Innovative use of conventional and new technologies to unravel breed options for smallholder dairy production in africa

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PicoTeam Institute for People, Innovation and Change in Organisations
facilitation - coaching - research for change

UNE UNIVERSITY OF NEW ENGLAND

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AFRICAN UNION INTERAFRICAN BUREAU FOR ANIMAL RESOURCES

Africa occupies a large area of the World

West Africa

Countries: Gambia, Sierra Leone, Togo, Guinea, Mali, Senegal, Nigeria, Ghana, Niger, Cameroon, Gabon, Ivory Coast, Senegal, Burkina Faso, Guinea Bissau & Central African republic

East and Central Africa

Countries: Kenya, Tanzania, Uganda, Ethiopia, Rwanda, Burundi, DR Congo, Sudan, Somalia, Eritrea & Djibouti

Southern Africa

Countries: Zambia, Malawi, Mozambique, Zimbabwe, Botswana, Namibia, Angola, Swaziland, Madagascar, Lesotho, Mauritius & South Africa

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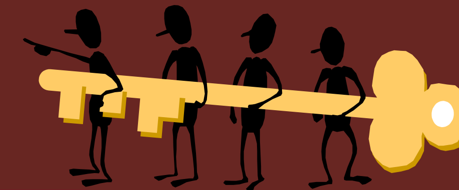
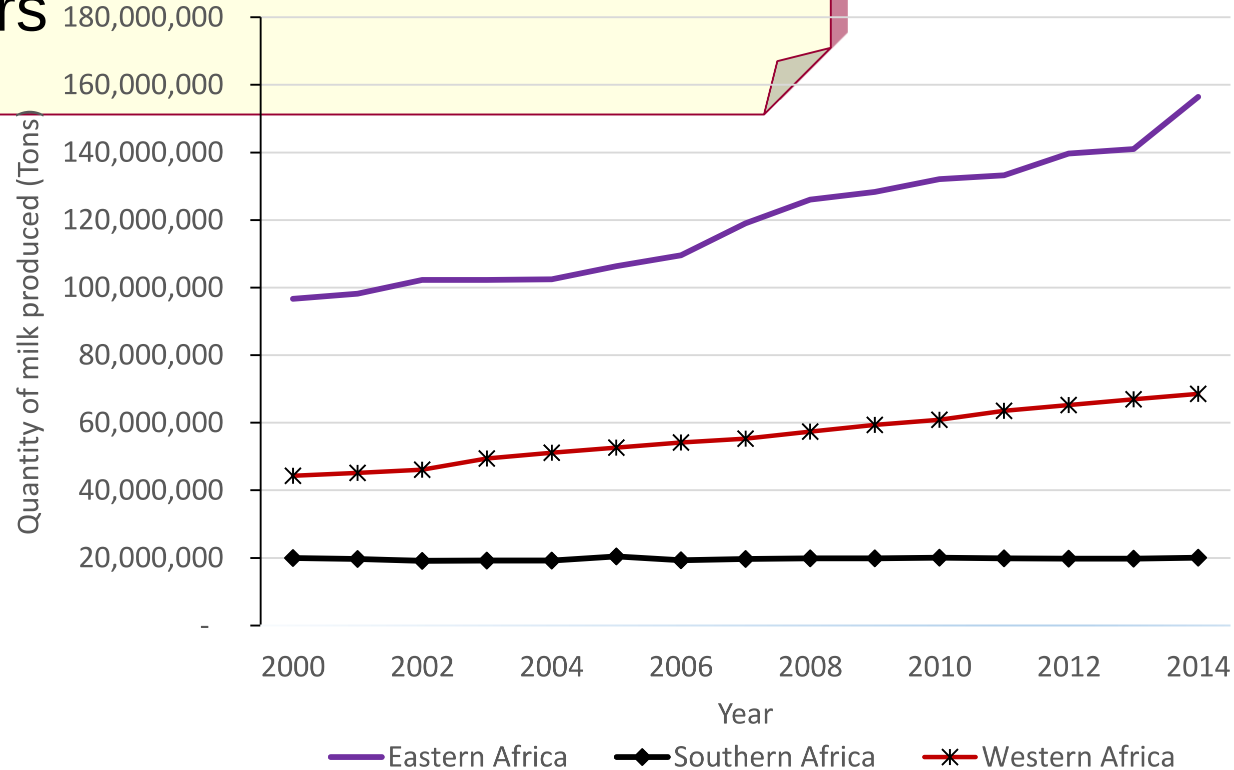
Cattle in Africa



- Africa hosts 310 million head of cattle (**20.9%** of the world cattle population)
- Africa produces **5.4%** of the global milk from cattle (FAOSTAT, 2016)
- Up to **80%** of the milk produced in Africa is by small-holder farmers



Smallholder dairy production systems

- Less than 10 head of cattle reared
- land sizes less than 0.5 of an acre to 10 acres








Animals are the products of their genes, their environments and their gene-environment interactions

$$P = G + E + GE$$

P is the phenotype	The animal we see, its production etc.
G is the genotype	The genetic make up of the animal
E is the environment	All factors (ambient conditions, health, nutrition, husbandry) except the genes of the animal
GE is the interaction	Between the genes and the environment

Animals are also influenced by markets, institutions and policies

Markets

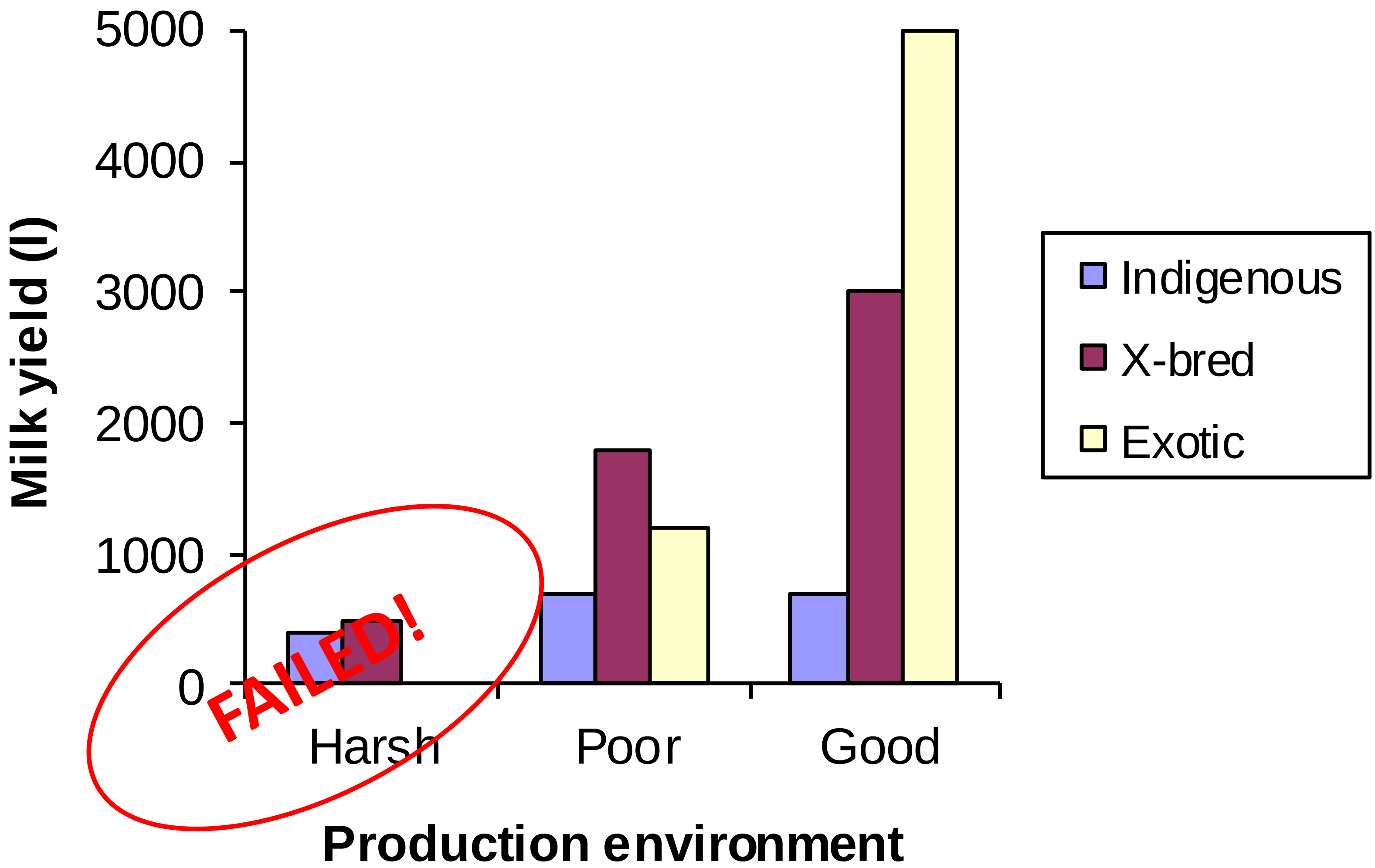
Institutions

$$P = G + E + GE$$

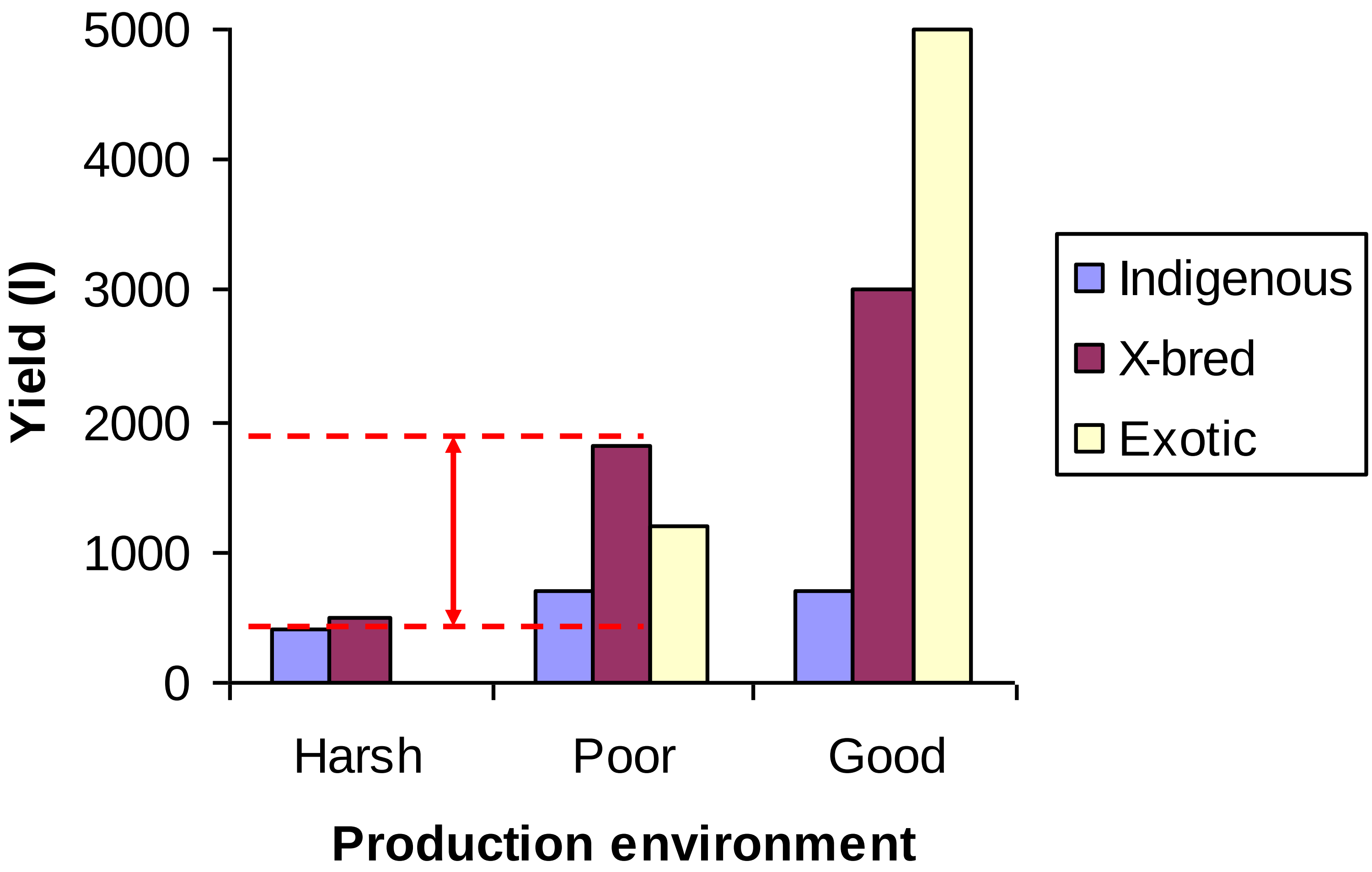
Policies

P is the phenotype	The animal we see, its production etc.
G is the genotype	The genetic make up of the animal
E is the environment	All factors (ambient conditions, health, nutrition, husbandry) except the genes of the animal
GE is the interaction	Between the genes and the environment

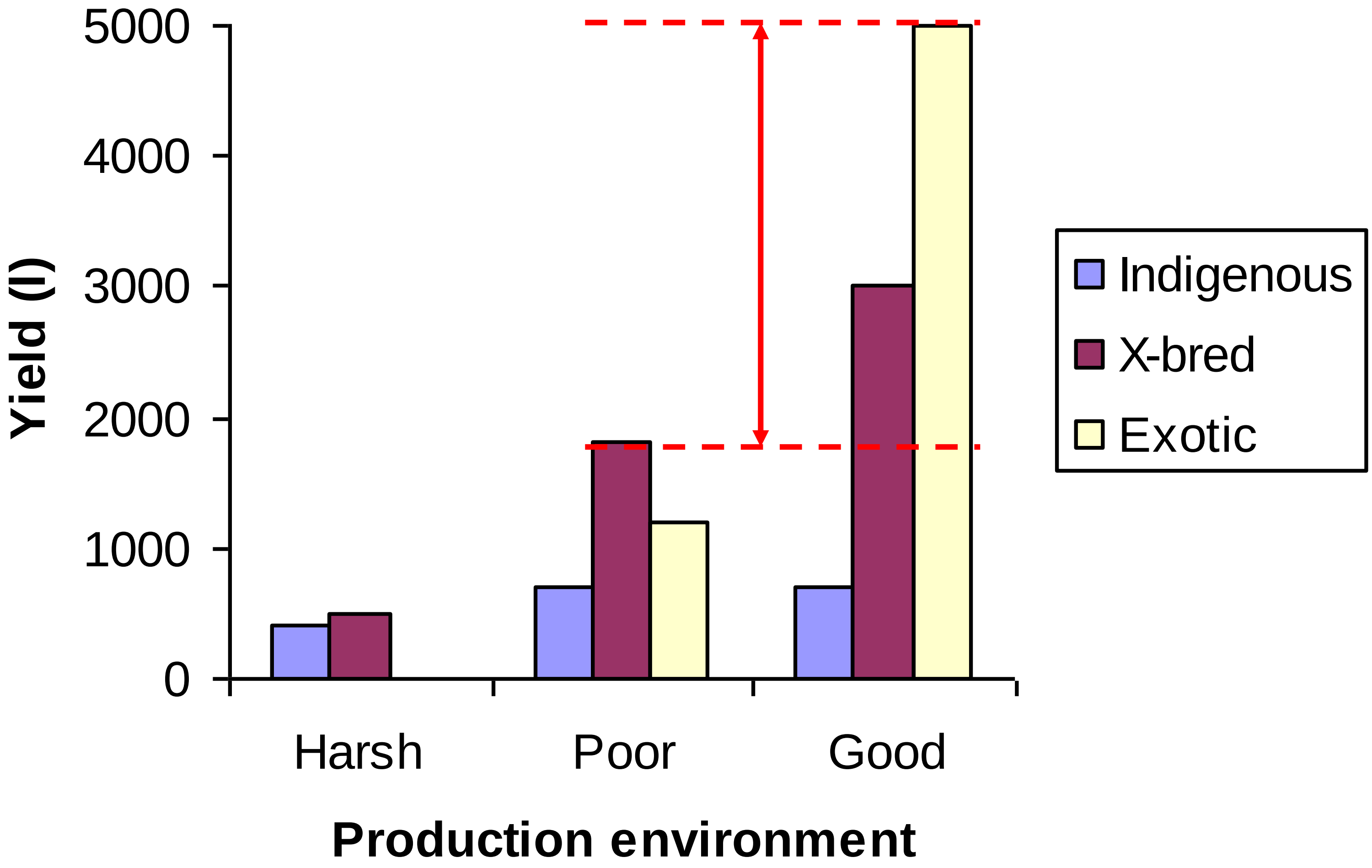
What happened? Exotic genotypes were introduced into harsh production environments



Improve management a little and change the genotype



Good management and different genotype



Why is change a challenge in Africa

- Production systems are mainly small scale or pastoral, transaction costs are high
- Climate change!
- Limited resources, poverty, available feeds
- Endemic diseases
- Local Markets, skewed prices
- Poor Infrastructure
- Lack of feedback systems to inform management decisions
- Weak institutions

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"You never change things by fighting the existing reality, to change something, build a new model that makes the existing model obsolete"

- Buckminister Fuller

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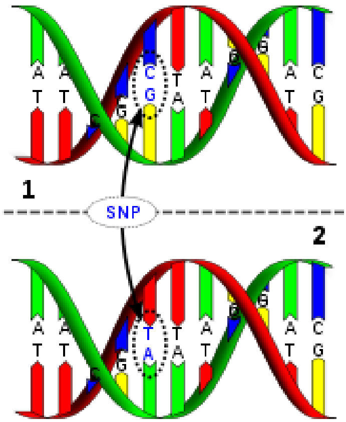
Questions of interest in adapting genetic technologies

1. What genotypes perform well in smallholder systems
2. What delivery system(s) would best suit the identified genotype(s)
3. What Partnership(s) would be required to deliver the genotype(s)
4. Is there a business model and plan for delivery – ready to implement

- A random sample of 2000 animals from 900 small holder farmers were selected from 7 sites in Kenya and Uganda



- Selected animals:
  - Were genotyped using high density SNP technology to determine their breed composition
  - Their productivity was monitored over 2 years (March 2011 to March 2013)
- Field and SNP data was combined to determine which breed combinations perform best under different conditions.

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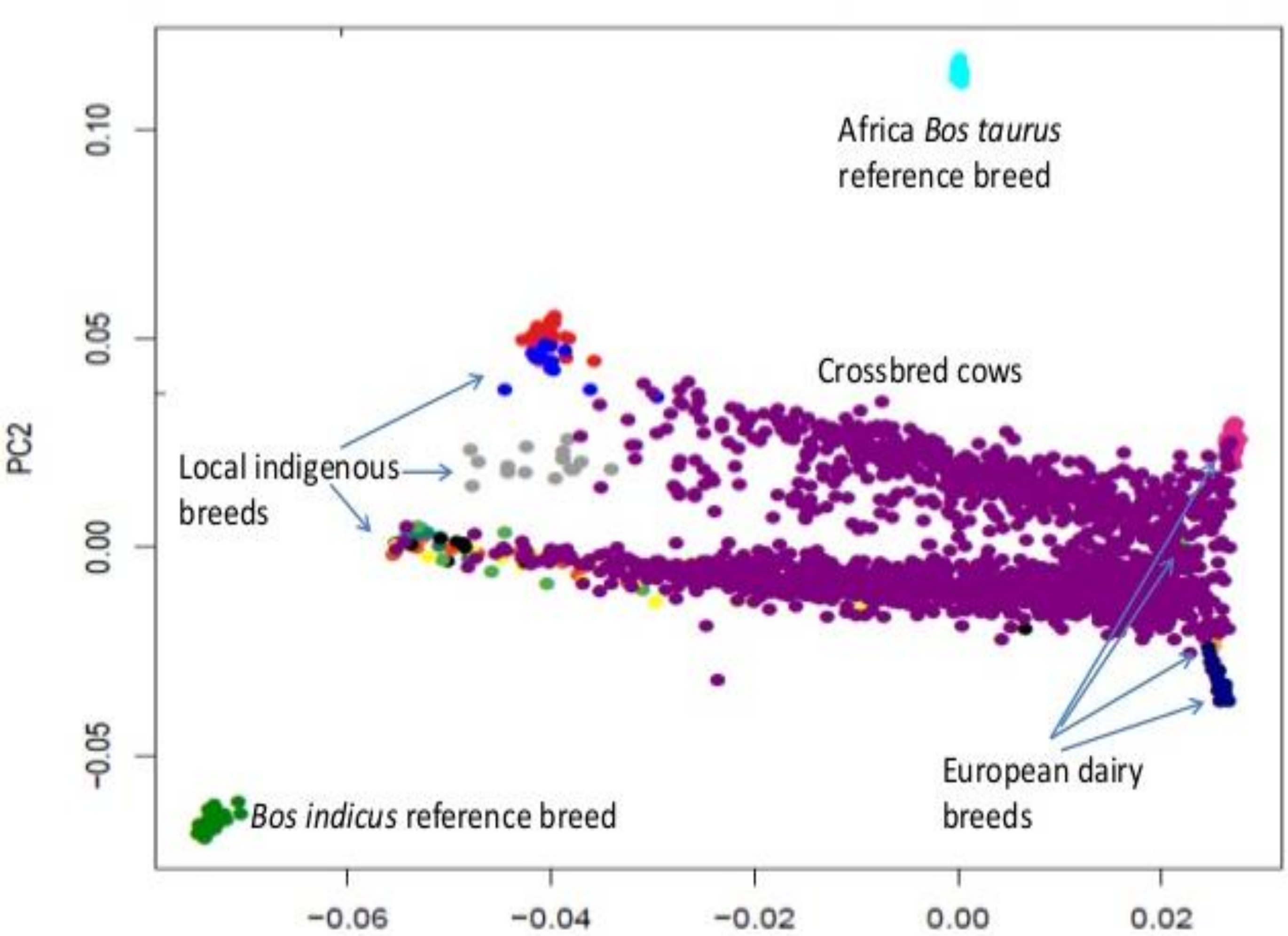
Results
Breed composition from SNP assays

- Breed types identified in the populations were
  - **Exotic breeds**: Holstein-Friesian, Ayrshire, Guernsey, Jersey
  - **Indigenous breeds**: Zebu, Ankole, Nganda
- Animals were **highly admixed** with exotic breed composition ranging from 0% to 99%

Principal component analysis results based on 566k chip



Estimated proportions of exotic dairy breed alleles from SNP were used to categorize animals into 5 groups termed "% dairyness "; 0-20%, 21-35%, 36-60%, 61-87.5% and >87.5% exotic.

Breed groups derived from SNP analyses- Kenya

	Genotype combination for various % dairyness				
Breed type	>87.5%	61-87.5%	36-60%	21-35%	<20%
Ayrshire	AAAA,	AAA,	AAZZ, AZZ, AAZ	--	--
***Friesian**	FFFF, FHHH, HHHF	FFF, FHH, FFZ, FF	FFZZ, FZ, FZZ,	FZZZ	--
Guernsey-Jersey	GGG	GGZ, GG,JJ	GGZZ, GZ, JZ, GZZ	--	--
Ayrshire-Friesian	AAFF, AAHH, AAAF,	AAF, AF, AH, FFAZ, AAFZ	--	--	--
Ayrshire-Guernsey	AAAG, AAGG	AG, GGAZ, AAJ	-	--	--
Friesian-Guernsey	GGGF, FFFG, FFGG	GGF, FFG, FFJ, FGZ, FFGZ	--	--	--
Ayrshire-Friesian-Guernsey	AAFG, FAGG, FFAG, FAGJ	FAG, FAJ, AAFZ	-	--	--
Mixed	--	MMM	MMZZ	MZZZ	--
Zebu	--	--	--	--	ZZZZ, ZZZ

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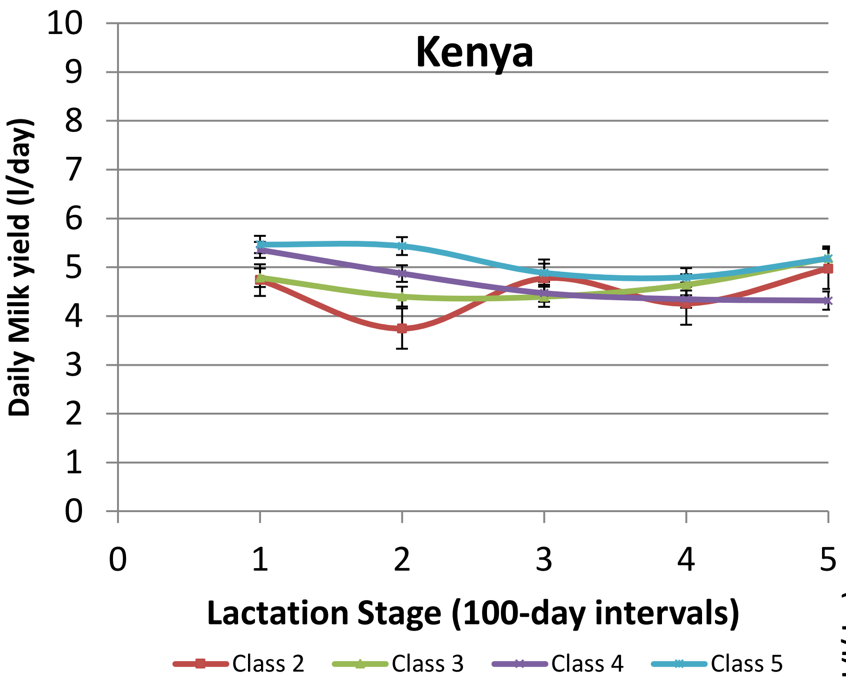
Breed groups derived from SNP analyses-Uganda

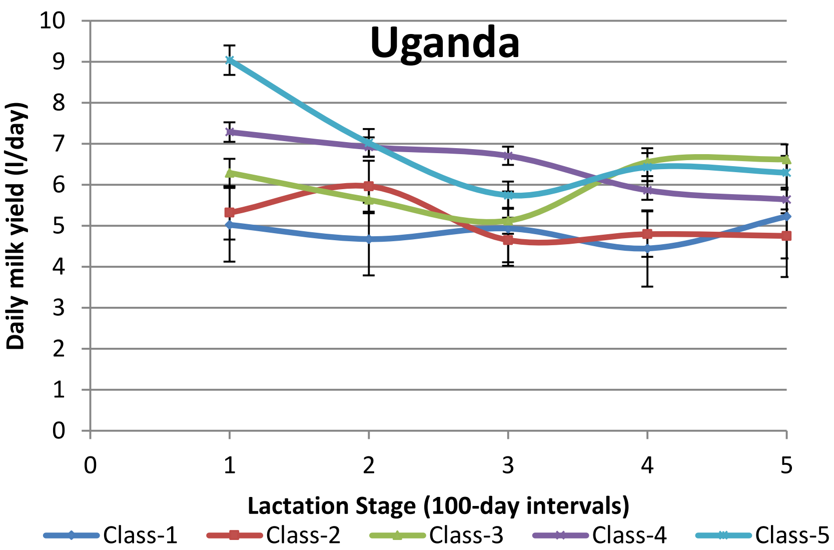
	Genotype combination for various % dairyness				
Breed type	>87.5%	61-87.5%	36-60%	21-35%	<20%
Friesian	**FFF**	**FFFZ, FFZ**	**FFZZ, FF**	**FZZZ, FZZ**	**--**
Holstein	**--**	**HHZ**	**HZZ, HHZZ**	**--**	**--**
Holstein-Friesian	**HHHF, FFHH, FFFH**	**HHF,FHHZ, FFH**	**FHZZ, FHZ**	**--**	**--**
Zebu	**--**	**--**	**--**	**ZZZ**	**ZZZZ**

- Milk yields were generally low, averaging 5.39±3.32 in Kenya and 5.62±3.45 in Uganda, with long lactations > 400 days

Daily milk production for different dairy groups of animals within countries



Lactation curves for animals were generally flat with no evidence of a peak in early lactation



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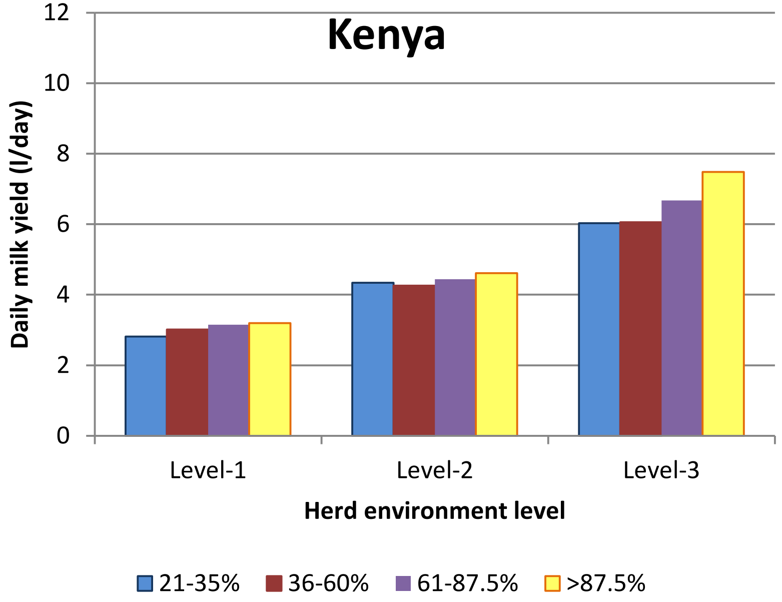
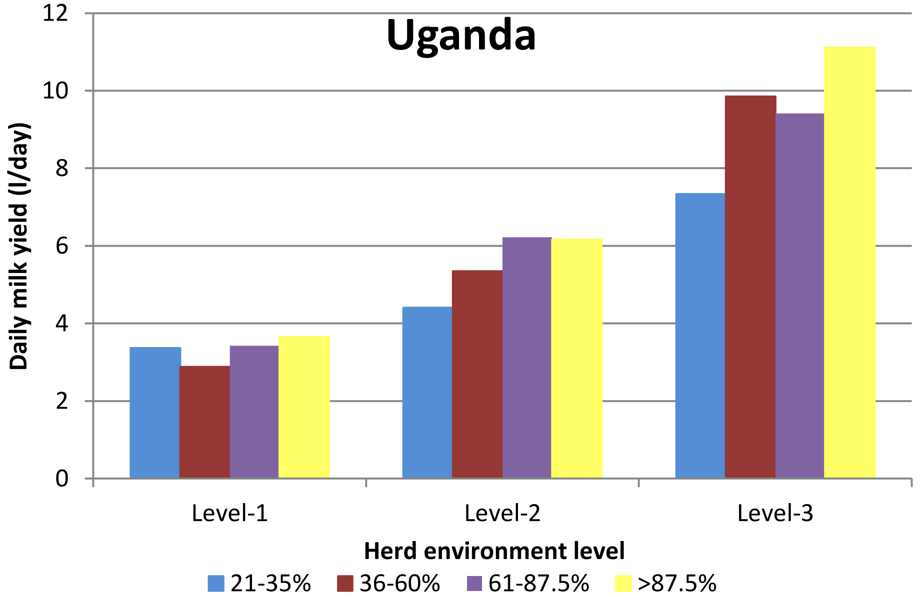
Milk production by animals with different proportions of exotic genotypes (%dairyness)

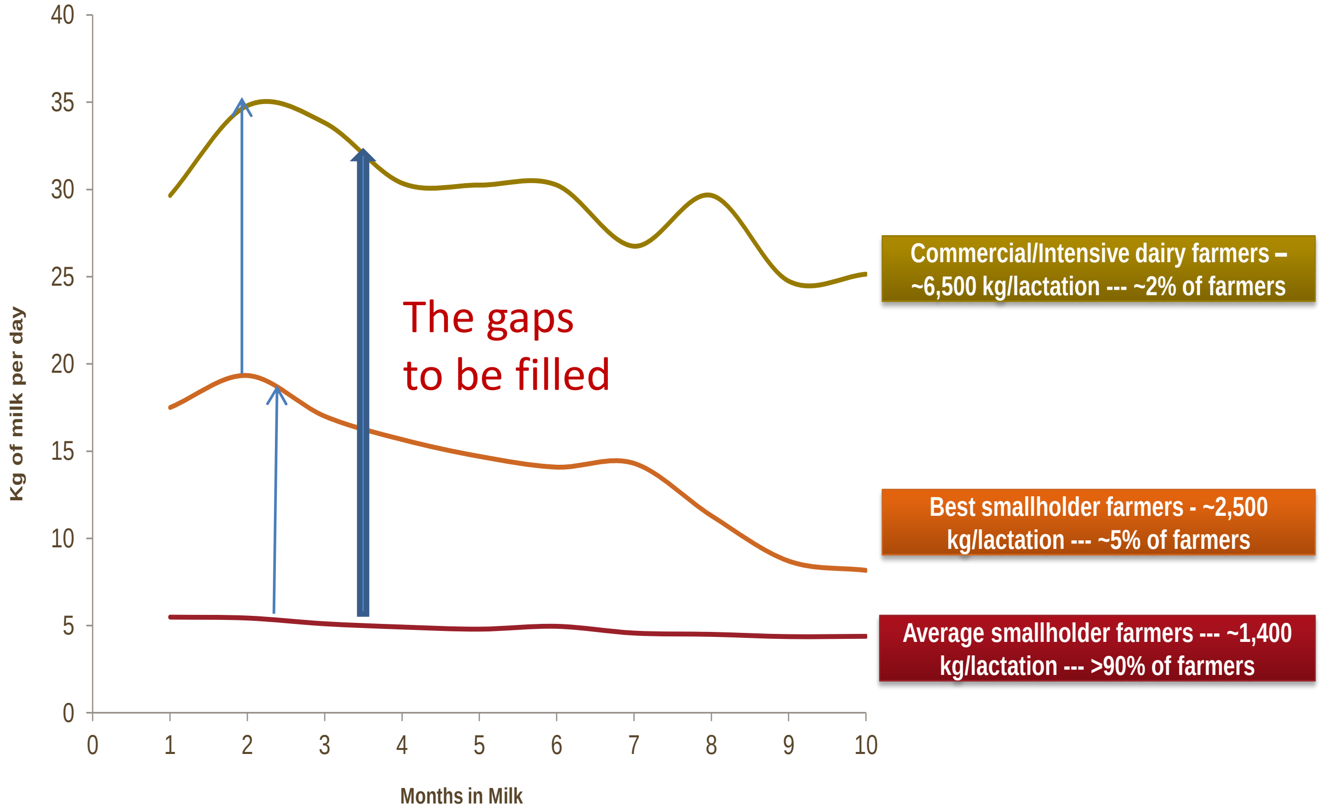


High grade cattle only showed substantially better milk yields than other grades in the highest production environment



There exists a huge yield gap in production by the same breed of dairy cattle in the different farming systems

Figure 1: Realized lactation curves of improved (crossbred or higher) dairy cows achieved by different farmer types in Kenya



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- The lower than expected milk yields in the smallholder farming systems have profound implications for dairy extension and development programs and for businesses providing services to these farmers
- Given the larger size and maintenance requirements of high grade exotic cattle, lower grade exotics will be the most economically productive animals in the low and medium herd production levels

Use of Technologies to effect change in Africa

Genotype adaptation to local agro-ecology

- **Targeting of appropriate genotypes to the optimum agro-ecology**
- **Use of young bulls with a focus on production & adaptation**
- **Local feed/fodder resource use efficiency**

Development of synthetic breeds

- ***"Africa needs to create dairy breeds that are best suited to local & emerging ecological conditions***

- **Digital platforms for on-farm performance tracking**
- **Decision-support and Farmer-to-Farmer performance benchmarking**
- **Smart use records & genomics tools for selection and better AI service delivery**

Accelerate on-farm genetic gains

Economically Relevant Traits

- Milk Yield/density
- Adaptability Indices
- Reproductive Performance
- Heat tolerance
- Survival rates
- Lactation persistency
- Mastitis incidences

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Concluding remarks

Genetic improvements have resulted in huge economic returns*:* - *Meat and Livestock Australia reported from 1963-2001, investment in genetic selection and crossbreeding resulted in net gain about $861 million*

Undergirding these improvements is the accurate evaluation of animals on which selection is based

Do we have enabling policies and appropriate policy frameworks in place to allow biotechnology and information technologies to effectively solve Africa's food scarcity & safety problems?

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Thank you

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Patron: Professor Peter C Doherty AC, FAA, FRS
Animal scientist, Nobel Prize Laureate for Physiology or Medicine–1996

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