Farm Animal Research in Crisis

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Lunch-N-Learn

National C-FAR Hill Seminar Series

National Coalition for Food and Agricultural Research (National C-FAR)
FARM ANIMALS: A NEGLECTED RESEARCH RESOURCE FOR ADVANCING HUMAN HEALTH AND ANIMAL AGRICULTURE
Key points:

1. Farm animals are the only animal model that offers dual benefit of advancing research in human medicine and animal agriculture.

2. Research using farm animals is in jeopardy.

3. Congressional help is needed.
Outline:

I. Why are farm animals a neglected research resource for advancing human health?

II. Why are farm animals a neglected research resource for advancing animal agriculture?

III. Summarize key points and make recommendations to Congressional Staffers with expected outcomes?
I. Are farm animals a neglected research resource for advancing human health?
Farm animals have a rich history as research resource for human disorders/diseases.
Seventeen 17 Nobel Prize winners used farm animals as biomedical models!
Smallpox killed 500M humans!

Cowpox virus used to make first vaccine against smallpox in humans. Paved way for modern vaccination programs!
Bovine and porcine were source of insulin for humans from 1920 to 1982.
Artificial insemination & embryo transfer in cows is basis for ART in humans.

Willett.....1st live calf by ET in 1950

Louise Brown 1st IVF-ET baby born in 1978
First mammal cloned was a sheep...Dolly!
Prions (infectious proteins replicate without DNA!) discovered in sheep and goats and led to Nobel Prize.
Transplantation friendly pigs
Genomes of bovine, pig, chicken, turkey, sheep, horse determined.
Current Biomedical Problems
More than 130 million Americans suffer from chronic conditions; that number will continue to rise.
### Infectious Diseases:

<table>
<thead>
<tr>
<th>Disease</th>
<th>Annual Deaths (Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory infections</td>
<td>3.96</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>2.77</td>
</tr>
<tr>
<td>Diarrhoeal diseases</td>
<td>1.80</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1.56</td>
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<tr>
<td>Vaccine-preventable childhood diseases</td>
<td>1.12</td>
</tr>
<tr>
<td>Malaria</td>
<td>1.27</td>
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<tr>
<td>STDs (other than HIV)</td>
<td>0.18</td>
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<tr>
<td>Meningitis</td>
<td>0.17</td>
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<tr>
<td>Hepatitis B and C</td>
<td>0.16</td>
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<tr>
<td>Tropical parasitic diseases</td>
<td>0.13</td>
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<tr>
<td>Dengue</td>
<td>0.02</td>
</tr>
<tr>
<td>Other infectious diseases</td>
<td>1.76</td>
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</tbody>
</table>

### Other Causes of Death:

- Cardiovascular conditions: 16.7 million
- Infectious diseases: 14.9 million
- Neoplastic diseases: 7.1 million
- Asthma and chronic obstructive pulmonary disease: 3.0 million
- Injuries: 5.2 million
- All other causes of death: 10.8 million
Global rise in obesity (30% adults in US are obese) & associated disorders: diabetes, cardiovascular disease and cancer.

By 2030 >330,000,000 people worldwide will develop type 2 diabetes with obesity being potentially responsible!
Cost Burden of Obesity-Related Conditions to Society and Health Industry

- **Heart Disease**: $8.8 billion
- **Osteoarthritis**: $21.2 billion
- **Gallbladder Disease**: $3.4 billion
- **Type 2 Diabetes**: $98 billion
- **Hypertension (high blood pressure)**: $4.1 billion

1. 17 percent of the total direct cost of heart disease, independent of stroke
2. Direct cost: $5.3 billion; Indirect cost: $15.9 billion
3. Direct cost: $3.2 billion; Indirect cost: $187 million
4. Direct cost: $4.1 billion—17 percent of the total cost of hypertension
"Saturated fat does not cause heart disease"—Annals of Internal Medicine, 18 Mar, 2014, vol 160.
Humans can’t always be used for research, and not yet possible to replace living animals in research with alternative methods.
Animal models
Most widely used biomedical model to study human disorders and diseases is.....?
ANIMALS USED FOR EXPERIEMENTS
EUROPEAN UNION, 2008

Advantages of mice models for biomedical research:

1. Small, easy to handle and maintain, cheap, less ethical concerns.

2. Short generation time, reproduce in litters, and accelerated lifespan.

3. Mouse genome is similar to humans.
World’s # 1 genetically pliable model for understanding human biology and disease.
The mouse model has disadvantages:
More than 130 million Americans suffer from chronic conditions; that number will continue to rise.
Disadvantages of mouse models for biomedical research:

1. Highly inbred strains are nearly genetically identical to each other thus do not represent individuals within a normal population.
Genetic similarity to humans:

Chimpanzees: 96%
Cat: 90%
Cow: 80%
Mouse: 75%
Fruit Fly: 60%
Banana: 50%
2. Lab rodents live short lives in a single, sterile environment, and fed *ad libitum* in a cage.
3. Drugs that work in mice rarely work in humans.
Research in other mammalian models is needed to better translate results from mouse to humans, and in many cases farm animals are superior biomedical models because…..
Advantages of farm animals vs rodents are greater similarity in: size, genetics, physiology, response to disorders & diseases, reproduction & infertility, and surrounding environment to humans.
Farm animals are better models for many human diseases/disorders but underutilized.
For example:
In U.S., 16 million people have diabetes and 56 million may be insulin resistant and have much greater chance to develop coronary heart disease!
Asthma occurs in 3 to 10% of world’s population and 100,000 die annually!

Allergic asthma does not occur in animals, but sheep, horses and pigs have asthma symptoms similar to humans.
Alcoholism and alcohol effects on prenatal development best studied in pigs and sheep.
Farm animals are better preclinical models for drug toxicity than rodents.

Genetic changes during infection in humans not mimicked in mice yet mice used in drug testing.
Nutrition and food safety are best evaluated in pigs because of similar immune systems.
During ART in women, 90% of eggs recovered by clinicians cannot be used to generate children! The reason is unknown.

Cattle have very similar reproductive cycles to women, but are underutilized as models to improve ART.
Melanoma: one of most deadly forms of cancer and its rate is increasing!

Lines of minipigs have a high incidence of spontaneous melanoma which is rare in rodent models.
Ovarian cancer afflicts 1 in 70 women in US!

Chickens are only known species to develop spontaneous ovarian cancers similar to humans.
Research in cattle and chickens led to better understanding of immunology and a Nobel Prize.
Novel vaccines can be tested in farm animals to directly control spread of zoonotic diseases such as swine or avian flu to humans.
Best example of vaccines benefit?

I ♥ ALL MY ANIMALS AGAINST RABIES
Despite advantages of farm animals as biomedical models.....
“An analysis of funded NIH grants that made use of animals revealed that ~92-98% of funding for grants was for rodent models.”
Farm animals are a neglected resource in advancing human health!
Have scientists become too reliant on one animal model to resolve complex human disorders?
II. Are farm animals a neglected research resource for advancing animal agriculture?
Animal Agriculture (cattle, hogs, broilers, eggs, turkeys, sheep, aquaculture):

- 6,193,639 jobs (4.2% of U.S. work force).
- 6.3% of $16.2 trillion GDP.
Animal agriculture is responsible for 50 to 70% of total agriculture economy.
Consumers reap significant, but unrecognized benefits from basic research in animal agriculture:

- Super markets are filled with high quality, nutritious, and safe milk, meat and eggs.
- Consumer spending on food in U.S. has dropped 60%!
Annual income spent on food
(% of household consumptive expenditures)
SOURCE: LEGAL ECONOMIC RESEARCH SERVICE, 2008

Malnutrition
(% of children under 5 years of age)

- < 5%
- 5-30%
- > 40%
- not in survey

A map of the world based on food costs as a percentage of income compared with incidence of juvenile malnutrition.

The size of the country represents the percentage spent on food. The darker the color, the higher the rate of malnutrition.
Current challenges facing animal agriculture.
Sustainability of animal agriculture in the U.S. is threatened by:

- rapidly escalating energy costs,
- environmental concerns and regulations,
- animal welfare issues, antibiotics, growth agents,
- new emerging diseases (e.g. porcine epidemic diarrhea) can rapidly increase food prices,
- climate change, food safety,
- foreign competition.
Global demand for meat, dairy and egg products will increase 30-50% by 2020-2030 as farmland continues to rapidly shrink (1M acres/year).

The World Bank estimates that escalating food prices will lead to 1 billion people being underfed.
Zoonotic diseases such as avian influenza are transmitted from farm animals to humans.

Humans must be protected from devastating pandemics, such as “Spanish flu” which killed 50 to 100M people!
Basic research is crucial to development of new technologies to offset these threats and meet global challenges.
USDA expends 2% ($2.7B) of its budget for research, education and extension vs $45B for agricultural research in China!
USDA funds primarily focused on applied research programs, teaching and extension of information to the public but support little basic research.
In reports in 1972, 1989, 2000, the National Research Council (NRC) of National Academy of Sciences advised Congress that:

“grossly inadequate support has been given to the basic sciences that underpin agriculture.”
In 2008, Congress established the National Institute of Food and Agriculture (NIFA) at USDA.

In 2008, USDA-NRI competitive grants program was replaced within NIFA with the Agriculture and Food Research Initiative (AFRI) with Congressionally authorized funding in farm bill of $700M.
AFRI Budget for Competitive Grants

- Congressional Appropriation
- Farm Animal Research

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<tr>
<th>Years</th>
<th>Millions</th>
<th>Farm Animal Research</th>
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<tr>
<td>2010</td>
<td>280</td>
<td>13%</td>
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<tr>
<td>2011</td>
<td>280</td>
<td>11%</td>
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<tr>
<td>2012</td>
<td>280</td>
<td>18%</td>
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<tr>
<td>2014</td>
<td>280</td>
<td>18%</td>
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</table>
Despite economic significance (e.g., 6,193,639 jobs) and challenges (e.g., new emerging and zoonotic diseases, energy costs, environmental concerns, foreign competition) facing animal agriculture…….
AFRI only makes available $50M!
Relatively minor federal funding committed to farm animal research has contributed to:

- 50% decline in faculty in past 30 years,
- 46% decline in PHDs in animal and veterinary sciences since 1985,
- significant reductions in farm animal species and numbers at nearly every land grant institution.
Relatively minor federal funding committed to farm animal research has contributed to:

- Recruitment of top quality scientists into land grant institutions to conduct state-of-the-art basic research relevant to animal agriculture and human health and to train the next generation of scientists is clearly at risk!
Genomes of bovine, pig, chicken, turkey, sheep, horse determined.
Farm animals are a neglected resource in advancing animal agriculture!
III. Summarize key points and make recommendations to Congressional Staffers with expected outcomes?
Key point:

1. Farm animals are the only model that offers dual research benefit of advancing research in human medicine and animal agriculture.
Dual benefit of farm animals recognized by both USDA and NIH:
PAR-13-204: Dual Purpose with Dual Benefit: Research in Biomedicine and Agriculture Using Agriculturally Important Domestic Species (R01) funded by NIH (NICHD, NHLBI) and USDA (NIFA-AFRI).
Purpose: “to advance our knowledge of”:

- Assisted reproduction/stem cell biology,
- Metabolism, as related to obesity and nutrition,
- Developmental origins of adult disease, and
- Infectious zoonotic diseases in humans and farm animals.
Benefits: to strengthen ties between human medicine, veterinary medicine and animal sciences.

17 new grants funded by this program!

Budget is “shoestring”!
Recommendation 1: Congress authorize and appropriate funds for USDA-NIH to develop jointly funded grant’s program (new study section) that uses farm animals as dual-benefit models to advance human health and animal agriculture.

Outcome: Improved use of public funds for the public good.
2. Research using farm animals is in jeopardy because of the near exclusive use of mice as the best translatable biomedical models (95%) and very minor federal funding for competitive grants for farm animal research ($50M).
Recommendation 2: Congress mandate NRC to evaluate scientific ramifications of near exclusive use of mice as biomedical models for human health at NIH and advantages of enhanced use of farm animals as better biomedical models.

Outcome: Enhanced pace of discovery of safer more effective drugs/therapies/vaccines to prevent/resolve complex human disorders and diseases.
Recommendation 3: Congress fund NIFA-AFRI competitive grants program at its authorized level of $700M ASAP, but mandate these new funds are for basic farm animal research.

Outcome: To maintain a safe, high quality, affordable supply of meat, milk and eggs produced in the U.S., enhance animal health and human safety from diseases, create new technologies and jobs in animal agriculture, and ensure the future global competitiveness of U.S. animal agriculture.
Cost of Recommendations to Congress = $920,200,000, which is 0.00084% of $1.1T USDA and Human Health Services Budgets.
Key point:

3. Congressional help is needed to optimize the benefits of enhanced utilization of farm animals for research in human medicine and animal agriculture.
The Beginning?
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