Animal Genetic Resources Characterization & Conservation Research in Africa: An Overview

Okeyo A. M.

Nairobi, Kenya, April, 6th 2011

Outline of the presentation

1. Introduction- The global perspectives
2. Importance and role of livestock
3. Research Overview
4. Some of the Results
5. The threats to livestock genetic diversity
6. Opportunities and actionables
7. Conclusions
8. Recommendations

1. The Global Facts

- World population keeps on growing: Currently 6.9 billion & will reach 9 billion by 2050)

- Livestock production is NB: 1billion keep livestock & 60% of rural hhs, *most of whom are poor,* draw income from livestock production

- Effect of climate change will be a significant factor (temp., water, forage/crop yields!)

- Great diversity (genetics & environment): opportunities, but both are threatened

2. Importance & Role of Livestock

Importance of livestock in Africa

- 70 % of Africa's rural poor keep livestock

- > 200 Million people rely on livestock for their livelihoods
- Livestock play pivotal roles in all-agro-ecological zones (genetic diversity is key)

African cattle

- 200 million head
- 150 indigenous breeds

2. Role of Livestock

food (milk, meat &

dairy products)

Fuel & manure

Scola and her family in Malawi eat animal products – milk, eggs or sometimes meat - 1 day per month, *so animal product related health concerns are non-issues here; in fact, more milk and meat would be desirable!*

Role cont..

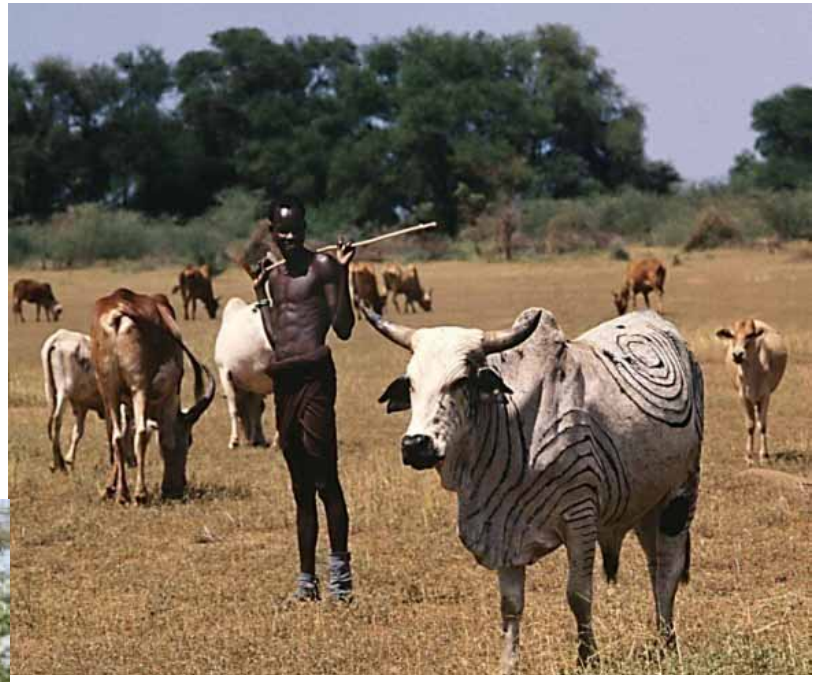
Draft power

nutrient recycling etc.

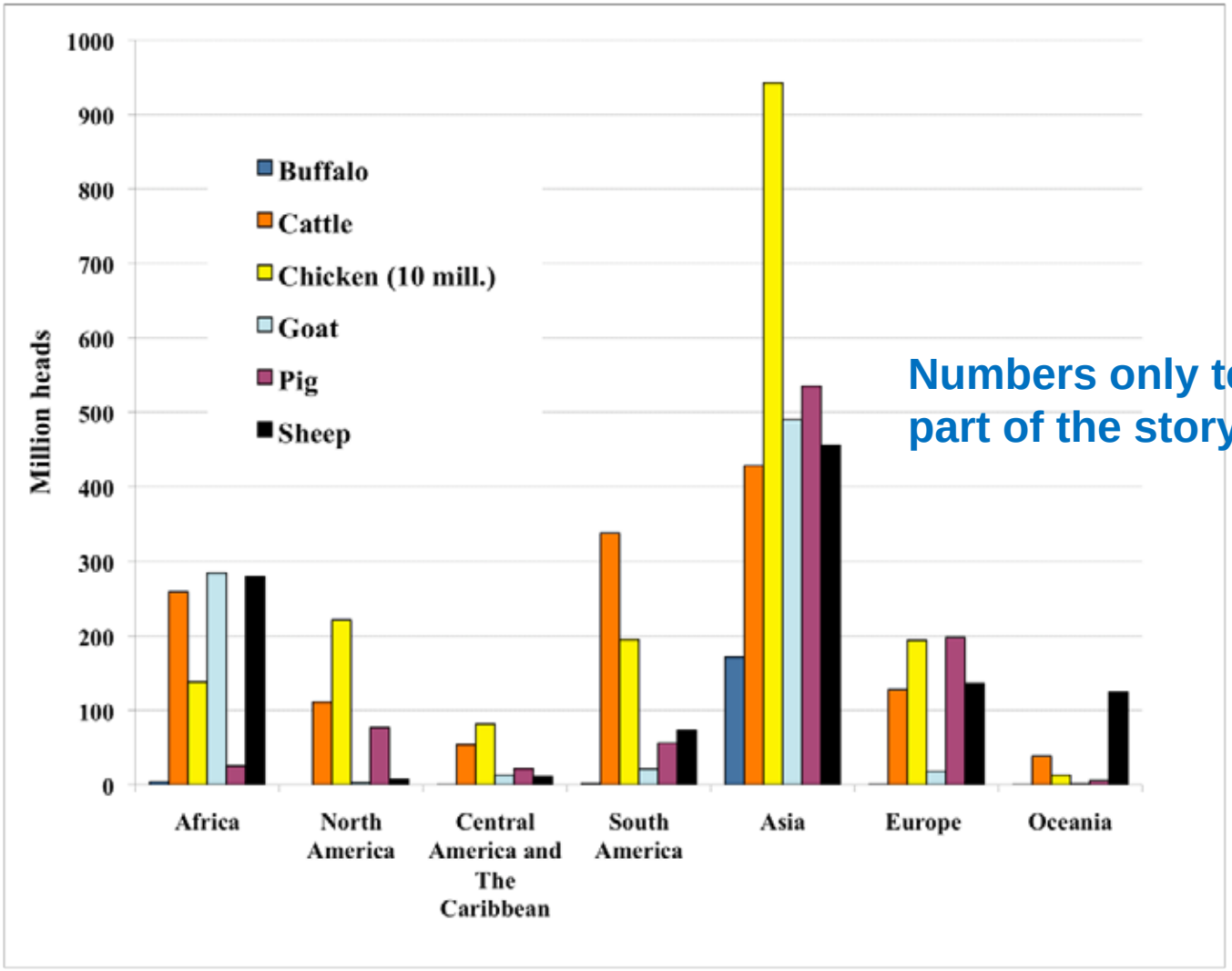
saving and insurance

Role cont..

Cultural



Total world livestock population by region in 2007



Source: FAO (2009)

Per capita annual consumption of animal products (kg/person/yr) by region

Region	Product and year					
	Meat		Milk		Eggs	
	1980	2005	1980	2005	1980	2005
Developed countries	76	82	198	208	14	13
East & S East Asia	13	48	4.5	21	2.7	15.4
Sub Saharan Africa	14	13	34	30	1.6	1.6

Source: FAO (2009)

Intensification needed in Africa, to achieve the required productivity and to safeguard the natural resource base

3. The Diversity, Overview of Characterization & Conservation Research

Diverse

Environments-

diverse genes/options

Even at a country level the diversity can be huge!


Dauara


Borana


Curko


Gasara

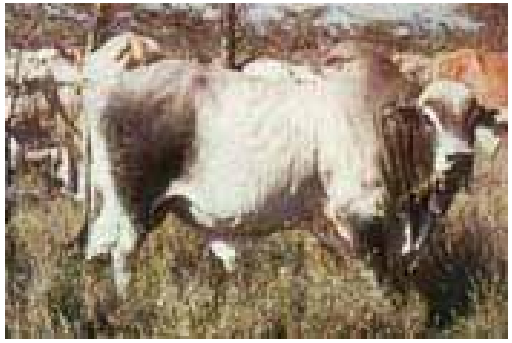
Somalia

&

Ethiopian cattle breeds


North Somali zebu


Barca


Improved Boran


Fogera

Type of studies

- Genetic characterization (use of genetic markers)
- Phenotypic characterization
- Production systems assessments
- Indigenous knowledge systems
- Combinations of the above

4. Some Research Results

Several Breed diversity studies results

- In cattle
- In sheep
- In goats
- In camels
- In chicken

Successful Breeding/conservation programs!

Few and far between

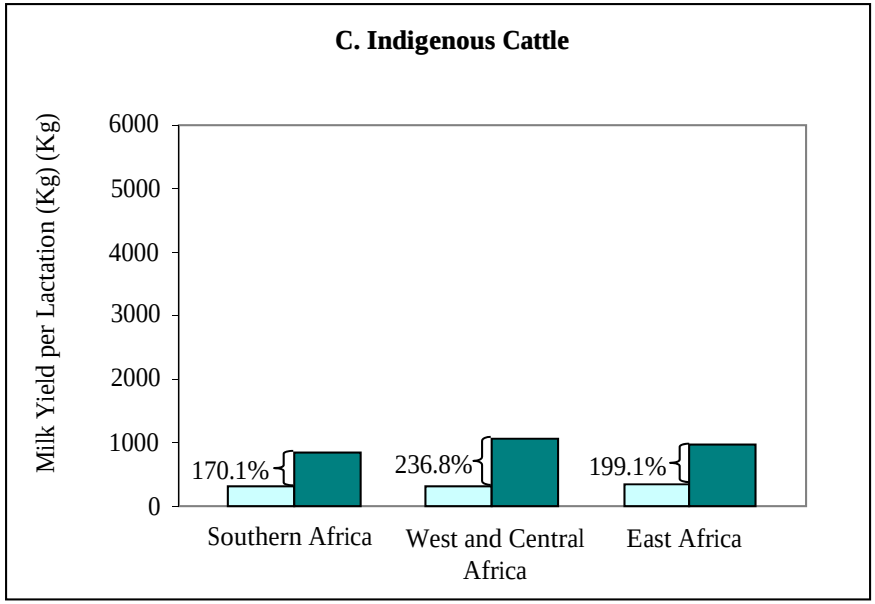
- Boran in Kenya
- Nguni in Southern Africa
- A few beef cattle crossbreeding programs
- Boar goat and Dorper sheep in South Africa

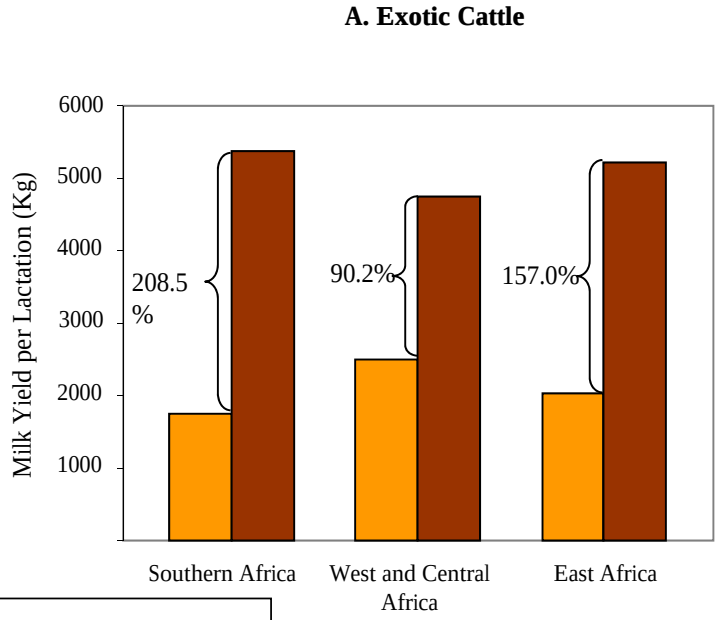
Potential but inadequately exploited breeds

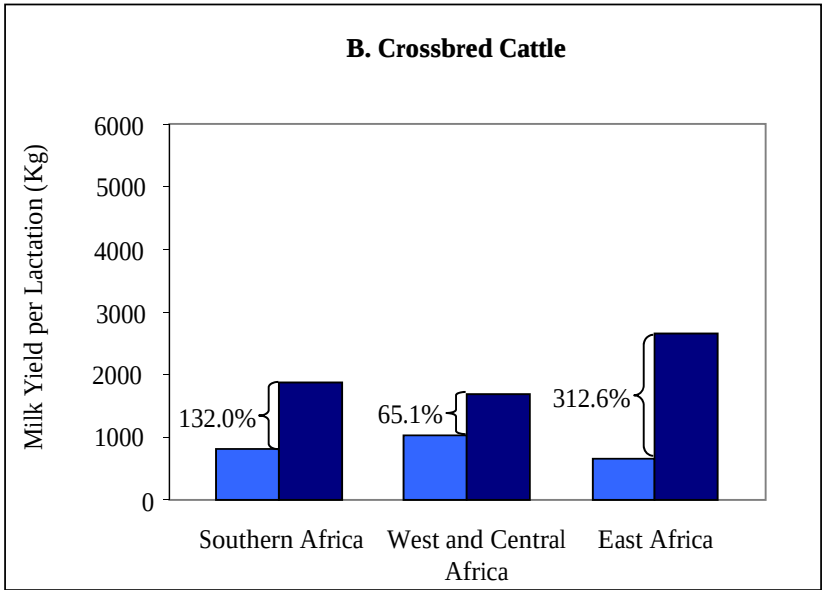
Dawara, N'Dama
Borana goat
Kenana & Butana
Red Maasai, Bonga and Djallonke sheep
Several camel breeds

Too little from many!: great diversity but low productivity!

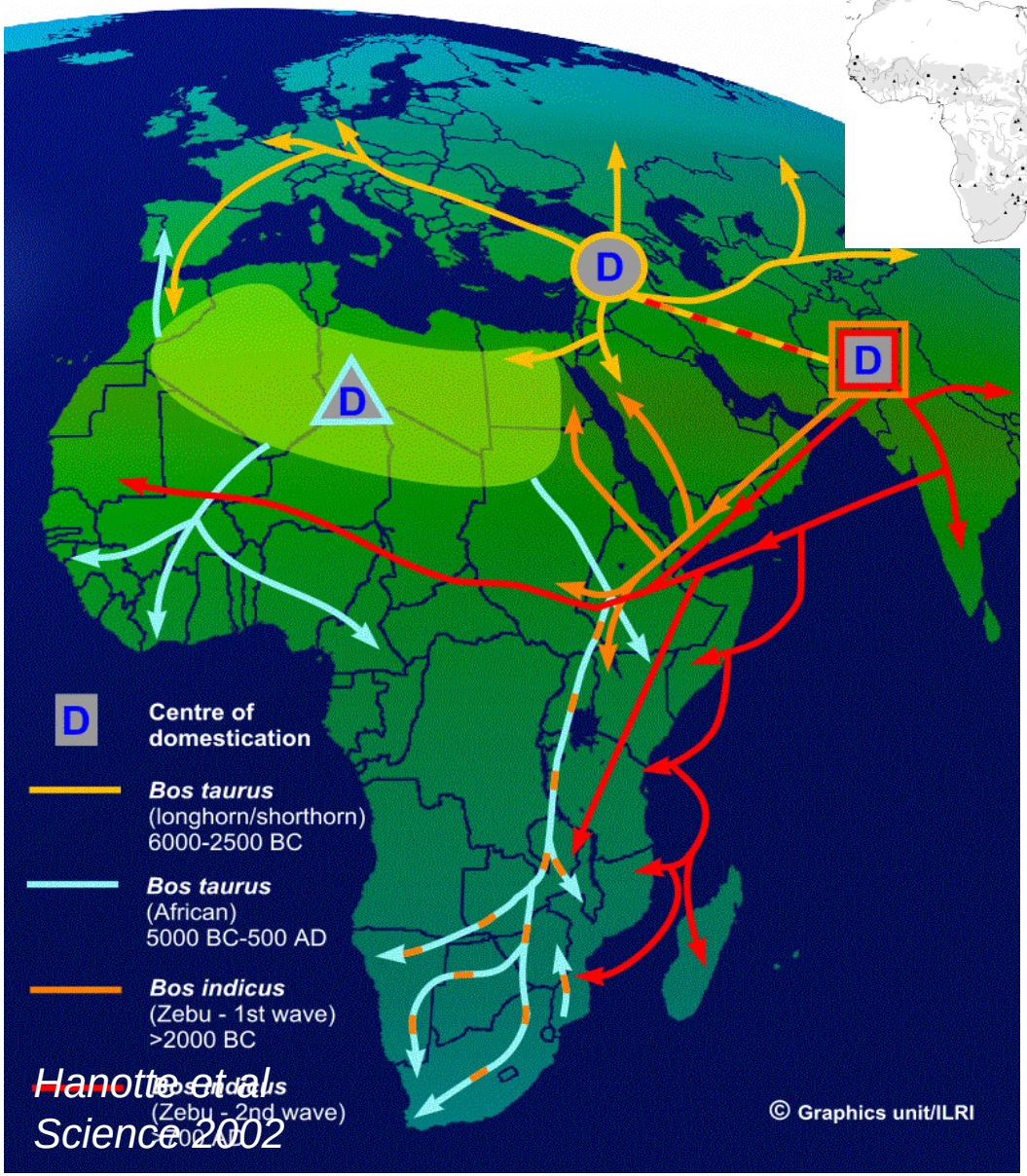
Potential (bolder bars) vs realized yields & the gaps







Origin and migration routes of domestic cattle in Africa



Hanotte et al. Science 2002

Richness found no where else

X

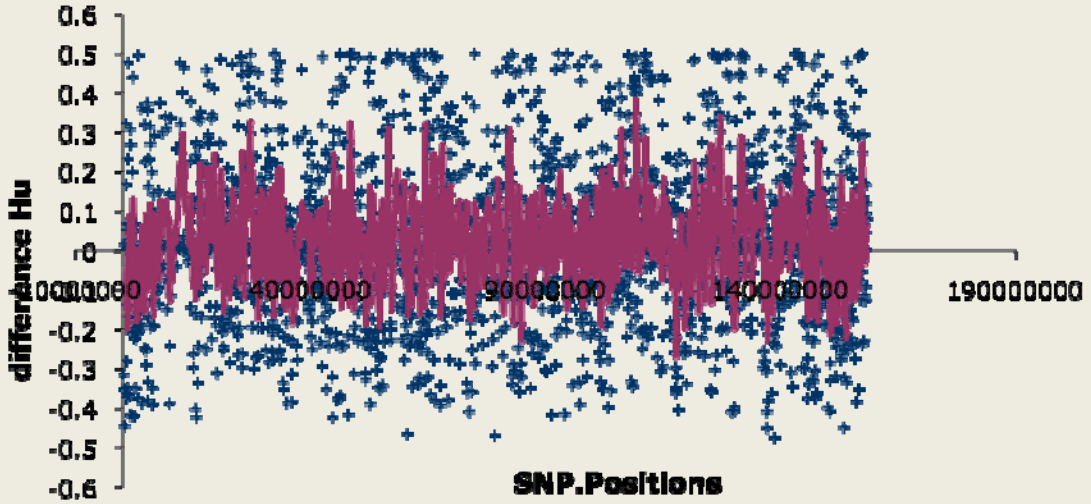
X

X

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

Informativeness of illumina Bovine50SNP in some african cattle

IDEAL vs	Mean of difference
HOLSTEIN	-0.075
NDAMA	0.028
NELORE	0.083
SHEKO	-0.006
CAPE BUFFALO	0.218



Need to include diverse genetic resources in tools development.

Unique adaptation to heat, diseases, parasites etc.

- Tolerance to disease:
  - ND'ama to try-panosomosis

Delays onset of parasetemia

5 QTLs for tryp-tolerance

(affects 37% of Africa & costs US$1billion/yr)

- Sheko

When exposed to severe trypanosomosis challenge, other breeds need **4 x number** of treatments as Sheko in a year

Unique adaptation to heat, diseases, parasites etc.

- Tolerance to heat and water stress-Boran

Can be watered every other day and cope with very high temperatures

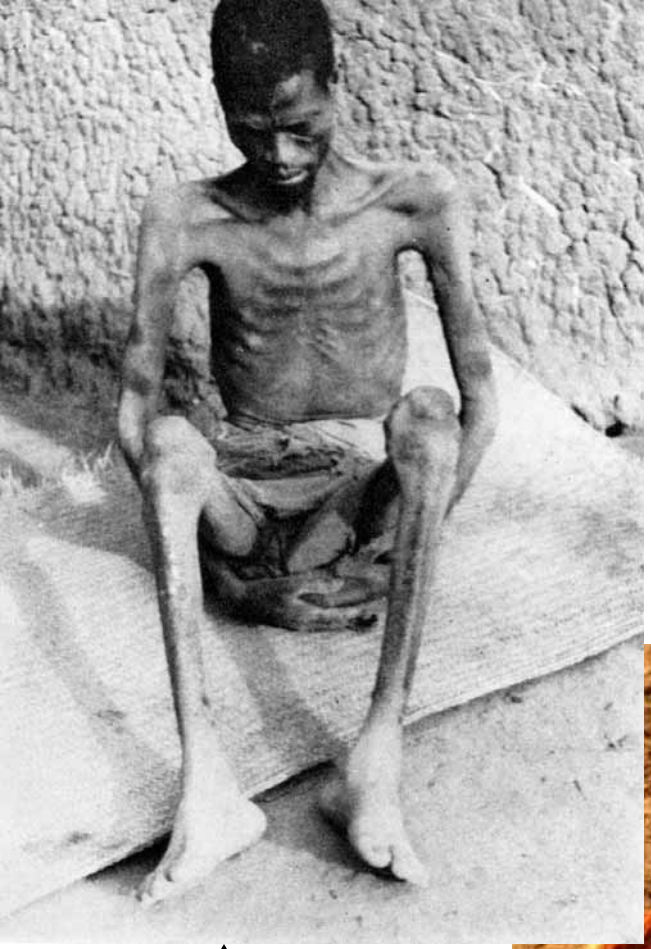
- Able to utilize low quality forages –Boran & Ankole

AFC: 39 Months
CI: 13 Months
8-11 calves/lifetime
Weight: 700k; 400kg

Trypanosomiasis

Is a fatal disease of livestock.

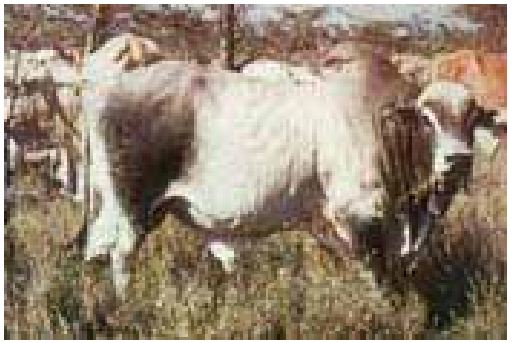
The livestock equivalent of sleeping sickness in humans



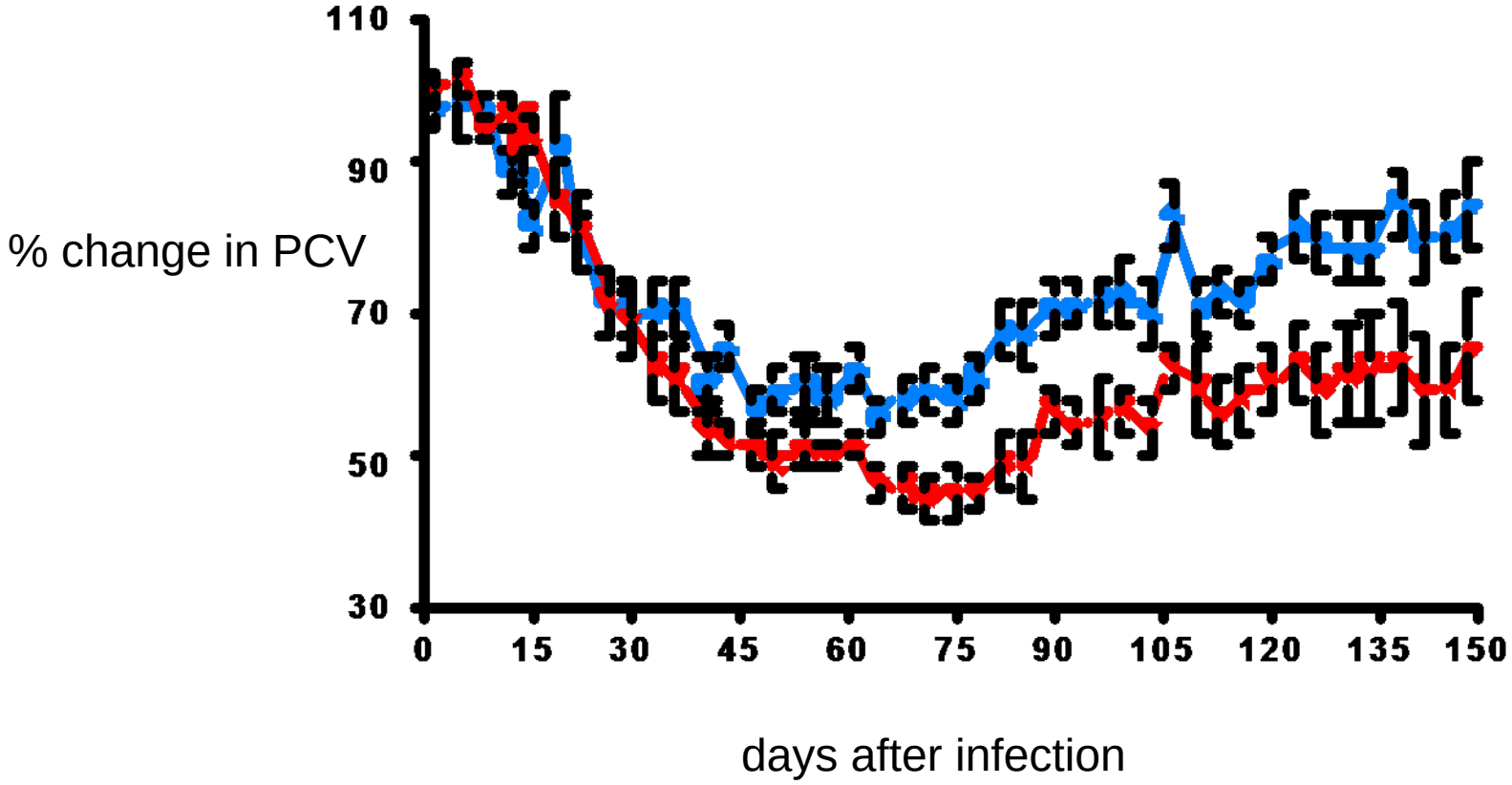
T brucei rhodesiense
T gambiense

T. congolense,
T. vivax

N'Dama



Boran

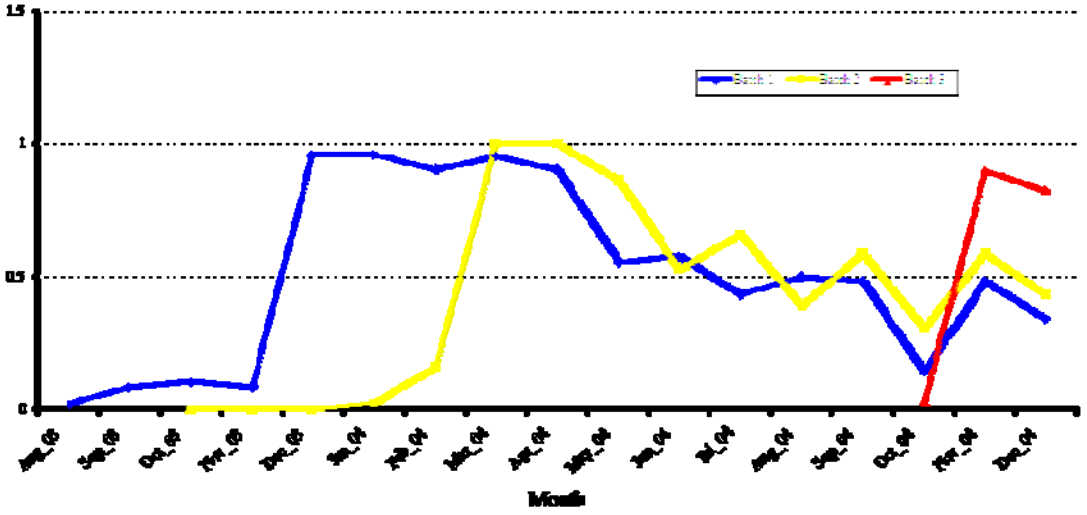

% change in PCV
110
90
70
50
30
0
15
30
45
60
75
90
105
120
135
150
days after infection

Natural field challenges

body weight
parasitaemia
PCV

F1 n'dama x boran, boran, backcrosses

Western Kenya, Narok



High Challenge Areas

האוניברסיטה העברית בירושלים
The Hebrew University of Jerusalem

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

KARI-TRC

Alignment of N'Dama ARHGAP15 with homologues

H → P mutation at AA282

```
Cow NDama    KFITRRPSLKTLQEKGLIKDQIFGSPLHTLCEREKSTVPRFVKQCIEAVEK
Cow Boran    KFITRRPSLKTLQEKGLIKDQIFGSHLHTLCEREKSTVPRFVKQCIEAVEK
Human        KFISRRPSLKTLQEKGLIKDQIFGSHLHTVCEREHSTVPWFVKQCIEAVEK
Pig          KFITRRPSLKTLQEKGLIKDQIFGSHLHTVCERENSTVPRFVKQCIEAVEK
Chicken      KFISRRPSLKTLQEKGLIKDQIFGSHLHLVCEHENSTVPQFVRQCIKAVER
Salmon       KFISRRPSMKTLQEKGIIKDRVFGCHLLALCEREGTTVPKFVRQCVEAVEK
```

Gene frequency

	N'Dama (n = 35)	Boran (n = 28)
282P-Allele	0.990	0.125
282H-Allele	0.010	0.875

5. The Great genetic diversity but is under threat.. but not everywhere!

Unlike for crops, no gene livestock gene banks in place in most of the African countries, and no comparable global effort currently being made, yet they host 70% of world's livestock genetic diversity

Action is needed now

The rate of meltdown is worrying

2003

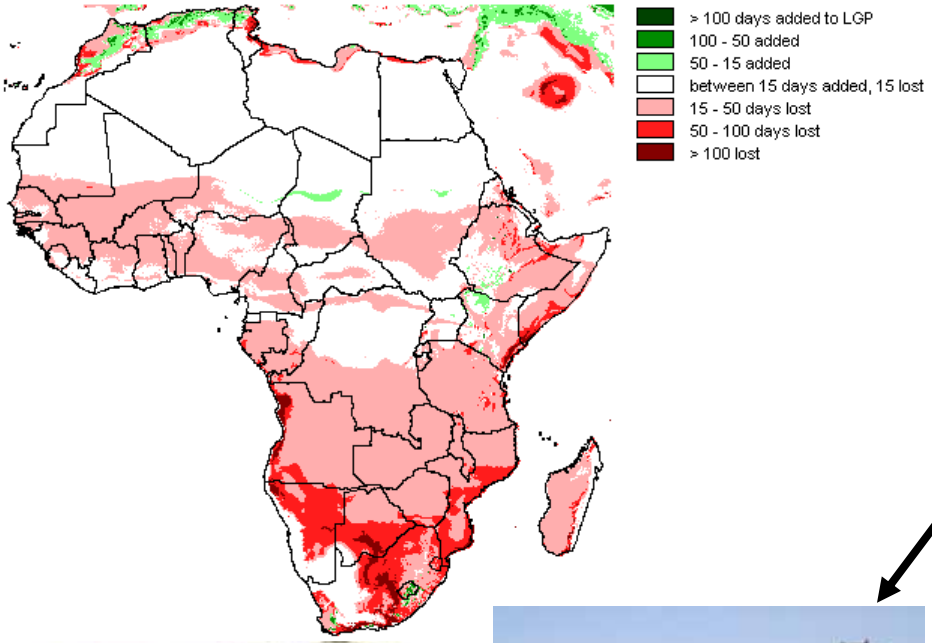
2009

The Ankole story:
Who knows what will be left in 50yrs time!

Uganda:

Proportion of pure Ankole cattle South Western Uganda has significantly dropped since 2003

Drastic changes are occurring but not every where



Increased frequency of climatic extreme events: (drought/floods), erosion, soil degradation

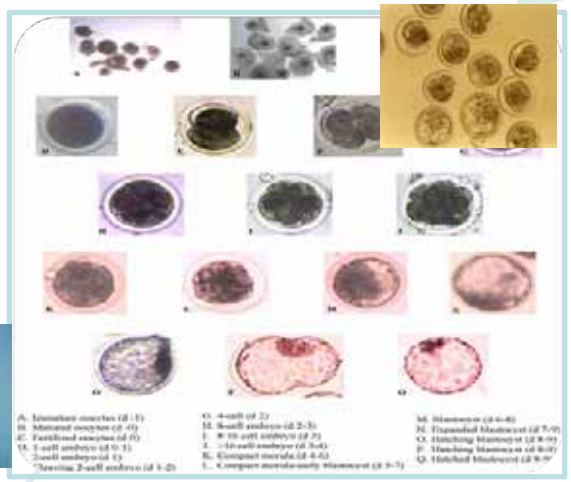
6. Opportunities and actionables

Rep.technologies: potential for conservation of breeds under threat

Using ovaries from dead cows, female embryo's can be developed in the lab

Lab

Abattoir/OPU



Embryos then transferred grow within recipient cows

Contracted surrogates

IVF & IVM

Indigenous donor cows

OPU

Ex-situ conservation is doable

Ex situ conservation is perfectly technically possible

Estimated Repository Equipment Costs

	Small - Necessary	Small - Optional	Medium	Large
Total	$12,000 - $47,000	$30,650 - $65,650	$113,350- $213,150	$206,350 - $227,350

- Equipment cost increase due to increased quantity and special equipment e.g., straw fillers and labelers

Costs of Collecting Germplasm – Field Collection

Indicative cost (Euros) per animal for different tissues and species.

	Somatic cells*	Semen	Embryos
Cattle	10	105	500
Sheep	10	82	500
Goats	10	82	500
Pigs	10	130	?
Chickens	10	40	

an *ex situ* collection is useless without a catalogue

There are two separate data types to catalogue

1. Genotype. Is now easy!

2. Phenotype remains a critical gap. But filling this gap will pay huge dividends.

3. The same gap limits *in situ* exploitation. This is a win-win!

Phenotype remains a critical gap

1. We need to describe animals and their environment as richly as we possibly can.

2. This must be individual-centric and not breed centric. Breed-centric descriptions are of limited value and potentially highly misleading.

3. New approaches allowing “proxy” phenotyping on a large scale are needed to bring this half of the equation to reality.

Phenotype remains a critical gap

Can we leverage the galaxy of information from non-traditional sources to deduce a phenotype ?

ICT (e.g. Hand held phones digital cameras)

GIS

Remote sensing

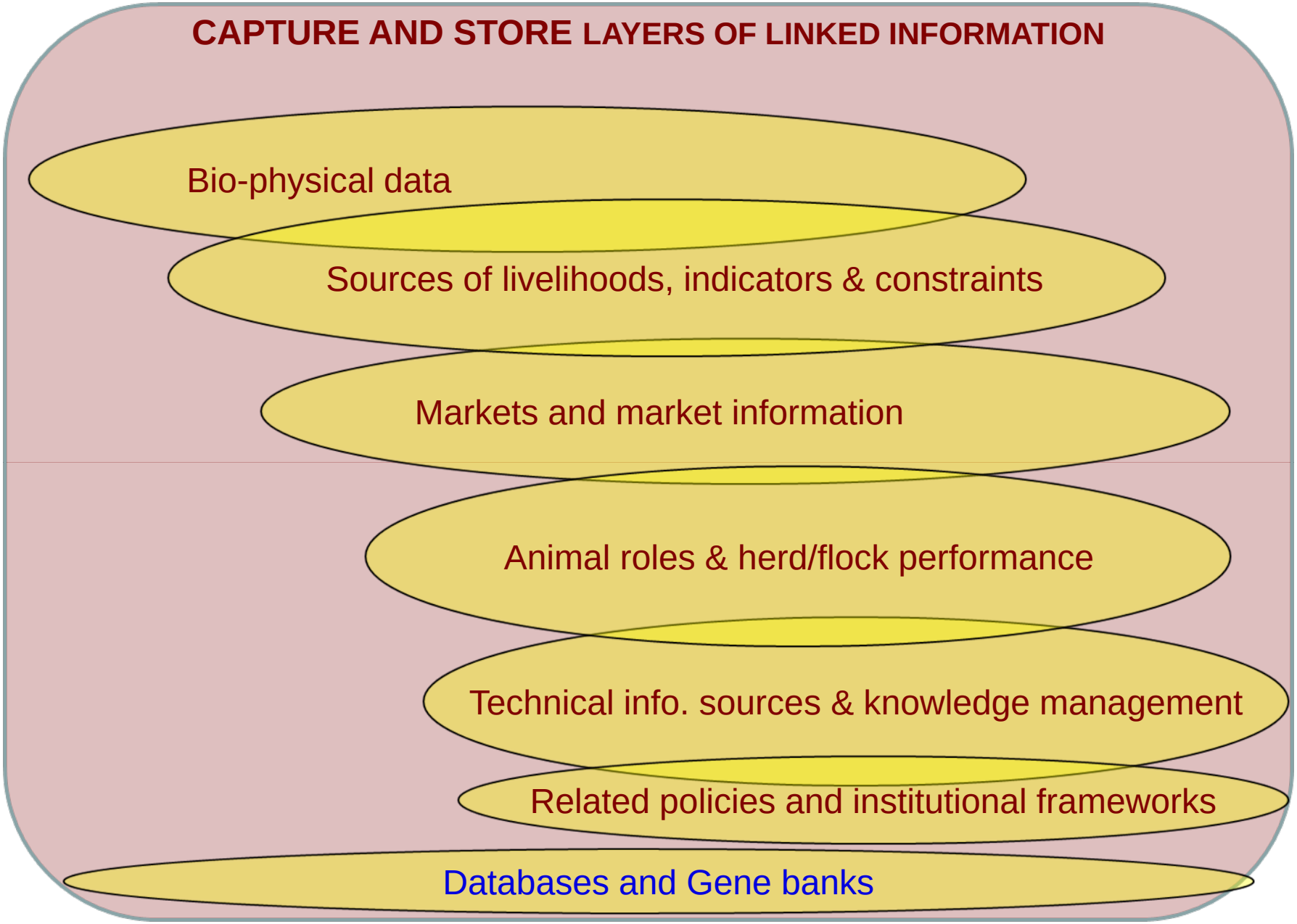
Disease modelling

Climate modelling

Markets analysis

etc

What to do & How



7. Conclusions

- African livestock are unique reservoirs of genetic diversity and adaption that shouldn't be lost.
  - *Need to develop context specific utilization/conservation options & strategies*

- African livestock are not genetically inferior but they are mostly inadequately managed-genetically
    - ***match better & produce more from fewer animals!***

- Diverse development opportunities for livestock
  - *reducing poverty; risk management, coping with unpredictable future*
- Capacity to sustainably & better manager the existing AnGR and deliver/share improved genetics is low

Conclusions cont..

- Bio-banking is not too expensive and no one will do it for Africa, let us start now!
- In Africa, the indigenous knowledge is being lost faster than the breeds

- Technological options to enable their conservation and sustainable use of African AnGR exists today:
  - Genomics, bioinformatics and assisted reproductive *t*echnologies-*We only need to apply them wisely*

8. Recommendations

- Better and more participatory study designs needed
- Tools and guidelines exist, so no excuse for doing the wrong things!
- Take advantage of emerging technologies
- New commitments & additional resources needed to actualize the international commitments (GPA) to immediately start:
    - Informed in-situ & in-vitro and conservation of selected populations/breeds need to be done
    - Support capacity building in the above areas,


Thank you