Contemporary Topics on the Role of Grain Legumes in Human Health and Nutrition: Micronutrients

PABRA
Pan - Africa Bean Research Alliance
Better Beans for Africa

Mercy Lung'aho, PhD
March 1st 2016

Key Strategies for Addressing Malnutrition

Supplementation

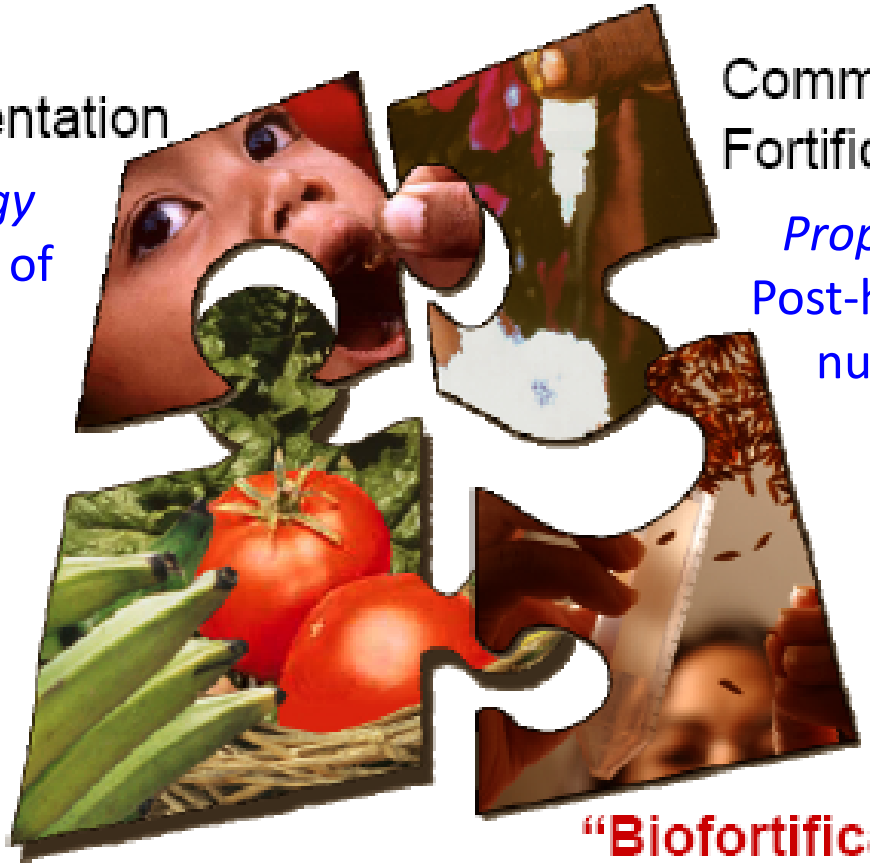
Therapeutic strategy

Provides high doses of nutrients
- adults: tablets
- children: drops

Commercial Fortification

Prophylactic strategy

Post-harvest addition of nutrients to foods



Dietary Diversity

Ideal approach

Increases nutrient intake through food and diets

"Biofortification"

CIAT Focus

Breeding micronutrients into beans

Courtesy of H+ Ghana

Will iron biofortification of beans improve nutrition?

Q1. Has breeding increased iron concentration in beans to levels that could improve nutrition?

Q2. Is the extra iron bioavailable at sufficient levels to improve micronutrient status in target population?

Photos: Neil Palmer (CIAT)

Efficacy of Iron Biofortified Beans: Study in Rwanda

Proof of concept: Rwanda Efficacy study

Randomized double blind control study

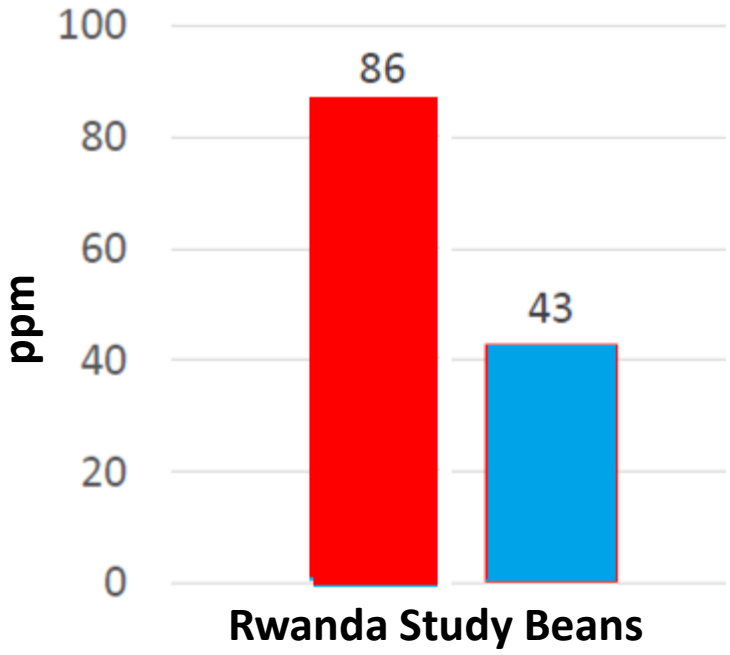
257 screened, 234 female students at the University of Rwanda enrolled

116 (High iron group)
118 (Control group)

44% of the women had anemia; of this 71 % was iron deficiency

Q1. Efficacy of Iron Biofortified Beans: Iron concentration

a. Iron concentration of study beans (ppm)

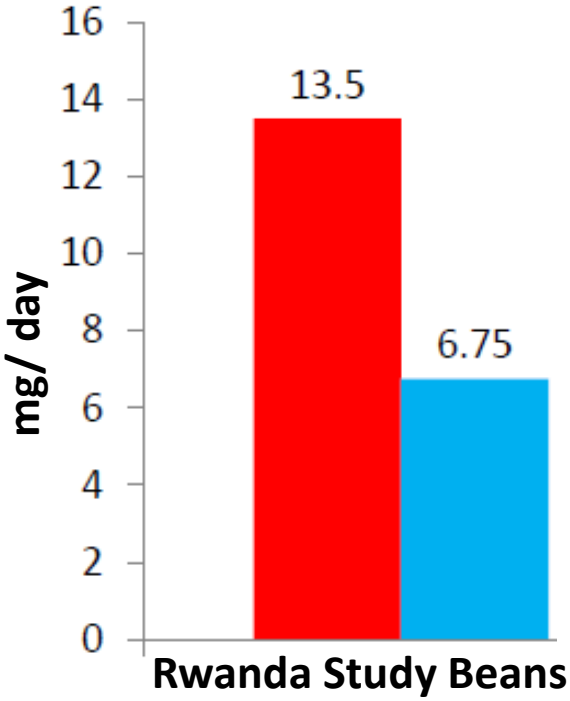


Δ= 43 ppm

KEY: BEANS

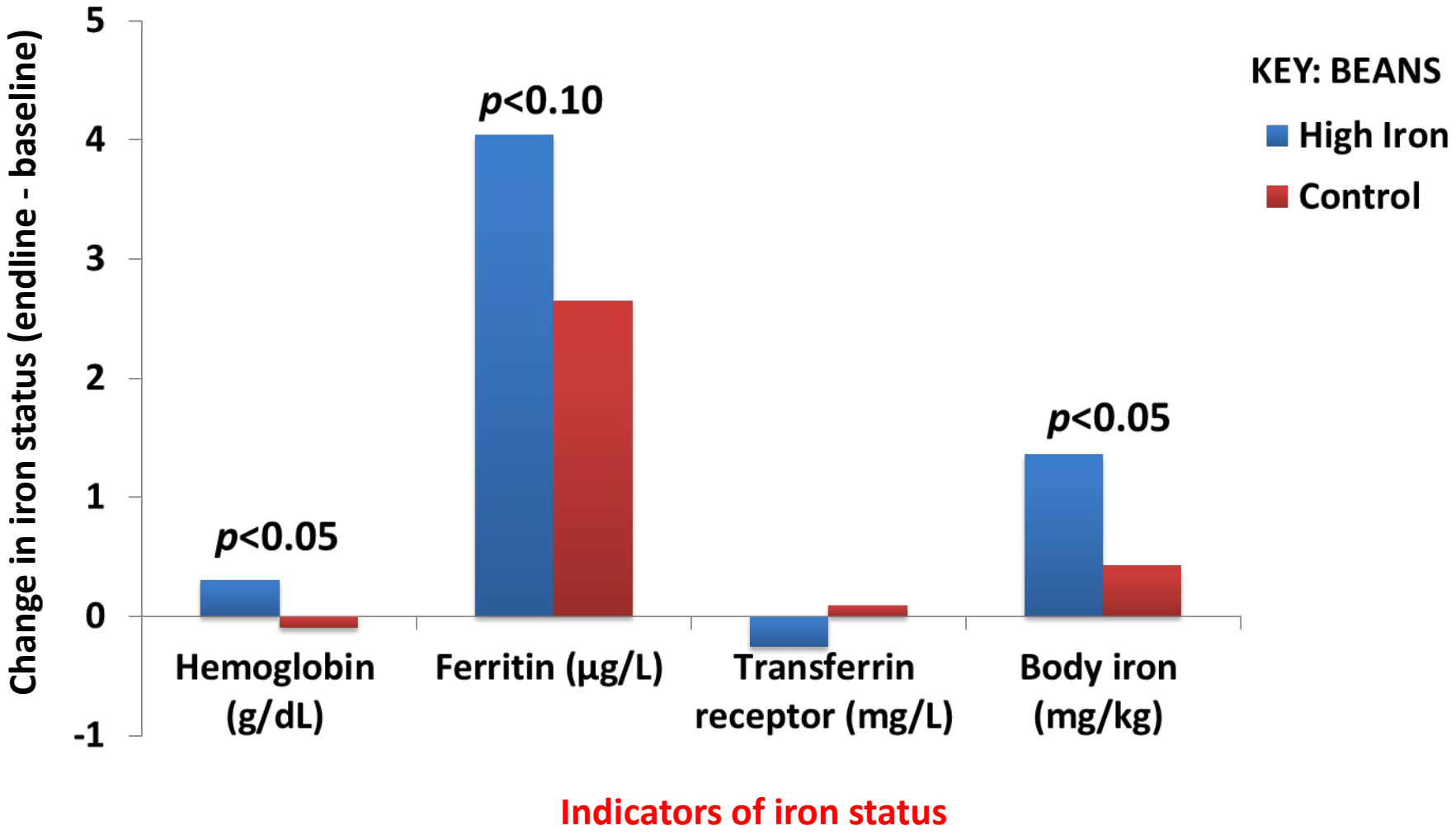
- High Iron
- Control

b. Daily iron intake from beans consumed (mg/day)



Δ= 6.75 mg/day

Q2. Efficacy of Iron Biofortified Beans: Iron bioavailability



Iron biofortified beans improve iron status in Rwandan University women: results of a feeding trial (646.1)

Jere Haas[3], Sarah Luna[3], Mercy Lung'aho[1], Fidel Ngabo[5], Michael Wenger[7,3], Laura Murray-Kolb[6], Steve Beebe[2], Jean-Bosco Gahutu[8] and Ines Egli[4]

[+] Author Affiliations

Abstract

Objective: To examine the efficacy of an iron biofortified bean intervention on iron status in iron depleted young women. Methods: 257 Rwandan university women (18-27 y) with screening ferritin <20 µg/L were randomized to consume ~155 g/d, dry wt. of either iron biofortified beans (Fe=78 mg/g) or control beans (Fe=59 mg/g) per day for 135 days. Iron status (hemoglobin-*Hb*, ferritin-*Fer*, transferrin receptor-*TfR*, body iron-*BI*), inflammation (*CRP, AGP*), and anthropometric indices were determined at enrollment, 7 random midpoints and after 135 days. Difference-in-difference analysis plus repeated measures ANOVA and linear and binomial regression models were used to evaluate the effect of the intervention on iron status. Results: At baseline, for the 231 study subjects who completed the study, 34% were anemic (*Hb* <120 g/L), 73% had *Fer* <15.0 µg/L) and 48% had negative *BI* stores (Cook's algorithm). After 135 days of feeding, there was significant group difference in change in *Hb* (difference=3.5 g/L, p<.001) and *BI* (difference=0.45 mg/kg, p=.033) in the high iron compared to control group. Also, 54 of 109 women with negative *BI* at baseline increased their *BI* by 1.5 mg/kg, with 30% more responders in the high iron compared to the control group. Conclusions: Consumption of iron-biofortified beans over 4.5 months improved iron status in iron depleted Rwandan women.

Grant Funding Source: *HarvestPlus/IFPRI*

Effects of an Iron-biofortification Feeding Trial on Physical Performance of Rwandan Women

Sarah Luna[1*], Mercy Lung'aho[2], Jean Bosco Gahutu[3] and Jere Haas[1]

Objectives: To examine the effects of an iron-biofortified bean intervention on physical performance in Rwandan women assessed by VO2max and work efficiency.

Methods: 145 Rwandan women (18-26 years) were randomized to receive either iron-biofortified beans or traditional beans twice daily for 5 months. Blood biomarkers and physical performance were measured before and after the feeding period. VO2max and work efficiency at 70 watts were assessed with a mechanically braked cycle ergometer (Monark 874E). Heart rate, O2, and CO2 were directly measured with the Cosmed K4B2 system. Non parametric tests and mixed effects models with repeated measures were used to evaluate the effect of the intervention on blood biomarkers and VO2max and work efficiency.

Results: Serum ferritin significantly increased in the iron-biofortified group (4.0 µg/l increase in median in treatment group, 2.5 µg/l increase in median in control group; p=0.04). VO2max significantly increased in the iron-biofortified group compared to the control group (p=0.05). Work efficiency at 70 watts significantly increased over time but was not different between groups.

Conclusions: Consumption of iron-biofortified beans significantly improved serum iron status and VO2max in Rwandan women but had no effect on work efficiency.

Effects of consuming an iron-biofortified bean on behavioral and electrophysiological measures of attention

M Wenger PhD[1,2], S Rhoten[1], S Scott[3], L Murray-Kolb[3], M Lung'aho[4], J-B Gahutu[5] and J Haas[2]

+ Author Affiliations

Abstract

Iron deficiency (ID) can produce deficits in cognition and brain dynamics, and repletion may reverse these changes. We conducted a double-blind efficacy study involving healthy female students (n = 239) screened for low iron status. Participants were randomized to groups that consumed either a high-iron-biofortified (BB) or a normal-iron bean (CN) for 20 weeks. A subsample (n = 53) performed cognitive tasks while concurrent EEG was acquired at baseline (BL), endline (EL), and at one of eight random time-points in between. Cognitive tasks included (a) a measure of perceptual speed (simple reaction time, SRT); (b) a test of inhibitory control (go/no-go, GNG); and (c) an assessment of three aspects of attention (attentional network task, ANT). Small but significant improvements from BL to EL were observed for hemoglobin, ferritin, and total body iron, with larger improvements for the BB vs CN group. Behaviorally, there were no improvements in the SRT, possibly reflecting a floor-effect. Significant condition (BB, CN) x time interactions were obtained for the behavioral measures from the GNG and ANT. The EEG data revealed significant differential increases for the BB vs CN group in the amplitudes of two components (N1 and P2), and normalized spectral power in two frequency ranges (alpha and gamma) that index aspects of attention in all three tasks. The results suggest that consuming BB may benefit behavior and brain function.

Iron Biofortification of Beans Can Improve Nutrition

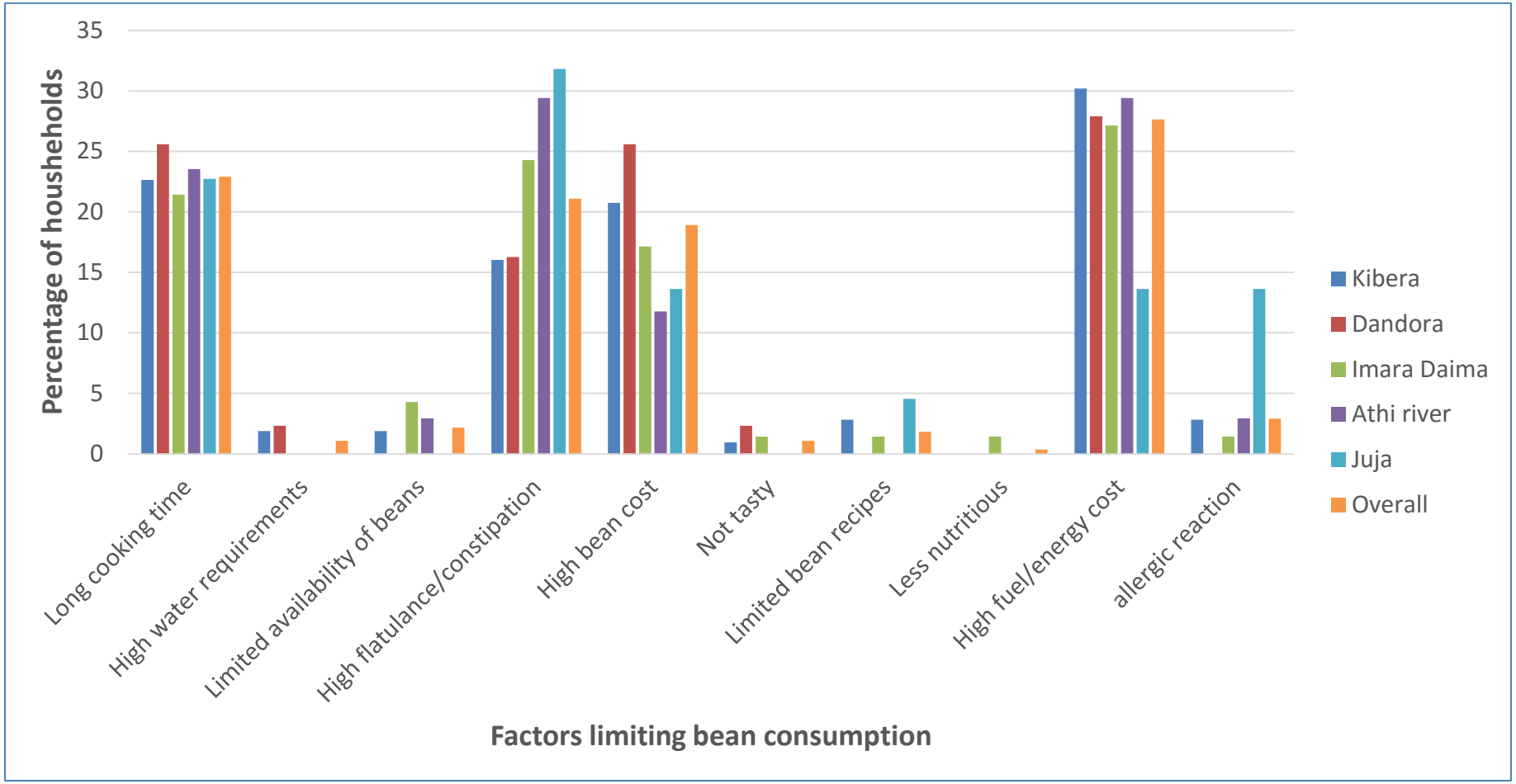
Q1. Has breeding increased iron concentration in beans to levels that could improve nutrition? YES

Q2. Is the extra iron bioavailable at sufficient levels to improve micronutrient status in target population? YES

Next Step?
Commercialization and Mainstreaming into value chains

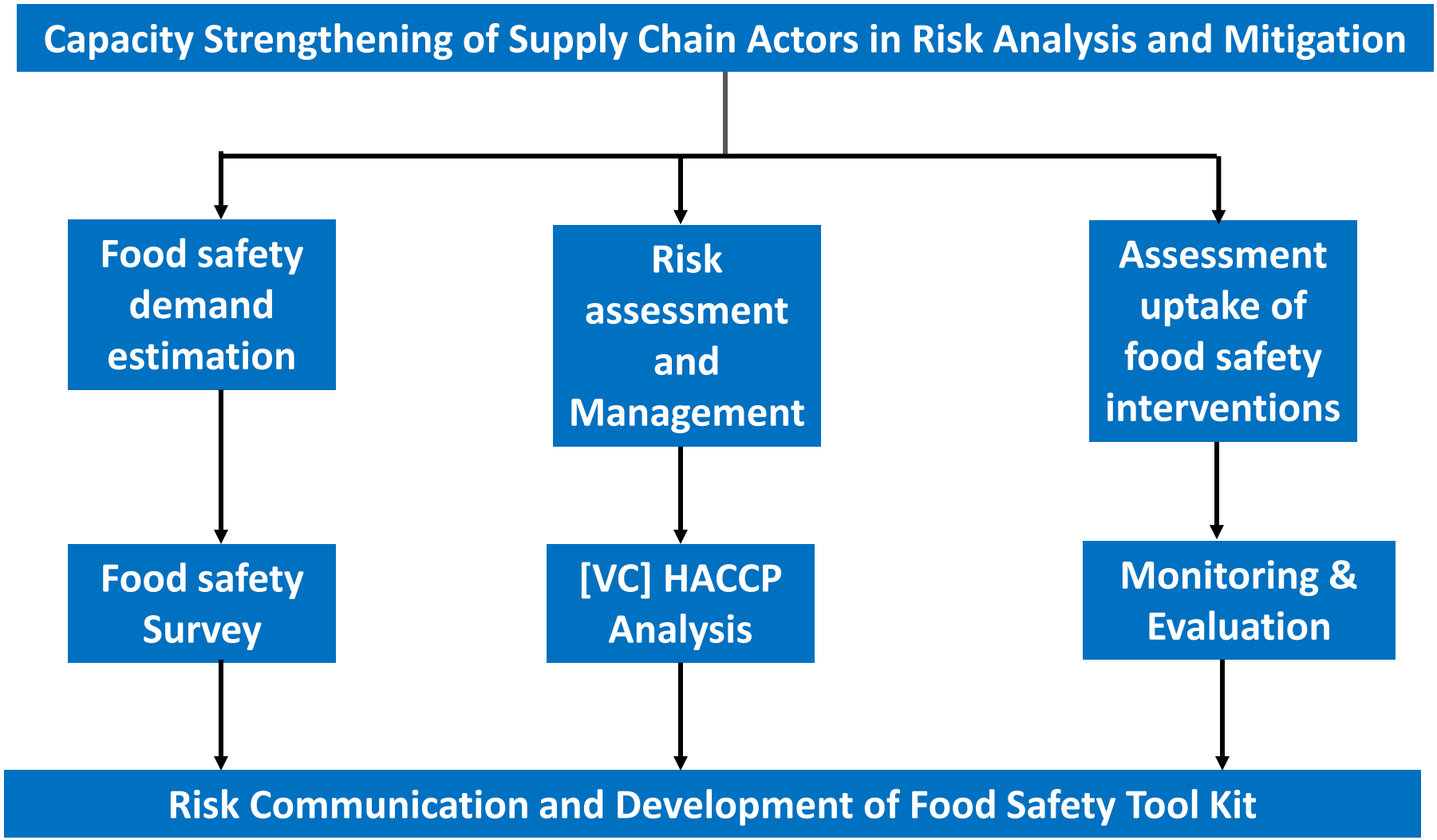
Photos: Neil Palmer (CIAT)

Factors Limiting Beans Consumption in Kenyan Sample



Key constraints: High fuel/energy cost (28%); Long cooking time (23%); High flatulence (21%); High bean cost (19%)

Food Safety Priorities



Food safety framework