Food and Agriculture Organization of the United Nations

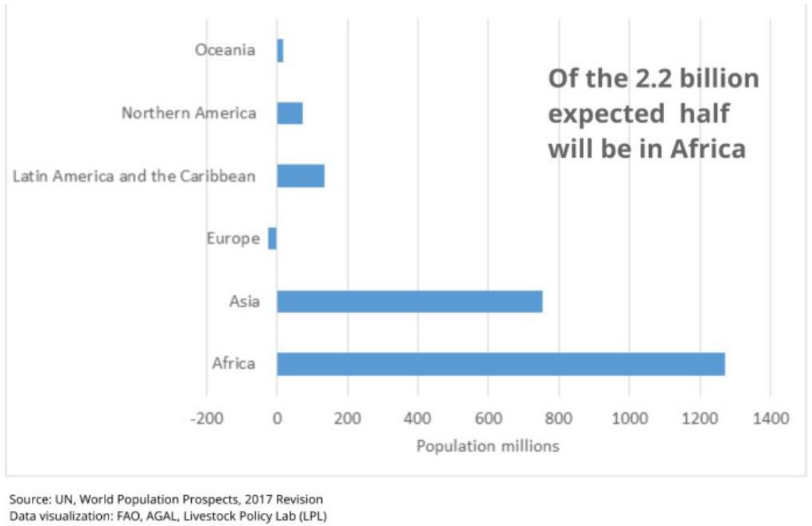
Exotic breeds and crossbreeding in developing countries

Gregoire Leroy, Roswitha Baumung, Carlos Pena, Paul Boettcher, Florence Jaffrezic, Badi Besbes

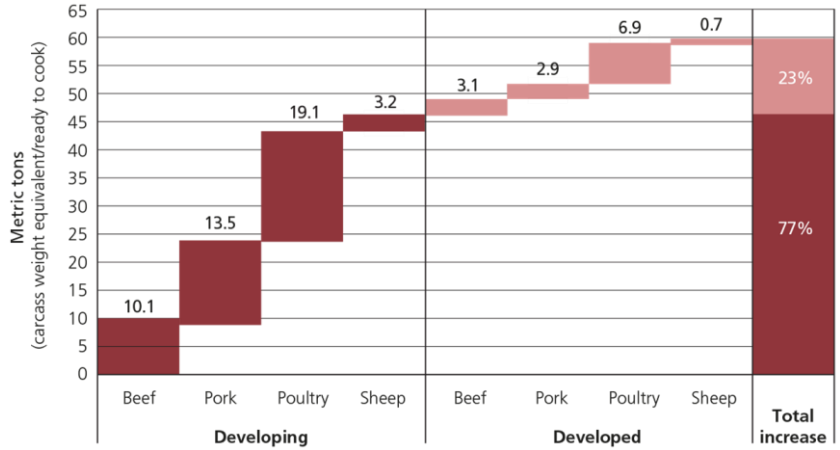
Food and Agriculture Organization of the United Nations
INRA

IMPLEMENTING THE GLOBAL PLAN OF ACTION FOR ANIMAL GENETIC RESOURCES

The context



Expected changes in population by region over 2030



Growth in global meat production 2015-2030 (FAO 2018)

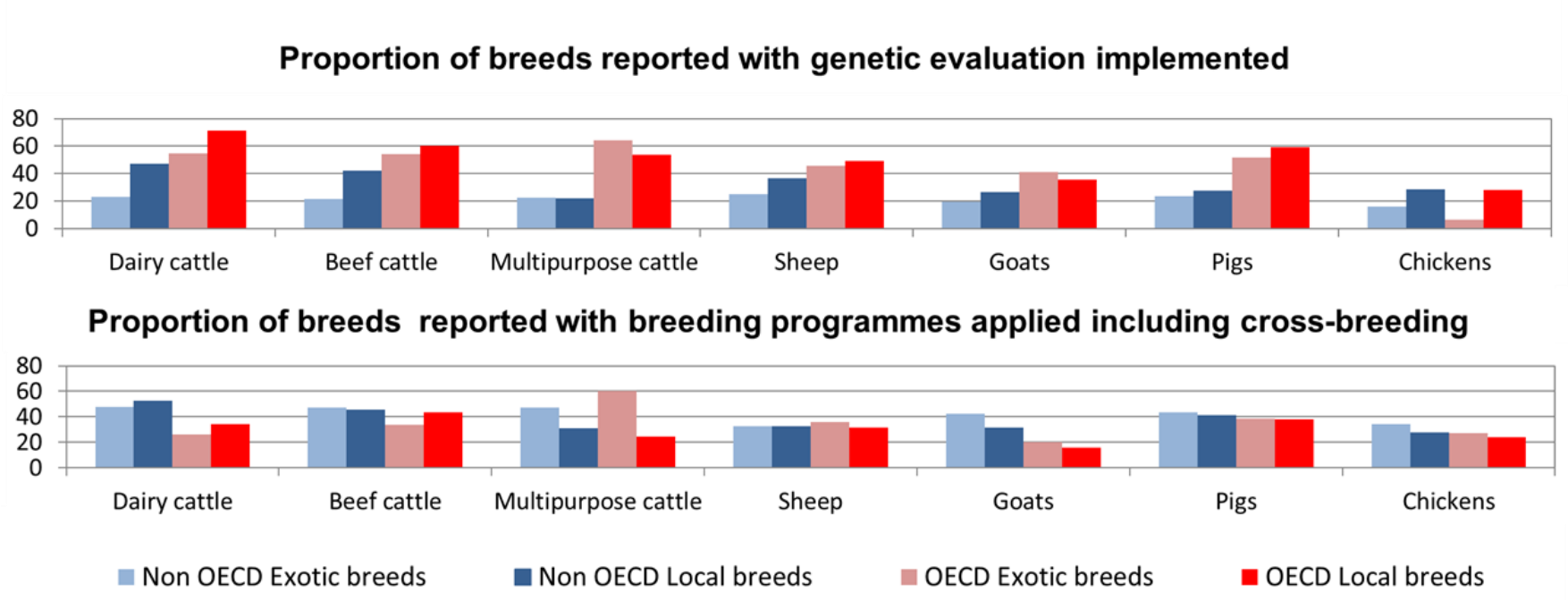
- The world's population will reach 8.6 billion by 2030 and 9.8 billion by 2050, driven by developing regions

- Increasing demand for and production of livestock products in the next years, especially in developing countries

Improved genetics to close the production gap for livestock products?

- Mayberry et al. (2017) estimate bovine milk yield gaps ranging from 49% to 261% according to different approaches and areas in India and Ethiopia, that could be closed through improved genetics and nutrition.
- Major strategies for genetic improvement:
  - Within-breed selection (pure-breeding/straight-breeding)
  - Crossbreeding
- Many developing countries lack capacities to develop their own within-breed selection programmes

Crossbreeding vs pure breeding in developing countries



Proportion of breeds applying pure-breeding or crossbreeding according to SoW2 country reports

- Non OECD countries: For majority of breeds no genetic evaluation is carried out
- Non OECD countries report greater proportion of breeds with breeding programs, if crossbreeding is including, than OECD countries

➢ *Genetic progress is therefore imported rather than generated domestically.*

Crossbreeding as part of national development strategies of livestock

National livestock policy of India (2013)

- Encourage crossbreeding with exotic breeds in pig, yak and mithun, however in cattle focus on selective breeding of indigenous cattle

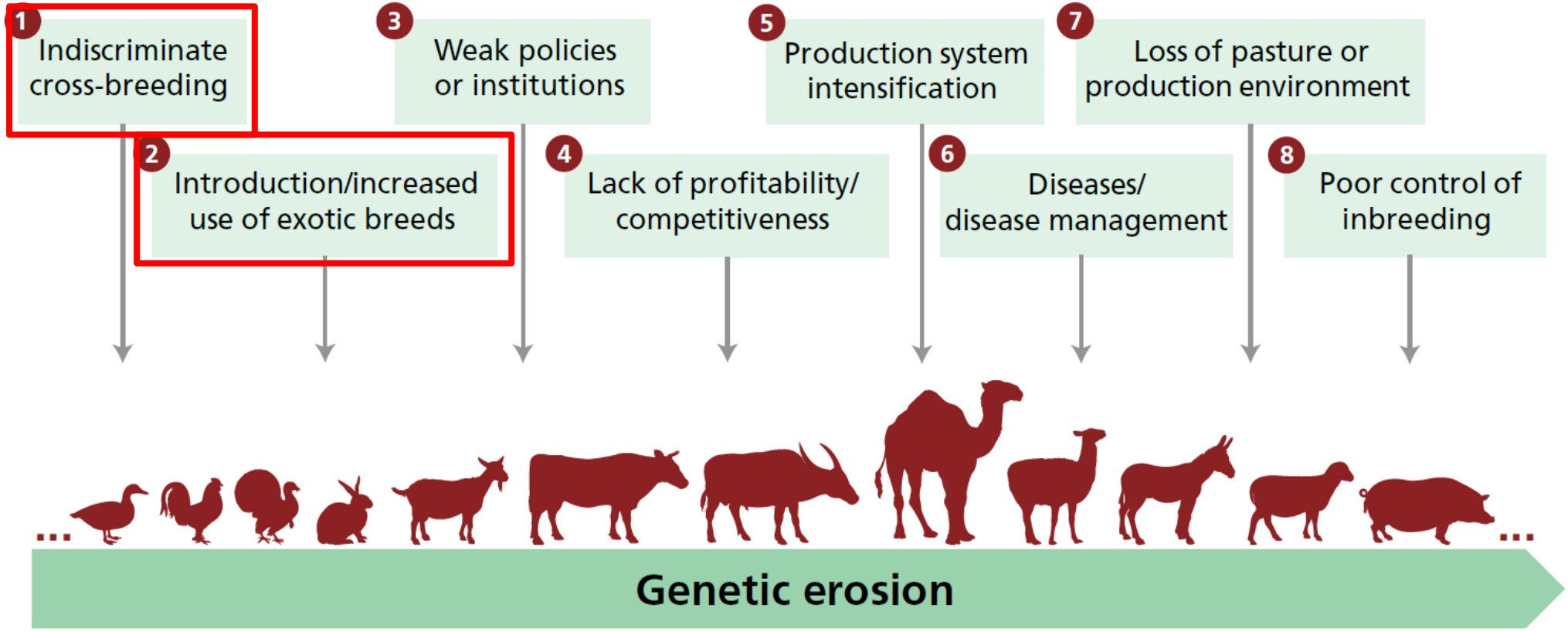
National livestock policy of Malaysia (2013)

- Crossbreeding and importation of breeding stocks recommended in many species (also pure-breeding)

Livestock master plans in Ethiopia (2015), Rwanda (2017), and Tanzania (2018)

- Use of AI and importation of exotic breeds to increase production of local chicken and dairy cattle

Main threats for local genetic resources at country level



Source: FAO (2014)

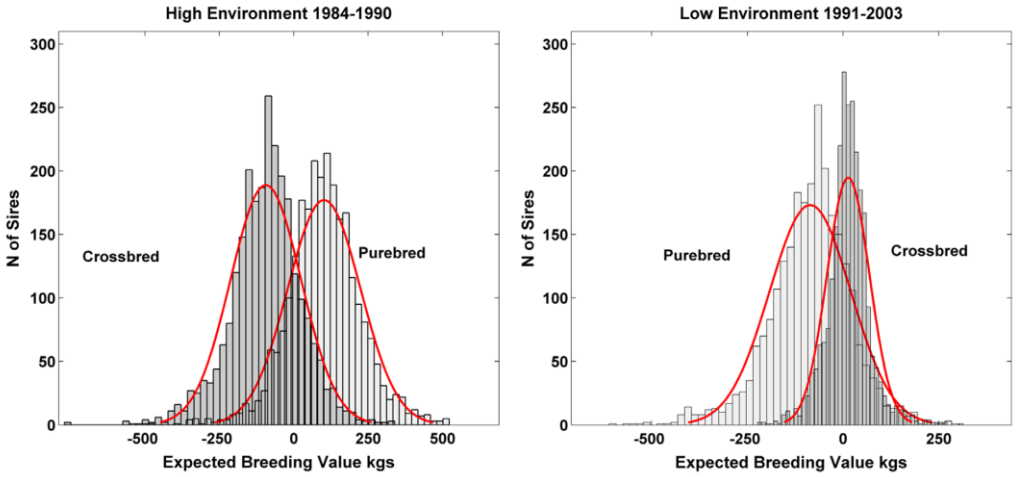
I. Impact and sustainability of introgression and crossbreeding at local scale

Different strategies

Cross-breeding type	Heterosis use	Use of adapted genes	Maintenance of local breeds	Genetic composition of products	Management constraints
Terminal crossing	Yes	Yes	Yes	Stable	Need to supply continuously genetic material (both sexes)
Rotational crossing	Yes	Yes	Yes	Variable	Need to supply continuously genetic material (males only)
Breed substitution/ upgrading	Only short term	No	No	Stable after several generations	Adaptation constraints
Synthetic breed creation	Only short term	Yes	No	Stable after several generations	Several generations required

- In absence of a strategy, exotic animals are often indiscriminately diffused among local livestock

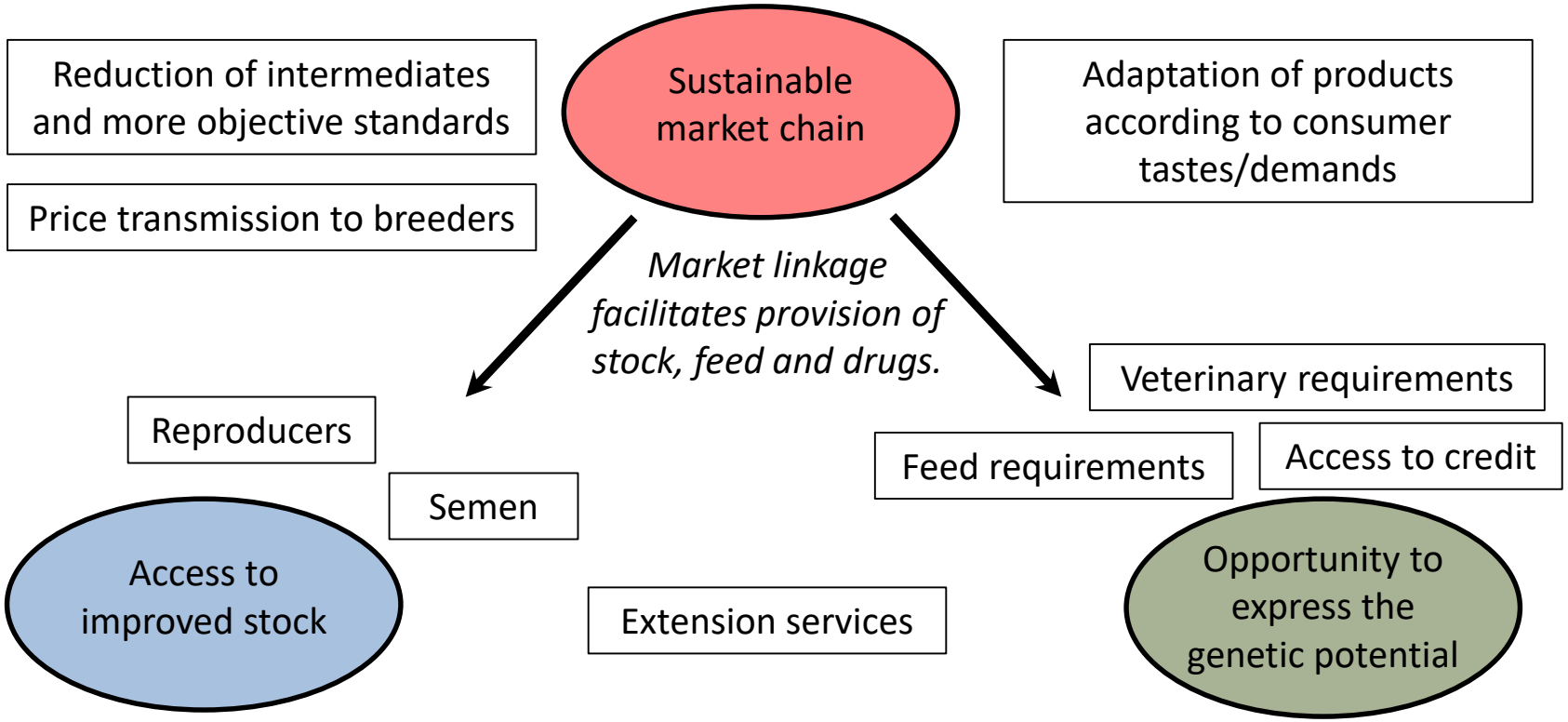
Consequences on production and livelihood at local scale



EBV of Holstein and crossbred Zebu-Holstein as a result of GxE interaction in Cuba (Menedez-Buxadera et al. 2016)

- Potentially, positive impacts on performance
  - Galukande et al. (2013) meta-analysis estimated that individuals with 50% B. Taurus showed on average 2.6, 2.4 and 2.2 times higher milk yield than local animals according to various tropical environments
  - In Ethiopia, Getachew et al. (2016) reported improved growth and lamb survival for sheep crossbreds
- Fitness traits of crosses usually deteriorated in comparison to local breeds (Murray et al. 2013)
- Several studies indicated that replacement and crossbreeding could improve food security (Hedge 2018; Traore et al. 2018), but local breeds may remain a valuable option in harsh environment or for subsidence oriented farmers (Traore et al. 2017)
- Genetic by Environment (GxE) interaction!

Three factors for success or failure of crossbreeding programs

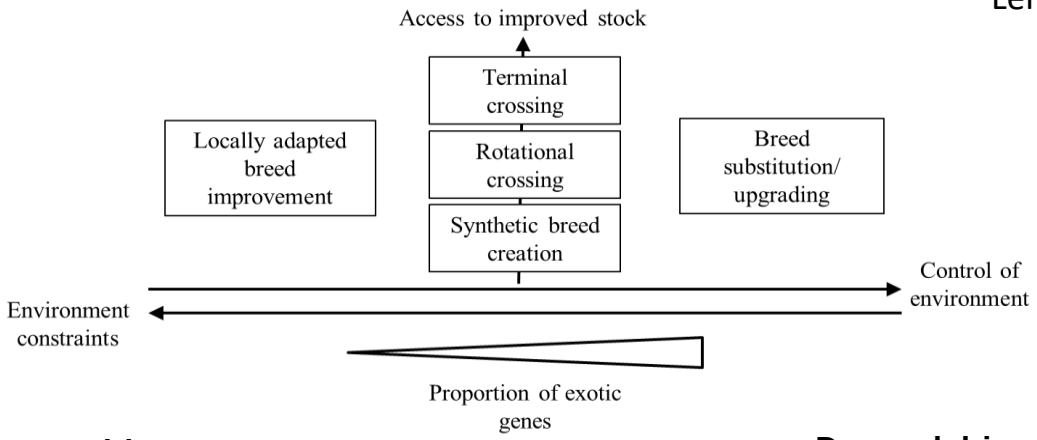


*Need to plan, from the beginning of a program, the **sustainability of genetic material delivery** and farmer support, **including its cost recovery***

*Expression of genetic potential **facilitated in demand driven** systems versus **resources driven** systems*

What strategy to choose?

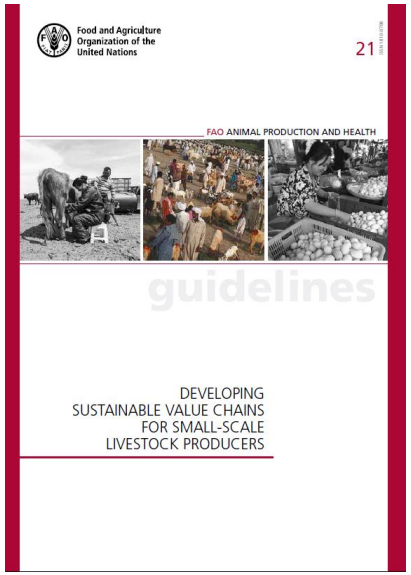
Leroy et al. 2015



Resource driven systems **Demand driven systems**

The choice of a given strategy is highly dependent upon

- Access of improved stock
- Environment control/constraints, i.e. the opportunity for improved livestock to express its potential.
- Indirectly, the linkage to the market chain



➢ ***Integration of crossbreeding and introgression programs into value chains considering the sustainability of the food system***

II. Impacts of introgression and crossbreeding at country scale

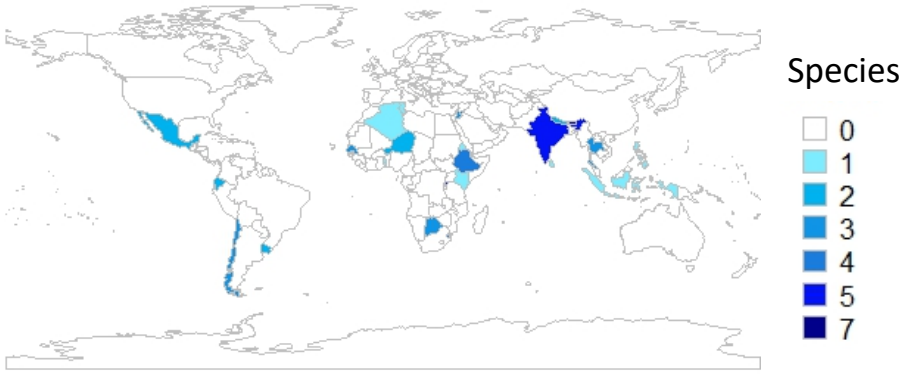
What is the actual extent and sustainability of introgression in developing countries?

What are the trends in terms of extent of exotic breeds and crossbreeding in developing countries?

What are the impacts at country level?

- In terms of production?
- In terms of erosion of genetic diversity?

Data and approaches used



Countries with information on percentage of local, crossbred, and exotic animals

Data used

- National censuses and breed surveys
- Domestic Animal Diversity Information System (DAD-IS)
- FAOSTAT

Analysis (2000-2019 period)

- Assessment of trends in relative importance of locally adapted, crossbred, and exotic animals within species
  - *26 countries and 10 species*
- Relationships between % of crossbred/exotic and cattle milk yield
  - 8 countries
- Percentage of local/regional transboundary national breed populations with increasing demographic trends
  - *213 breeds from 28 countries and 17 species*

Breed classification

Adaptedness

- *Locally adapted:* breeds in the country for a sufficient time to be genetically adapted to one or more of traditional production systems or environments in the country.
  In this study, animals defined by countries as local, indigenous, native, locally adapted, backyard, with a specific name expressing that breed is local (e.g. Criollo, Desi or Tswana)…
- *Exotic* : defined according to countries as exotic, foreign, broilers and layers, specific improved breeds (such as Holstein, Dorper, Boer…) or other than crossbred and local.

- *Crossbred*: defined according to countries as crossbred, crossed, hybrid, improved local…

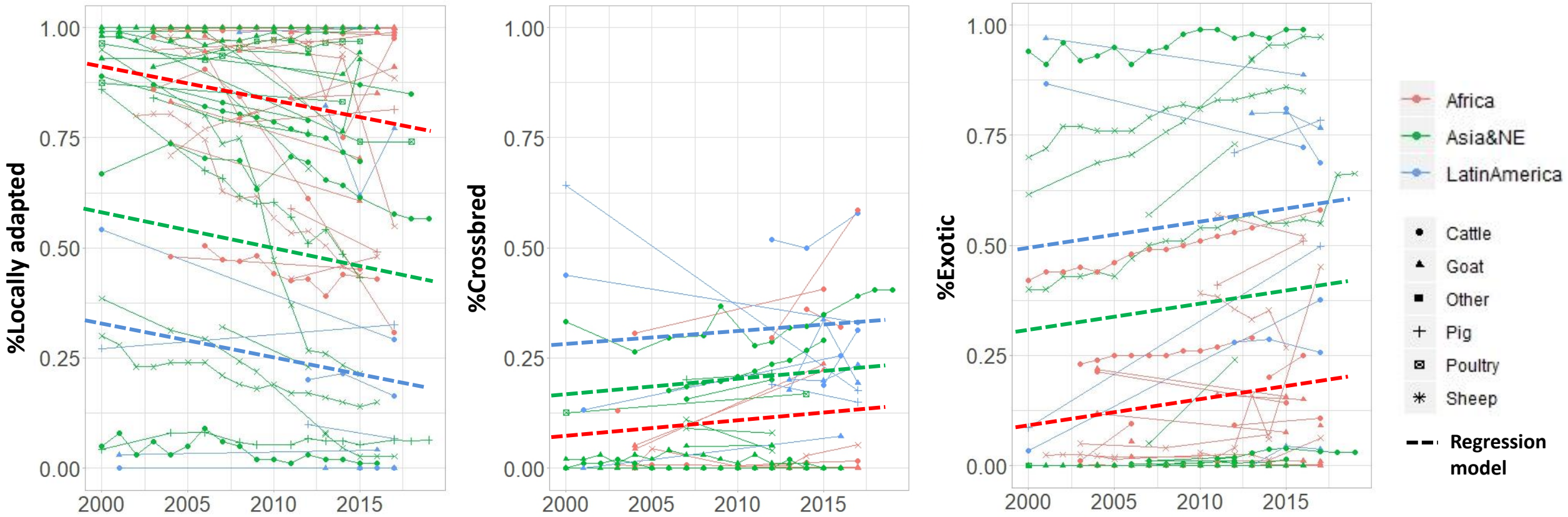
Geographical status (DAD-IS)

- *Local breeds*: breeds that occur only in one country.
- *Regional transboundary breeds*: transboundary breeds that occur only in one region of the World.

In this study, Local and regional transboundary breeds have been approximated as locally adapted.

- *International transboundary breeds*: transboundary breeds that occur in more than one region of the World

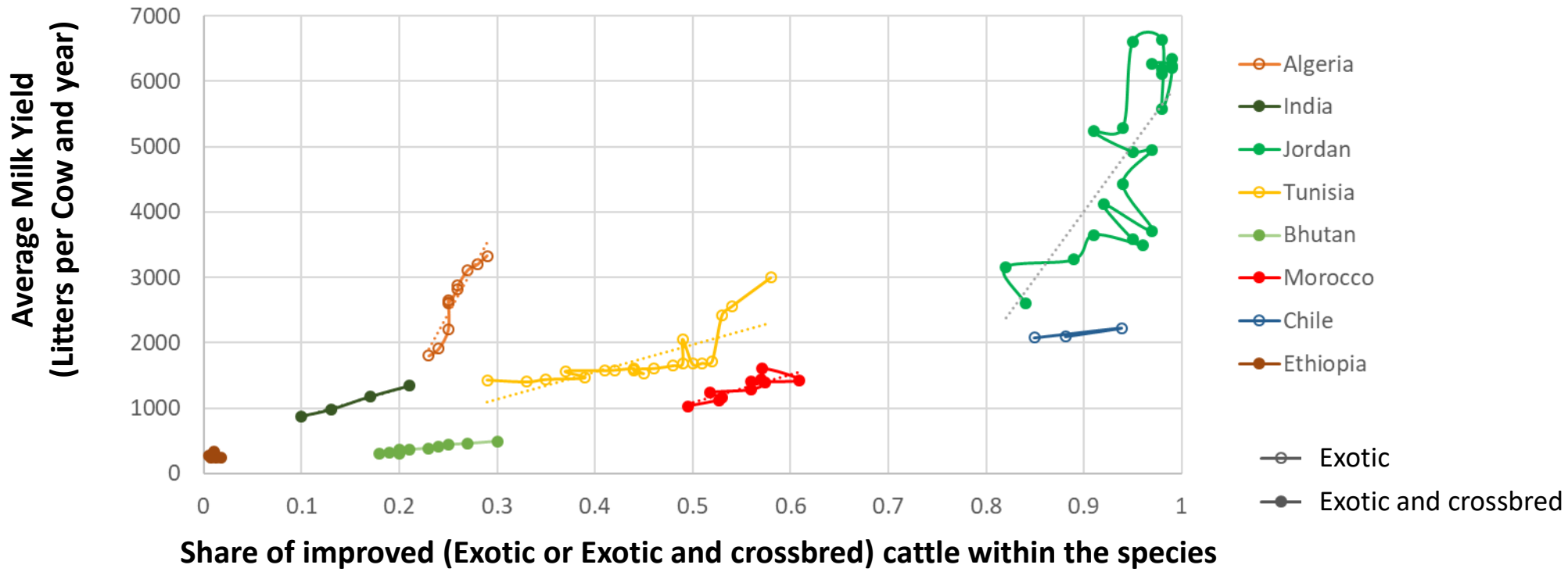
Trends in locally adapted, crossbred and exotic share of livestock in countries



- According to the linear regression model used (best BIC), estimated trends are:
  -0.7% per year for locally adapted breeds, +0.2% per year for crossbred, +0.5% per year for exotic breeds

⚠ Heterogeneity in term of type categorizations, species and year coverage

Relation between crossbred/exotic share and milk yield in cattle



- In general, positive correlations between percentage of improved livestock and milk yield
- Heterogeneity in the relationships according to countries

Changes in production systems and environments not accounted for!

Demographic trends of locally adapted national breed populations

	Africa	Asia	Latin America
Number of locally adapted national populations considered	88	101	24
Percentage of locally adapted national populations with population size increasing	75%[a]	48.5%[b]	41.7%[b]
LTU increase 2000-2017 (5 main species, FAOSTAT)	+56%	+9%	+18%

Different letters indicate significant differences between groups (P<0.05)

- The majority of locally adapted national populations from Africa showed increase in population size,(and there fore reduced risk of genetic erosion) in contrast to Asia and Latin America
- Hypothesis: in those two regions, the general increase in number of livestock does not compensate the decrease in percentage of locally adapted breeds.

Discussion

- There is an ongoing trend in replacement of locally adapted breeds by crossbred or exotic animals
- Depending on regions, the general increase of livestock population may have compensated the decrease of the proportion to locally adapted breeds

- Crossbreeding and introgression may have brought increase in productivity… however we need to consider other factors:
  - Dependencies on external inputs (feed, drugs, animal, semen…)?
  - Adaptability to environment changes (CC…) ?

- Livestock development strategies require a strategic and holistic thinking for sustainable implementation of genetic improvement programs.

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Thank you for your attention

More information:
gregoire.leroy@fao.org
http://www.fao.org/dad-is
http://www.fao.org/3/ca5717en/ca5717en.pdf

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