

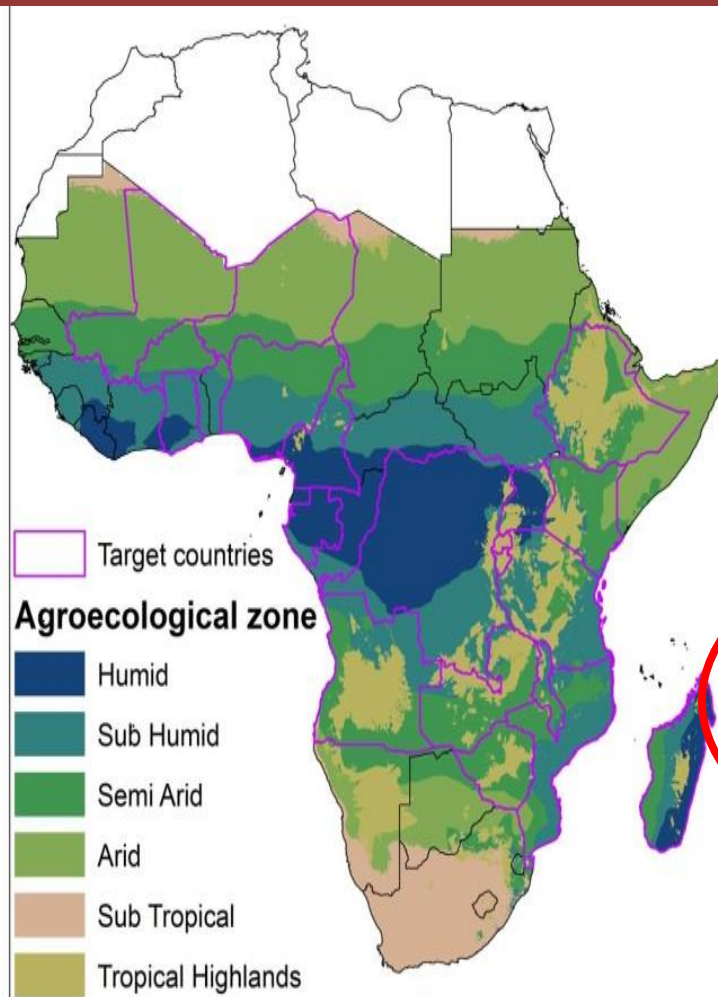
# Challenges and opportunities for improved tropical dairy productivity and resilience

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CTLGH Annual Meeting 2017  
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# The Tropics: Some Facts on SSA



Source <http://harvestchoice.org>

Key agro-ecological zones in sub-Saharan Africa .

## African livestock

- 310 million cattle, 360 & 340 million goats & sheep
- 34 million pigs, 23 million camels and 1.9 billion chicken
- 150 indigenous breeds
- Kept by 309 million people

Source : FAO, 2015

# Coverage & demographic characteristics of key agro-eco zones in Sub-Saharan Africa

Agro-Ecological Zone (AEZ) <sup>1</sup>	land area (km <sup>2</sup> )	cultivated land (%)	Population (millions)	below poverty line (%)
<b>Humid</b>	3,177,532	8.0	127.2	48.5
<b>Sub-humid</b>	5,138,577	10.3	238.8	57.3
<b>Semi-arid</b>	5,466,015	16.2	197.0	52.5
<b>Arid</b>	6,096,894	2.0	43.8	23.3
<b>Highland</b>	2,758,556	18.1	217.9	44.0
<b>Sub-tropical<sup>2</sup></b>	1,489,561	8.1	30.3	30.5
<b>Total</b>	<b>24,127,135</b>	<b>10.5</b>	<b>855.0</b>	<b>48.8</b>

Source <http://harvestchoice.org>

- The proportion of unemployed youth is highest in the world (> 40%)
- Political strife is frequent, signaling sense of hopelessness
- Average cereal yields are 1.4 tons/ha (*6 times lower than the N. America's figures*)

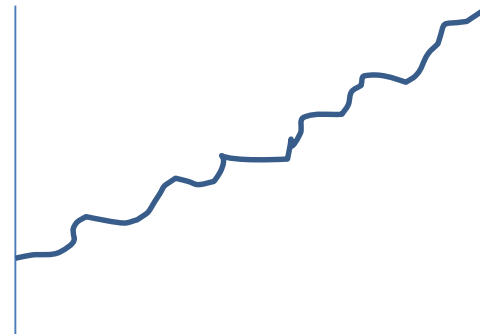
# Potential impact of improved tropical dairy productivity and resilience

## 1. Sustained increase in income and improved livelihoods for millions of dairy smallholders

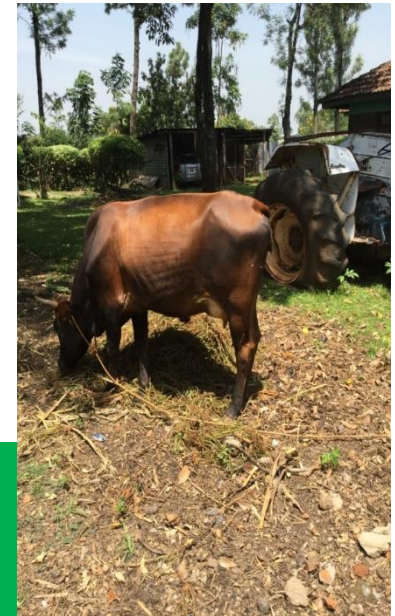
Better match of breed-type to farmers' production systems



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**Optimize Realized Productivity for farmers**



*From too large and underfed Purebreds to moderate sized well-fed, productive & more resilient genetics*

# Potential impact cont..

## 2. Improved food, nutrition security & health of the poor households in Sub Saharan Africa:

A glass of milk/day for children under 5 yrs affordable by millions of rural households

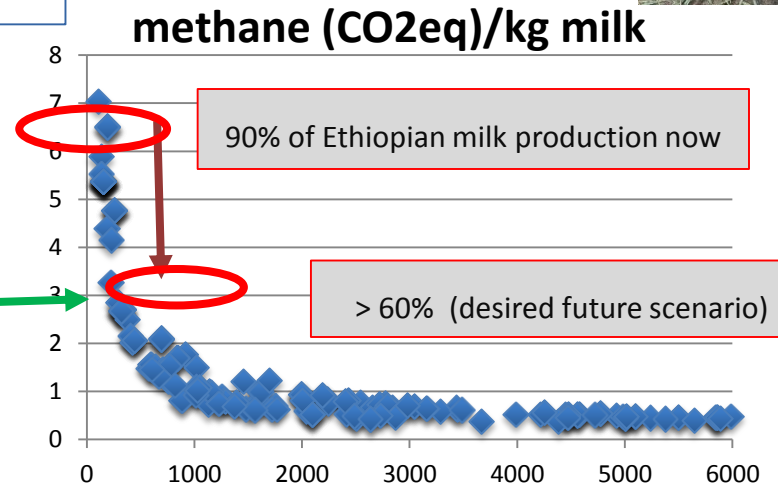


# Potential impact cont..

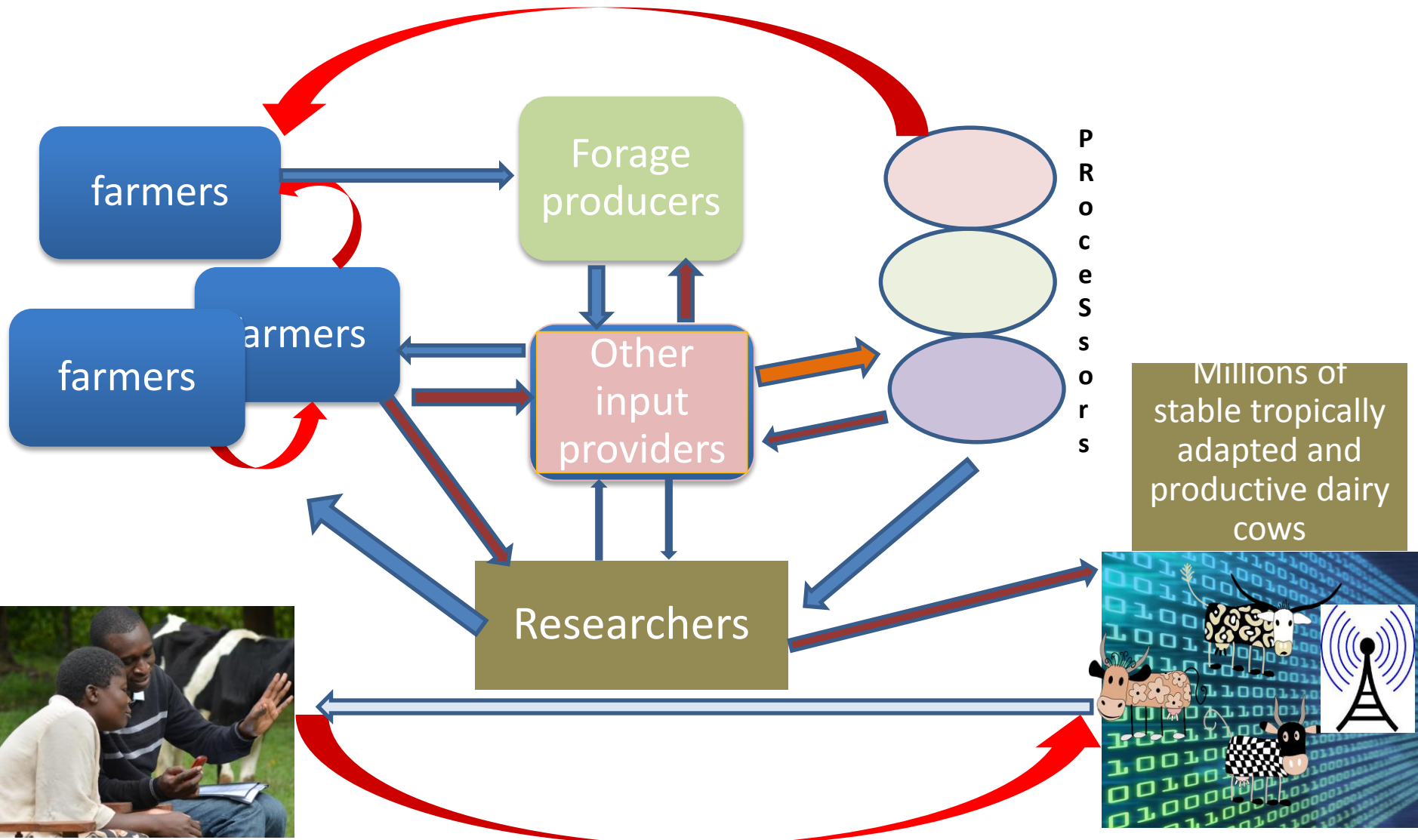
## 3. Improved/sustained environmental health



Fewer but more productive cows

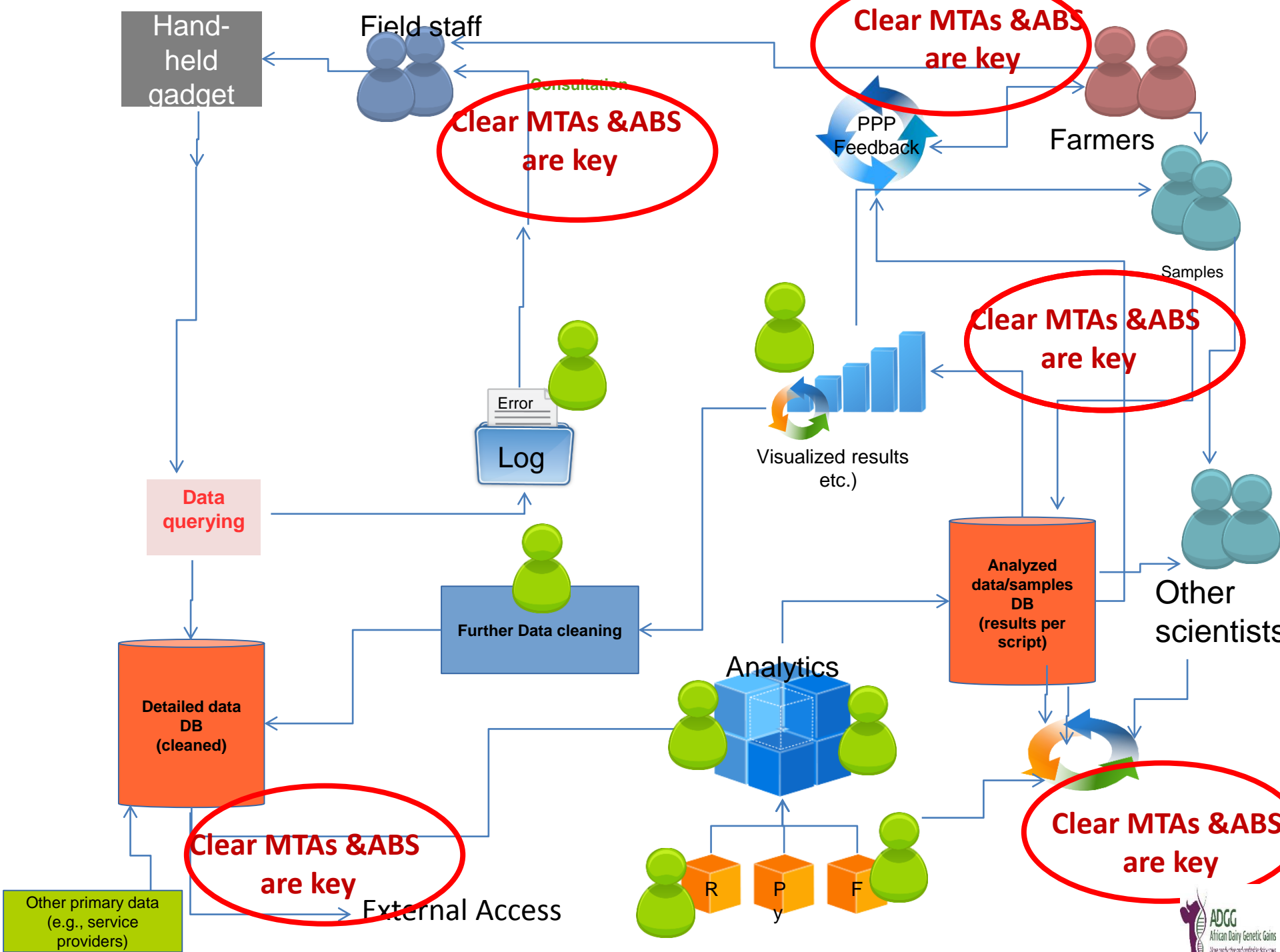


# Vision: What would success look like?



A globally shared data platforms and samples but with clear MTAs & Access & Benefit Sharing (ABS) frameworks





# Challenges to improved tropical dairy productivity and resilience

- Lack of systems/infrastructure for livestock performance recording, analysis and feedbacks
  - genetic evaluation and certification programs are lacking
- Limited access to the desired dairy genetics for the different production systems:
  - *Crossbreds commonly demonized for the wrong reasons !*

Innovative application of Genomic technologies and IT technologies are hampered by poor infrastructure



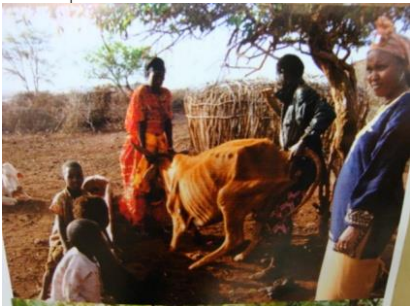
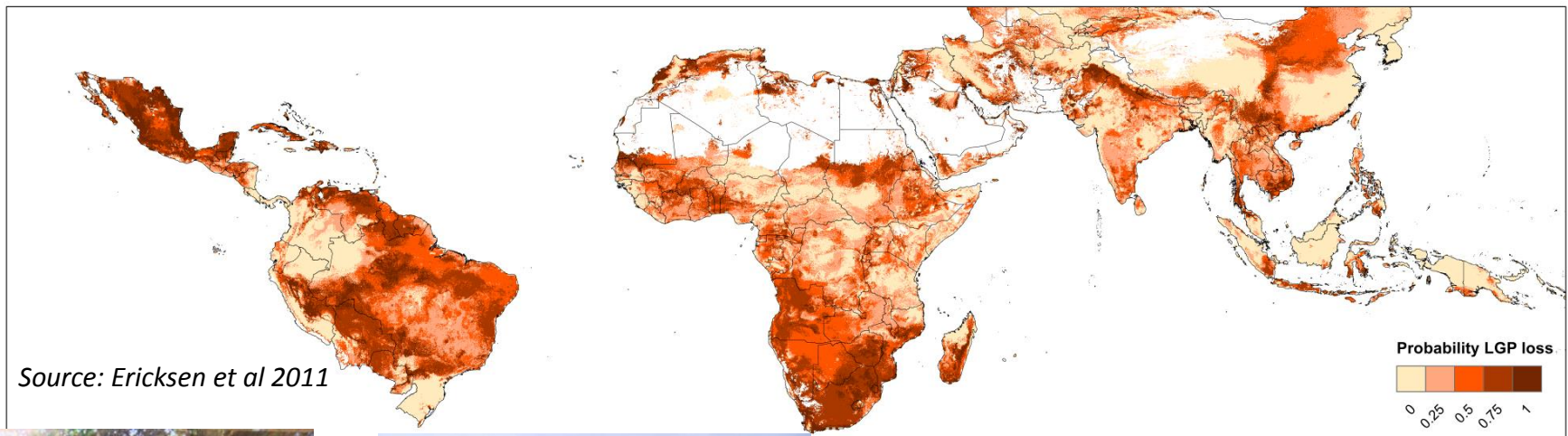
# Challenges cont..

- Efficient multiplication and delivery systems often lacking:
  - AI is demanded by majority (70%), but delivery remains unsatisfactory
- Inadequate technical and organizational capacity:
  - Local tropical systems are least understood by ARIs (*strong links needed between those who understand local situations & ARI scientists*)
  - Quantitative geneticists are scarce (*notion in the early 90"s - molecular genetics would solve every thing!*)
  - Actors/farmers not organized into strong enough groups but even when attempted, *poor governance impedes progress!*

# Challenges cont..

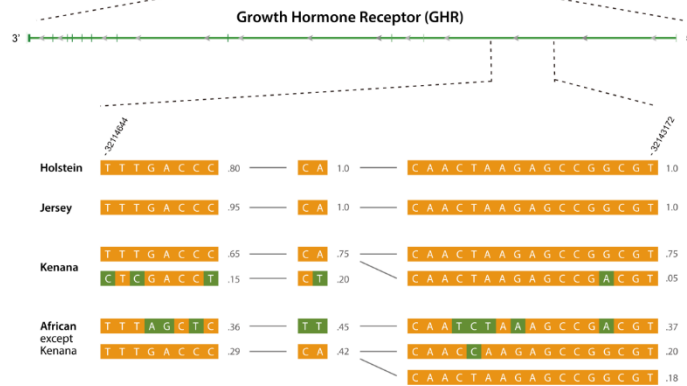
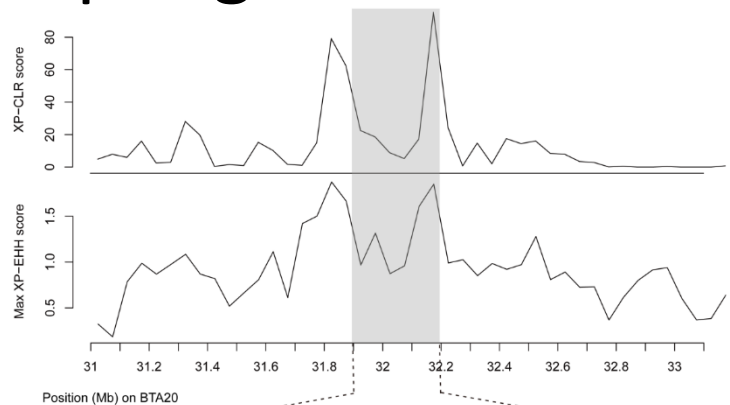
Access to input, market services, including AI service that are necessary for sustained productivity gains is inadequate.

Uncertainty of climate change effects

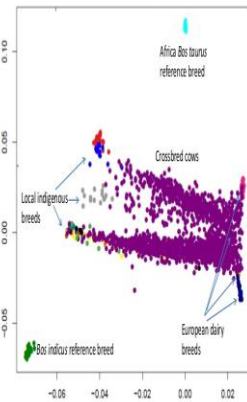


# Opportunities

- Exploiting the existing genetic variability using sharper genomic tools



Selective sweep for milk production in Kenana cattle



ZFN

TALEN

ZFNs and TALENs. Schematic (not to scale) of a ZFN pair (top) and a TALEN pair (bottom) to illustrate the DNA-binding principles. Image modified from *Nat. Methods* 8, 53–55 (2011).

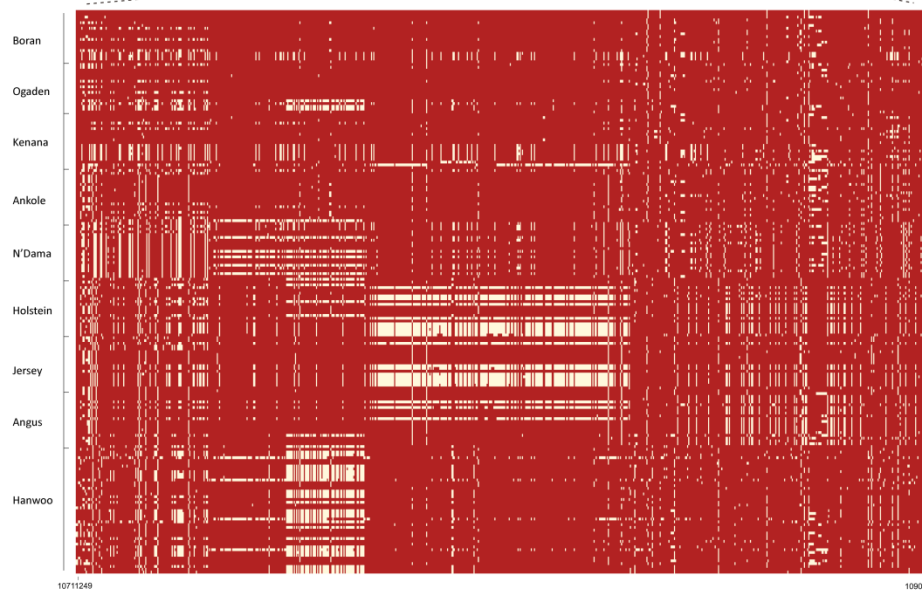
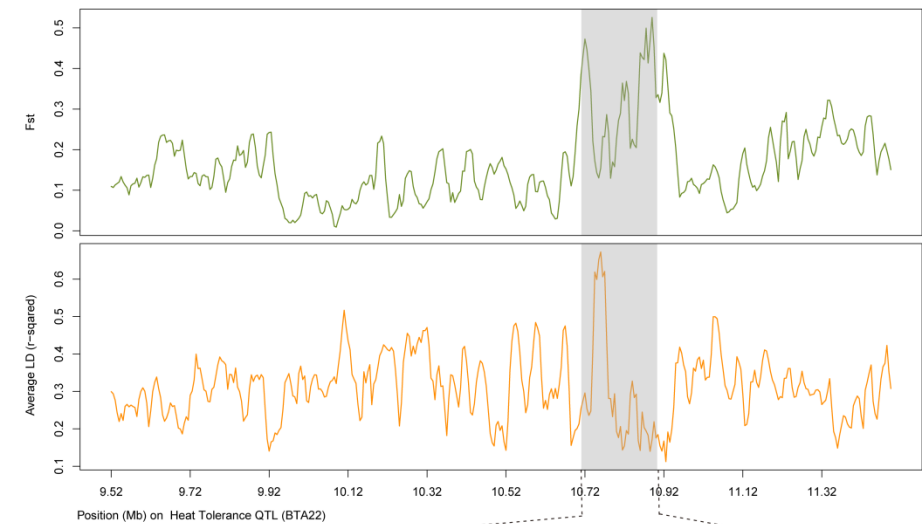
**Review: ZFN, TALEN, and CRISPR/Cas-based methods for genome engineering**  
 Thomas Gaj<sup>1,2,3</sup>, Charles A. Gersbach<sup>4,5</sup>, and Carlos F. Barbas III<sup>1,2,3</sup>

<sup>1</sup>The Biaggi Institute for Chemical Biology, The Scripps Research Institute, La Jolla, CA, USA  
<sup>2</sup>Department of Molecular Biology, The Scripps Research Institute, La Jolla, CA, USA  
<sup>3</sup>Department of Chemistry, The Scripps Research Institute, La Jolla, CA, USA  
<sup>4</sup>Department of Biomedical Engineering, Duke University, Durham, NC, USA  
<sup>5</sup>Institute for Genome Sciences and Policy, Duke University, Durham, NC, USA

Zinc-finger nucleases (ZFNs) and transcription activator-like effector nucleases (TALENs) comprise a powerful class of tools that are revolutionizing the frontiers of genome editing research. These chimeric nucleases are combining strategies and the potential for adverse ecological effects. Targeted gene knockdown by RNAi (see Commentary) has provided researchers with a rapid, inexpensive, and high-throughput alternative to homologous recombination.

Cell  
 PERSPECTIVES

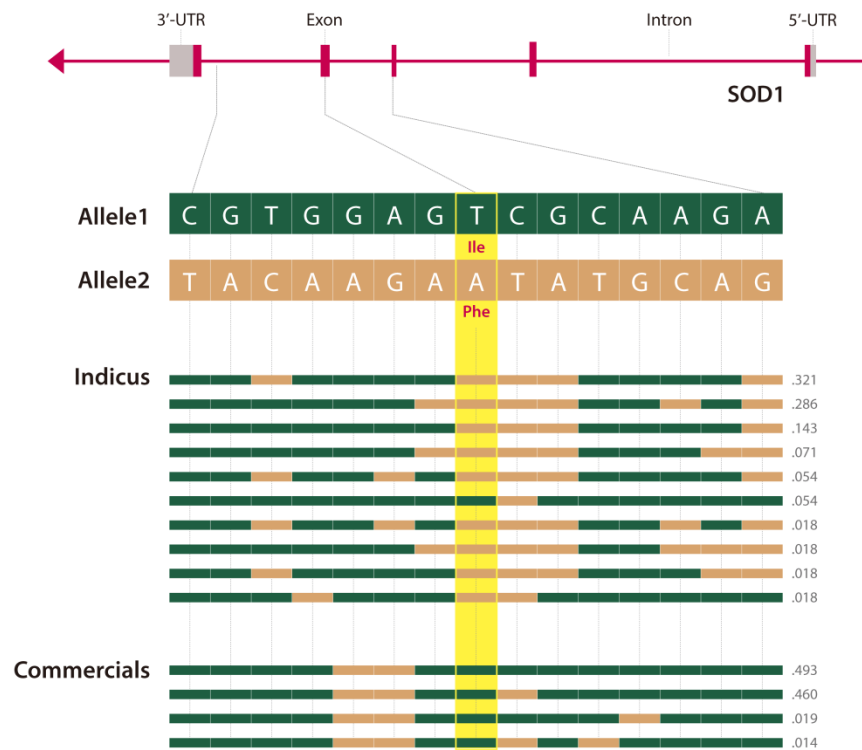
A)



**Selective sweep for heat tolerance in African cattle**

Source: Kim et al., 2017

B)



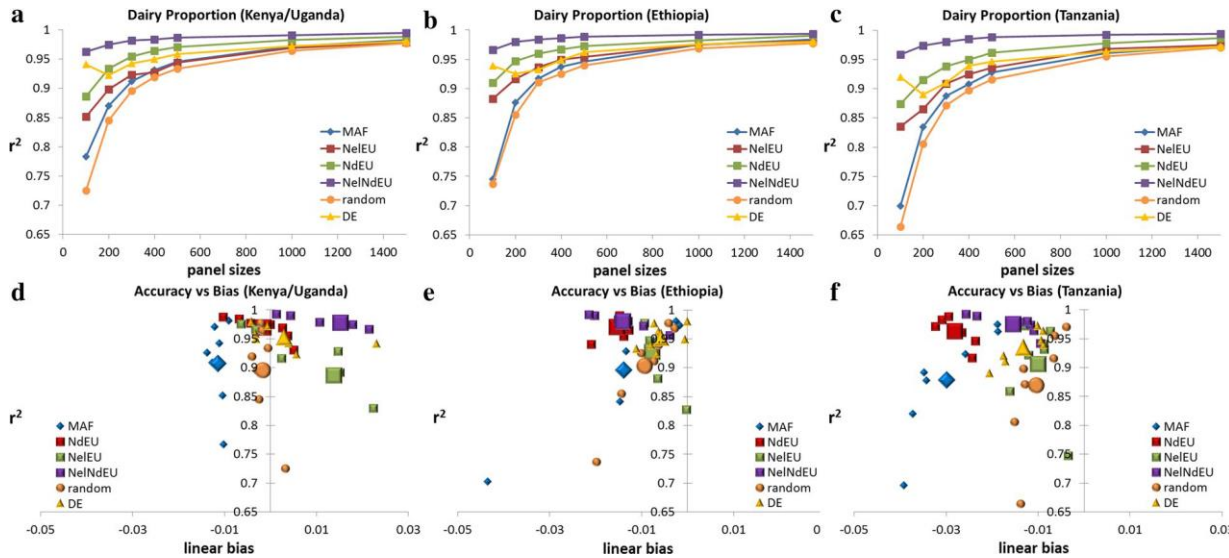
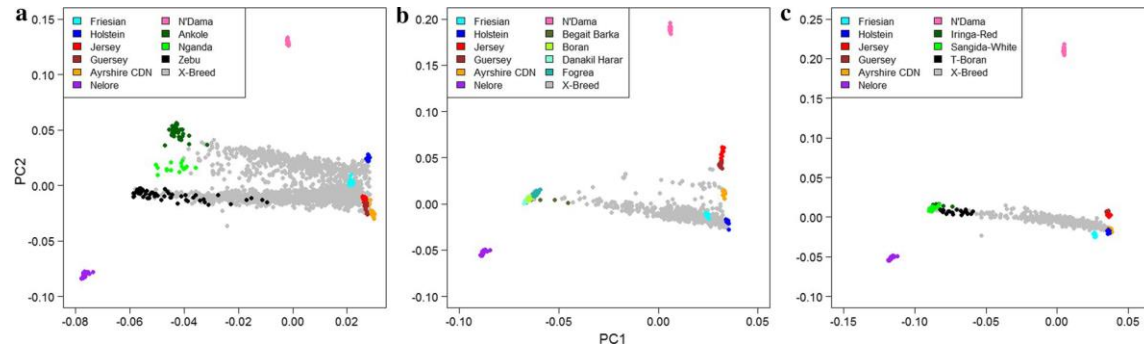
**ILRI**

INTERNATIONAL  
LIVESTOCK RESEARCH  
INSTITUTE



# Opportunities cont..

*Making use of the genetics underlying natural variations in different ways, including designing of new genomic tools*  
*(150 livestock breeds!)*

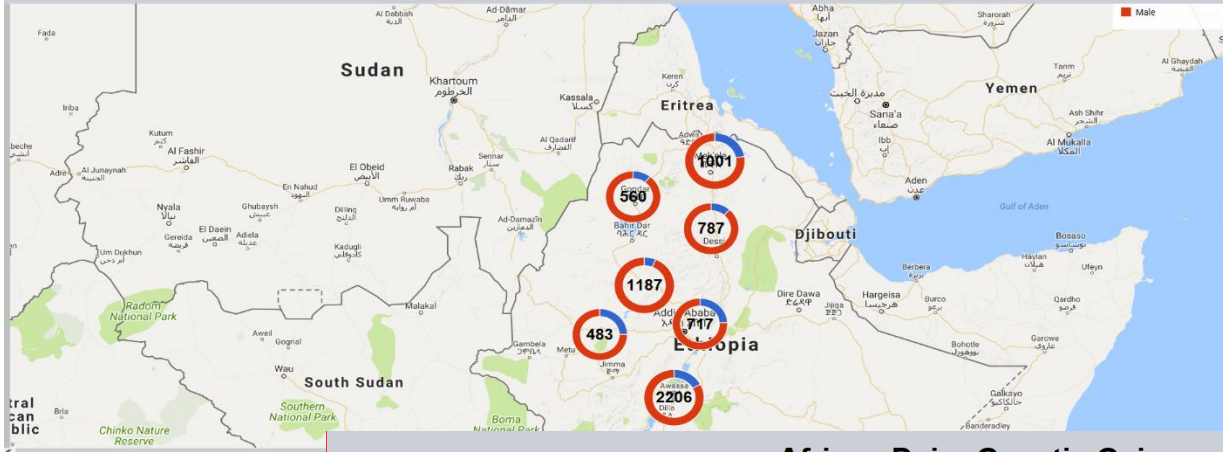


Accuracy ( $r^2$ ) of dairy proportion estimates (a–c) and accuracy versus bias (d–f) for different panel sizes. d–f large symbols show average linear bias across all panel sizes. Standard errors of accuracy ranged on average from 0.008 for 100 SNPs to 0.003 for 1500 SNPs (Kenya/Uganda), 0.015 to 0.005 (Ethiopia), and 0.02 to 0.008 (Tanzania)

# Use of digital platforms to record, geo-reference and share livestock performance and feedbacks

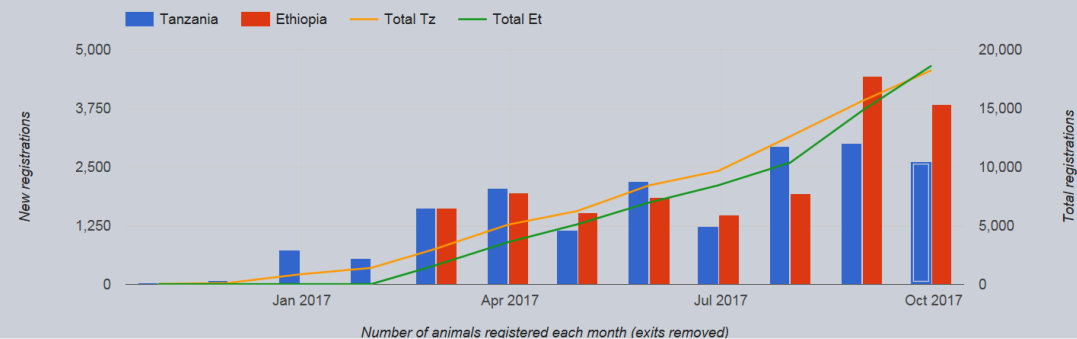
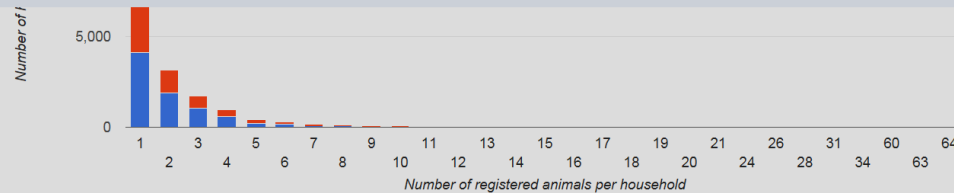
**African Dairy Genetic Gains activities**

20,228 households



**African Dairy Genetic Gains activities**

20,372 households



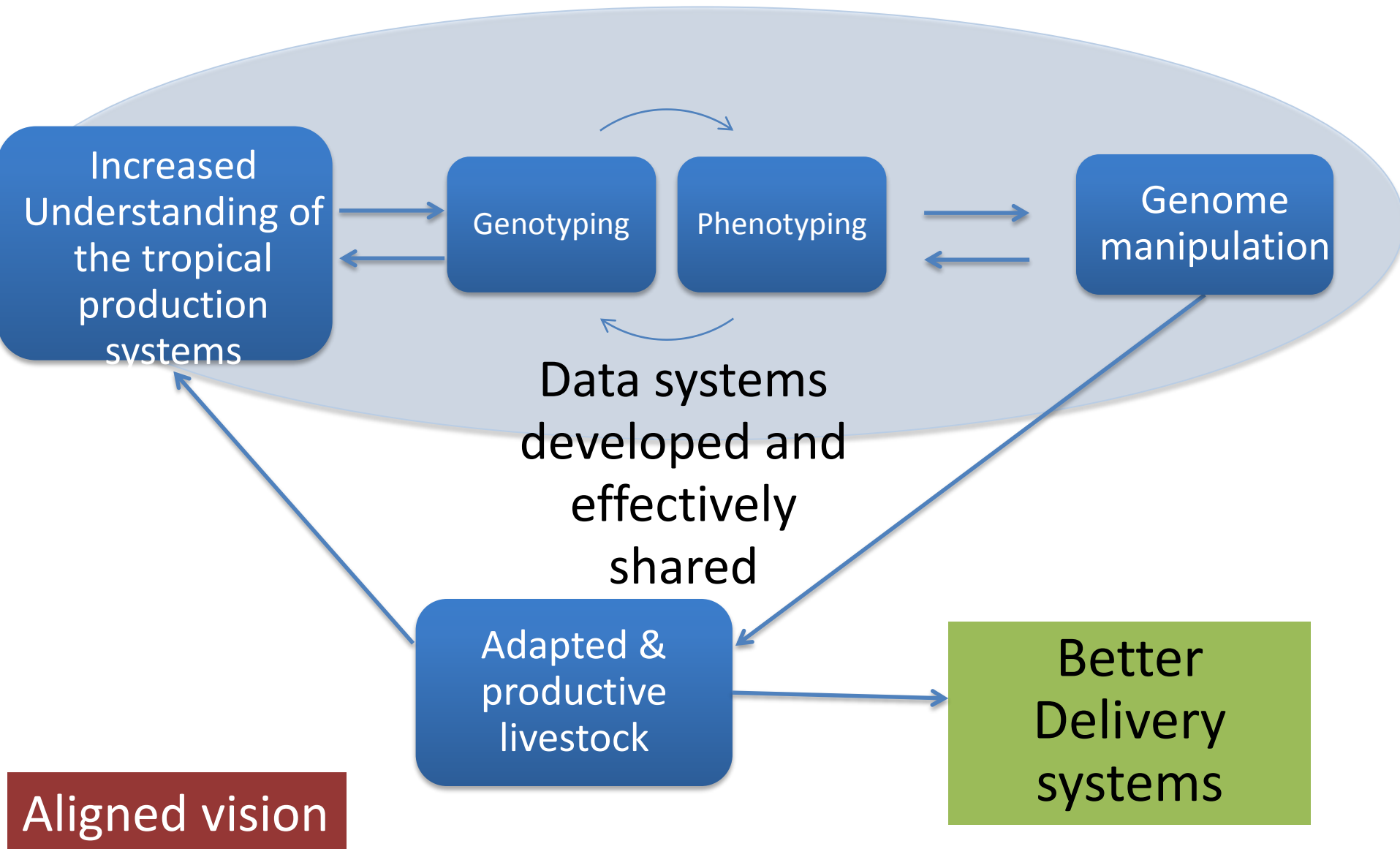


Opportunities for CTLGH to improve tropical dairy productivity and resilience

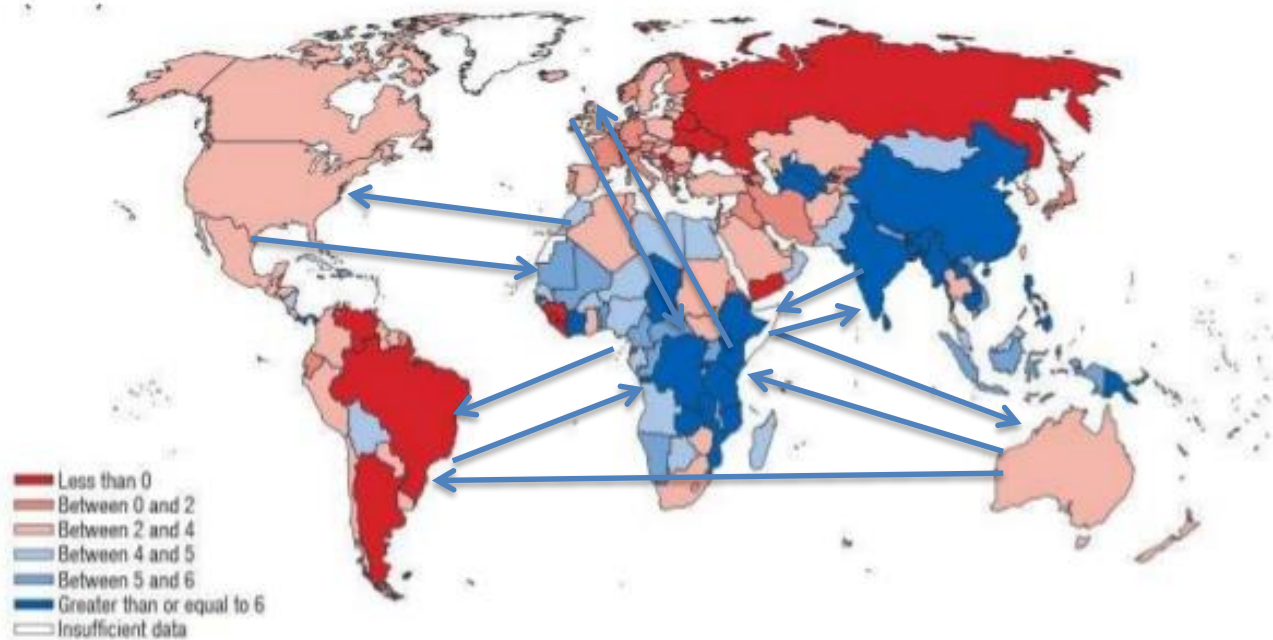
# Mapped CTLGH Dairy Genomics projects to the CTLGH-BMGF-DFID results framework

Outputs	BMGF original funding	DFID funding (* proposed)	Next funding priority
<p>1.1.1 Define and characterize cattle adaptability or productivity traits</p>		<p>Dairy cattle adaptation to (1) protracted nutritional deficits and (2) disease</p> <p><b>ADGG</b> <b>P4</b></p>	
<p>1.1.2 Identify putative causal variants linked to cattle adaptability/resilience or productivity traits</p>			<p>Genomic variants for milk and other ADGG traits*</p> <p><b>ADGG</b></p> <p>Signatures of selection for adaptation e.g. heat</p>
<p>1.1.3 Develop genomic tools and/or prediction algorithms to aid the selection of superior dairy cattle – including in collaboration with ADGG</p>	<p>Enhanced SNP-chips for African cattle genome interrogation and assignment of breed composition</p> <p>Genomics Reference Resource for African Cattle</p> <p><b>P3,P4,P5</b></p>	<p>Strengthening and testing wider applicability of ADGG developed genomic tools</p> <p><b>ADGG</b></p> <p>Suitability index for screening global dairy cattle for use in East Africa</p> <p><b>ADGG</b></p>	

# Conclusions



# Better networks and impact



An vibrant & impactful network of south-south and north-south Scientists and action research programs that are continuously responding to the tropical challenges, farmer needs & emerging diseases (esp. zoonoses)



Thank you

FARMERS



BILL & MELINDA GATES foundation

NARES & Regional Governments

