Sustainable African Indigenous Vegetable Production and Market-Chain Development for Improved Health and Nutrition and Income Generation by Smallholder Farmers in Kenya, Tanzania and Zambia

Institutional Collaborators:

U.S. - Purdue University, PI - Stephen Weller, Rutgers University, PI – James Simon
Kenya - AMPATH, University of Eldoret, KARI, Fintrac
Tanzania - AVRDC, Horticulture Research Institute, Sokoine University, St. John's University
Zambia - ASNAPP

African Indigenous Vegetables Tested


African Nightshade


Amaranthus


Spider plant

Two Goals: Build Local Scientific and Farmer Capacity For Increased Small Producers' Participation in African Indigenous Vegetable Markets

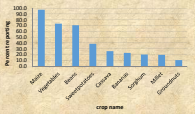
Objective 1. Evaluate the status of the Growers, AIV Market Chain and Identify the Needs for Improvement of the Chain and Program Impacts

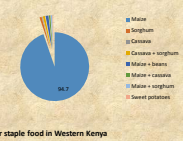
Objective 2: Evaluate Agronomic Potential of Improved AIV Germplasm and Develop Improved Production Techniques

Objective 3: Evaluate Best Preparation and Preservation Techniques that will Enhance Micro-nutrient Composition and Retention.

Objective 4: Build Capacity of Stakeholders (Farmers, Marketers, Scientists and Graduate students) in the AIV Market Chain

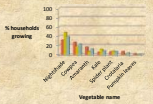
Objective 1. Household Survey Results*



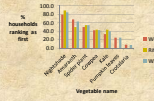


Major crops grown by households in Western Kenya

Major staple food in Western Kenya



Adoption of AIVs in Western Kenya



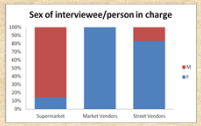
Ranking of AIVs in Western Kenya

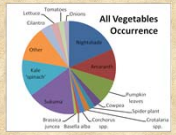
Key Findings of Household Survey in Kenya

- There was variation in AIV type preferences across regions. African nightshade was the most preferred AIV in the Rift valley; Amaranth and Spider plant were the most preferred in western regions
- The key socioeconomic constraints in AIV value chain were high price of fertilizer, poor quality seed and lack of money to buy fertilizers and the major biophysical constraints were drought, pests and low soil fertility
- Households were headed by people of about 49 years of age
- 59% of the households were male headed of whom 53% were primary school level
- A majority of the household heads were married, living with their spouses
- An average household size was 6 persons.
- Landholdings are small, averaging 2 acres per household
- Women are the main contributor of household labor to AIV production
- About 70.9 % of the households sold some AIVs
- Most sales were to other farmers rather than large commercial enterprises
- Most households (92.1%) obtained the AIVs they consumed from their own-farms
- Limited processing of AIV was done and boiling was the common processing and consumption method

*Results in Tanzania and Zambia followed similar trends

Objective 1. Market Survey Results





Objective 2: Evaluate Agronomic Potential Of Improved AIV Germplasm and Develop Improved Production Techniques

Impact of Fertilization on African Indigenous Vegetables, conducted in Kenya, Tanzania and Zambia

- 3 varieties of each AIV species (2 improved varieties from AVRDC and a local variety)
- Fertilizers : farm yard manures (chicken and cattle manures), applied at rate of 20 t/ha, three inorganic fertilizers that included Urea (200kg/ha), Minjingu Mazao and NPK and a control (0 MT /ha Kenya and Tanzania tested farm yard manure, commercial fertilizer vs. 0 fertilizer
- Data included mature leaf harvest (Fresh weight) every 2 weeks for 3 harvests and cumulative yield

AIVs had increased quality and yield in response to all organic and inorganic fertilizers compared to 0 fertilizer.
Key goal is to next provide for year-round supply of AIVs with grower groups accessing water tanks, drip irrigation, peddle pumps and more.

Common AIV Insects and Diseases

Insects	Diseases
Early stages of crop growth	
Cutworms (*Agrotis* spp) **A, N, S***	Damping off (*Pythium* spp)
White grubs, bagrada bugs S	
Crickets	
[Birds]	
Vegetative to flowering stages	
Aphids (*Aphis fabae, Myzus* sp) A, N, S	Leaf spots (*Alternaria & Septoria* spp) A, N
Flea beetle (*Phyllotreta mashonana*) , N, S	Late blight (*Phytophthora* spp) A, N
Leafminer (*Liriomyza* sp) A	
Whiteflies (*Bemisa* sp) **A, N, S**	
Thrips (*Frankliniella sp*) S	
Flowering to senescence	
African bollworm (*Helicoverpa armigera*)	
Flower bugs (*Bagrada* spp)	
[Birds] **A, N, S**	

*A = Amaranth, N = Nightshade, S = Spider Plant

Measurements of AIV nutrient levels in Tanzania*

Nightshade Nutrient Levels – Example - Leaves samples at various days after seedling emergence and analyzed for phytate, No3, Vitamin C, Fe, Zn and Se. Similar measures for Amaranthus and Spider plant and data are available if requested. Analysis and comparisons with other vegetables is ongoing.

	Days after nightshade emergence					
	21		28		35	
Nutrient mg/100g	BG-16	SS-49	BG-16	SS-49	BG-16	SS-49
Phytate	03	.15	.2	.3	.3	.43
NO3	66	85	64	80	63	75
Vitamin C	49	27	49	66	115	107
Oxalate mg/Kg	28	42	38	55	59	60
Fe	273	230	345	411	845	850
Zn	71	57	54	51	43	43
Se	420	405	2190	720	285	1500

*Similar measurements have been conducted in Kenya in the agronomic studies with all AIV lines and species

AIV Seed Evaluation Trials

- 3 species of Africa indigenous vegetables; African nightshade (*Solanum scrabrum*), Spider plant (*Cleome gynandra*) and Amaranth (*Amaranthus cruentus*) at the Kenya Agricultural Research Institute (KARI) in Alupe in 2013.
  - Days to flowering - The days to 50 % flowering were 28 days for Spider plant ML-SF-29 and 35 days for the local and commercial variety, for amaranth ranged between 35 days (AC-45) and 98 days (AC-38) and for African nightshade were 48 days in SS-04.2 and all the rest were 52 days

Information on seed germination obtained at University of Eldoret

- The AIVs (nightshade, amaranth and spider plant) require an after-ripening period to ensure proper development of the embryo, break physical dormancy and ensure germination
- Fertilizer use in cultivation increased seed size and germination %
- Seeds of *Solanaceae* family contain germination inhibitors in the seed coat which may contribute to the lower germination potential in freshly harvested seeds
- 2 varieties each of African nightshade (BG16 and Ex-Hai), Amaranth (AC-38 and Ex-Zim) and spider plant (PS and ML-SF-29 have been submitted for Kenyan DUS tests and eventual commercial release
- 2 trainings for farmers and staff under the HIL project on AIV seed storage using neolite drying beads (collaboration with HIL seed storage project) were held at KARI-Kakamega. 20 participants - 7 farmers and 13 staff from AMPATH and KARI

Training:

- Composition, characteristics, source and cost of the drying beads
- Advantages of using drying beads verses other drying substances like silica gels
- How to dry beads to required moisture contents
- How to measure moisture absorption capacity of the beads
- How to determine the weight of seeds and beads using the drying bead calculator

- Trials of seed storage using drying beads being implemented by KARI

Objective 3. Value Addition - Drying Vegetables and Nutrient Composition and Quality of Dried AIVs

Solar Dryer – modified design from UC Davis (Mike Reid) – dry AIVs in 3 hours vs 24+ hours in Mace GH, functional and ready for replication.

Moisture content of dried vegetables derived from the tunnel solar dryer ranged from 4.5% to 8.2% compared to Mace foods dried leaves of 9.2% to 12.8 %. Will analyze leaves for N, Ca, Fe, Mg and Vitamin C.

Chemical analysis and assistance to Mace Foods, Kenya and Sylva's Catering, Zambia for nutrient content and antioxidant activity for each of their packaged AIVs.

Samples from Mace Foods, Eldoret, Kenya for Spider Plant (Saga), Black Nightshade (Managu), Amaranth (Dodo) *and* Cowpea Leaves (Kunde) were measured for total moisture, ash and acid insoluble ash and elemental analysis (see table below). Results were positive for quality and nutrient content compared to exotic vegetables. *Solanum* samples had alkaloid levels in low range and had an unusually low amount of α-solanine, a major alkaloid in nightshade

Nutrient Composition of Dried AIVs from Kenya and Zambia (Mace Foods and Sylva's Foods)

Species	Ca (g/100g)	Mg (g/100g)	K (g/100g)	Fe (ppm)	P (g/100g)	Zn (ppm)	Mn (ppm)	Vitamin A (IU via β-carotene)
Amaranth	2.79	1.23	1.99	32.30	0.41	6.70	15.50	4855 ± 3.1%
Nightshade	1.02	0.31	1.86	35.70	1.86	3.70	8.75	5842 ± 8.9%
Spiderplant	1.52	0.43	0.94	58.80	0.94	4.60	9.98	7300 ± 39%
Spinach*	0.99	0.79	5.58	27.1	0.49	5.3	10.2	9377
Kale*	2.63	0.82	8.59	25.7	1.61	0.98	9.08	9990

*Data for spinach and kale from USDA nutrient database not from comparative field-grown varieties in Africa.

Evaluate Oganoleptic, Vitamin Retention and Micronutrient Bioavailability in Improved AIV Recipes

- Recipe Cookbook in review from AVRDC for publication in 2014
- Sensory evaluations conducted in Kenya and Tanzania (pictures at KARI in Kenya)

- Cooking and consumption and evaluation
- Vitamin retention and nutrient levels in- progress in Kenya vitamin A and C and N, Ca, Fe and Mg in cooked AIV recipes

Objective 4. AIV Outreach,Training and Capacity Building

Training - germplasm, agronomics, seed collection and storage, field demonstrations, seed fairs

Capacity building – graduate students Kenya, Tanzania, US-Purdue and Rutgers, host country collaborators, private sector - Mace Foods, Sylva Foods, Sun International Hotels

Training Courses in Tanzania*

- Vegetables and Seed production
  - Arusha trainings – 149 farmers, 74 female, 75 male
  - Seed Fair - 269 farmers, 104 female, 165 male, 6 seed companies
- Production practices (amaranths, nightshade and spider plant)
  - Nursery management
  - Plant protection (safe use of pesticides)
  - Preservation of vegetable by drying, postharvest practices
  - Nutritional value of vegetables for balanced diet
  - Recipe preparation and utilization of AIVs
  - Safety and hygiene
- Training Materials Provided
  - Production leaflets for amaranth, nightshade and spider plant
  - Recipe leaflets
  - Garden Seed Packets

*Similar trainings done in Zambia and Kenya with 1000 total farmers trained (~60% women)

Steps in AIV Harvest and Handling

- Training on harvest during the cooler times of day (in the early morning or even at night if possible)
- Use of shade after harvest
- Cool AIVs after harvest whenever possible
- Coolbot demonstrations and experiments in Zambia
  - Evaporative cool storage

Collaborative Agreements

The HIL - AIV project partnered with four groups of fifteen to twenty farmers in western Kenya associated with the USAID-KHCP, to introduce groups to AIVs and train them on agronomic practices, harvesting, postharvest, seed saving and market connections. None had grown AIVs before.

Kakamega-Blessed Development Youth Group;
Bungoma- Muanda Support Group;
Bungoma- Tunapo Self Help Group;
BUSIA-Budinyu Bwe Dala;

- All groups were able to grow and harvest AIVs and market locally.
- USAID Mission highlighted this work and its economic impact on the groups in a November 2013 newsletter.
- Fintrac in Kenya –AIV to KHCP smallholder collaborators
- Seed Storage HIL project
- CASH Project in Zambia- A GDA now including AIVs

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