Social Sustainability of Egg Production Project

Project Leaders:

Janice Swanson, MSU
Paul Thompson, MSU
Joy Mench, UC-Davis
Project Coordination Team

- Patricia Hester, Purdue
- Hongwei Xin, Iowa State
- Ruth Newberry, Washington State
- Don Lay, USDA-ARS
- Hamish Gow, MSU
- Peter Holt, USDA-ARS
- Dan Sumner, UC-Davis
- Frank Mitloehner, UC Davis

- Abby Dilly: Facilitator
- Richard Bawden: Facilitator
Socio-political intensity for changing farm animal production systems in the US

Lack of US whole system studies
- How change affects different parts of a system
- To date patchwork and narrow emphasis on different features of production systems

Lack of constructive public/political discourse
- Few neutral venues for stakeholder interactions
Project Mission

- Create a working framework for examining the potential effects / outcomes when changes are proposed to existing food animal production systems
  - Immediate needs and vision sustainable systems for the future
  - Framework also allows novel approaches to be evaluated for the purpose of continued improvement based on new information
- Develop recommendations that are credible, salient and legitimate
  - Respectful of divergent values and beliefs of relevant stakeholders
- Produce white papers
- Establish funding for integrated systems research
Project Scope

- **Technical Phase I**
  - **Project Team Workshop** (April 24, 2008)
    - Development of Study Group platforms and workshops
  - **Expert Study Group Workshops** (November 2008; April 28-29, 2009)
    - Identification of critical issues
    - Formulation of study questions and research problems
    - Identify research priorities, identify areas of overlap
    - Produce white papers for each critical area
  - **Stakeholder Workshop** (Jan/Feb 2010)
    - Expert study group white papers serve as basis for stakeholder input
    - Output from stakeholders integrated into final report
Expert Study Areas and Chairs

- **Hen Health and Welfare**
  - Don Lay, USDA-ARS

- **Supply Chain Dynamics, Economics and Labor**
  - Dan Sumner, UC Davis

- **Food Safety, Security, Quality and Human Health**
  - Pete Holt, USDA-ARS

- **Environmental Impacts, Ecological Integrity and Sustainability**
  - Hongwei Xin, Iowa State

- **Public Attitudes, Discourse and Assurance**
  - Paul Thompson, Michigan State
Synthesis

Integration

- Generation of knowledge
- Values and beliefs of relevant stakeholders
- Boundary work
  - How do we harness what we know for the purpose of creating a sustainable future and to put knowledge into action
Outreach

- Lay version of each white paper
  - Available to the stakeholders and public

- Technical White Papers
  - Presented at 2010 Poultry Science Association annual meeting
    - Special Symposium
  - Papers to be published in Poultry Science
Grant Proposal Team (2010)

Composition
- Project leaders and Coordination Team
- One member of each Study Group
  - Selected by the Study Group

Use Technical Phase I output used to generate funding opportunities
Joy Mench
Socially Sustainable Egg Production
Stakeholder Workshop
February 5 – 6, 2010

The Egg Industry
Issue Scope

- U.S. Egg Industry
- Hen Housing Systems
- Drivers of Change
Egg Industry

- U.S. 3rd-largest egg producing region in the world, behind China and EU-15
- 280 million hens
- Concentrated – 5 states account for 43% of production
- Few imports or exports
Conventional (Battery) Cages
Shifts in Production

- EU has outlawed conventional cages effective 2012 based on hen welfare concerns
- Increasing pressure on U.S. retailers to purchase eggs produced in non-cage systems
- Legislation (mainly in the form of voter initiatives, or in response to threatened initiatives)
- Industry-based and independent certification programs
EU has outlawed conventional cages effective 2012 based on hen welfare concerns

Increasing pressure on U.S. retailers to purchase eggs produced in non-cage systems

Legislation (mainly in the form of voter initiatives, or in response to threatened initiatives)

Industry-based and independent certification programs
Floor Systems
Aviaries

BIG DUTCHMAN
Range Access or Free Range
“Furnished” Cages
Proposition 2

- Covered animals must be able to
  - Lie down, stand up, fully extend his or her limbs, turn around freely
- In the case of laying hens, fully extending the limbs means
  - Fully spreading both wings without touching the side of an enclosure or other egg-laying hens
California Proposition 2

- Significant uncertainty about what the language means – what systems will be allowed, and what kinds of management?
- State-by-state variation? National regulation?
- Overall sustainability
"Values and Public Acceptability Dimensions of Sustainable Egg Production"
The future of egg production in the United States will be affected by the climate of public opinion.

Members of the public have opinions on each aspect of egg production covered in other white papers, though these opinions are neither uniform throughout the public, nor are viewpoints held with uniform confidence, tenacity or intensity.

These viewpoints include both implicit and explicit value commitments: assumptions and attitudes about what *ought to be the case* in sustainable egg production.
Although it is difficult to predict how opinion will be mobilized or swayed at any given moment, understanding the climate of opinion is our best way to grasp the potential for trends in social activism, political initiatives and long-term trends in consumer and citizen behavior.
“The public” is composed of multiple subgroups with different concerns, interests and social agendas.

What people do as “consumers” (e.g. when they spend their money) is not always a good predictor of what they will do as “citizens” (e.g. how they will vote, how they will express their views, and what financial or other support they will lend to various forms of social activism).

It is therefore commonly the case that there are inconsistent indicators of “what people want,” or what they would find acceptable.
A number of measures indicate that political support for environmental quality and animal welfare has been growing steadily in the U.S. public.

Food safety rates very high as an area of concern in studies that ask respondents to comparatively rank concerns or expectations from the food system.
A variety of standards regimes have emerged as key arenas where conflicting values and visions for sustainability are negotiated and action for reform is pursued.

These include:

- Federal regulatory standards for food safety
- State, local and Federal standards for air and water quality
- Private standards for animal welfare and other variables set by producer groups and retailers
- A mix of public & private standards for process attributes (organic, local, non-cage)
The most successful efforts at integrating science and values for sustainability involve active participation from multiple stakeholders and include ongoing efforts of negotiation, dispute resolution and consensus building.

Standard setting bodies are among the organizations suited to such tasks.
Beyond economic indicators of consumer choice, we have few data that permit judgments about the relative importance or preferred trade-offs that might be made among the various dimensions of sustainable egg production. We have limited ability to forecast scenarios for mobilization of public opinion in support of or in response to specific policy initiatives or patterns of change in production methods. We do not know how subsets of the public would respond to or interpret results from scientific studies on environmental, animal welfare, food safety, health or economic dimensions of egg production.
- We have very limited data on public attitudes to support standards development that would be intended to improve public confidence in the sustainability of egg production.
- We have little basis for predicting how each of the various approaches to the integration of diverse values would be received by subsets of the public.
- We have limited information or experience in developing collaborative, participatory mechanisms for joint development and/or certification of such standards.
Study Group

- Paul B. Thompson, Study Team Leader, Michigan State University
- Michael Appleby, World Society for the Protection of Animals
- Lawrence Busch, Michigan State University and Lancaster University, UK
- Linda Kalof, Michigan State University
- Mara Miele, Cardiff University, UK
- Bailey Norwood, Oklahoma State University
- Ed Pajor, Calgary University
A Comparison of Hen Welfare in Relation to Multiple Housing Systems
Welfare is not a discrete, tangible characteristic which can be easily measured.

- Disease
- Skeletal and Foot Health
- Nutrition
- Pest and Parasite Load
- Behavior
- Stress
- Affective States
- Genetics
Consideration of not only minimizing negative aspects, but also on enhancing positive features.

Improvement in one attribute of the environment can decrease another.

Clear effects of environment/learning.

Appropriate genetic strains for each system is critical.
What Do We Know

Disease:
- Environments which are more easily cleaned offer the ability to decrease disease.
- Litter based and free range systems have more problems with bacteria and viral diseases.
- Appropriate vaccines and effective disinfectants can reduce these risks.
What Do We Know

- Nutrition
  - Not much!
  - Systems which allow hens to ingest non-nutritive substrates can alter both digestion and nutrient balance.
  - Different types of litter can significantly alter digestion and nutrient absorption.
What Do We Know

- **Disease:**
  - Environments which are more easily cleaned offer the ability to decrease disease.
  - Litter based and free range systems have more problems with bacteria and viral diseases.
  - Appropriate vaccines and effective disinfectants can reduce these risks.
What Do we Know

- Skeletal and Foot Health
  - Conditions which limit movement, increase the chances of osteoporosis.
  - Environmental complexity, including perches and nest boxes, increases the chances of broken bones.
  - Hens in conventional and furnished cages have better foot health, key seems to be not standing in litter or earth.
What Do We Know

- Nutrition
  - Not much!
  - Systems which allow hens to ingest non-nutritive substrates can alter both digestion and nutrient balance.
  - Different types of litter can significantly alter digestion and nutrient absorption.
What Do We Know

Behavior

- The more space a hen has available, the more freedom she has to perform highly motivated behavior.
- However, increased behavioral freedom can be accompanied by welfare problems such as cannibalism and predation.
- Behavior problems in non-cage systems typically affect only a proportion of the hens.
What Do We Know

- **Stress**
  - Not Much!
  - Not a clear distinction between housing systems
  - Each system has stressors, but they are different depending upon the system.

- **Affective States**
  - Not Much!
  - It is clear that hens can feel pain and fear, thus systems which reduce these feelings would enhance welfare.
Genetics

- Selective breeding for specific traits, important in each housing system can help to improve welfare.
- However, a large number of other traits, important to production, must also be selected for, thus progress in any one trait will be slowed.
Data is lacking from research which compares all systems under the same conditions.

Need for appropriate vaccines and disinfectants.

Need information on genetics and environmental factors which will decrease osteoporosis.

How ingestion of litter and other substrates will impact nutrition.
What We Don’t Know

- The effect alternative housing systems will have relative to parasites, their interaction and control strategies.
- Need to understand how rearing conditions effect hen adaptation.
- Need to understand which opportunities to perform specific behaviors creates positive affect.
- Need to understand resource need/usage in alternative systems.
What We Don’t Know

- Need to solve behavior problems associated with non-cage systems.
- Need new tools to be able to assess traits expressed in group environments, which are usable at the individual level.
- Need a much better understanding of the genetics of behavior, to adapt to new systems.
- Need to continue refine and develop novel measures of psychological and physical welfare.
Don Lay, Stress, USDA-Agricultural Research Service
Mick Fulton, Disease, Michigan State University
Scotti Hester, Skeletal and Foot Health, Purdue University
Darrin Karcher, Nutrition, Michigan State University
Joergen Kjaer, Genetics, Fed. Agri. Res. Centre, Germany
Joy Mench, Affective States, Univ. of California, Davis
Brad Mullens, Parasites, Univ. of California, Riverside
Ruth Newberry, Behavior, Washington State Univ.
Christine Nicol, Behavior, Univ. of Bristol, U.K.
Neil O’Sullivan, Genetics, Hy-Line
Rob Porter, Disease, University of Minnesota
Economic and Market Consequences of Alternative Hen Housing Systems in the United States
The first step in economic impacts focuses on market prices and quantities. From these, we may derive input use and other impacts, including labor use. The paper considers impacts of state-by-state regulations, but focuses primarily on a nation-wide change in housing regulations. Results include measures of costs and projections of changes in market prices and quantities under alternative assumptions.
Concerns over marketing margins from farm to retail are not considered explicitly.

Potential impacts on markets shares of firms or how the industrial organization might be affected are not considered explicitly, but these are likely small.
Comparison of Production Costs Between Cage Production System and Non-cage Production System in Cost per Dozen

<table>
<thead>
<tr>
<th></th>
<th>Cage production system range and median</th>
<th>Non-Cage production system range and median</th>
<th>Cost Differential Non-Cage minus Cage System using mid-points</th>
<th>Cost differential Non-Cage minus Cage System using low costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pullets</strong>¹</td>
<td>0.09 - 0.11</td>
<td>0.14 - 0.17</td>
<td>0.55</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>0.10</td>
<td>0.155</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Feed</strong></td>
<td>0.28 - 0.45</td>
<td>0.35 - 0.50</td>
<td>0.06</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>0.365</td>
<td>0.425</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Housing</strong>²</td>
<td>0.05 - 0.14</td>
<td>0.09 - 0.37</td>
<td>0.135</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>0.095</td>
<td>0.23</td>
<td></td>
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<tr>
<td><strong>Labor</strong>³</td>
<td>0.03 – 0.04</td>
<td>0.07 – 0.19</td>
<td>0.095</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>0.035</td>
<td>0.13</td>
<td></td>
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<tr>
<td>Cage production system range and median</td>
<td>Non-Cage production system range and median</td>
<td>Cost Differential Non-Cage minus Cage System using mid-points</td>
<td>Cost differential Non-Cage minus Cage System using low costs</td>
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<td>----------------------------------------</td>
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<td>---------------------------------------------------------------</td>
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<tr>
<td>Sum of the itemized costs and difference at the mid-points</td>
<td>0.595</td>
<td>0.94</td>
<td>0.345</td>
<td></td>
</tr>
<tr>
<td>Sum of the itemized costs and differences at the low costs</td>
<td>0.45</td>
<td>0.65</td>
<td>0.20</td>
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<tr>
<td>Percentage cost difference based on sum of items</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>0.345/0.595= 58%</td>
<td>0.20/0.45= 44%</td>
<td></td>
</tr>
<tr>
<td>Total Cost&lt;sup&gt;4&lt;/sup&gt;</td>
<td>0.57 - 0.92</td>
<td>0.97 – 1.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.745</td>
<td>1.05</td>
<td></td>
<td></td>
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<tr>
<td>Percentage cost difference</td>
<td></td>
<td>0.305</td>
<td>0.40</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>0.305/0.745 = 41%</td>
<td>0.40/0.57 = 70%</td>
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</tbody>
</table>
Market Price, Willingness to pay, Marginal cost

Price of eggs after housing restriction

Price of eggs before housing restriction

Demand for eggs after housing restriction

Demand for eggs before housing restriction

Supply of eggs after housing restriction

Supply of eggs before housing restriction

Supply curve shifts up with higher costs

Q shell eggs consumed

Q1, Q0
Price and Quantity effects of a 40% cost increase with different elasticities and willingness to pay for eggs, United States

<table>
<thead>
<tr>
<th>Cost shift dlnC (percent)</th>
<th>Willingness to pay shift dlnB (percent)</th>
<th>Demand elasticity ( \eta = -0.1 )</th>
<th></th>
<th>Demand elasticity ( \eta = -0.2 )</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Supply elasticity ( \varepsilon = 5 )</td>
<td>Supply elasticity ( \varepsilon = 10 )</td>
<td>Supply elasticity ( \varepsilon = 5 )</td>
<td>Supply elasticity ( \varepsilon = 10 )</td>
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<tr>
<td></td>
<td></td>
<td>Price effect (percent)</td>
<td>Quantity effect (percent)</td>
<td>Price effect (percent)</td>
<td>Quantity effect (percent)</td>
</tr>
<tr>
<td>40</td>
<td>0</td>
<td>39.22</td>
<td>-3.92</td>
<td>39.60</td>
<td>-3.96</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>39.31</td>
<td>-3.43</td>
<td>39.65</td>
<td>-3.47</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>39.41</td>
<td>-2.94</td>
<td>39.70</td>
<td>-2.97</td>
</tr>
</tbody>
</table>
What We Don’t Know: Need for Research

- Better cost data on several alternative systems, especially from commercial scale operations
- Better analysis of median (or typical) consumer increase in willingness to pay for eggs produced with alternative housing systems
- Data on how marketing margins differ with eggs produced differently
- Analysis of alternatives to regulations to encourage welfare changes where the costs imposed are tied more directly to the beneficiaries of the policy
What We Don’t Know: Need for Research

- More analysis of how alternative housing systems may affect other aspects of production and marketing
- Would we expect firm size to grow or would smaller firms gain advantages
- Would we expect the input market relationships to change
- Would we expect the market chain to change if the housing system changed?
Study Group

- Daniel A. Sumner, Chair
- Hamish Gow,
- Dermot Hayes
- William Matthews
- Bailey Norwood
- John Thomas Rosen-Molina
- Walter Thurman
Environmental Impacts and Sustainability of Egg Production Systems

Hongwei Xin, Iowa State University, Chair
Richard S. Gates, University of Illinois Urbana-Champaign
Angela R. Green, University of Illinois Urbana-Champaign
Frank M. Mitloehner, University of California-Davis
Philip A. Moore, USDA-ARS
Christopher M. Wathes, University of London, UK
Outline of WP Highlights

- Scope of the issue: Comparatively assess environmental impacts or footprint of different hen housing systems and production management practices in terms of
  - Air quality (gaseous & PM levels), thermal comfort
  - Air emissions to the atmosphere
  - Water quality
  - Resource (feed, equipment, land) utilization efficiency
- What we know based on available literature information
- Knowledge gaps to be filled through research
High-Rise (Cage) Hen House
Manure-Belt (Cage) House + Manure Storage
Air Drying of Manure on Belt under Cages

Courtesy of Tom Lippi, CTB
Supplemental Air Drying Chamber

Courtesy of Tom Lippi, CTB
Enriched Cage Hen House

Water line is located on the wire mesh separation between the 2 cages.

Nestboxes

Feed trough with egg belt underneath

Perches

Manure drying system

Litter mat: artificial grass on top of wire cage bottom
Non-Cage Hen Houses
One-Story (Non-Cage) Floor Hen House
Aviary (NC) Hen House
Aviary (NC) Hen House
For cage housing systems, high-rise houses generally have lower air quality and emit more ammonia than manure-belt counterparts;

Manure removal frequency in MB houses greatly impacts ammonia emissions;

Emissions from manure storage is largely affected by storage conditions – manure moisture content, ambient temperature, and stacking profile;

More baseline data on air emissions of HR (6) and MB (2) houses are being collected (NAEMS) in CA, IN, and NC;
We Know ....

- Non-cage (NC) houses generally have much worse air quality (ammonia and dust levels) than cage houses.
- NC houses tend to have lower temperature during cold weather due to low stocking density.
- NC house are more energy intensive (supplemental heat in winter), hence higher footprint.
- Hens in NC systems are less efficient in feed energy utilization, leading to greater environmental footprint.
- NC systems are less efficient in land resource utilization.
Excessive application of hen manure to cropland can lead to nutrient runoff to water bodies, adversely affecting ecological systems.

Hen manure on open range may be subject to runoff during rainfall, although quantitative data are lacking.

Some mitigation means exist that reduce generation and emission of noxious gases and dust. However, work is needed to evaluate their economic feasibility.

Dietary manipulation holds good promise for mitigation.
Gaps to Be Filled by Research

- Indoor air quality, air emissions, thermal conditions and energy use for alternative hen housing systems, e.g., 1-story floor, aviary, and enriched cage systems (along with conventional system) under U.S. production conditions;
- Life cycle assessment (LCA) of environmental footprint for different egg production systems in different U.S. regions (being done for Midwest egg production/processing);
- Continue to develop and validate process-based models for predicting air emissions and their fate; and
- Further explore practical means to mitigate air emissions.
Overlapping with ..... 

- Animal welfare & health (concentrations of noxious gases and respirable PM, thermal comfort)
- Human health (noxious gases, respirable PM)
- Economics (supplemental heat energy use, additional feed use, utilization efficiency of capital investment, extra land required for barns and feed production, etc.)
The Impact of Different Housing Systems on Egg Safety and Quality

Peter S. Holt, Chair
Socially Sustainable Egg Production
Stakeholder Workshop
February 5 – 6, 2010
Egg safety includes both microbiological and chemical issues.

Microbiological issues deal primarily with *Salmonella enterica* serovar Enteritidis (SE) which infects the bird and eventually enters the egg.

Chemical issues deal primarily with environmental contaminants such as dioxins, pesticides and heavy metals consumed by the hen and enter the egg.
**Issue Scope**

- **Egg quality**
  - Shell – integrity, cleanliness, quality
  - Yolk - vitelline membrane, yolk index, yolk color, viscosity
  - Albumen – Haugh unit, albumen height, viscosity integrity
  - Functional quality – whipping, emulsification and foam stability
  - Nutritional quality

- These variables may be influenced by housing situations but season, climate, flock age, flock size and flock breed will also exert effects

- The investigations need to be conducted over the life of the flock and matched between production systems with regards to season, climate, and geographic location
What Do We Know

*Salmonella*

- Bird density affects incidence (>density = > SE)
- Seasonal (> summertime)
- Regional (> NE US)
- Incidence increases with flock age
- Rodents important “amplifier” of flock infection
- Vaccination decreases infection
- Other diseases can increase incidence
- Higher incidence in multi-age facility
- Facility age affects incidence (>age = >SE)
What Do We Know

- Chemical contamination
  - Ground – raised birds generally at higher risk for producing eggs contaminated with PCB, heavy metals, and pesticides
  - History of the prior land usage important
  - Also important is pollution produced by neighbors
  - Urban areas generally linked more with contamination problems (ie pollution)
What Do We Know

- Quality
  - Egg characteristics are influenced by hen breed
  - Nutrition is important for egg quality
  - Lighting will impact egg production and quality
  - Quality parameters change with the age of the hen
  - Disease and temperature can markedly alter egg quality
Taking into account region, season, flock age, hen breed, vaccination status etc:

- What is the prevalence of *Salmonella* in US egg-producing establishments and is this improved or diminished in different housing systems?
  - EU: *Salmonella* in conventional cage than cage free
    - Aging cage facilities?
  - US: *Salmonella* in cage free than conventional cage
  - Why higher *Salmonella* incidence in high density facilities?
    - Reflection of conventional cage housing?
    - Will be seen with ground-raised, high bird density facilities?
What We Don’t Know

- What is the prevalence of chemical agents of food safety concern in US egg-producing establishments and is this improved or diminished in different housing situations?
- What factors affect egg quality, both physical and nutritional, and how would these be influenced in different housing systems?
What We Don’t Know

- What questions can be addressed under controlled conditions using small research flocks and what questions can only be answered using large commercial flocks?
Study Group

- **Dr. Richard Gast** and **Dr. Deana Jones**, USDA/ARS ESQRU Athens, GA
- **Dr. Janice Huwe**, USDA/ARS Animal Metabolism Research Unit, Fargo, ND
- **Dr. Douglas Waltman**, Georgia Poultry Laboratory, Oakwood, GA
- **Dr. Kyle Willian**, Chemistry Department, Tuskegee University, Tuskegee, AL

**EU Safehouse participants**

- **Dr. Rob Davies**, Veterinary Laboratory Agencies, Weybridge, UK
- **Dr. Jeroen Dewulf**, Veterinary Epidemiology, Ghent University, Ghent, Belgium
Project Acknowledgement

American Egg Board