Emerging Biotechnologies in Food Production: Edible Insects as Food and Feed

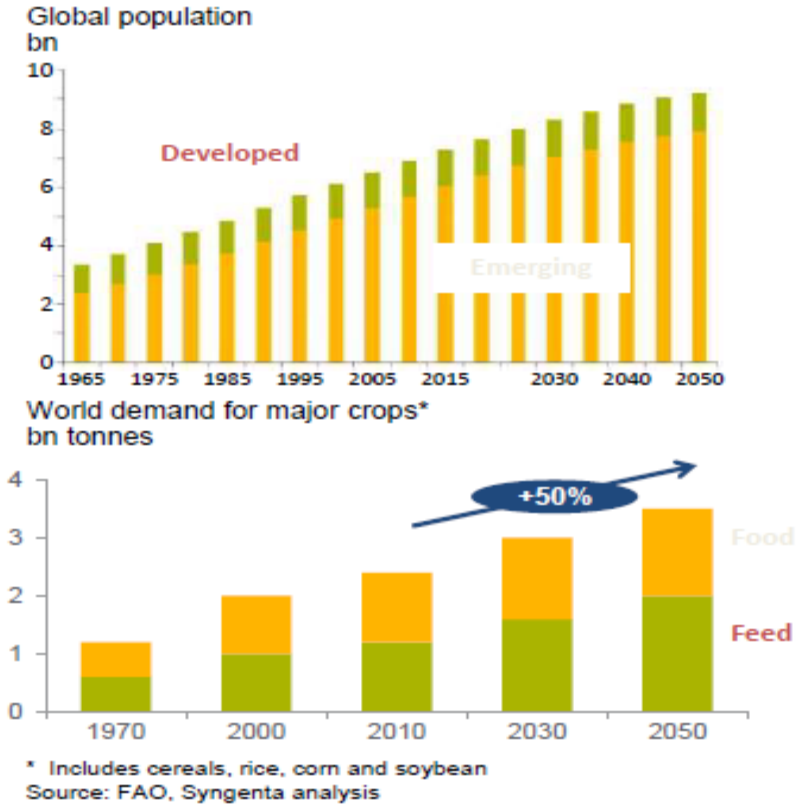
John Masani Nduko, PhD
(Biotechnology & Macromolecular Chemistry)
Hokkaido University, Japan

Lecturer & Research Scientist, Dept. of Dairy & Food Science & Technology,
Egerton University

6th National Biosafety Authority Conference

INTRODUCTION

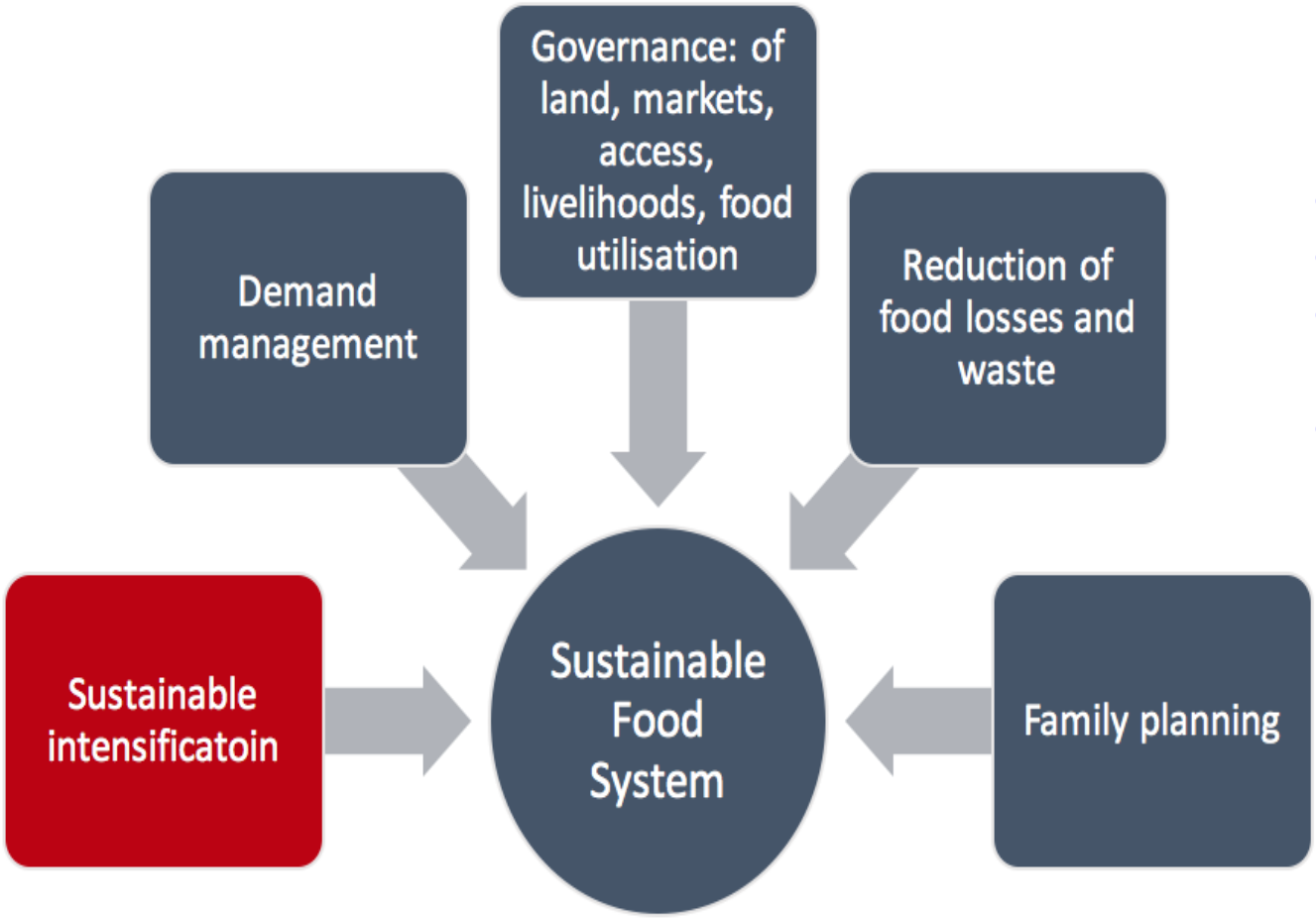
Demand growth from population growth and diet changes



- 9bn people by 2050
  - Rapid increase in emerging countries
- 2050 grain demand: +50%
  - food grain +25%
  - meat consumption +70%

More land and natural resources will be dedicated to food production and this will affect the remaining biodiversity

Sustainable Intensification



- High yields
- Same land
- Little effect on environment
- Recycling resources & waste

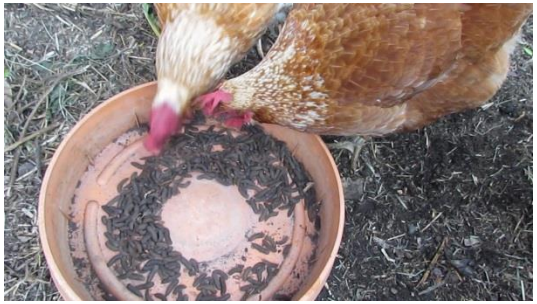
Sustainable intensification in relation to other activities to help achieve a sustainable food system (adapted from Garnett and Godfray, 2012).

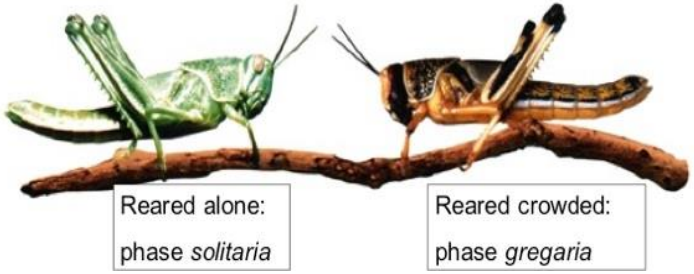
Edible Insects

- In Sustainable Intensification, diversification of food sources, especially protein for human & animal consumption is important.

- In developing countries alone, meat consumption is growing at 5% per annum.

- To meet this demand, insects have been identified as a suitable candidate to supplement other animal-based proteins, in addition to new/ existing plant-based protein sources.





Farmed: Black soldier fly, mealworms, locusts, crickets & housefly maggots

Why Eat Insects?

❑ Health:

- Insects are healthy, nutritious alternatives to mainstream staples.

- Many insects are rich in protein and good fats and high in calcium, iron and zinc.

Table 1. Examples of crude protein and ether extracts of fats (% of dry matter) in house cricket, silk-worm and mealworm (Source: Makkar et al., 2014)

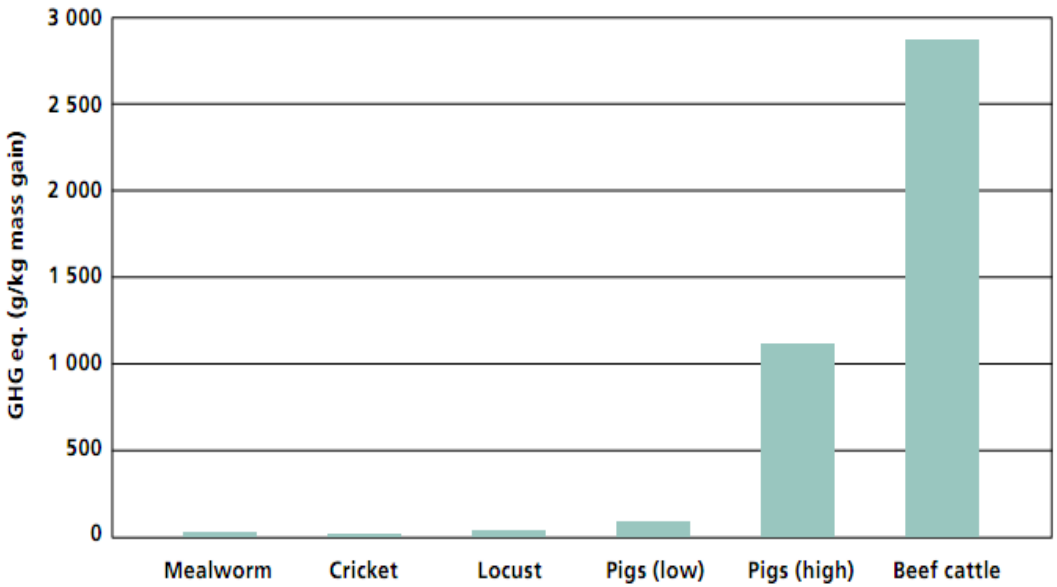
	House cricket *(Acheta domesticus)*	**Silk worm** *(Bombyx mori)*	**Meal worm** *(Tenebrio molitor)*
Crude protein	55-67	52-71	47-60
Fats	10-22	6-37	31-43

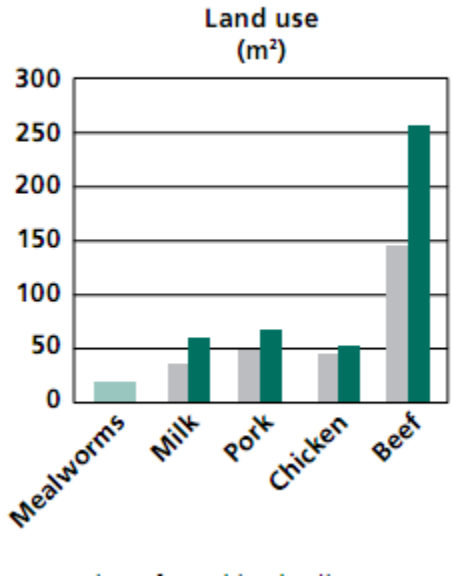
Fatty acid content of *Tenebrio molitor* and beef on a dry matter basis

Fatty acid	Saturation	*T. molitor*[1]	Beef
Essential			
Linoleic	Omega-6 polyunsaturated	91.3	10.2
Linolenic	Omega-3 polyunsaturated	3.7	3.9
Arachidonic	Omega-6 polyunsaturated	–	0.63

❑Environmental:

- Insects emit considerably fewer greenhouse gases (GHGs) than most livestock.
- Insect rearing require less land & does not require land clearing to expand production.
- Insects are very efficient at converting feed into protein.
- Insects can be fed on organic waste streams.





(FAO, 2013)

❑Livelihoods (economic and social factors):

- Insect harvesting/rearing is a low-tech, low-capital investment option that offers entry even to the poorest sections of society, such as women and the landless.

- Mini-livestock offer livelihood opportunities for both urban and rural people.

- Insect rearing can be low-tech or very sophisticated, depending on the level of investment.

Grasshopper/ Locust Farming as a Sustainable Food/Feed Ingredient Source for Non-ruminant Livestock and Humans

- Some communities consume grasshoppers/ locusts in Kenya: Could easily be adopted.

- The grasshoppers/ locusts in Kenya are captured from the wild: Unsustainable.

Research hypothesis:

Grasshoppers/ Locusts are an economically, socially and environmentally viable source of protein for human food and poultry /fish feed on smallholder farms in Kenya.

Objectives

To contribute to food & nutrition security by strengthening the role of locusts/grasshoppers in local diets while enhancing sustainability, safety & efficiency of insect farming, processing and consumption.

- To develop appropriate methods for Grasshopper/locust farming and utilization in smallholder farming systems in Kenya, based on inexpensive feeding substrates.

- To understand and ensure the social, economic and environmental sustainability of the proposed innovations.

- To validate and implement the innovations with the beneficiaries, and disseminate the project's findings to the stakeholders, general public, scientific community and policy makers.

Methodology

Biodiversity and Abundance of Grasshoppers/Locusts

Nakuru and Baringo Counties, Kenya

Cage farming of locusts& Grasshoppers

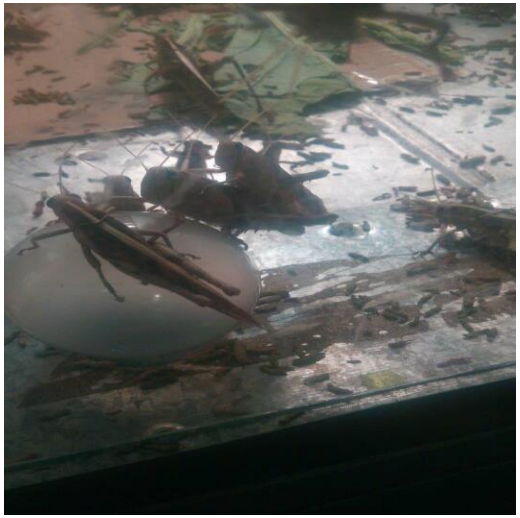
Rearing In Lab scale cages (1.5 × 1.5 × 1.5 foot Metal Cage)

Growth parameters

- Temperature (30 – 35°C by light bulbs)
- Humidity (Humidified by water)
- Feeding (Grass, Bran and Kales)

Cage farming of insects- Steps

Mating



Egg Laying

Egg Hatching

Key Parameters

- Feeds
- Temperature

- Sand moisture

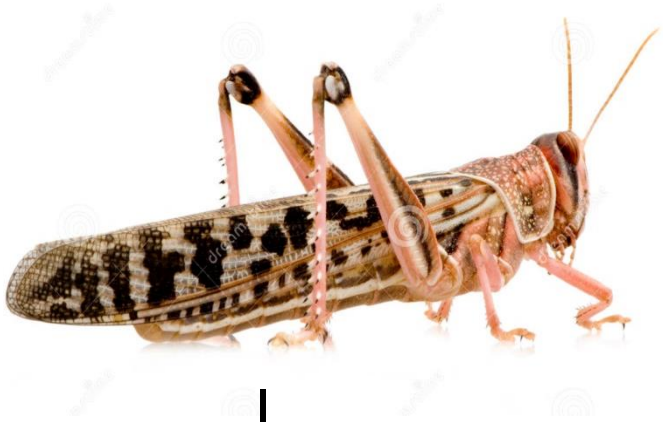
- Sand moisture
- Temperature

Locust/Grasshopper Maturation

Maturation: 28–35 days

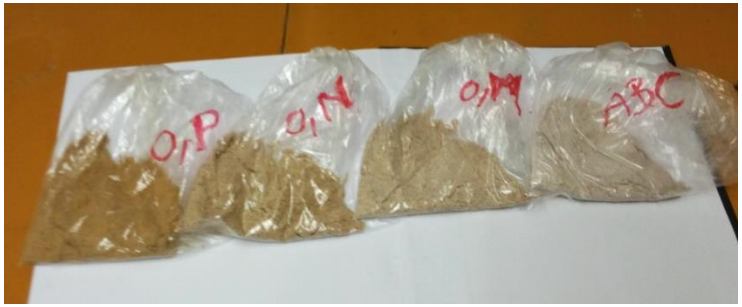
Processing of Locusts/Grasshoppers

1. Baby Weaning Meal



Preparation, Grinding & Blending

Probiotics

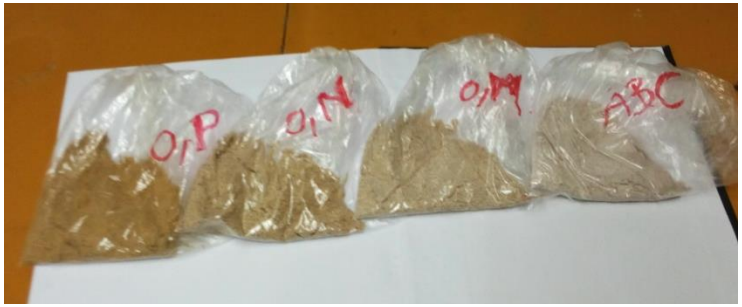


LocusWean: Baby weaning meal: Nutritious and easily digestible. Highly acceptable product

2. Poultry meal

Maize etc

Grinding & Mixing



Feeding trials on Kari Improved chicken: Ongoing

3 Locust/grasshopper Manure

- Analysis-Chemical
- Farming trials

Conclusion

- Locusts and grasshoppers can be farmed inexpensively to produce protein and oil ingredients

- Locusts and grasshoppers can be processed into safe and nutritious products for livestock and humans

- Optimization of the process can give a commercially viable Process for insect farming

- Safety issues- Hazards are dealt with Proper processing & HACCP procedures. Locusts have History of safe use as food/feed.

Future Plan

- Additional characterization of the products and registration.
- Process scale-up and additional product development.
- Product sensitization for uptake.

Acknowledgement

Funds & Research support

Michigan State University

Funder under USAID

NBA

Thank You!

Some Members of the team in the Insectary at Egerton University

Postharvest Processes of Edible Insects in Africa: A review of Processing Methods, and the Implications for Nutrition, Safety and new Products Development.

Critical Reviews in Food Science and Nutrition
C. Mutungi, F. Irungu, J. Nduko et al., 2017