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

Our two overall objectives are to build local scientific and technical capacity and apply research findings and technical knowledge to increase small producers' participation in African indigenous vegetable markets

- Institutional Collaborators:
- U.S. - Purdue University, Rutgers University
- Kenya - AMPATH, University of Eldoret, KARI (Fintrac)
- Tanzania - AVRDC, Horticulture Research Institute, Sokoine University, St. John's University
- Zambia - ASNAPP

Objective 1. Evaluate the status of the AIV market chain, identify the needs for improvement of the chain and program impacts

1.1 Household survey to obtain basic demographic data, current knowledge and challenges of production practices of AIVs, postharvest handling practices, household consumption patterns, preparation methods, and market accessibility.

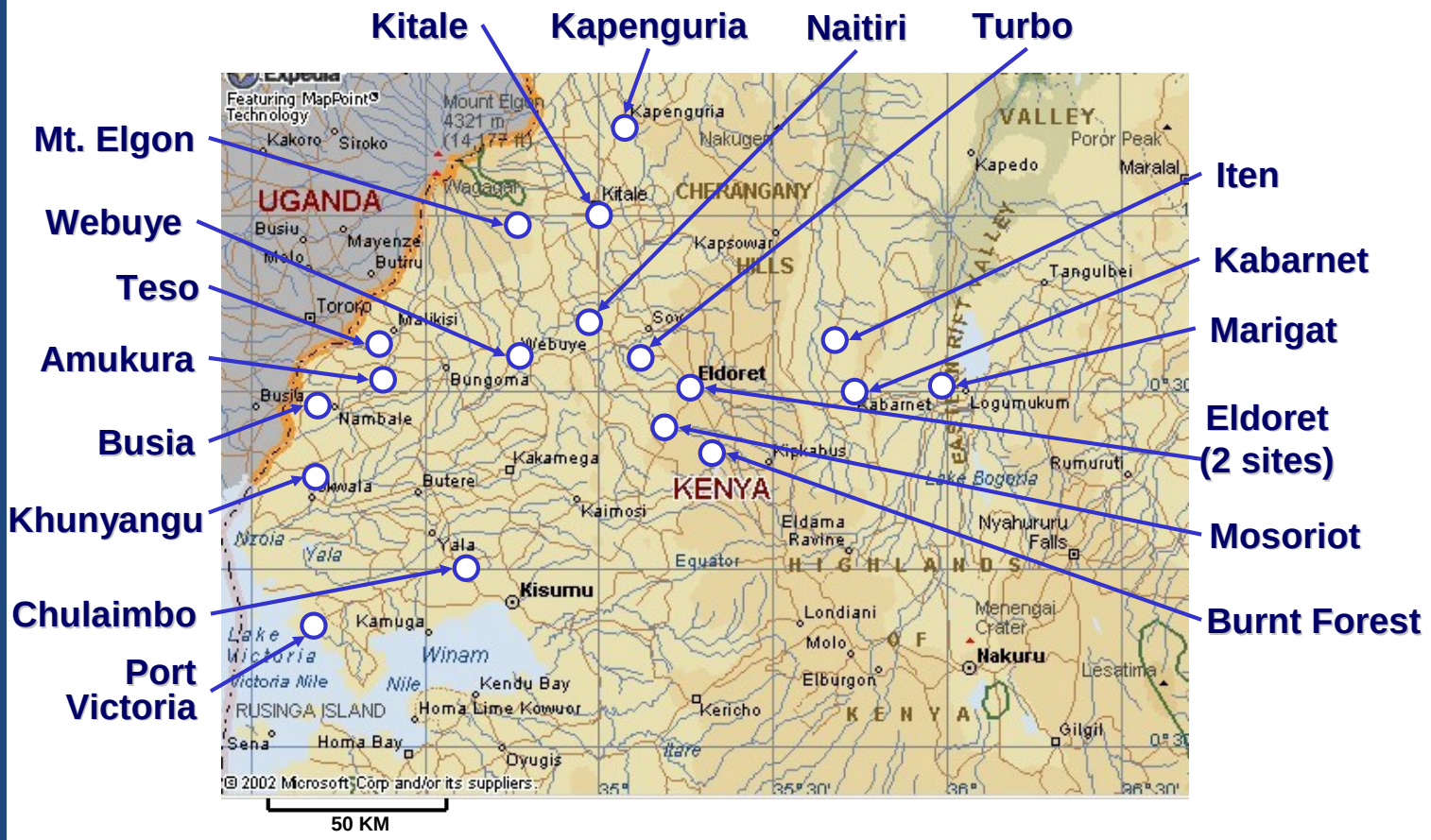
Done in Kenya, Tanzania and Zambia

1.2 Market survey to understand existing linkages between AIV producers and market chain actors.

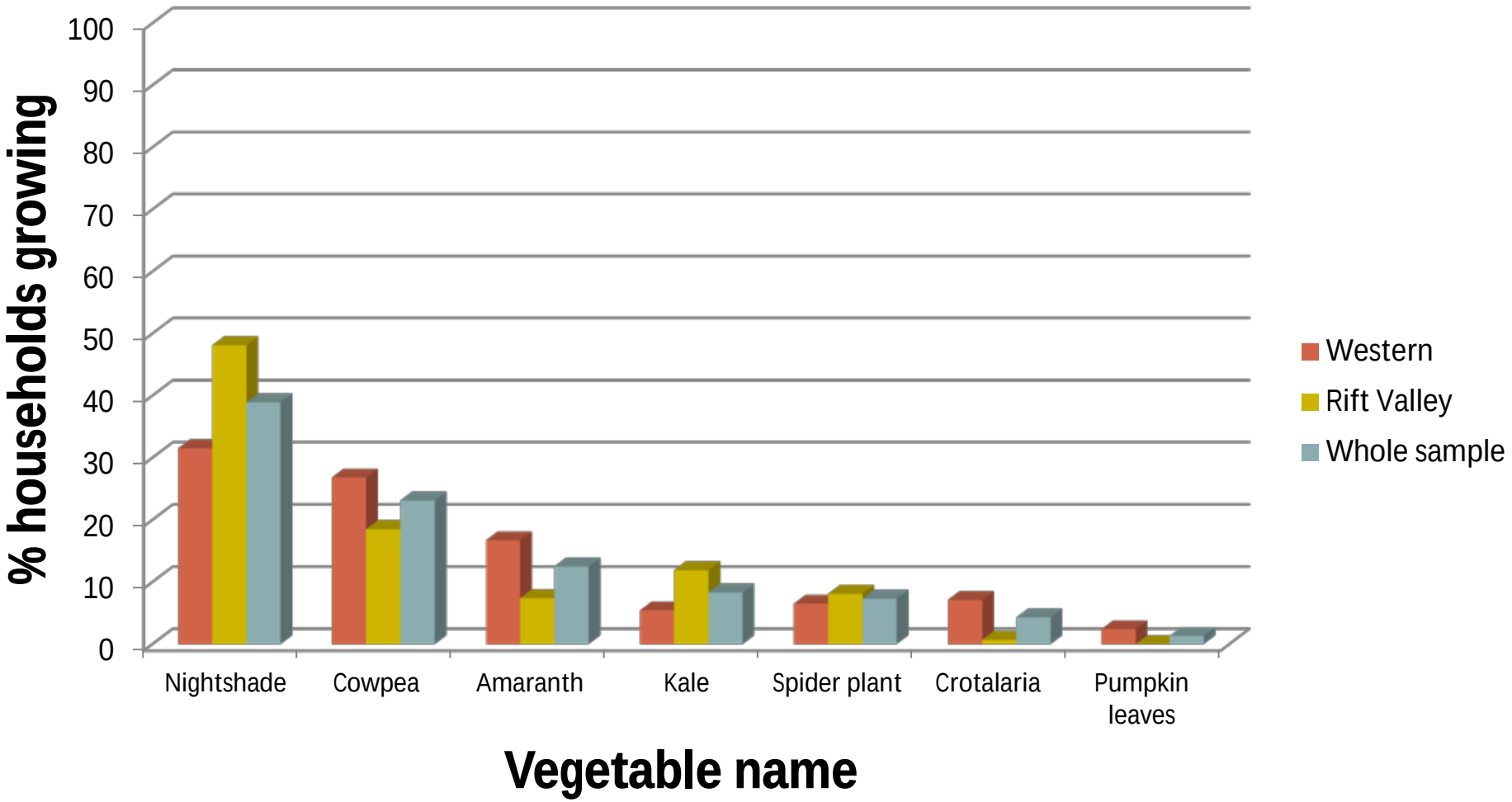
In – progress – 2013-2014

1.3 Follow-up survey to assess the outcomes of project interventions along the AIV value chain.

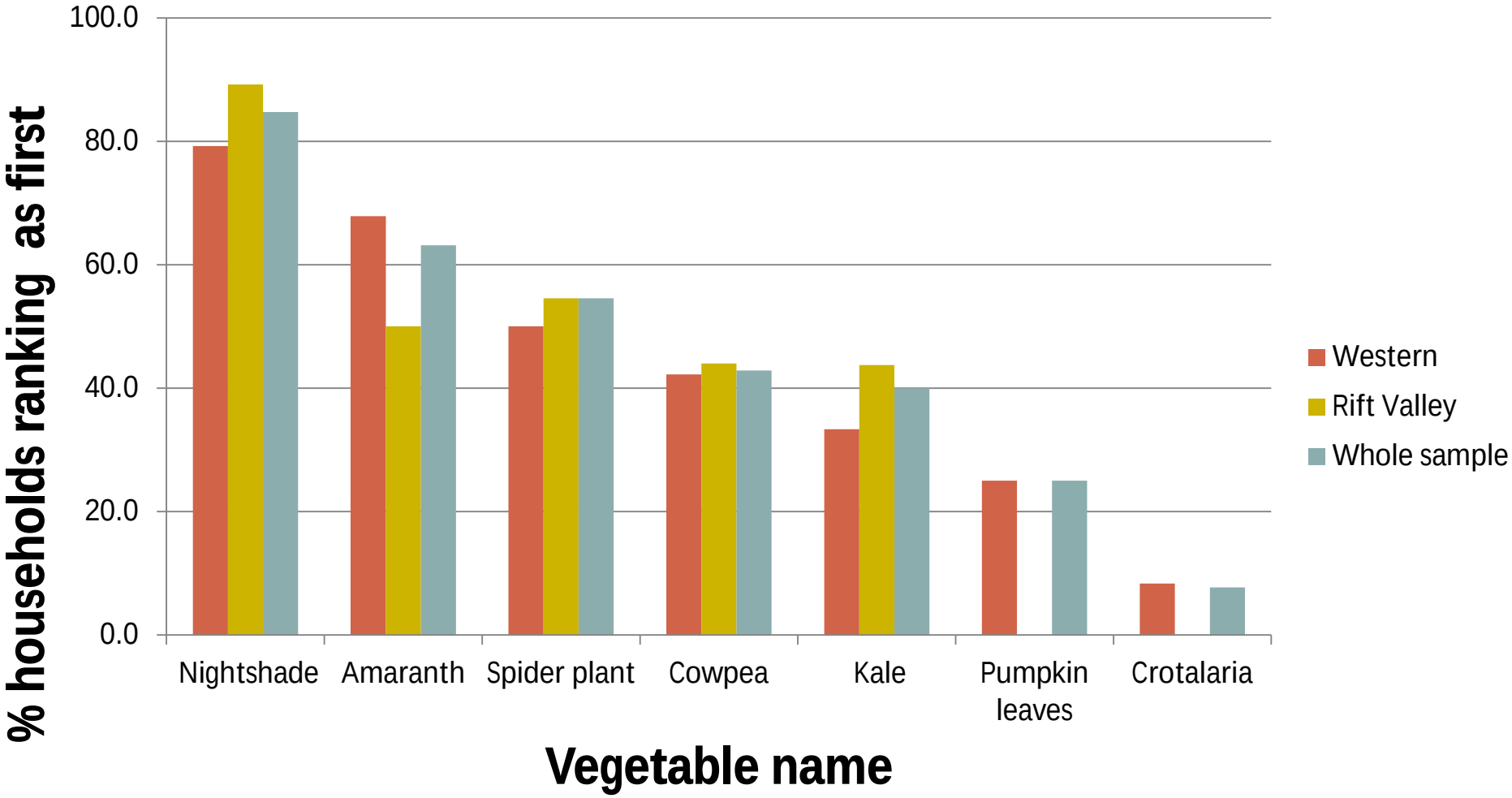
Kenya Survey Locations



Survey Results – Vegetables Grown



Vegetable Popularity



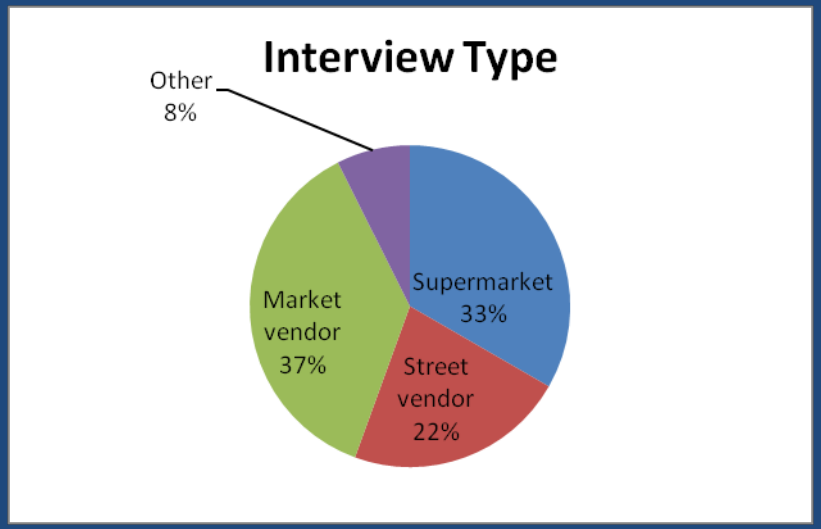
Key Findings from Kenya

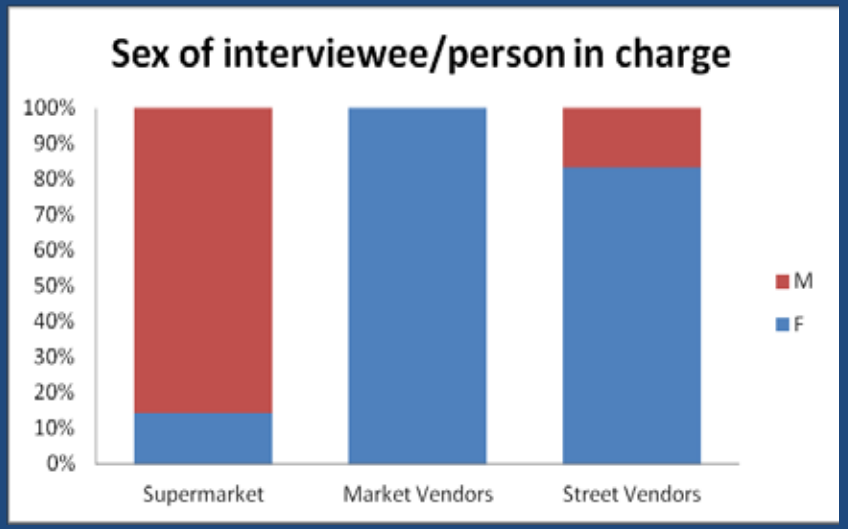
- African nightshade and cowpea are the most widely grown AIVs in Western and Rift Valley regions of Kenya.
- There was variation in AIV type preferences across regions. African nightshade was the most preferred AIV in the Rift valley; Amaranth and Spider plant were the most preferred in Western regions.
- 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.

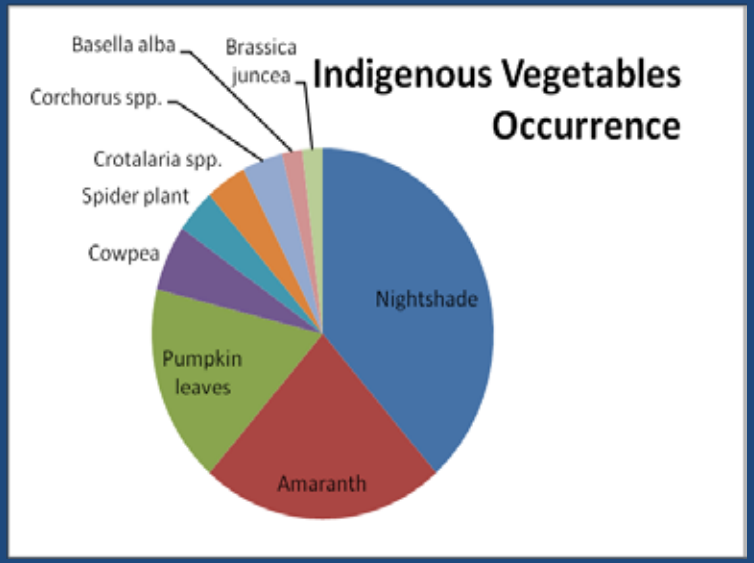
These findings should be considered during research development and promotion of AIVs. Emphasis should be placed on targeting the preferred AIVs in each region and translating the identified constraints into opportunities.

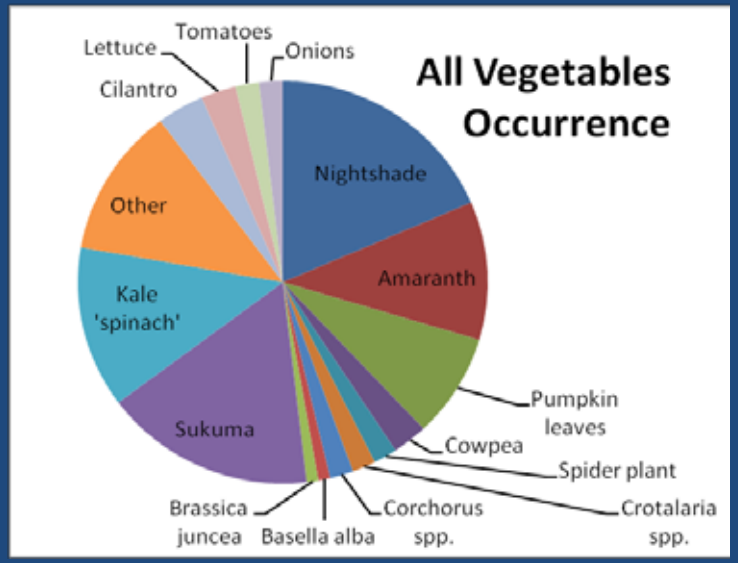
Policies should focus to ensuring farmers' access to production technologies and markets.

Initial Market Survey in Kenya



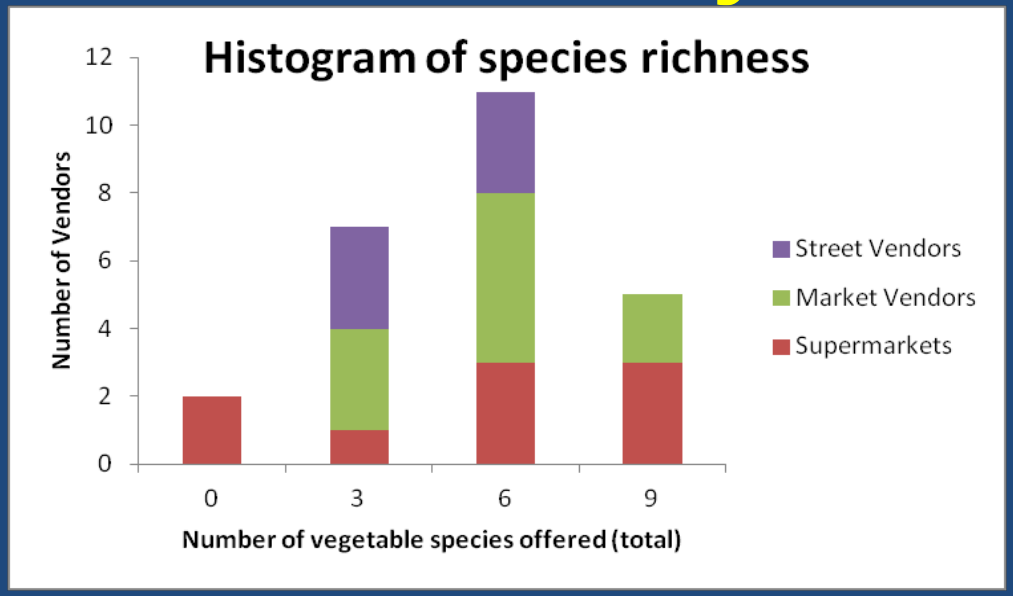


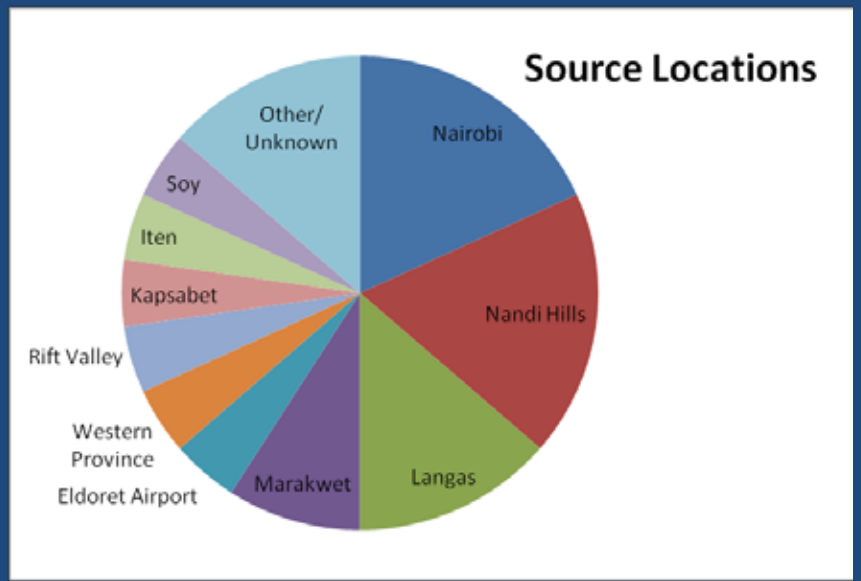


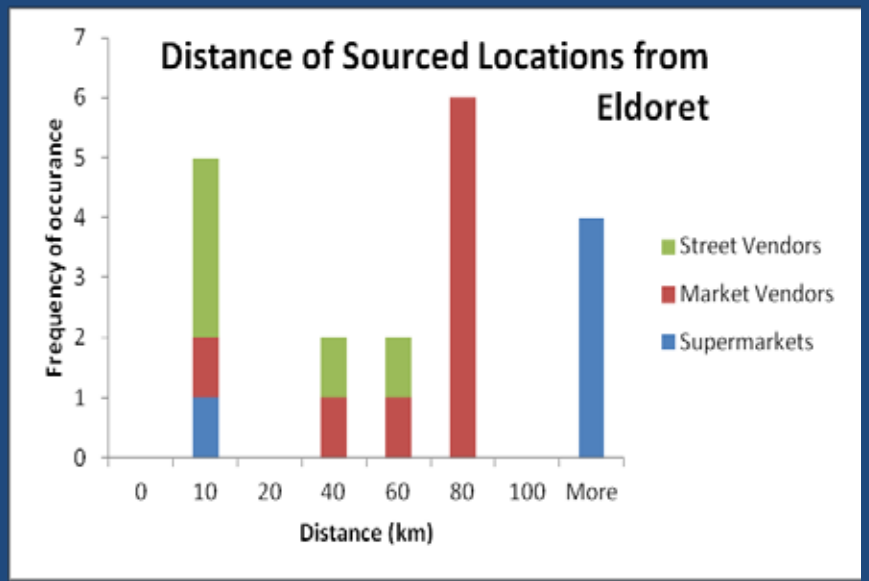


Marcia Croft

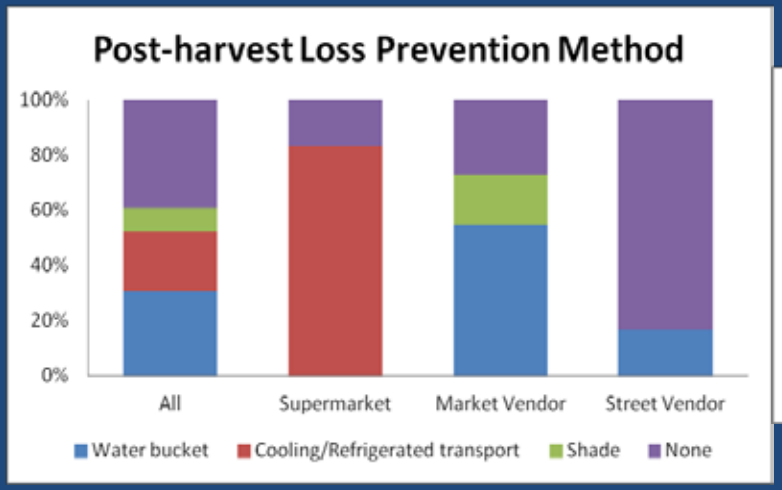
Initial Market Survey in Kenya







Initial Market Survey in Kenya



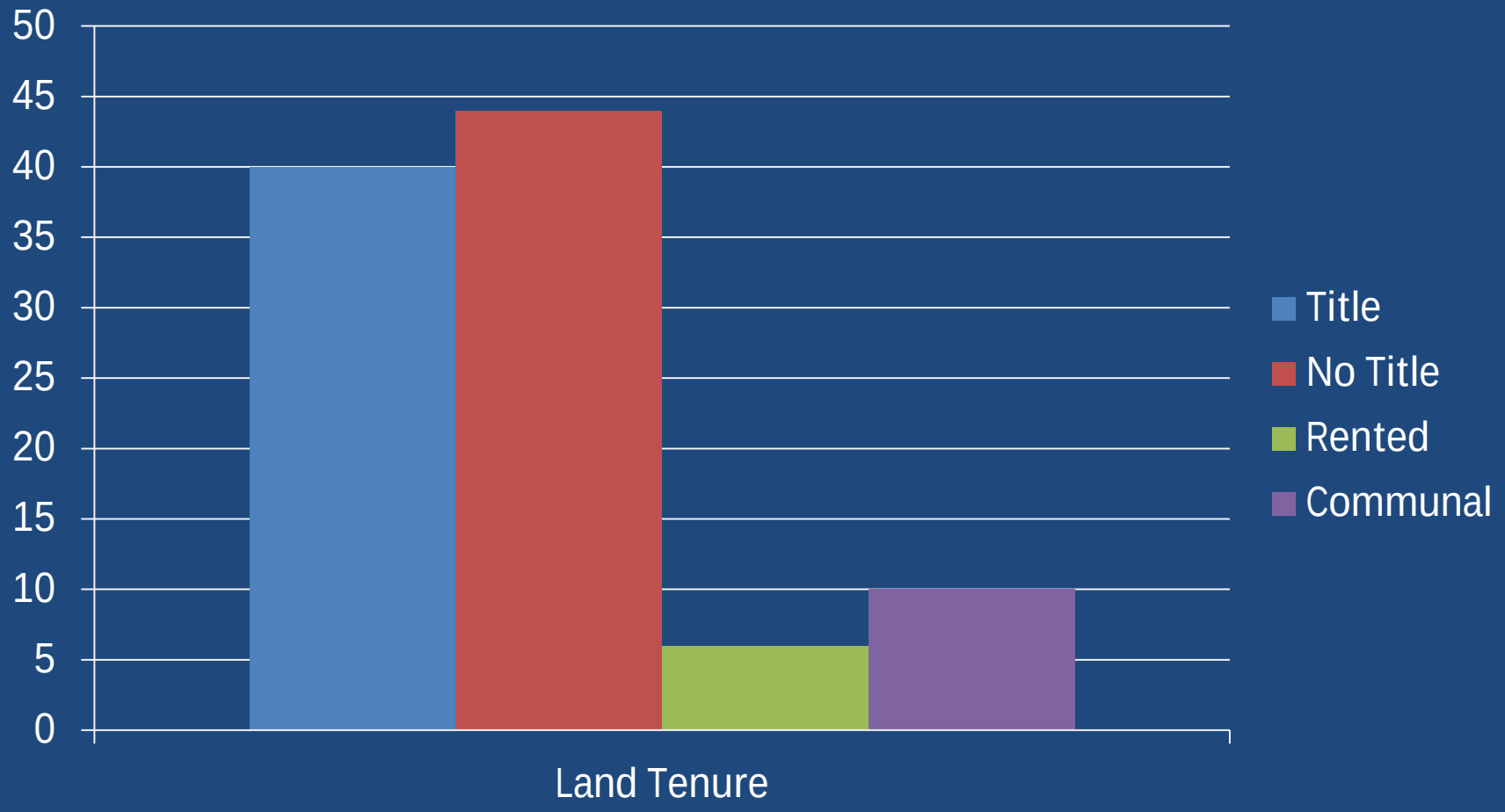
Zambia Survey Data

Prepared by Maria I. Marshall

Demographics of Respondents

- Average acres is 7.3
- Average area under veg production is 1.62A
- Mean age is 48 years
- Mean income is $439 (2284 Kwacha)
- 18% of respondents are women of which:
  - 43% are widowed
  - 40 % are never married, divorced, or separated
  - 17% are married

Land Tenure


50
45
40
35
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5
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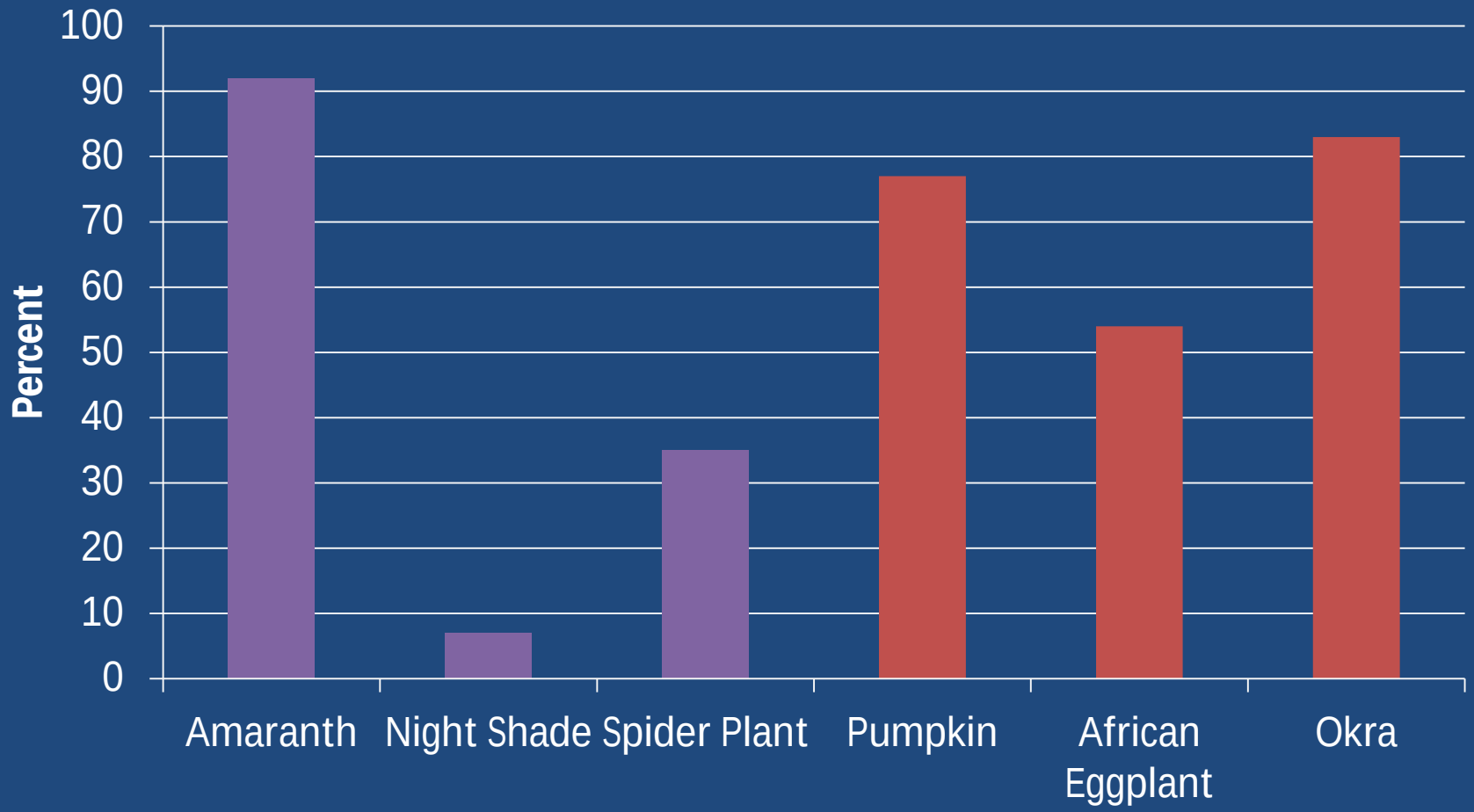
Land Tenure
Title
No Title
Rented
Communal

Vegetables Grown

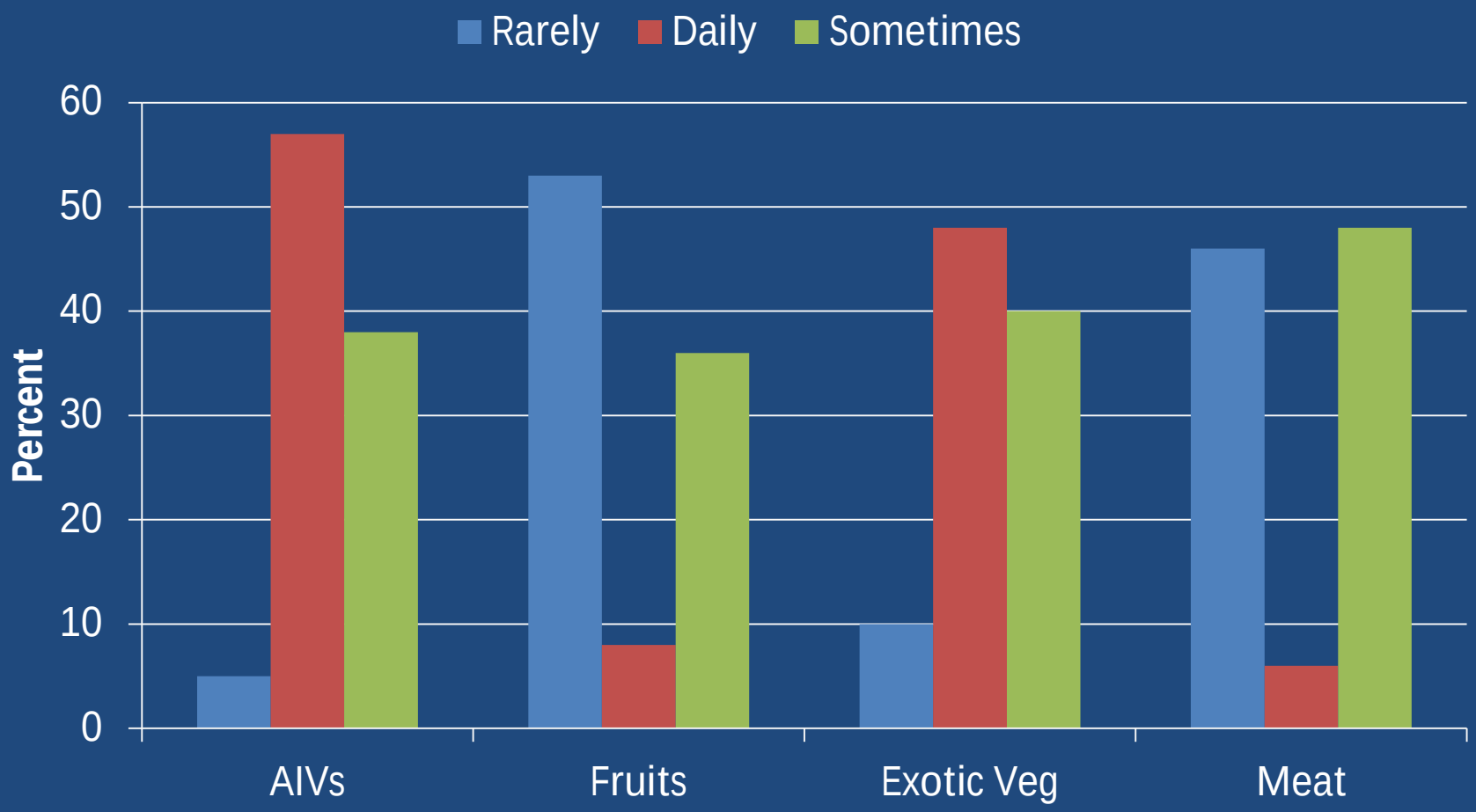


Major Constraints to Growing AIVs

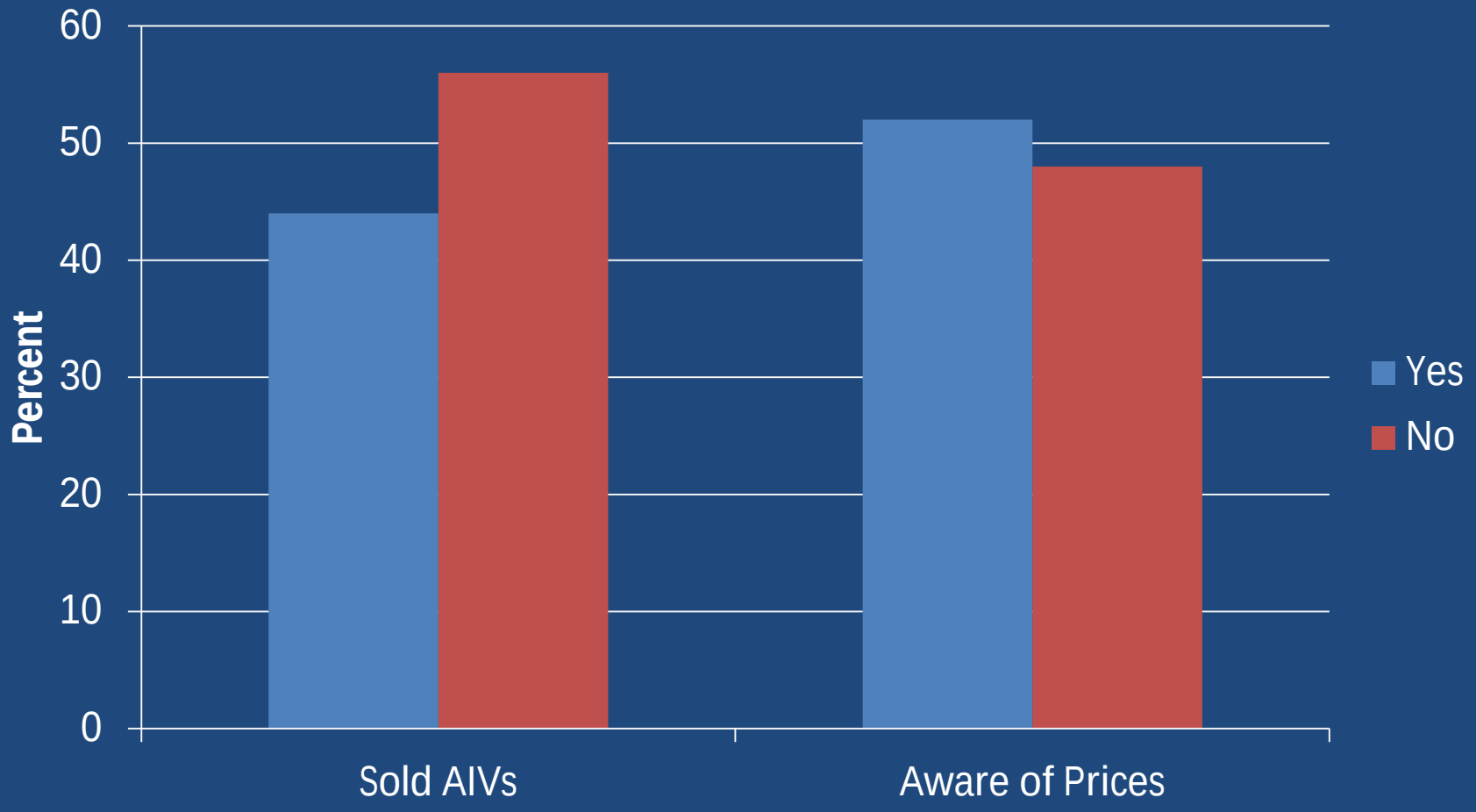
Amaranth

1. Inadequate capital
2. Too many sellers and few buyers
3. Price of fertilizer
4. Poor infrastructure
5. Lack of labor
6. Pests

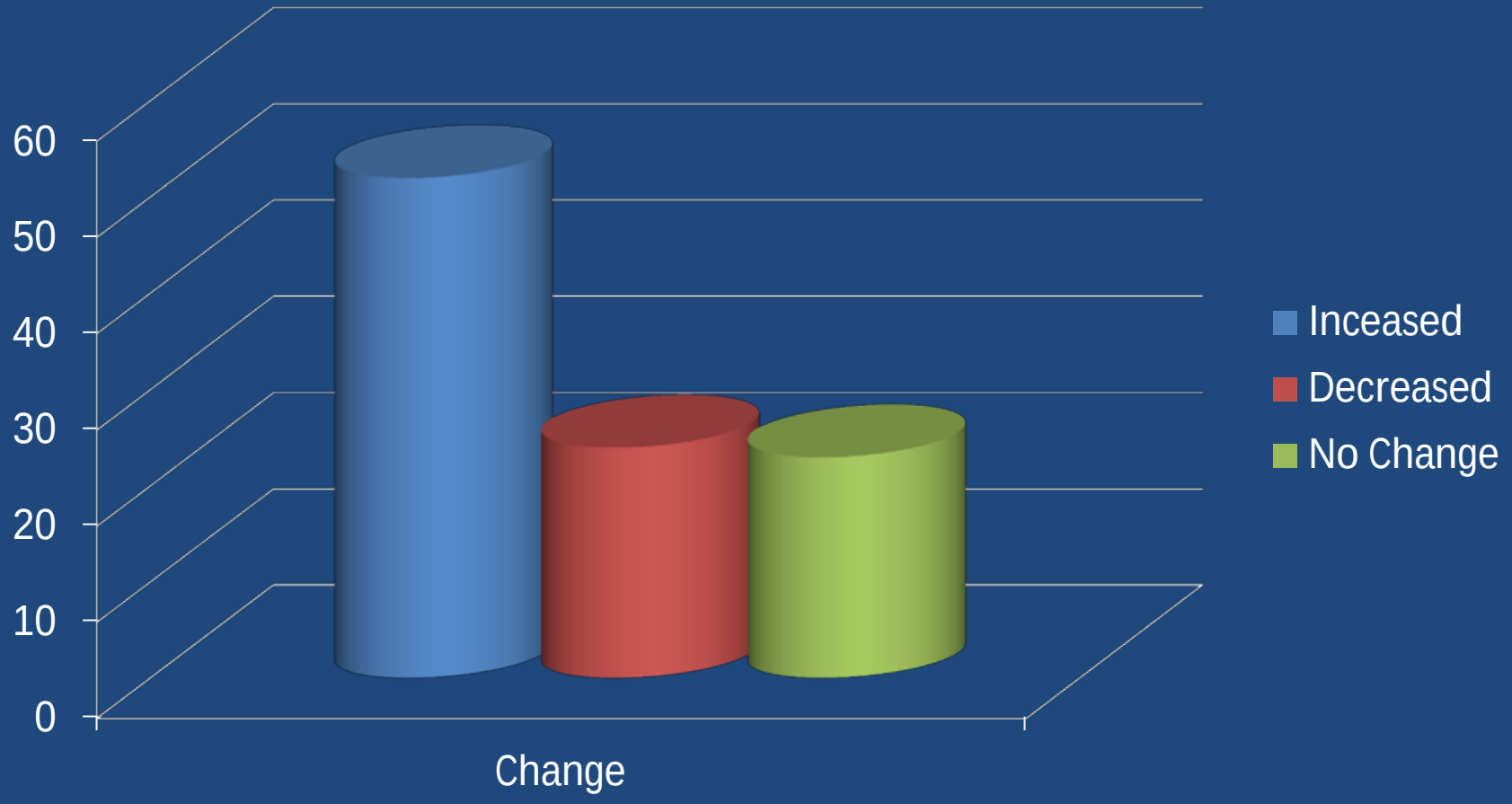
Food Consumption



Marketing



How have prices changed?



Tanzania Marketing Survey* - Sellers

- Surveyed Sellers in 4 Regions – 182 surveyed
  - Dodoma, Arusha, Morogoro, Iringa
  - 67% rented space in markets (district and regional)
  - 20% sell farm piece of plastic on ground
  - Rest are mobile/roaming sellers
  - Average end of day discount was 13%
  - Stored excess is NOT refrigerated – CoolBot potential
  - Most do not process but hose that do did some type of sun drying

*Don Lotter

Objective 2: Evaluate agronomic potential of improved AIV germplasm and develop improved production techniques

- 2.1 Germplasm evaluation trials and production studies (KE, TZ, and ZA). - On going
- 2.2 Evaluate nutrient composition of leaves of AIVs. (KE, TZ, ZA). – begun in 2012
- 2.3 Evaluate best harvest and postharvest storage practices for maintaining nutritional composition of AIVs (KY). 2013
- 2.4 Two lines of each of amaranth, African nightshade, and spider plant from the immediate impact project will be submitted for national performance trials (NPT) and Distinctness, Uniformity and Stability (DUS) trials for release and registration as commercial varieties (KE). - underway
- 2.5 Determine best harvest and processing techniques for optimum AIV seed, yield, quality and storage (KY). - underway

Germplasm Evaluations – Seed Production and Agronomics

Agronomic Trials in Kenya, Tanzania and Zambia

- Study 1
- 3 species x 5 varieties x 3 fertilizers x 1 irrigation (water as necessary to ensure no stress) x 3 reps. Study in both the dry and wet season. The three fertilizer types are: - control (none), *Mavuno* or equal fertilizer and farm yard manure as typical.

- Study 2
- 3 species x 5 varieties x 1 fertilizer rate x 3 water regimes (one= no water, 2 = 1/2 water or 50% of field capacity and, 3 = full water (field capacity). Use an organic fertilizer which is typical for the area.
-
- <u>Seed experiments (only in Kenya)</u>
- Five varieties of each AIV, RCBD
- Blanket fertilizer rate to be determined after soil analysis
- Seed yield and quality will be determined by Eldoret University

Data Collected in Agronomic Studies

- Date of sowing and number of plants in each plot
- Days to 50% flowering
- Fresh Leaf Yield (g/plant)
- Fresh Leaf Yield (t/ha)
- Seed Yield (g/plant)
- Seed Yield (kg/ha)
- 200 Seed Weight (g) - based on dry seed weight
- Disease Occurrence
- Insect Occurrence (%)
- Weeds Present

Major Insect Pests on AIVs

African nightshade

- whiteflies and aphids; also leaf hoppers, leafminers, beetles and grasshoppers

Amaranth

- aphids, brown bugs, whiteflies, leaf hoppers and leafminers; also grasshoppers, caterpillars and stink bugs

Spider plant

- flea beetles, stink bugs, whiteflies and bagrada bugs; also caterpillars, aphids and thrips

See poster by : Linnet S. Gohole, Steve Yaninek , Silvia A. Omasaja, Simon Kiarie, Elizabeth Omami, Pamela Obura, Steve Weller, Jim Simon and Maria Marshall

Impact of Fertilization on African Indigenous Vegetables

- 3 selected varieties of each AIV species (2 improved varieties from AVRDC and a local variety) were treated with no fertilizer, an inorganic 10:26:10, Ca – 10 fertilizer and an organic pig manure). Soil pH was adjusted to 5.5 in all plots.
- Data collected included mature leaf harvest (Fresh weight) every 2 weeks for 3 harvests and cumulative yield.

Results: Selected varieties of the AIVs respond differently to organic and inorganic fertilizers.

Pig manure generally resulted in excellent yields for all AIVs.

See poster by: Benson Migwi , Wilson Ng'etich, Elizabeth Omami, Steve Weller, Steve Yaninek, James Simon and Pamela Obura

Effects of Fertilizer Types on Pod Length, Inflorescence Size and Thousand Seed Weight of African Indigenous Vegetables

- Conclusions
- Pig manure use as a fertilizer during production of AVIs species resulted in an increase in pod length, inflorescence size and thousand seed weight
- Future studies will determine best management practices for optimum seed production

See poster by: Letting, F.K., J.O. Ochuodho, E.N. Omami, P. Obura, S. Weller, J. Simon and S. Yaninek

African Leafy Vegetable Seed Evaluation Trials

Christine Ndinya, S. Weller, P. Obura, M. Odendo, J. Ochuodho, E. Omami, W. Ngetich

Introduction

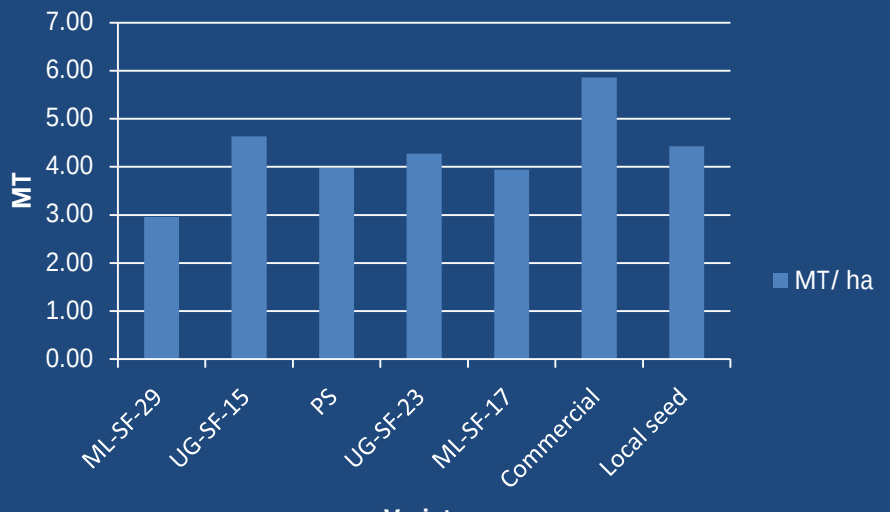
The steady increased interest in ALV has raised demand on high quality seeds and improved cultivars. Locally produced seeds are the most commonly found but are often contaminated by seed born diseases and are of genetic diversity

Objective

Evaluate agronomic potential of improved AIV germplasm and develop improved production techniques

Results and Discussion

Table 1:Seed yield of *spider plant*



- The flowering dates of the varieties are between 30 and 26 days which are not significantly different. But the seed yields were significantly different.
- Tested commercial and UG-SF-15 were highest seed yielding
- Future work also includes Amaranth and African nightshade

Objective 3: Evaluate best preparation and preservation techniques that will enhance micro-nutrient composition and retention.

- 3.1 Evaluate best leaf drying methods to preserve nutritional composition of AIV leaves (KY).
  - Technology next week in Kenya
- 3.2 Evaluate vitamin retention and micronutrient bioavailability in improved AIV recipes developed in earlier projects. - Underway
  - Kenya and US, next in Tanzania
- 3.3 Conduct organoleptic evaluation to determine consumer acceptability of improved recipes.
  - Delayed due to Passing of Mama Guga, we do have a draft cookbook with nutritional information included which is being reviewed and Kenya will start this spring

Quality Assessment & Essential Nutrient Preservation of Three Dried African Indigenous Vegetables (AIVs)

- Samples from Mace Foods, Eldoret, Kenya for Spider Plant (Saga), Black Nightshade (Managu), Amaranth (Dodo) *and* Cowpea Leaves (Kunde)
- Measurements: Total moisture, ash and acid insoluble ash and elemental analysis.
- Work is parallel to conducting nutritional proximate analysis, antioxidant screens, total phenols, total carotenoids, and tocopherols
- Results were positive for quality and nutrient content compared to exotic vegetables
- Data can assist in development of nutritional labels for the packaging of each dried vegetable and provide nutritional information and facilitate entrance into export markets. An increase in market demand, will support more local production of the AIVs in our targeted communities.

See poster by: David Byrnes, H. R. Juliani, Q. Wu, P. Langenhoven, V. K. Mugalavai, J. Msuya, S. Weller and J. E. Simon

Alkaloid analysis of *Solanum nigrum* indigenous to Kenya

- Black Nightshade (Managu) *Solanum nigrum* leaf (AIV 12060) and Black Nightshade (Managu) *Solanum nigrum* leaf (AIV 12061) were provided by Mace Foods, Eldoret, Kenya. Our role is to assist in developing nutritional labels for their AIV products and science to support market expansion.

- TLC and HPLC used for analysis of tissue for alkaloids

- The *Solanum nigrum* samples had alkaloid levels in the lower range of what is reported in the literature and had an unusually low amount of α-solanine, which was previously reported as major alkaloid in nightshade. Guidelines for potatoes recommend limiting glycoalkaloid content to 200 mg/kg fresh weight, which is well above the levels found in *S. nigrum* species analyzed.

See poster by: Kelsey Gustafson, Lisa Giordano[1] Qingli Wu, Petrus Langenhoven, V. Kadenyeka Mugalavai, John Msuya, Steve Weller[5]and James E. Simon

Objective 4: Build capacity of stakeholders in the AIV market chain

- 4.1 Agronomic training on improved production practices and best germplasm
  - on going have trained > 250 farmers in each country
- 4.2 Participatory on farm trainings
  - on going – Kenya has had an average of 5 trainings per period
- 4.3 Training on best post-harvest handling and preservation practices and technologies –
  - Naman Nyabinda and 2 UNZA scientists (Zambia Hort CRSP) trained in postharvest class of Lisa Kitinoja
  - Naman Nyabinda (KY) and Nancy Kaaya (TZ) attended J. Simon training 2012 with Zambian Hort CRSP
  - On going
- 4.4 Training on best seed harvesting, processing and storage
- 4.5 Strengthen formal and informal market linkages among stakeholders
  - On going, US students from US and leveraged funds GPRI - Concept proposal

Objective 4: Build capacity of stakeholders in the AIV market chain

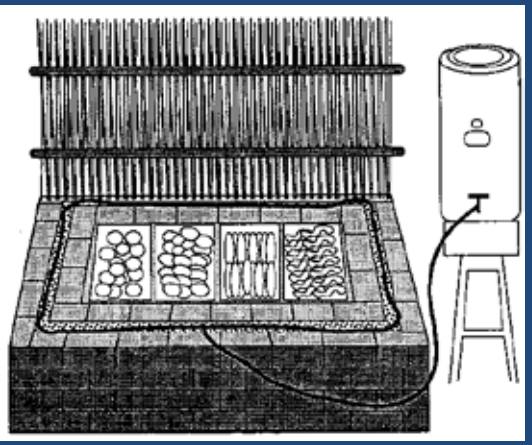
- 4.6 Training of farmers and other stakeholders on best AIV recipes and preparation methods for optimum nutritional quality
  - Delayed will begin in Kenya 2013
- 4.7 Awareness creation through field days, seed fairs, national agricultural shows and exhibitions
  - On going in Tanzania and Zambia, Kenya soon
- 4.8 Train the trainer programs of extension and private sector personnel on key AIV value chain technologies developed through the project – initiation of activities with Fintrac in Kenya
- 4.9 Interaction with Hort CRSP Innovation Centers
  - Now can begin in Kenya and future with Hort CRSP Seed Project
- 4.10 Graduate training and capacity building of key research project personnel
  - Kenya – 4, Tanzania – 1, US – 2 (2 leveraged), Zambia – next year

Recommended Best Practices for Postharvest Handling of AIVs

- Harvest at proper maturity
- Use clean sharp tools and have clean hands
- Use containers that protect AIVs and allow air circulation
- Harvest during cooler parts of day
- ShadeBot™: Shade Chain- Shading after harvest
- Cool AIVs using appropriate practices such as evaporative cooling
- Keep AIVs in short term cool storage if not marketed immediately
- Process AIVs if long term storage is desired (ex: solar drying and well sealed packaging)

Steps in AIV Harvest and Handling

- Harvest during the cooler times of day (in the early morning or even at night-time if possible)
- Use of shade after harvest
- Cool AIVs after harvest whenever possible
  - Evaporative cool storage



Steps in AIV Harvest and Handling CoolBot™ Cold Room

- Keep AIVs at 5 to 10°C to extend their postharvest life for up to one week.
- CoolBot™ can be used with a regular window style air conditioning unit to cool storage air down to 2°C.

CoolBot™ in Zambia plus New Concept of a ShadeBot™

Innovative in our project is the introduction of *ShadeBots*™ to stand alongside CoolBots™ and in providing shade above the CoolBot™ to reduce heat-load on structure






Farmers Field Days

Kenyan Farmer Collaborators

Zambia Collaborators and Training

Tanzania Collaborators

Tanzania Collaborators

AIV Seed Training

- A field day was held to train farmers in proper seed collection, processing and storage

AIV Village Training at Khunyangu

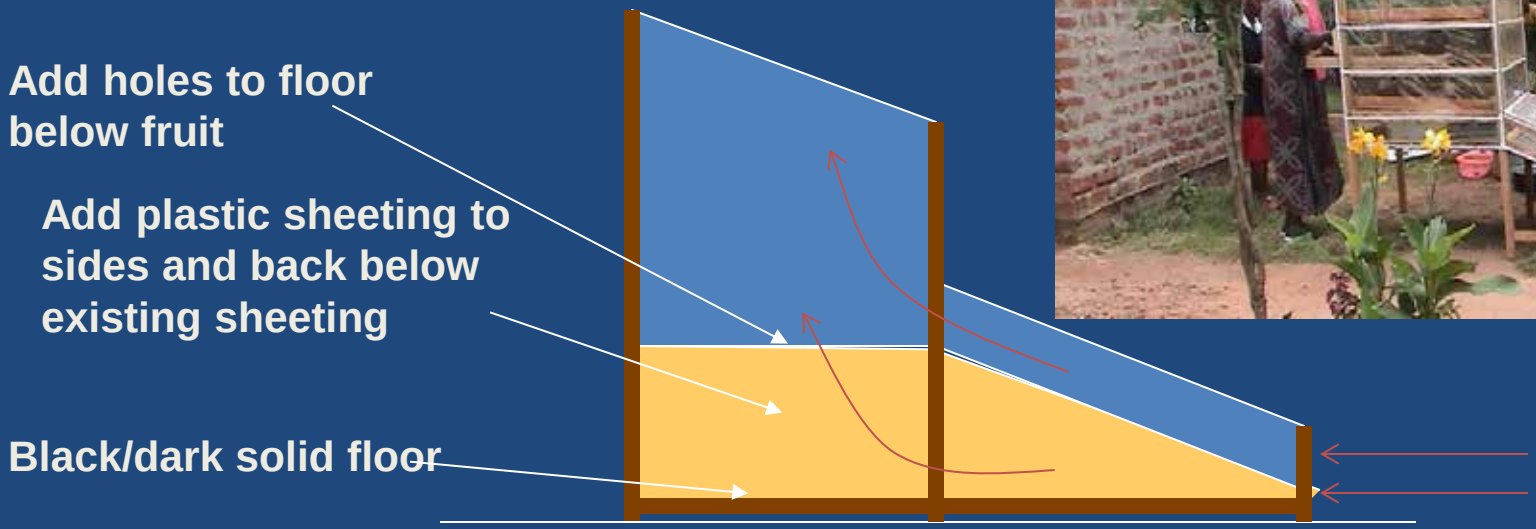
Farmer Taste Testing AIVs and Recipe Development

Potential for value adding

- Fresh vegetable
- Juices, beverages
- Dry ground vegetable (powder form)
- Dried vegetable
  - In powder form
  - Whole leaves or in chopped form
- Other products
  - Oil from some vegetable seeds

Value Addition Technology for Drying Vegetables

Adding plastic sheeting to the sides and back of the dryer allows it to collect more solar energy in the morning and afternoon hours. Existing dryers can be easily modified and the cost is small.



Kenyan Graduate Students

Kenyan Team


UOS University Development Cooperation
WWW.VLIRUOS
Chepkoilel
UNIVERSITY COLLEGE
flame of knowledge and innovation
P.O. BOX 1125 - 30100
ELDORET
UOS PROGRAMME

Leveraged Funds

- Purdue University
  - Fellowship for Ph.D. student – Marcia Croft
  - 2 fellowships to attend Borlaug Summer Institute
  - IPIA travel grant for summer studies in Kenya
  - 4 students were sent to Kenya in summer of 2012 and 4 more in 2013 on non-CRSP funds to assist on project
  - 75% of a Research Associate in Kenya salary is paid on non- CRSP funds
  - Purdue Global Policy Research Institute grant - "Leading with Knowledge" - Empowering communities to attain food security, proper nutrition, good health and economic growth for families with HIV in Western Kenya

- Rutgers University
  - Ph.D. student (David Byrnes) has been awarded a Borlaug Fellowship to work on breeding of AIVs with AVRDC Tanzania

- ASNAPP – Zambia – A Global Development Alliance project called 'CASH')Commercial Agribusiness in Sustainable Horticulture) with Stellenbosch University and Rutgers University