SIMULTANEOUS SELECTION FOR DROUGHT TOLERANCE, CANNING AND NUTRITIONAL QUALITY, AND AGRONOMIC TRAITS IN COMMON BEAN

(Phaseolus vulgaris L.)

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Contents of the presentation

• Introduction
• Problem statement
• Justification
• Objectives
• Materials and Methods
• Expected Results
• Work plan
• Budget
Introduction

• Common bean (*Phaseolus vulgaris*, L.) is most important food legume in the world (CIAT, 2001).
• In Africa, an estimated 3.7 million ha is grown with beans every year (Wortmann et al, 1998)
• In eastern Africa, beans play an important role in food and nutrition security and income generation.
• Beans are not only an important source of protein (>20%), but also are one of the best sources of minerals (especially Fe, Zn, Ca) and dietary fiber, and hence referred to a ‘near perfect food’ (CIAT, 1995).
• Globally, more than 2 billion people suffer from micronutrient malnutrition (‘hidden hunger’) especially lack of iron and zinc
• In urban areas, one important form of consumption is canned beans.
• Consumption of canned bean is likely to increase with urbanization, due to changing eating habits (with preference for fast cooking foods), and rising costs of cooking fuel.
• Productivity is however threatened by frequent droughts, associated with climate change and variability.
• Breeding for drought tolerance, resistance to biotic stresses, enhanced nutritional value is probably the most effective strategy of ensuring food and nutritional security and resilience in the face of climate change and variability and growing demand for beans.
Problem statement

• Bean is grown by resource poor small holder farmers with very limited access to external inputs such as irrigation, fertilizers, fungicides and insecticides.
• More than 60% of world beans produced under risk of drought (Thung and Rao, 1999).
• In eastern Africa, drought is major abiotic constraint.
• Limited work has been done to develop drought tolerant bean varieties in eastern Africa (Kimani et al., 2009, 2010).
• More than 2 billion suffer micronutrient malnutrition or hidden hunger.
• Fe and Zn are the most common deficient micronutrients in local diets
• Biofortification is the most effective, low cost and sustainable strategy for fighting hidden hunger in eastern Africa (HarvestPlus, 2006; Kimani et al., 2001, 2002, 2007, 2010 and 2011)
• Growing preference for fast cooking foods, pre-cooked or canned foods due to rapid urbanization and high costs of cooking fuel
Problem statement ..continued

• Available canning bean varieties such as Mex 142 are low yielding, highly susceptible to rust, angular leaf spot, common bacterial blight and drought (Kimani et al, 2001)
• For a farmer, tangible agronomic traits are more important than any superior quality traits
• There are no varieties that combine drought tolerance, resistance to biotic stresses, nutritional quality and canning quality at present in the region
Justification

• Drought tolerant variety is best option in drought-prone areas.
• Most low cost and sustainable approach to reduce hidden hunger is to develop micronutrient-rich beans.
• Urbanization and changing eating habits of bean consumers in favor of fast cooking or pre-cooked foods.
• Thus, the challenge is to combine these traits into agronomically superior variety.
OBJECTIVES AND HYPOTHESIS

• GENERAL OBJECTIVE: to identify Common bean genotypes that are agronomically superior, drought tolerant, with good canning and nutritional quality.

• specific objectives:
  1. To assess agronomic and drought tolerance traits of bean genotypes.
  2. To assess iron and zinc concentrations in seeds of common bean genotypes.
  3. To determine canning quality of common bean genotypes.
Materials and Methods

- **Field trials:**
  - **Plant Materials**
  - **Advanced lines from two genetically diverse populations**
    - 436 advanced lines variable for drought tolerance
    - 105 F\textsubscript{6} lines selected from Biofort nursery (with multiple traits including Fe and Zn concentration)
    - 16 checks will be included.
  - **Experimental sites**
    - Trials will be conducted at Kabete Field station and KARI-Thika research station for two seasons.
  - **Experimental design and treatments:** Split plot design design with two replications
    - **Main plots:** Irrigation treatments
      - Stressed
      - non-stressed
    - **Subplots:** genotypes
Conceptual Framework

- Number of genotypes
- Germplasm working collection
- Evaluation and selection for agronomic traits
- Drought phenotyping
- Fe and Zn analysis
- Canning quality
Data Collection

• **First season**: Evaluation of test lines under stress and non-stress condition and selection for agronomic traits
  – Growth habit,
  – Plant vigor
  – Days to flowering and maturity
  – Disease incidence and severity (using CIAT,1987 scale)
  – Grain yield

• **Second season**: Selection for drought tolerance, micronutrient density and canning quality
  – Besides agronomic traits, data on drought tolerance related traits will be collected. This include: leaf chlorophyll content, canopy temperature, harvest index, drought intensity index (DII) and drought susceptibility index (DII).
  – Samples will also be analyzed for Fe and concentration
  – Samples harvested in season 2 will evaluated for canning quality

• Soil moisture will be quantified. Met data on daily rainfall, minimum and maximum temperature, relative humidity and pan evaporation for both sites will be obtained.
Determination of Fe & Zn concentration

• Seed samples will be washed, oven-dried and ground. Then samples will be prepared by digestion with a mixture of perchloric and nitric acid prior to elemental analysis (Zarcinas et al, 1987)

• Elemental analysis will be determined by atomic absorption spectrophotometry (AAS), (AOAC,1995).
Determination of canning quality

Pre-canning stage:

• **Cooking time**: Matson cooker method will be used to determine cooking time (Matson, 1946). Mex142 will be used as check.

• Samples will soaked overnight (16 hours) and then cooked in distilled water at 95°C. Seed will be considered cooked when tip of steel rod has dropped through the bean seed.

• Duration of cooking will be determined with a stop-clock

• **Water uptake**: 16 g of beans will be soaked in 100ml of distilled water at 20.5 ± 0.5 for 16 hours (Berrios et al., 1999).
  – Number of soakers and non-soakers will be determined
  – Samples will be weighed to determine water uptake after 16 hours
Canning evaluation

• **Canning stage:** this stage will be conducted at Pilot plant, Department of Food Science, Nutrition and Technology following procedures of Uebersax and Hosfield (1996).

• Beans will be soaked in hot water (80-100°C) for 10 minutes, then filled in M1 (0.5kg) cans of which 60% is beans and 40% brine. Cans will be seamed using semi-automated machine INDOSA ® can seamer.

• Canned beans will be weighted, labeled and transferred to retort for sterilization. The retort is heated up to 121°C for 45 minutes.
Pilot food processing Plant-CAVS

Blanching  Seaming

Retort  Cooling system  Recorder

Steam generation and regulation

Source: Kimani et al, 2012
Evaluation of Canned beans

- **Post canning stage:** sterilized beans will be left in the shelves for two weeks then evaluated. Data will be recorded: hydration coefficient (HC), washed drained weight (WDWT), and percentage of washed drained weight (PWDWT).

- Also visual evaluation for seed size, shape, uniformity, will be done using 7-1 scale (Uebersax and Hosfield, 1996).
Data analysis

• Data collected will be subjected to analysis of variances (using GENSTAT software) at significance level (0.05).
Expected results

1- At least one or two of bean genotype(s) that combine good agronomic traits, drought tolerance and, good canning and nutritional quality will be identified.

2- M.Sc thesis will be obtained.

3- At least one journal article will be published.
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