Common bean as a protein source for individuals eating a plant based diet

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Grain legume as a source of nutrients for a poor resource community

- Grain legumes in Sub-Saharan Africa play a vital role by being a source of livelihoods for millions of people.

- In Sub-Saharan Africa, where diets are usually based on carbohydrate staples, grain legumes (mainly dry beans, cow peas, and groundnuts) provide an excellent low cost source of high quality protein and micronutrients.
Grain legume as a source of nutrients for a poor resource community

- They have the potential to contribute to the alleviation of malnutrition among resource poor farmers
Grain legume as a source of nutrients for a poor resource community

- The grain legume protein content, mainly in the form of phaseolin, has balanced amino acids that complement that of cereals, roots and tubers when eaten together.

- This greatly improves the protein quality of the combined food, especially when eaten in balanced ratios (Broughton et al., 2003; Hillocks et al., 2006).
Grain legume as a source of nutrients for a poor resource community

- The protein sourced from grain legumes costs one-fifth as much as protein from milk, hence the name ‘poor people’s meat’

- The crop can provide up to 25% of the total dietary caloric intake and 45% of the protein intake (KilimoTrust, 2012).

- Grain legumes contain a larger variety and concentrations of micronutrients (i.e. most B vitamins, iron, calcium and zinc) compared with cereal crops
Grain legume as a source of nutrients for a poor resource community

- In humans, iron is essential for preventing anemia and for the proper functioning of many metabolic processes

- While zinc is essential for adequate growth and sexual maturation and for resistance to gastro-enteric and respiratory infections, especially in children (Bouis, 2003).

- Grain legume are also as a good source of dietary fiber
Grain legume as a source of nutrients for a poor resource community

- This makes grain legumes a strategic food in the diets of young children and women of reproductive age, who are the most vulnerable to micronutrient deficiencies.

- In Eastern and Southern Africa, common bean (*Phaseolus vulgaris* L.), also referred to as dry bean, is the most widely and frequently consumed legume.
Grain legume as a source of nutrients for a poor resource community

- The advances in breeding, especially the application of biofortification in common bean breeding, further position it in the diets of poor households as a strategic remedy for anemia, which is a widely prevalent nutritional issue in the region (Larochelle et al., 2013; Asare-Marfo et al., 2013)

- The common bean is a source of some vitamins and minerals including iron and zinc

- Fe concentrations in beans are high relative to the cereals and therefore beans can deliver substantial increased amounts of Fe
# Nutritional quality of common bean

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Value</th>
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<tbody>
<tr>
<td>Protein</td>
<td>22-25%</td>
</tr>
<tr>
<td>Energy</td>
<td>32%</td>
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<tr>
<td>Fibre</td>
<td>56%</td>
</tr>
<tr>
<td>Iron</td>
<td>70ppm (improved iron-rich bean varieties with 75 – 110 ppm released and commercialized in Rwanda)</td>
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<tr>
<td>Zinc</td>
<td>30 ppm (zinc-rich beans released and commercialized in Rwanda with 30 – 40 ppm)</td>
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Grain legume as a source of nutrients for a poor resource community

- Eating beans several times a week may decrease the risk of coronary heart disease, diabetes, colorectal cancer, and helps with weight management (Heller, 2011)

- It is therefore important that every household in poor dwelling consumes bean in sufficient quantities
Bean as an income generation crop

- Poor households in SSA do not only depend on legumes for their nutritional needs but also sell them in order to meet other household financial needs, such as school fees and essential non-food items.

- In particular, bean trade has been growing over the past decades, with unknown consequences on bean availability for own consumption among bean-producing households.
Common bean production in Rwanda

- The bean is prepared in various recipes as a mixture with other foods such as bananas, cassava, potato, etc.

- It is eaten either boiled or fried as a relish served with other food (Potatoes, sweet potatoes, cassava and banana) or crushed and fed to children.
Common bean production in Rwanda

- In Rwanda and most East African countries, common bean plays an important role for food security and income generation and is produced for subsistence agriculture and for regional markets.

- Nearly all farmers (85-90%) in Rwanda produce bean (NHS, 2011)
Common bean production in Rwanda

Production of dry bean ranged from 200,000 MT to 330,000 MT from 2001 to 2010 (Figure.1).

- Brazil produces more than 3 times while North America produces more than 2 times Rwanda’s production (Ferris et al., 2002).
Common bean production in Rwanda compared to EAC

<table>
<thead>
<tr>
<th>Country</th>
<th>Production between 2001-2010 (MT)</th>
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<tbody>
<tr>
<td>Rwanda</td>
<td>2,700,745</td>
</tr>
<tr>
<td>Uganda</td>
<td>4,715,000</td>
</tr>
<tr>
<td>Tanzania</td>
<td>3,361,207</td>
</tr>
<tr>
<td>Kenya</td>
<td>3,983,428</td>
</tr>
<tr>
<td>Burundi</td>
<td>2,222,714</td>
</tr>
</tbody>
</table>
Common bean production in Rwanda

Percentage of farmers producing bean
Common bean consumption in Rwanda

- Per capita consumption varies with each producing and consuming country and also among regions within a country depending on consumer preferences but can be as high as 66 kg/capita/year in Rwanda and parts of western Kenya (Broughton et al. 2003).

- Averages in the Americas are from 4-5 kg/capita/year in the United States, to more than 10 kg/capita/year in Brazil to as much as 35 kg/capita/year in Nicaragua.
Protein Energy malnutrition in Sub-Saharan Africa VS Bean consumption

WHO defines malnutrition as:” the cellular imbalance between the supply of nutrients and energy and the body’s demand for them to ensure growth, maintenance and specific functions”.

Malnutrition is the condition that develops when the body does not get the right amount of the vitamins and minerals and other nutrients it needs to maintain health tissues and organ function.
Nutritional status

In Rwanda,

- 38% of under five year old children are stunted
- 3% of under five year old children are wasted
- 11% of under five year old children are underweight
Nutritional status

- Iron (Fe) deficiency is the most common nutrient deficiency worldwide and the consumption of Iron fortified bean can greatly contribute to the downing of Fe deficiency.

- In Rwanda, anemia is also a critical public health problem where more than one third (38 percent) of children age 6-59 months are anaemic.

- A major cause of Fe deficiency is low bioavailability from plant-based diets containing mineral absorption inhibitors such as polyphenols.
Nutritional status

- Breeding high iron and high bioavailable bean would be one of the solution for anemia in a community with high bean consumption.
Common bean contribution to the alleviation of malnutrition

Common causes of malnutrition

- Improper breastfeeding practices
- Improper complementary feeding... Mothers should be taught to include common bean in the complementary foods
- Over crowding family
- Ignorance
- Illiteracy
- Lack of health education
- Poverty
- Infection
- Familial disharmony
Common bean contribution to the alleviation of malnutrition

Prevention:

- Promotion of breastfeeding
- Development of low cost complementary feeding foods. *In Rwanda, 50% of under two year old are fed on legumes and nuts*
- Nutrition education and corrective feeding practices
- Food fortification
Gut Health

- Ability of the gut to absorb all the necessary nutrients in adequate quantities
- Provide an effective barrier against a large population of microbes in a diversity of environs
- Mount an appropriate immunological response when microbial incursion occurs – vigorous enough to prevent infection, controlled enough to prevent chronic inflammation
The gut is the interactive external body surface

- The surface area of the gut is $40 \text{ m}^2$
- Its purpose is to interact with the nutrients, non-nutrients and microbes
- The gut needs to differentiate between food and germs.
- The gut surface is protected by mucous and a rich variety of immunologically active cells
The Microbiota

- The ecological community of commensal, symbiotic, and pathogenic microorganisms within our bodies
- Human gut has 100 trillion microorganisms; 100-fold more genes than the human genome
  - Anaerobic bacteria
  - Archaea
  - Yeast
  - Parasites
- Individual “finger-print” specificity – each person has a unique profile of organisms regulating their microbiome
- Complex and dynamic – it is constantly evolving and changing based on exposure
Role of the Microbiome

Gut microbiota influence the growth and differentiation of gut epithelial cells and play pivotal nutritive, metabolic, immunological and protective functions.

- Efficient extraction of calories from ingested food
  - Fermentation of non-digestible polysaccharides
  - Provision of short-chain fatty acids
- Enzymatic reactions of the microbiome aid in
  - Host homeostasis
  - Food digestion, absorption
  - Synthesis of micronutrients - Vitamins K, multiple B vitamins, H₂, CO₂, Methane, Lysine, Conversion of Urea to Ammonia
- Detoxification
  - Modulates enterohepatic circ of compounds detoxified by the liver
- Epithelial development
- Immune function
  - Stimulates the growth of enterocytes
  - Commensal organisms protect from pathogens
Core Microbiota

- All healthy adults share most of the same gut bacterial species
- Vast microbial diversity that is highly variable over time and across populations
  - Over 7000 distinct phylotypes have been detected in the human distal gut
- Adult Taxonomic Divisions
  - Bacteroidetes – fat and protein digestion
  - Firmicutes
  - Minor: Actinobacteria, Proteobacteroa and Verrucomicrobia
  - Methanogenic archaea, eukaryotes, viruses
- Proportions of micro-organisms vary person-to-person
Functionality of the Core Microbiome

- The activity and composition of the microbiota is affected by genetic background, age, diet, and health status of the host
- Understanding function
  - Ex-vivo phenotype experimentation
  - DNA
  - Active mRNA, protein and metabolite profiles
- Central, carbohydrate and amino-acid metabolism
During life the microbial composition increases in both diversity and richness and reaches highest complexity in the human adult, with several hundred species-level phylotypes dominated by the phyla *Bacteroidetes* and *Firmicutes*.

Thank you for your attention