0 to 6.5 million	330	138
Yam[d]	7	0 to 490,000	280	94
Banana	13	0 to 390,000	365	113
Rice[b]	2	0	140	149
Maize	1	0 to 300,000	130	145
Sorghum	<1	0	110	101
Millet	<1	0	100	82

Source: Woolfe (1992), p. 4. a Cereals, air-dry; roots/tubers/bananas fresh. b Paddy Rice. c RAE = Retinol Activity Equivalent

[d] Data for vitamin A values of range in existing germplasm from HarvestPlus, personal communication (2008).

Cassava varieties above 5 ug/100 gms still under development.

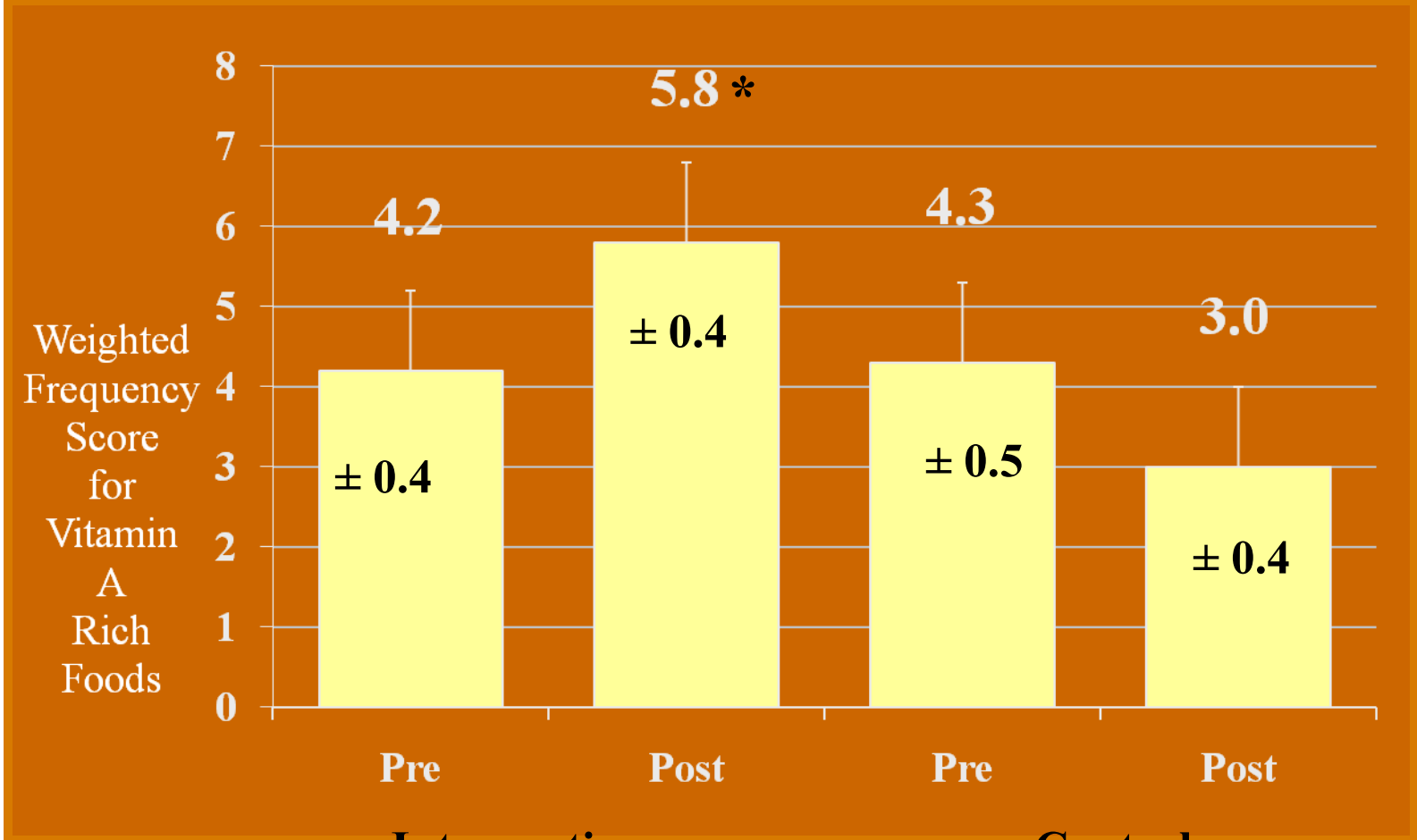
Other crops RAE values from USDA Nutrient Composition Table, version 16.

Conventional Wisdom #1: African and Asians will not eat orange-fleshed sweetpotatoes

Sweet potato cultivars with deep yellow or orange-fleshed roots are unfortunately rejected in many developing countries in favor of white or cream-fleshed types having little or no provitamin A activity. The Sweet Potato: an Untapped Food Resource. Jennifer Wolfe 1992.



- Attempts by AVRDC to introduce them in Asia had failed
- Failure to understand that rejection was due to texture, not color
- Pilot work in Kenya (1995-97) among 20 women's groups



Intervention Increase **1.6**

Control Decrease **1.3**

Net increase of Int. **2.9**

* The increase from pre- to post-intervention period is significantly greater in the intervention group than the change in the control group (ANOVA, p = 0.0015)

Frequency of Consuming Vitamin A Rich Foods, Ndhiwa/Nyarongi

(n=154 children 0-5 years)

Key Lessons From Pilot Work in Western Kenya:

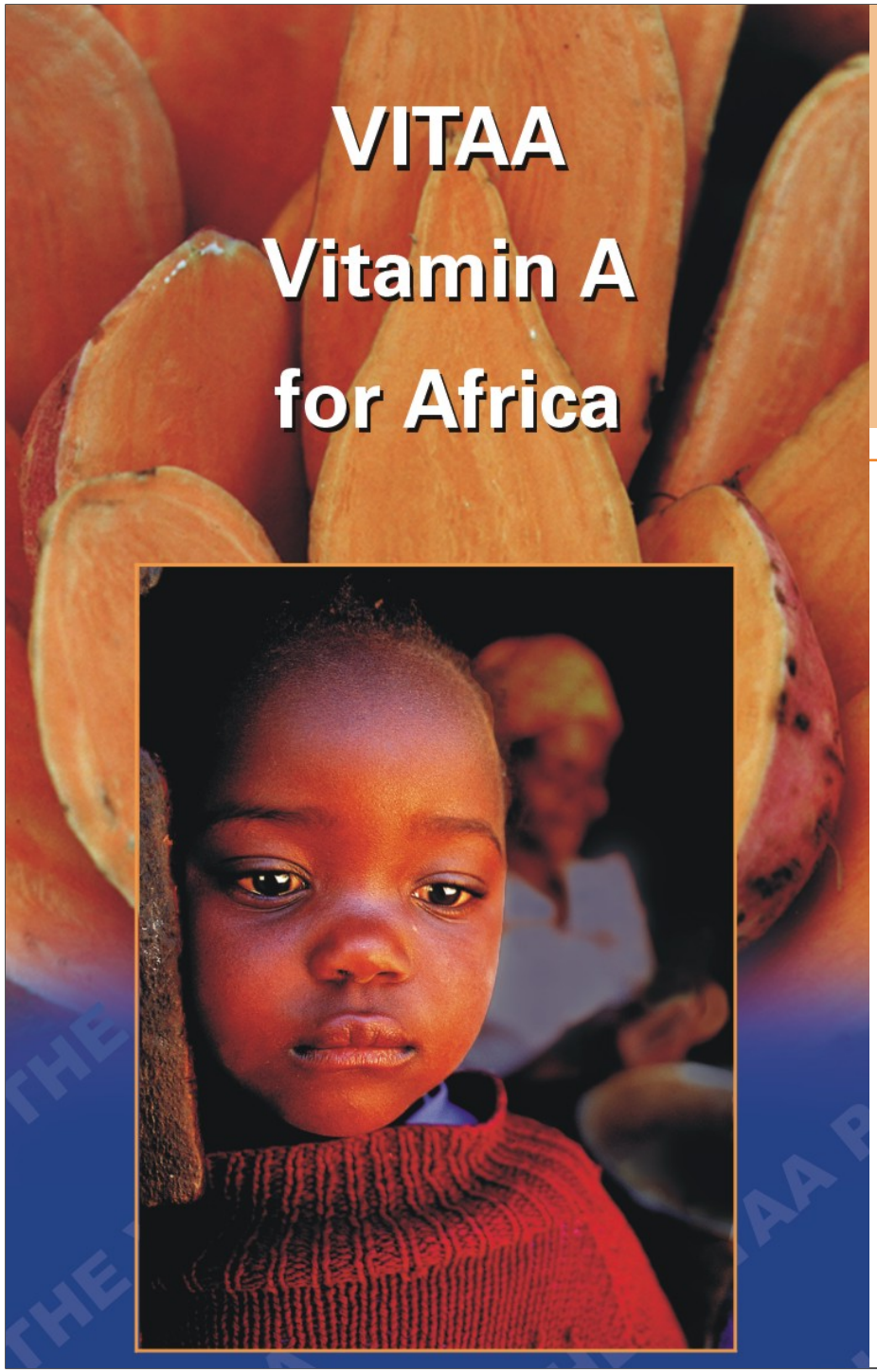


- Nutrition education component essential
- Preferences differed
  --Adults: high dry matter
  --Children: low dry matter
- Yellow-fleshed variety had inadequate beta-carotene → Eat Orange
- Easy to incorporate sweetpotato weaning foods into young child diet & improve feeding frequency

KARI/CIP/CARE collaboration funded by ICRW/OMNI/USAID

Conventional Wisdom #2: Plant sources of vitamin A have low bioavailability and cannot impact vitamin A status

- Major push for massive supplementation in late 1990s
- Preference for passive approaches
- New studies showed poor conversion rates for dark green leaves (24:1 and above) and orange fruits/vegetables (12:1) than previously assumed (6:1)
- Criticism that food-based approaches lack convincing evidence *but*
- An unwillingness of donors to fund studies to generate the evidence



THE VITAA PARTNERSHIP

VITAMIN A FOR AFRICA

www.cipotato.org/vitaa

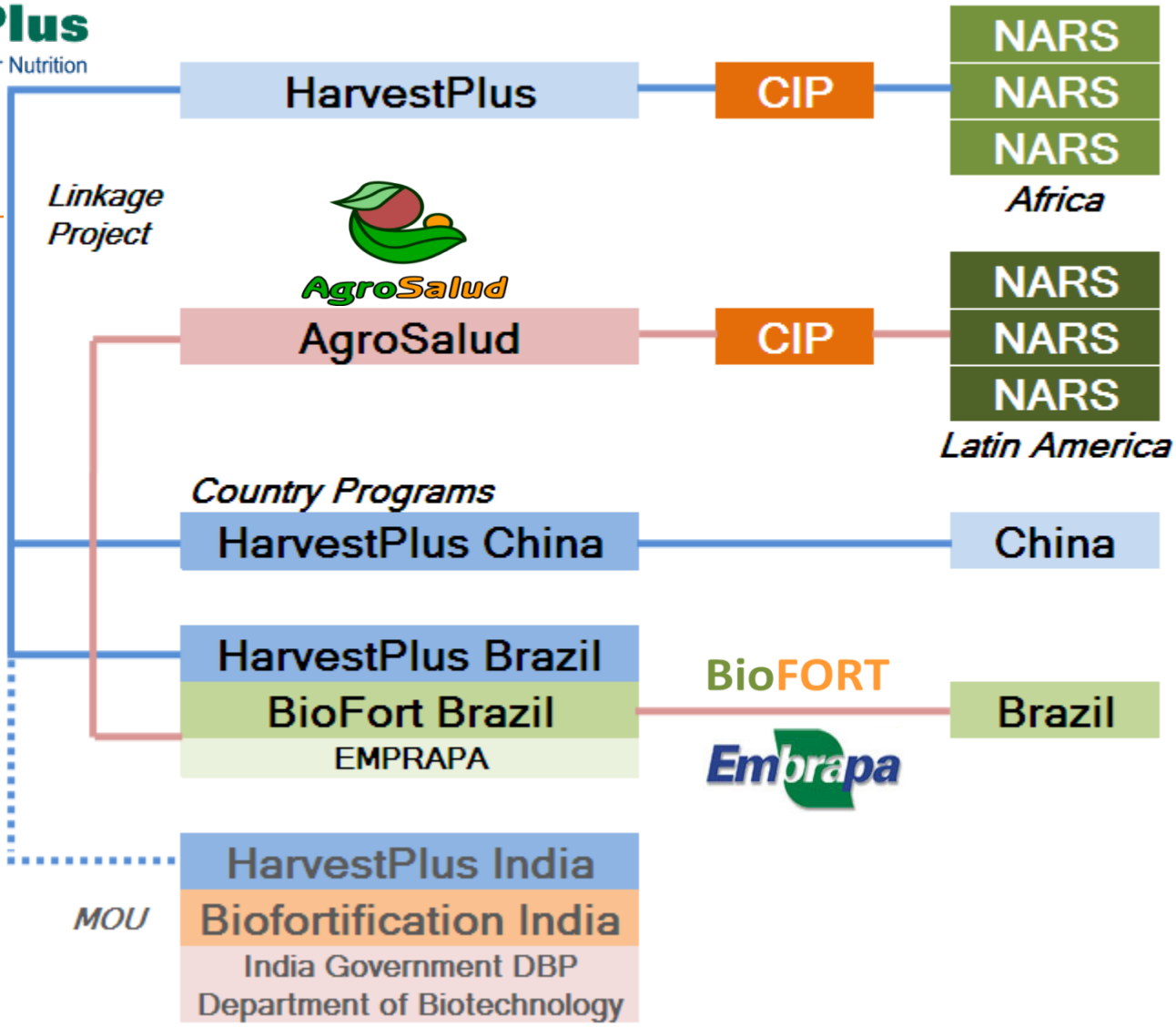
Launched in 2001
Potential of OFSP in combating VAD in SSA

Orange-fleshed sweetpotato can significantly contribute towards reducing Vitamin A deficiency among 50 million children under 5 years of age in Sub-Saharan Africa

Ex-ante study presented at IVACG meeting in February 2003

Major OFSP Support 2004-2009

HarvestPlus
Breeding Crops for Better Nutrition



HarvestPlus
Breeding Crops for Better Nutrition

Efficacy study shows potential of OFSP to combat Vitamin A deficiency

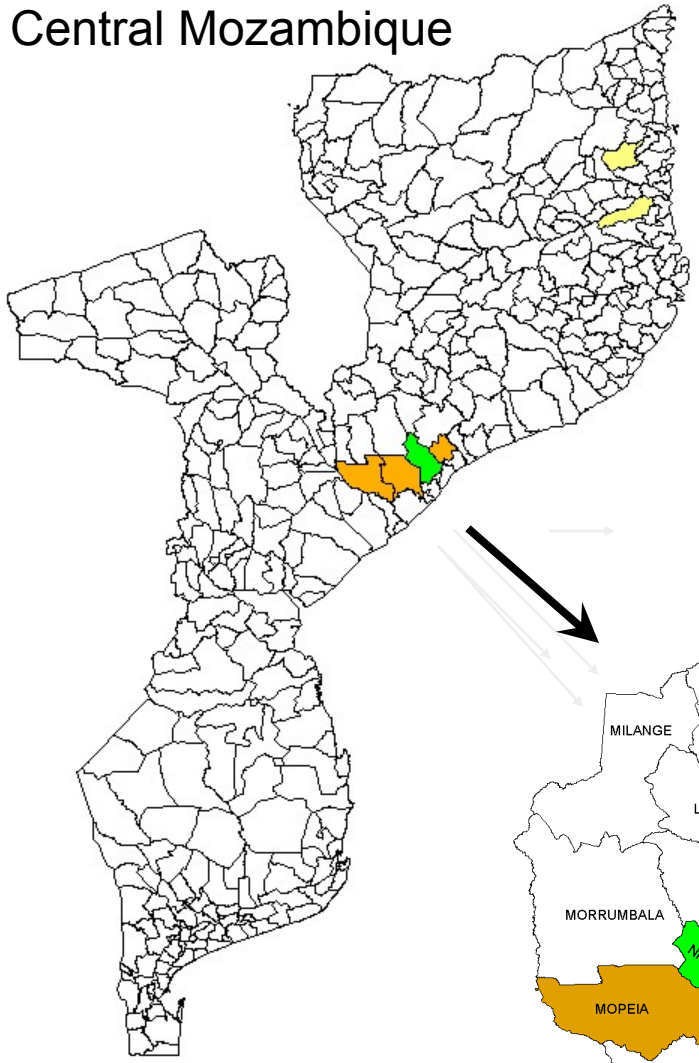


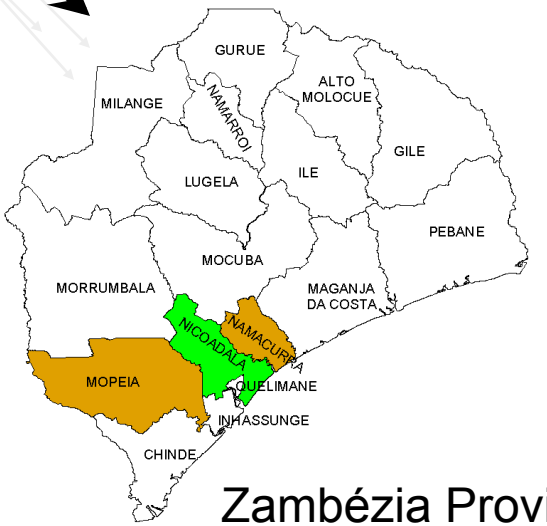
- Completed in South Africa in 2004
- 120 grams fed to school children for 5 days a week for 3 months significantly improved amounts of Vitamin A stored in the liver

Source: van Jaarsveld et al. 2005- MRC, South Africa

Community level study in Mozambique

Central Mozambique





Zambézia Province

Design:

- 2 yr quasi-experimental design
- Villages stratified within districts
- Intervention villages
  - *Randomly selected proportional to population*
  - *Random assignment of high or low intensity of the nutrition intervention*

90% completed:

2 Intervention Groups

-- 498 households

1 Control Group

-- 243 households

Data Collection:

Jan 2003-

March 2005

Integrated Intervention Model

AGRICULTURE

Introduce new source of Vitamin A and Energy: Biofortified OFSP

Outcomes

1. ***Increased supply of beta-carotene & energy***
2. **Sustained yields**
3. **Increased supply in off-season**



NUTRITION

Demand Creation and Empowerment through Knowledge

1. **Increased knowledge**
2. **Increased demand for Vitamin A-rich foods**
3. ***Increased intake Vitamin A & energy***



MARKETING

Market Development for OFSP Roots and Processed Products

1. ***Increased household income for growers***
2. **Sustained OFSP cultivation over time**



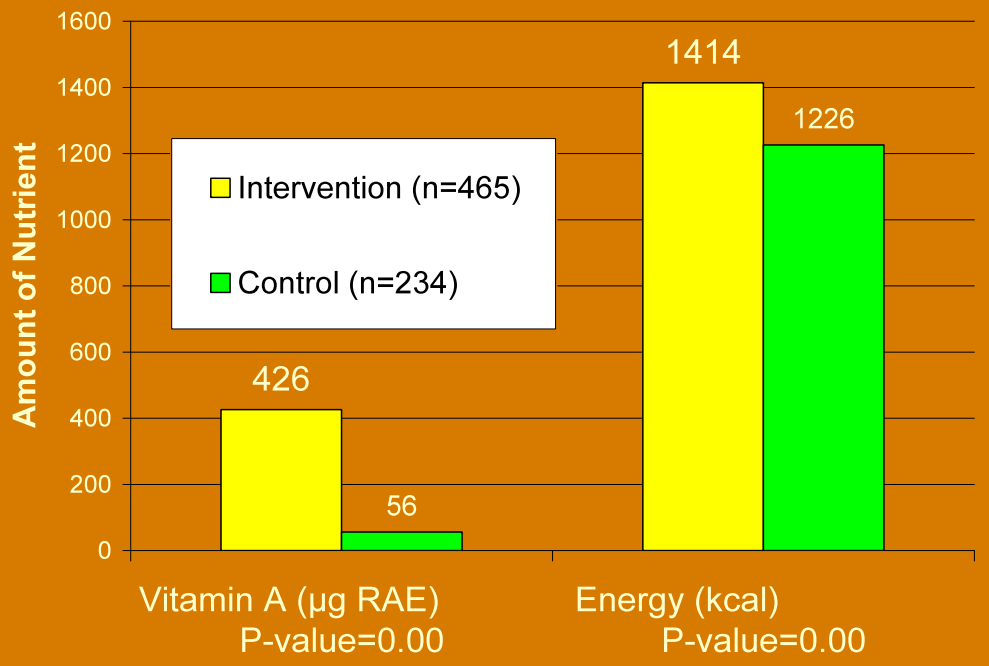
Increased Serum Retinol Levels

Did the Intervention Impact the Young Child Diet?

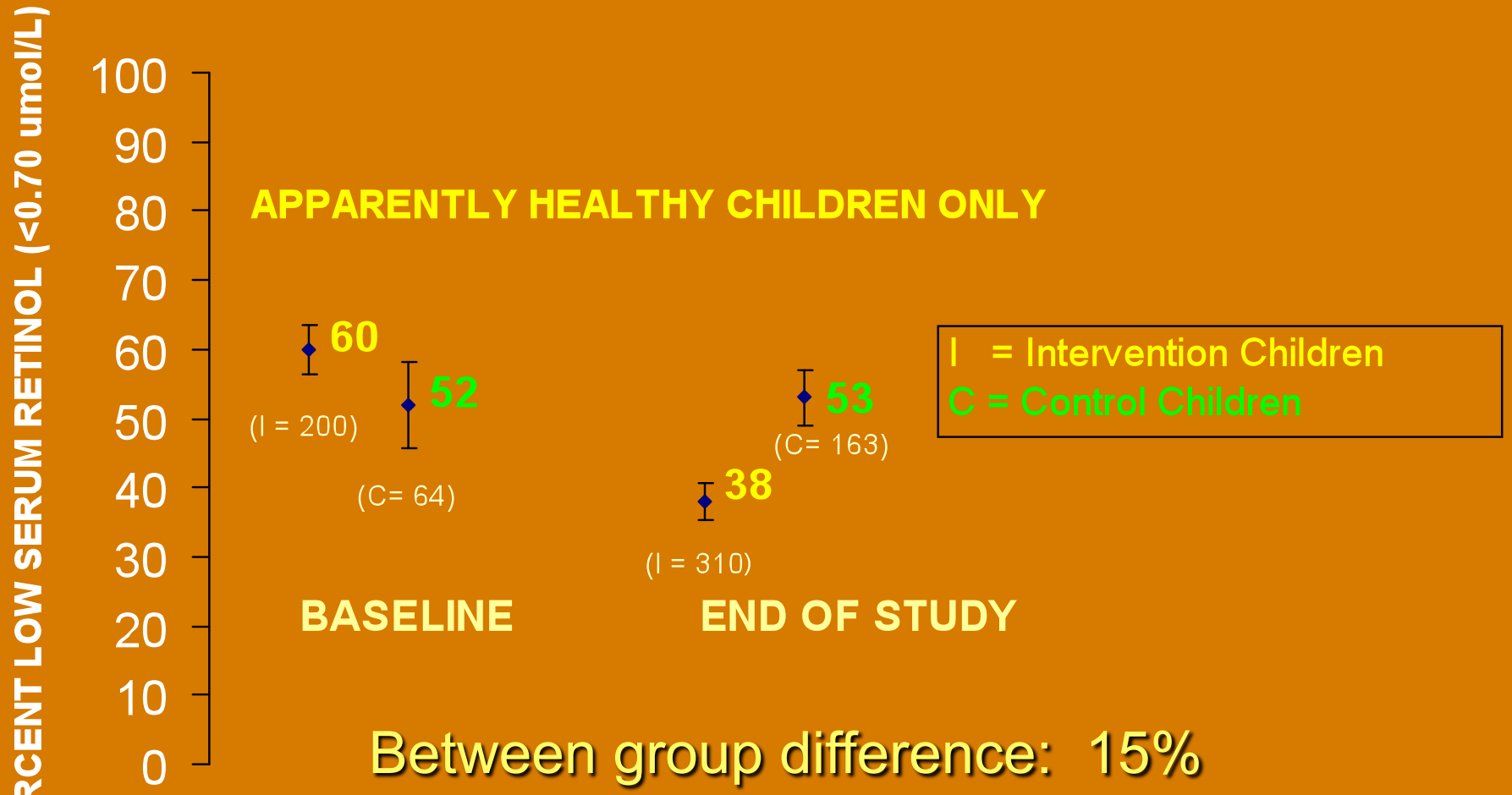
- Median intake vitamin A almost 8 times higher (24 h recall)
- OFSP contributed 35% vitamin A intake; 90% when consumed
- Children > 1 year old eat sweetpotato when caregivers eat it

Median nutrient intakes yesterday:
non-breastfed children (mean 32 months old)





Prevalence of Low Serum Retinol Significantly Less in Intervention (I) than Control Children (C)



Between group difference: 15%

Apparently healthy children: C-reactive protein <5 mg/L.

Journal of Nutrition 137: 1320-1327, 2007

A Doce que Dá Saúde
(The Sweet that Gives Health)

Building the Orange Brand:
Radio programs and market advertising to increase awareness of Vitamin A rich foods & increase demand





Conventional Wisdom #3: Save time & money by investing in selecting best among existing materials instead of building breeding programs in SSA



- Dearth of sweetpotato breeders in SSA
- Breeding programs require significant resources
- Donors in late 1990s/early 2000s should little interest in supporting breeding--- it takes too long
- Desire to show benefit of generating global public goods

Recognition that higher root yielding OFSP has insufficient vine vigor for drought-prone areas



CANASUMANA
-- Hardier vines, more drought resistant
--Alternating not agglomerated storage roots



RESISTO:
-- Has β-Carotene
--More consistent medium root size desired in commercial market

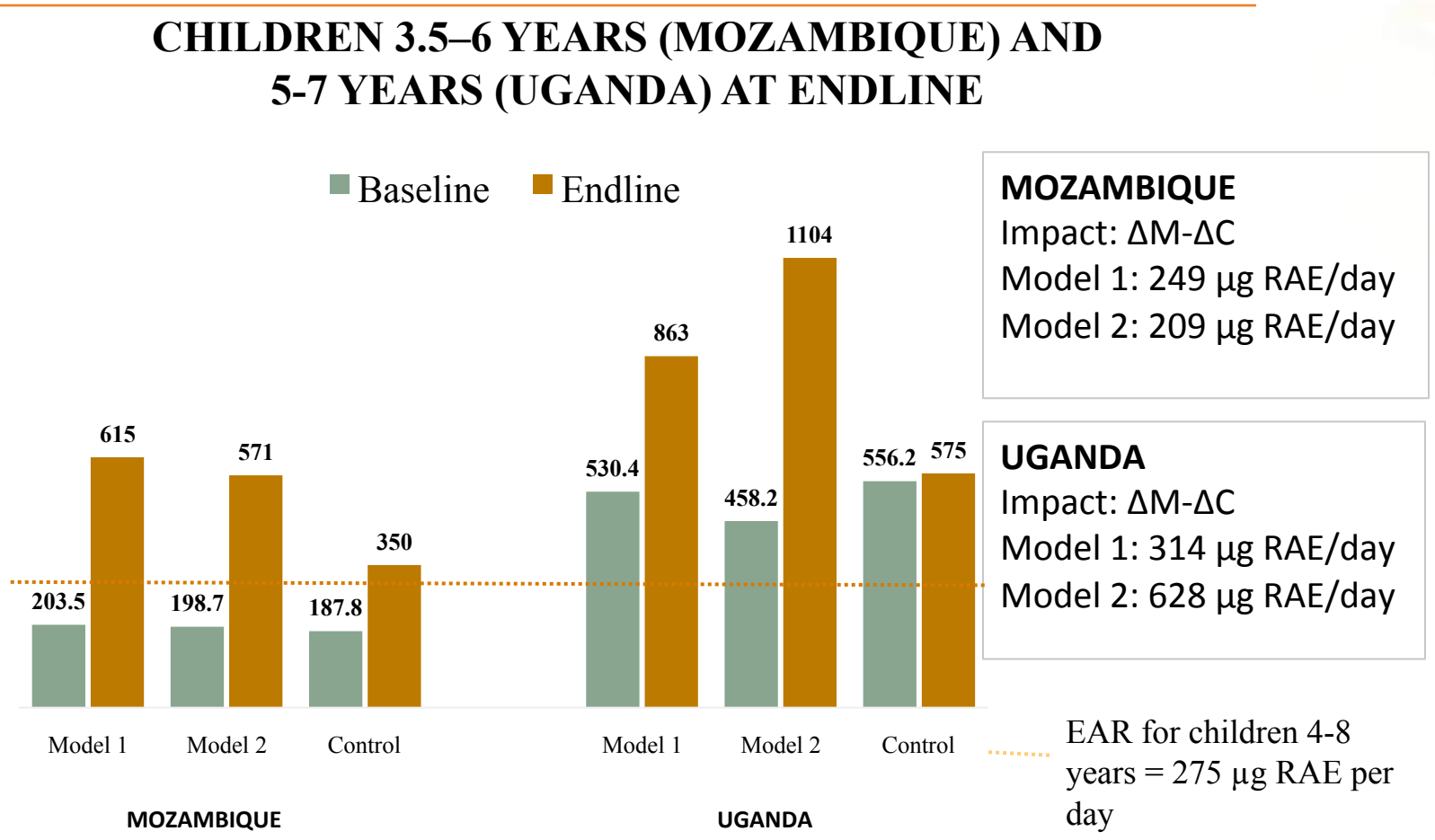
Draft

How can we reach larger number of households cost effectively? Reaching End Users Project (2006-2009) in Uganda & Mozambique (HarvestPlus)

Implemented in both countries	Model 1		Model 2	
	Year1	Year 2	Year 1	Year 2
Training Program for Extension Staff	✓	✓	✓	
Training Program for Promoters	✓	✓	✓	
Community Drama	✓	✓	✓	
Radio	✓	✓	✓	✓
Area-wide Activities	✓	✓	✓	✓

High adoption rates (>60%) & positive outcomes on vitamin A intake among children and their mothers

(intent to treat figures, include non-adopters)
(Impact Study led by IFPRI)



Understanding the costs of using the integrated approach

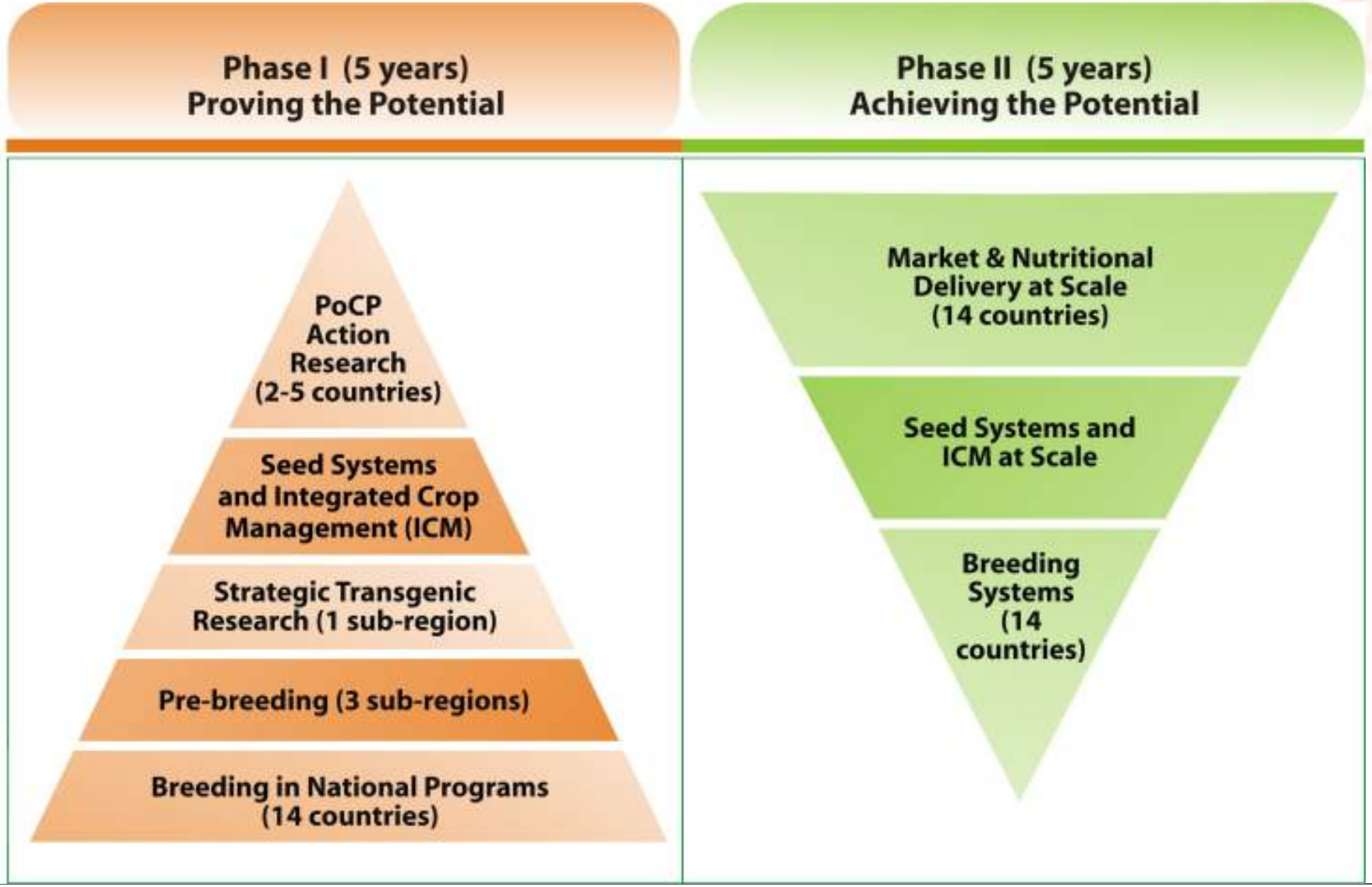
- Less intensive (M2) model 30% cheaper to implement
- No significant difference in 2 models on key metrics
- Mozambique (secondary staple):
  - Average cost for direct beneficiary: $86
  - Marginal cost for direct beneficiary: $36
  - Marginal cost if indirect beneficiaries included: $19
- Uganda (staple crop):
  - Average cost for direct beneficiary: $56
  - Marginal cost for direct beneficiary: $22
  - Marginal cost if indirect beneficiaries included: $12
- $15-20 USD for disability life year (DALY) saved



SPHI is a multi-partner, multi-donor initiative that seeks to reduce child malnutrition and improve smallholder incomes in 10 million African families by 2020 through the effective production and expanded use of sweetpotato.

The Sweetpotato Action for Security and Health in Africa (SASHA) Project is a 5 year project among 26 partners led by the International Potato Center that will develop the essential capacities, products and methods to reposition sweetpotato in the food economies of Sub-Saharan Africa. It serves as the foundation for the broader initiative.

Two Phases: Greater Emphasis in first 5 years on Breeding and Seed Systems Research as the Foundation for Success



Breeding in Africa *for* Africa

- Generate populations to meet needs of users
- "Accelerate" sweetpotato breeding systems to produce varieties in 3-4 years instead of 7-8 years
- Tackle new breeding methods (heterosis, molecular markers)





Linking Agriculture & Nutrition to Health: the search for alternative effective delivery systems



- 5 year study in Western Kenya (2009)
- Can linking orange-fleshed sweetpotato (OFSP) access and nutritional training to existing health services provide:
  - an incentive to pregnant women to increase health service utilization?
  - lead to increases in consumption of OFSP and other vitamin A rich foods by the women and their young infants in a cost-effective manner?
- Partners: PATH (International health NGO), CREADIS & ARDAP (two local agricultural NGOs) and CIP

Increasing recognition of benefits of nutrition-agriculture integration



Food security in the new Feed the Future Initiative:

A family is considered food secure when its members do not live in hunger or fear of hunger. Food security is defined as having four main components: availability, access, utilization, and stability. Families and individuals require a reliable and consistent source of **quality food**, as well as sufficient resources to purchase it. People must also have the knowledge and basic sanitary conditions to choose, prepare, and distribute food in a way that results in **good nutrition** for all family members. Finally, the ability to access and utilize food must remain stable and sustained over time.

Thanks for your attention!



Jeff Raikes (CEO Bill & Melinda Gates Foundation) & Bono of the One Campaign visit OFSP fields in Mozambique in March 2010