Preservation of fresh fruits and vegetables and quality standards during storage utilizing energy-efficient technologies for improved livelihoods

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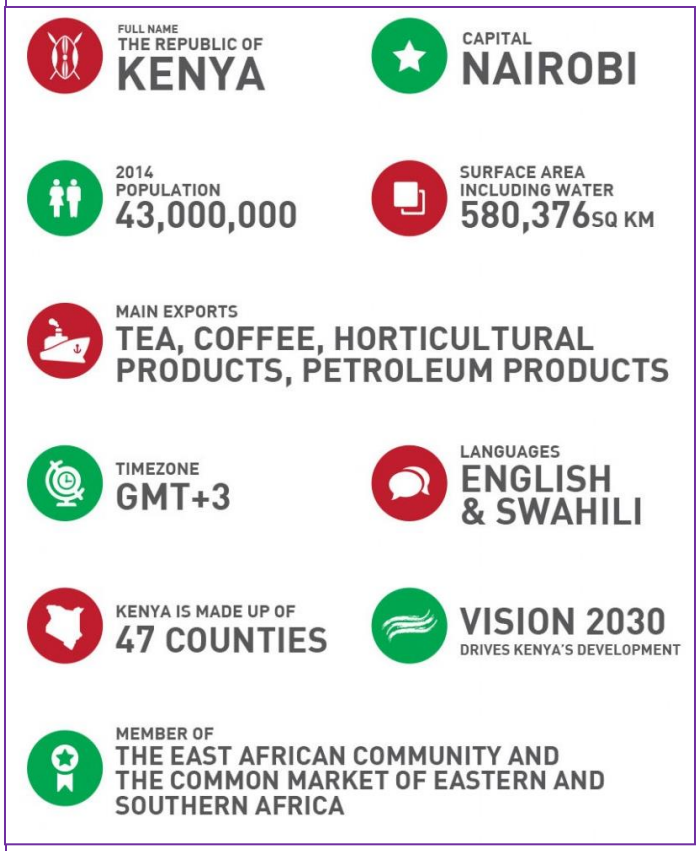
2018

Outline

- Introduction
- Overview of renewable energy food processing technologies
- Evaporative charcoal cooler
- Capacity building – training of farmers
- Quality standards
- Outlook

Introduction

- Agriculture accounts for ~24% of Kenya's gross domestic product (GDP) with about 75% of the population depending on it directly or indirectly.
- More than 80% of this population live in the rural areas and about 56% of it live below the poverty line.



Source: http://www.brandkenya.go.ke

- Role of fresh fruits and vegetables in nutrition (micronutrients, fibres and plant proteins) is well recognized in Kenya and globally
- Kenyan consumers have increasingly embraced healthy diet options, therefore consuming more of fresh fruits and vegetables
- Domestic consumption of fresh horticultural produce continues to increase
- Negative food safety reports linked to fresh fruits and vegetables in the domestic market - essential to resolve these food safety problems

- Significant postharvest losses are a result of (Global Food, 2013):
  a) Insufficient processing (e.g., cooling, drying, etc)
  b) Inadequate storage
  c) Poor transport
- Limited land for agriculture - need for efficient rural food processing technologies utilising renewable energy to improve rural livelihoods → ***RE4Food Project*** (July 2013 – December 2016).

  Link (RE4Food Final Report): http://www.jkuat.ac.ke/departments/abed/re4food/
- Solar and biomass energy sources dominate as rural energy supplies in Sub-Saharan Africa.

RE4Food Project Partners:

1. Newcastle University, United Kingdom (UK)
2. Njala University, Sierra Leone
3. Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya
4. Stellenbosch University, South Africa
5. Kwame Nkrumah University of Science and Technology (KNUST), Ghana
6. University of Kassel, Germany
7. Environmental Foundation for Africa (EFA), UK
8. Practical Action, UK
9. Practical Action Consultants of East Africa, Kenya

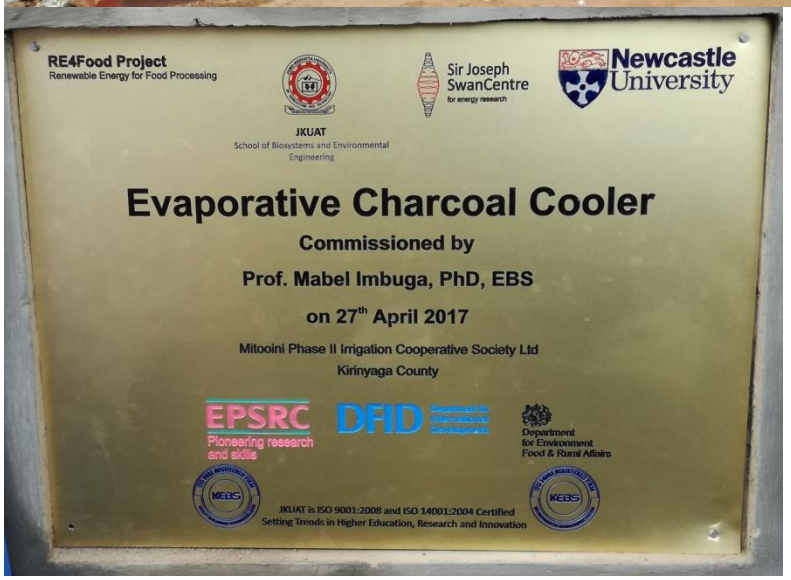
Evaporative Charcoal Cooler

- Low-cost facility, easy to construct at the farm level
- '*Innovative fridge*' - charcoal, wire mesh and water tank

(Source: www.nation.co.ke)

- Improved evaporative charcoal cooler was developed for a registered farmer group in Kirinyaga County, Kenya (Mitooini Irrigation Phase II Cooperative Society)
- Optimized for cooling of fresh tropical fruits and vegetables
- Design of cooler facility: 12 m long, 4 m wide and 2.5 m high
- Components of an improved charcoal cooler facility:
  - Cooler section (16 m^2) $\rightarrow$ 40 m^3 storage space
  - Preparation area (20 m^2)
  - Office (12 m^2)

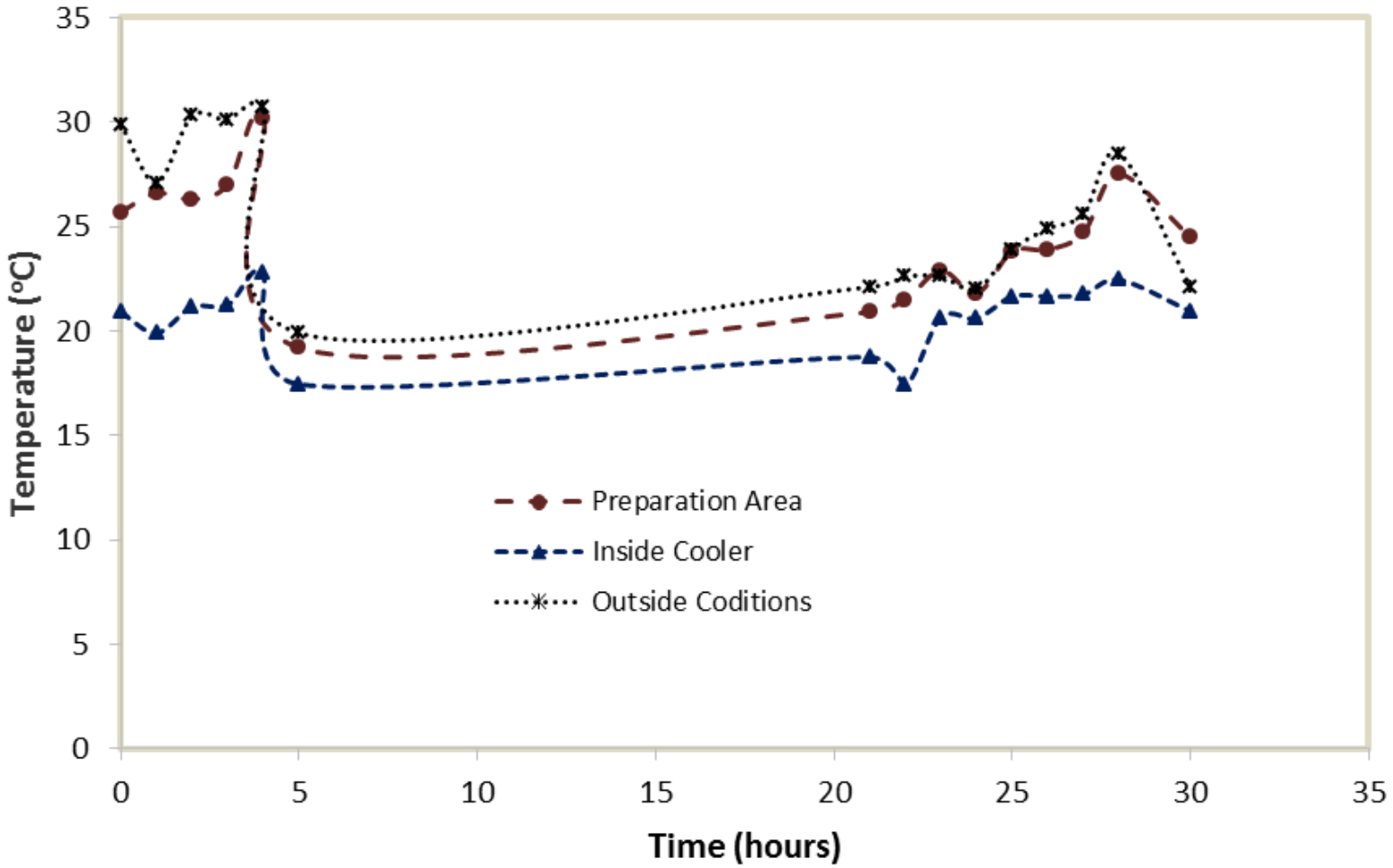

JUMBO TANK


RE4Food Project
Renewable Energy for Food Processing
JKUAT
School of Biosystems and Environmental Engineering
Sir Joseph SwanCentre
for energy research
Newcastle University
Evaporative Charcoal Cooler
Commissioned by
Prof. Mabel Imbuga, PhD, EBS
on 27th April 2017
Mitooini Phase II Irrigation Cooperative Society Ltd
Kirinyaga County
EPSRC
Pioneering research and skills
DFID
Department for Environment Food & Rural Affairs
JKUAT is ISO 9001:2008 and ISO 14001:2004 Certified
Setting Trends in Higher Education, Research and Innovation

- Target agricultural produce (charcoal cooler):

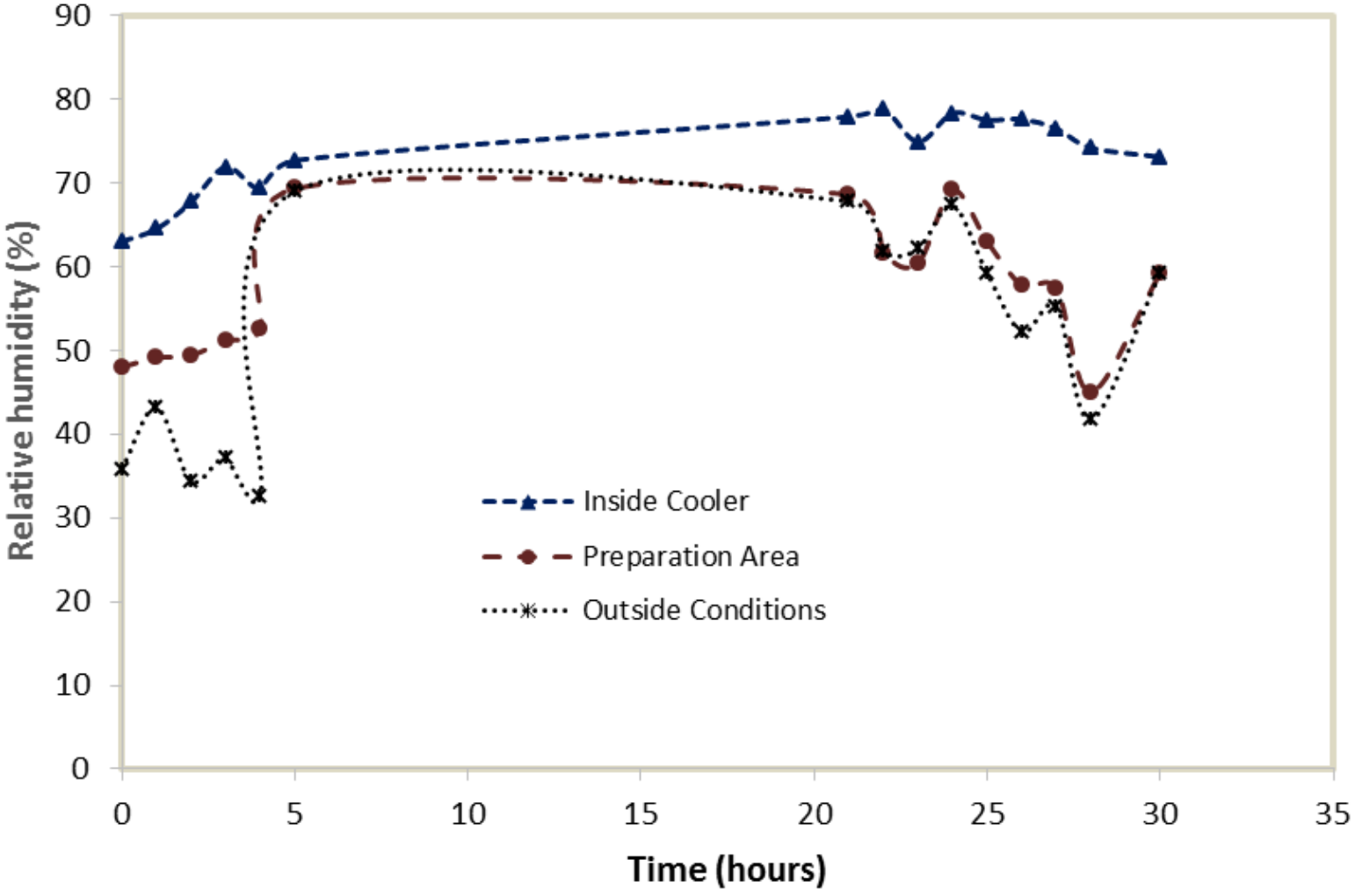
a) Kales
b) Spinach
c) Amaranth
d) Lettuce
e) Mangoes
f) Tomatoes
g) French beans

Variation of air temperature with time (cooler and outdoors)



(Average air temperature difference: **8.4±0.9 °C**)

Variation of air relative humidity with time (cooler and outdoors)



(Average air relative humidity difference: **30.7±6.4 °C**)

Appearance of produce (tomatoes and kales) stored in the cooler

Day 1 (upper tray)

Day 3 (upper tray)

Day 1 (lower tray)

Day 3 (lower tray)

Colour attributes, weight changes, cooler storage capacity and cost of kales and tomatoes

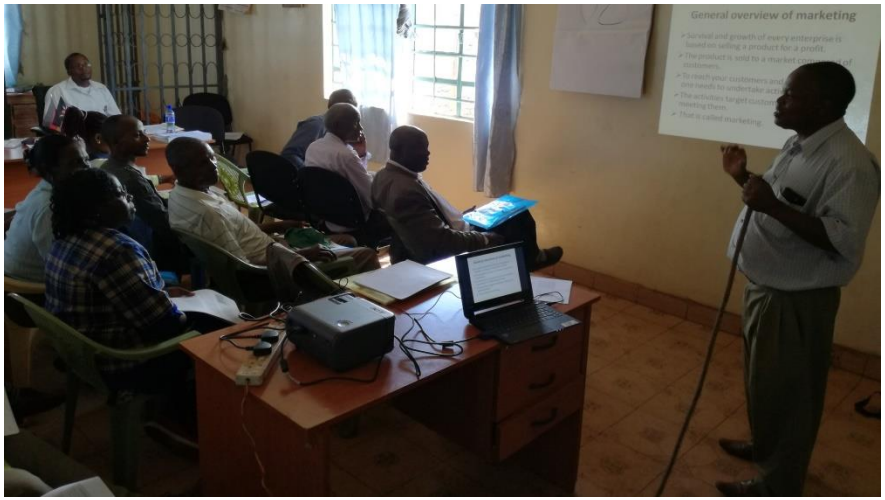
Produce	ΔE (cooler)	ΔE (outdoors)	Time (hrs)	Weight change (%)	Storage capacity, volumetric (m^3)	Cost (Kshs/kg)
Kales	8.27	16.75	48	-9.3	30	50
Tomatoes	1.07	5.54	48	-6.2	30	50

(ΔE is total colour difference; 10 m^3 gangway is left between crates for access in the cooler)

Remarks:

- Weight changes are <10% for both kales and tomatoes after 48 hours of storage
- Less shrinkage (low Δ*E*) in the cooler compared to outdoors conditions (control)
- Great potential to increase the shelf-life of kales and tomatoes using the developed charcoal cooler, and hence minimization of losses

Training of farmers for project sustainability



Training Topics

a) Review on harvesting (maturity indices)

b) Handling after harvest (damage at farm level)

c) Preparation for the market (sorting, grading, waxing and so on)

d) Storage of fruits and vegetables (including demonstrations on proper use of the developed charcoal cooler)

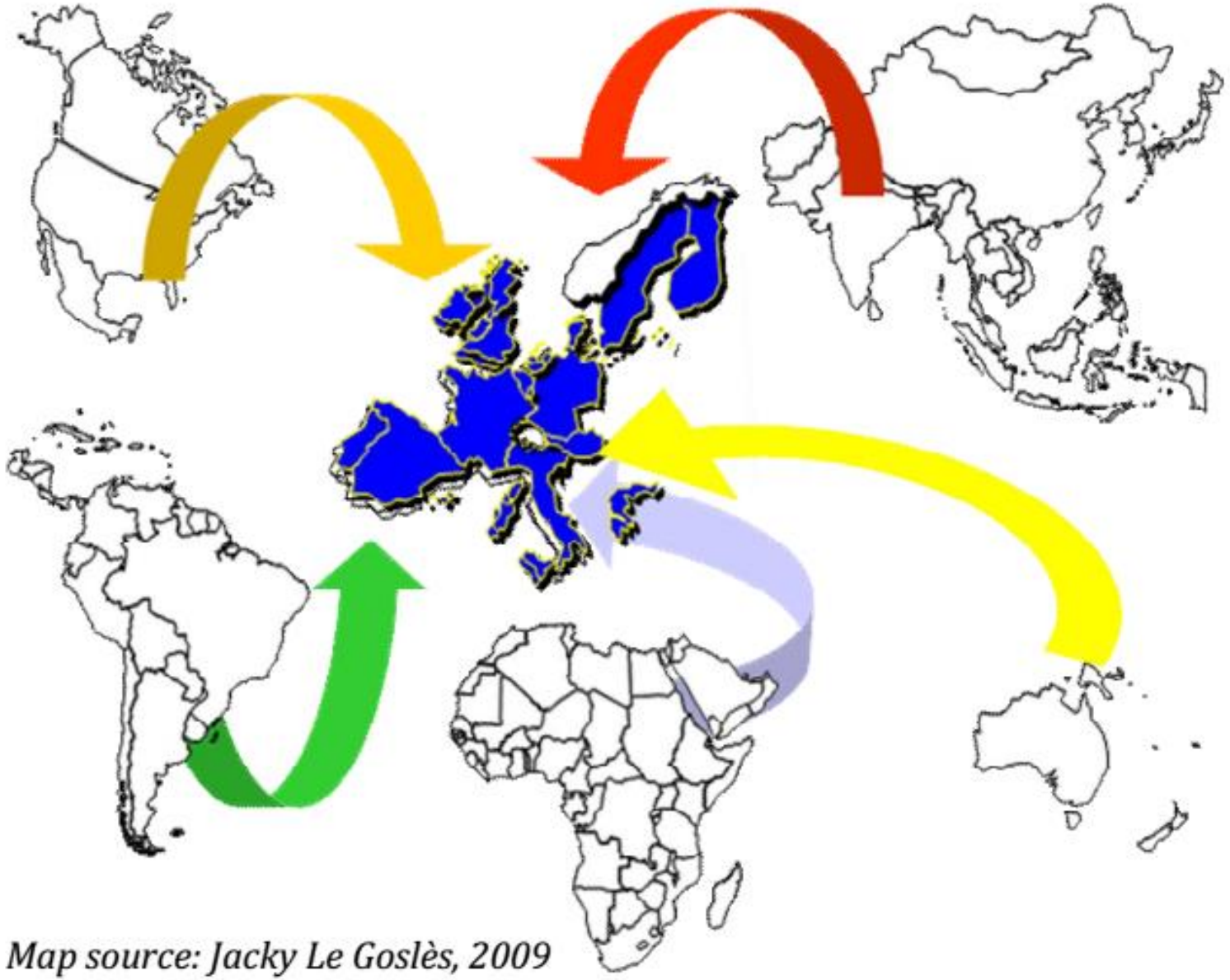
e) Food safety (including Ecolabels), quality and packaging

f) Business aspects and book keeping

g) Group dynamics and marketing

Quality Standards

- Certified firms are already in contact with the farmers for export of their produce.
- European Union (EU) has set Maximum Residue Levels (MRLs) for pesticides in and on food products – strict compliance.
- There are three types of control checks:
  a) Documentary checks
  b) Identity checks
  c) Physical checks

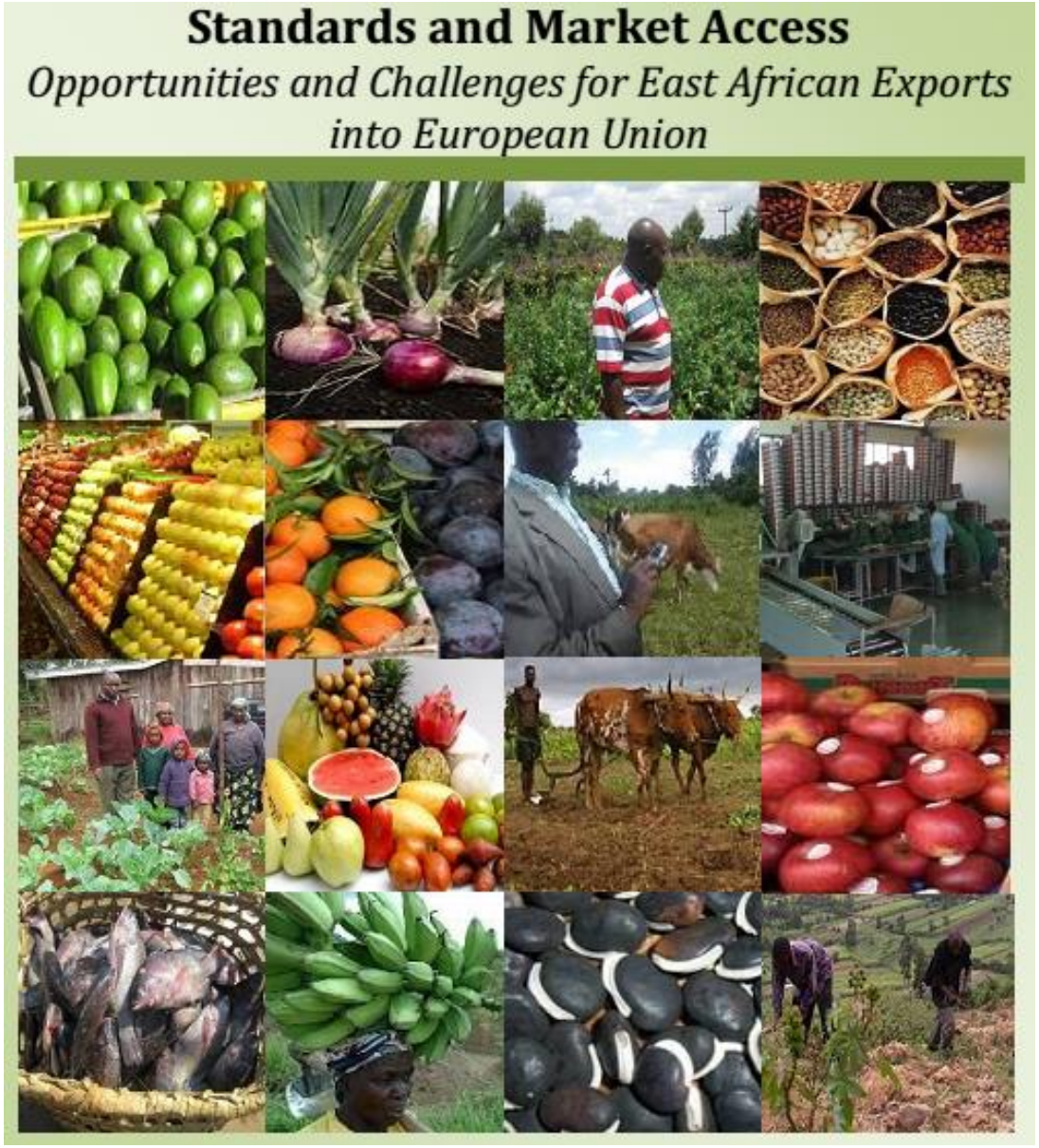

Map source: Jacky Le Goslès, 2009

- Prerequisite requirements in the export of fresh fruits and vegetables:
  a) Export licence from HCDA
  b) Phytosanitary and conformity certificates from KEPHIS
  c) Euro 1 Certificate (for EU Market)
  d) GlobalGAP Certification
  e) MRL limit compliance (EU)
  f) For UK supermarkets, they require BRC certification

- Private standards in EU, non-EU and other countries keep on changing with time → individual markets have additional private standard requirements.

Certification bodies (fruits & vegetables) in East Africa

➢ AfriCert Ltd., EnCert Ltd., Soil Association Certification Ltd., Bureau Veritas Kenya Ltd., SGS Kenya, IMO Uganda Ltd., IMO Tanzania, TanCert, Ecocert Bureau Madagascar/East Africa, Naturland-Verband, UgoCert



Implemented by CUTS Africa Resource Centre, Nairobi, Kenya (CUTS, 2009)

➢ Efforts made on quality standards in Kenya (KHCP, 2011)

Farmer on the farm

Grading in the field

Final packaging

Complied produce

- *Tools (knives, scissors, gloves etc.) are kept clean and disinfected.*

- *Vehicles are cleaned regularly.*

- *Hands are kept clean by having access to clean toilets and hand washing facility. Workers should be able to access a toilet within 500m from their work site or access one with a transport. Hand washing facility made of a bucket and a tab*

Source: CUTS (2009)

Outlook

- Energy efficient technologies and practices enhance good management of resources (e.g., land, water, etc) by farmers
- Techno-economic assessment and optimization of the developed dryer, product quality and shelf-life assessment are on-going.
- Minimisation of losses in the food chain increase the quantity and quality of produce and reduce energy, water and land use.
- Horticultural produce gets contaminated on and off-farm → food safety interventions are required along the entire value chain.
- Capacity building / public awareness - to ensure safe and high quality food

Acknowledgements

RE4Food JKUAT Team

Kanali CL, Kituu GM, Mutwiwa UN, Mung'atu JK, Ronoh EK, Njuguna SN, Kamwere MM, Mulamu LO

THANK YOU