The livestock revolution and implications for human health and disease

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Impact of Environmental Changes on Infectious Diseases
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Today’s talk

1. What is the livestock revolution and what is driving it?
2. What are its benefits and risks?
The livestock revolution

- 1970-Mid 1990s
- Demand-driven, unlike the green revolution

Figure 2: Increase in per capita consumption of perishables and pulses in developing countries with 1963 as index year (FAO, 2009).
7 billion people

- More and more people to feed
- More and more are not producing food
  - The rest need to produce more

- 1.7 billion overweight/obese
- 2 billion hidden hunger
- One billion hungry
7 billion people...

- 37 billion livestock
  - 31 billion in developing countries
  - 1 billion poor people depend on livestock
    - 600 million in South Asia
    - 300 million in Sub-Saharan Africa
    - 25% urban

*Density of Poor Livestock Keepers*

Year 2010*

*Update: March 2012*
Bridging the gaps between demand and supply – global level

• 60% more food than is produced now will be needed
• 75% of this must come from producing more food from the same amount of land
• The higher production must be achieved while reducing poverty and addressing environmental, social and health concerns
• This greater production will have to be achieved with temperatures that may be 2–4 degrees warmer than today’s
East Africa - gaps in food demand and supply

Agriculture – source of food and income for up to 90% of the population in the region

- Human population projected to increase by 2.55% per year [2007 – 2017]
- Projections to 2030: demand for meat will increase by 3.7% and milk – 2.7%
- Projected growth rates for livestock numbers, meat and milk production

<table>
<thead>
<tr>
<th></th>
<th>Projected change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total livestock numbers</td>
<td>1.41%</td>
</tr>
<tr>
<td>Total meat consumption</td>
<td>2.84%</td>
</tr>
<tr>
<td>Total milk production</td>
<td>2.95%</td>
</tr>
</tbody>
</table>

Source: FAO (2007)
Why increasing demands?

- Increased demands for animal-source food
- Growing middle classes
- Globalization
- Continued urbanization
- More and more people
- Changing preferences

Increased demands for animal-source food

More and more people

Continued urbanization

Growing middle classes

Globalization

Changing preferences
Gains in meat consumption in developing countries are outpacing those of developed countries.
Change in global and regional demand for food: Livestock and other commodities

% change 2005/07 to 2050

-50 0 50 100 150 200 250 300 350

developed  developing

cereals  root/tuber  meat  dairy

Modified from Alexandratos and Bruinsma (2012)
FAO statistics 2012

- **Production 1000 USD**
  - Milk, whole fresh cow
  - Rice, paddy
  - Meat indigenous, cattle
  - Meat indigenous, pig
  - Meat indigenous, chicken
  - Wheat
  - Soybeans
  - Sugar cane
  - Eggs, hen, in shell
  - Maize
  - Potatoes
  - Milk, whole fresh buffalo

- **Production MT**
  - 2,000,000,000
  - 1,000,000,000
  - 500,000,000
  - 100,000,000
Big productivity gaps
- largely due to poor animal health, inadequate feed and low genetic potential

Some developing country regions have gaps of up to 430% in milk

Steinfeld et al. (2006)
Major benefits seen

• Increased profits
• Growth of off-farm income
• Reduction in greenhouse gases per unit of animal-source food produced
• Intensive units can maintain higher biosecurity
• Separates animals from humans
• Increased incomes may render people less vulnerable to disease
Example: Greenhouse gases

GHG per kg of animal protein produced

Herrero et al. (2013)
Improving production - not always rocket science

- Training in Assam, Northeast India, hygiene measures to make milk less contaminated
- Trained farmers reported less diseases and higher milk production ($p<0.001$)

<table>
<thead>
<tr>
<th></th>
<th>Average milk production in liters per cow and day 2 years ago/before ILRI training</th>
<th>Average milk production in liters per cow and day now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trained farmers</td>
<td>7.0 (range 2.5-10)</td>
<td>7.8 (range 3-15)</td>
</tr>
<tr>
<td>Untrained farmers</td>
<td>7.3 (range 2.5-14)</td>
<td>6.8 (range 2.5-14)</td>
</tr>
</tbody>
</table>

- No difference in *Brucella* prevalence
Aflatoxins are produced by moulds growing on cereals.

- More high-producing animals need more concentrates.
- Concentrates can have high levels of aflatoxins.
- High-producing cattle also transfer a higher proportion to their milk.
- Milk is often targeted to children and pregnant women.
- Aflatoxins are associated with immunosuppression and stunting.
Negative health consequences

- Increase in food-borne disease
- New diseases emerging from animals and jumping species to humans
- Shifts in the dynamics of vector-borne diseases
- Increase in non-communicable diseases associated with over-consumption of livestock products
- Resistance to drugs transferring to pathogens that affect humans
- Environmental changes; over-grazing, wildlife conflicts etc.
Increased use of antibiotics

Increasing livestock populations, intensification

Increasing human populations

Increased use of antibiotics

More antibiotic residues, more resistance,
Graphs showing the mosquitoes collected in households with and without pigs in Ninh Kieu district, Can Tho city, Vietnam. Collections made close to humans are shown with thin boxes and collections close to pigs are shown with thick boxes.

A; total number of mosquitoes, B; Culex tritaeniorhynchus C; Culex gelidus D; Culex quinquefasciatus. Circles depict outliers > 1.5 x the interquartile range and stars extreme outliers > 3 x the interquartile range.

Example: Shifts in mosquito dynamics
Food safety issues

- Animal-source food perishable and susceptible
- New habits and foods
Lack of food safety...

- Imposes a burden on already struggling farmers and other value chain actors
- Deviates the attention from increasing production and commercialization
- Requires investments ... increase in prices:
  - Good for actors
  - Less good for poor consumers
Benefits with increasing demands

• Increasing markets for livestock production
• Livestock by the poor
  • Economic investments
  • Use common pastoral lands
  • Increased revenues- better for women than crops
• Livestock for the poor
  • Provide draught power and fertilizers
  • Even small amounts consumed improve nutrition
Example: Artificial insemination

- More exotic breeds; high production
- Loss of indigenous breeds; less resistance
- Reduced transport of boars to sows; less disease spread
- If a boar has a venereal infection, it gets spread to many
Urban agriculture?

More than 50% urban population

Increasing in both developed and developing countries

It involves approximately 800 million people and produces 15-20% of the food in the world

Economically crucial for many poor smallholders throughout the world

People often live in close proximity to their animals
Good and bad with urban agriculture?

- Closeness to the market
- Possibility to use urban wastes and waste water
- Women can combine it with household work
- It is an opportunity to provide food for the family and an extra income

- Local markets with living and dead animals
- Lacking sanitation
- Living in close proximity to the animals kept
- High density of people and animals
Or bringing the food to the cities?

- Large production units outside urban areas
  - Need for transporting
- Lack of infrastructure and cooling facilities
  - Need for transporting live animals
- Live animal markets
  - Risk of disease transmission
Livestock and the risk of diseases

ZOOONES and livestock disease

- Endemic disease (diseases of poverty)
  - Neglected tropical diseases
- "Endemic epidemics"
- Emerging disease
  - 75% zoonotic

58% of human pathogens are zoonotic
(Woolhouse et al. 2005)
Mortality: global projection, 2004-2030

High-income countries

Middle-income countries

Low-income countries

Deaths (millions)

2004 2015 2030

Intentional injuries
Other unintentional
Road traffic accidents

Other NCD

Cancers

Cardiovascular diseases
Mat//peri/nutritional
Other infectious
HIV, TB, malaria
Infectious diseases

- Neglected
- Mainly affecting poor communities
- Chronic morbidity

Source: WHO
Endemic disease (neglected zoonoses)

Source: WHO

**Top 10 causes of death in high income countries 2012**

- Ischaemic heart disease: 95
- Stroke: 91
- Trachea bronchus, lung: 49
- Alzheimer disease and ...: 42
- COPD: 31
- Lower respiratory infections: 31
- Colon rectum cancer: 27
- Diabetes mellitus: 20
- Hypertensive heart disease: 20
- Breast cancer: 16

**Top 10 causes of death in low-income countries 2012**

- Lower respiratory infections: 65
- HIV/AIDS: 53
- Diarrhoeal diseases: 52
- Stroke: 39
- Ischaemic heart disease: 35
- Malaria: 33
- Preterm birth complications: 31
- Tuberculosis: 29
- Birth asphyxia and ...: 27
- Protein energy malnutrition: 27

Deaths per 100,000 population
Zoonoses sicken 2.4 billion people, kill 2.2 million people and affect more than 1 in 7 livestock each year.

Cost $9 billion in lost productivity; $25 billion in animal mortality; and $50 billion in human health.

Map by ILRI, from original published in an ILRI report to DFID: Mapping of Poverty and Likely Zoonoses Hotspots, 2012.
Top zoonoses (multiple burdens)

• Assessed 56 zoonoses from 6 listings: responsible 2.7 billion cases, 2.5 million deaths
• Top 13 responsible for 2.2 billion illnesses and most deaths
  – Wildlife interface
  – 9 have a major impact on livestock- affect 1 out of 7
  – All 13 amenable to on-farm intervention
Timely detection and response

Exposure in animals → Clinical signs in animals → Exposure in humans → Clinical signs in humans → Cost of control outbreak → Humans seek medical care

Adapted from IOM (2009)
Benefits of controlling zoonoses in animals and along the value chain

- Credible economic cost benefit studies (n=13)
  - Average benefit cost ratio 6:1
  - Median 4:1
  - Range 1.1-19.8

- Implies $85 billion losses could be averted by $21 billion expenditure
The business case for One Health

This article outlines a pathway to develop the business case for One Health. It describes the origin and development of One Health and then identifies five potential areas where One Health can add value and reduce costs. These are: (1) sharing health resources between the medical and veterinary sectors; (2) controlling zoonoses in animal reservoirs; (3) early detection and response to emerging diseases; (4) prevention of pandemics; and (5) generating insights and adding value to health research and development. Examples are given for each category along with preliminary estimates of the potential savings from adopting the One Health approach. The literature reviewed suggests that one dollar invested in One Health can generate five dollars worth of benefits and a global investment of US$25 billion over 10 years could generate benefits worth at least US$125 billion. Conservation implications: the time has come to make the bigger case for massive investment in One Health in order to transform the management of neglected and emerging zoonoses and to save the lives of millions of people and hundreds of millions of animals whose production supports and nourishes billions of impoverished people per annum.

Introduction
This article is based on an invited keynote presentation given at the Southern African Centre for
Burdens of disease

• DIRECT Human Health / Animal Health impact
• Economic consequences
  - Inability to work
  - Resources devoted to treatment
  - Take care of sick family members
• Social impacts
  - WOMEN – Reduced availability for agr. tasks
    (decreased production, less opportunities for women)
  - CHILDREN – Taken out of school

- Productivity
- Investments on agriculture
- Adoption of modern technologies
- ....
Economic burden on country

- Decrease GDP from livestock
- Trade bans
- Challenges to achieve economic development from agriculture
Unwillingness to pay for prevention

How much did you spend last year on the following health protection (Kenya shilling)?

<table>
<thead>
<tr>
<th></th>
<th>Mosquito nets</th>
<th>Vaccines &amp; routine clinic visits for kids</th>
<th>Boiling or other water treatment</th>
<th>Insurance (annual fee)</th>
<th>Other health prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>762</td>
<td>254</td>
<td>6.8</td>
<td>0.9</td>
<td>586</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>0-3150</td>
<td>0-5000</td>
<td>4 households paid between 150-600</td>
<td>220 households paid nothing, one household paid 200</td>
<td>0-6000</td>
</tr>
</tbody>
</table>

How much did you spend last year on the following health prevention for animals?

<table>
<thead>
<tr>
<th></th>
<th>Deworming</th>
<th>Vaccinations (to prevent not to treat)</th>
<th>Tick and fly treatments</th>
<th>Insurance (annual fee)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>928</td>
<td>437</td>
<td>599</td>
<td>0</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>0-11000</td>
<td>0-5000</td>
<td>0-5000</td>
<td>Not existing</td>
</tr>
</tbody>
</table>
Why we must remember this:

- Self-actualization
- Self-esteem and respect
- Love and sense of belonging
- Safety and security
- Physiological needs: food, rest, water

Hierarchy of needs according to Maslow.

If this is not fulfilled, nothing else will be prioritized.
Conclusions 1

• The livestock revolution has benefitted poor farmers both by increased incomes and improved nutrition

• It has brought along risks, including food safety issues and disease emergence

• This process is not over yet
  • More mouths to feed
Conclusions 2

- Not the livestock revolution predicted by Orwell
- But still not a situation where all people are equally equal regarding a secured access to safe food
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