Livestock on Bio-diversified Farms: Food Safety Risks

On Farm Food Safety:
A 4-part June Workshop Series for Produce Farmers
June 20, 2016 - Petaluma

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What is Cooperative Extension?

**Mission Statement:**
Statewide Network of researchers and educators focused on the creation and application of knowledge in agriculture

- 200 locally based CE advisors and specialists
- 57 local offices
- 130 campus based CE specialists
- 9 research and extension centers
- 700 academic researchers

* Extension Specialists, Researchers and Farm Advisors

http://ucanr.edu/

* Extension Specialists, Researchers and Farm Advisors
Background

Food Animal Clinician (small - large - scale farms) and Lecturer, Portugal & UC Davis

Veterinary Epidemiologist (Food Safety & Epidemiology of Infectious Diseases), MSU & UC Davis
Livestock on Bio-diversified Farms: *Integrated Crop-Livestock Systems*

- Mixed/integrated crop-livestock systems are farms where animals and crops are raised with the goal of utilizing the products of one for the growth of the other *(Hilimire, 2011)*

Adapted from [www.ars.usda.gov](http://www.ars.usda.gov)
Livestock on Bio-diversified Farms: Integrated Crop-Livestock Systems

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- Other terms:
  - Mixed crop-livestock systems
  - Integrated farms
  - Bio-diversified farms
  - Diversified farms
Livestock on Bio-diversified Farms: *

*Integrated Crop-Livestock Systems*

Pathways of crop-livestock integration

Adapted Steinfeld, 1998
Livestock on Bio-diversified Farms: *Integrated Crop-Livestock Systems*

**Specialized systems**

*Courtesy of Monique Gunther*

**Integrated systems**

*Adapted from wikipedia*
Livestock on Bio-diversified Farms: *Integrated Crop-Livestock Systems*

- **Spatially Separated**
- **Rotational**
- **Fully Combined**

Adapted from reuters.com
Livestock on Bio-diversified Farms: *Integrated Crop-Livestock Systems*

**Benefits**

- **Fertilize the soil** with on-farm input, livestock manure
- Encourage and allow growers to maintain **semi-permanent pasture fields**, which can improve soil quality
- Increase **crop yield**
- Enhance on-farm **bio-diversity** and related **ecosystem services**: pollination, weed/pest management
- Enhance **economic gain** to growers
- Confer **social benefits** to growers and communities
- **Sustainability** *(Hilimire, 2011)*
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Challenges

• Confronting a loss of animal husbandry knowledge*
  • Animal Health
  • Cross-species Transmission & Cross-Contamination
    • Parasites
    • Enteric/Foodborne Pathogens

• Food Safety Concerns (new regulations)

• Erosion of Animal Genetic Diversity*
  • Heirloom species

• Limited Meat Processing Infrastructure for small-scale production*

(*Hilimire, 2011)
Livestock on Bio-diversified Farms: *Integrated Crop-Livestock Systems*

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  (*Hilimire, 2011*)
Livestock on Bio-diversified Farms: *Integrated Crop-Livestock Systems*

What are the risks?
- Predators
- Contact with wildlife
- Transmission of diseases
- Management/Husbandry practices to keep animals healthy

Grazing turnips in the fall provides sheep and goats with “clean” grazing and excellent nutrition during breeding season. Photo: Linda Coffey, NCAT
Adapted from, IP401, www.attra.ncat.org

Adapted from IP453, 2013 www.attra.ncat.org
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*Integrated Crop-Livestock Systems*

**Animal and Herd/Flock Health**
- Maintaining an herd/flock healthy
- Good Husbandry Practices
- Preventive Practices
- Biosecurity
- Minimize the contact with wildlife
  - pasture pigs & feral pigs (zoonotic diseases)
  - pasture poultry & waterfowl (ex: AI)
- Close Herd
- **Pasture Management**
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*Integrated Crop-Livestock Systems*

**Grazing behaviors:**
Dietary Preferences for different livestock species

Cows prefer grass; sheep prefer forbs; goats prefer trees and shrubs. Nevertheless, there is regular crossover among the three types of feeders.

<table>
<thead>
<tr>
<th>Species</th>
<th>Grass (%)</th>
<th>Weeds (%)</th>
<th>Browse (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horse</td>
<td>90</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Cattle</td>
<td>70</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Sheep</td>
<td>60</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Goats</td>
<td>20</td>
<td>20</td>
<td>60</td>
</tr>
</tbody>
</table>

Source: Multi-species Grazing can Improve Utilization of Pastures
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*Integrated Crop-Livestock Systems*

**Parasites**

- **Nematodes (Roundworms):**
  - Abomasum:
    - Haemonchus spp (sheep, goats, cattle)
    - Ostertagia spp (cattle)
    - Trichostrongyulus (ruminants, horses)
  - Small Intestine
    - Trichostrongyulus
    - Cooperia
  - Lungs
    - Dictyocaulus spp
- **Protozoa (coccidia)**
- **Trematodes (flukes)**
- **Cestodes (tapeworms)**  

Adapted from MA&VA Cooperative Extension Parasite Control Fact Sheet.
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**Parasites in Ruminants**

**Prevention:**
- Pasture Rotation
- Avoid overgrazing
- Animal Management
- Multi-species grazing
- Rotation between different anthelmintic
- Herd dogs (parasites)

Adapted from MA&VA Cooperative Extension Parasite Control Fact Sheet
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**Parasites in Poultry**

**Coccidea**
- Host and site specific (GI)
- Occurs under conditions of warmth and humidity (e.g., wet litter)
- One sporulated oocyst can produce 100,000 offspring!
- Oocyst very resistant (can survive 18 months in the environment)
Livestock on Bio-diversified Farms: Integrated Crop-Livestock Systems

- Wildlife (Deer, Feral Pigs, Reptiles, Birds, Rodents)
- Insects & Pests
- Water (source)
- Irrigation
- Animals (livestock & poultry)
- Untreated Manure
- Humans (visitors/vehicles)

Introduction of Foodborne Pathogens in produce crops
Livestock on Bio-diversified Farms: *Integrated Crop-Livestock Systems*

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Introduction of **Foodborne Pathogens** in produce crops
Livestock on Bio-diversified Farms: Some definitions

- **Foodborne Pathogens**: a biological infectious agent (bacteria, virus, parasites) that causes foodborne illness to host (food poisoning)
- **Food poisoning** is any illness resulting from consumption of contaminated food

### Bacteria:
- *Campylobacter*
- *Salmonella*
- *E. coli* O157:H7
- *E. coli* non-O157 STEC
- *Listeria monocytogenes*
- *Shigella*
- *Staphylococcus*

### Virus:
- *Noravirus*
- *Rotavirus*
- *Hepatitis virus*

### Parasites:
- *Cryptosporidium*
- *Cyclospora*
- *Toxoplasma*
- *Trichinella*

Adapted from CDC, NARMS
Livestock on Bio-diversified Farms: Integrated Crop-Livestock Systems

- **Bacteria** can be found in the **gastro-intestinal tract** of a wide variety of **domestic** and **wild animals**

**Bacteria:**
- *E. coli* O157:H7
- *E. coli* non-O157 STEC

Diagram courtesy of Dr. Jay-Russell
Livestock on Bio-diversified Farms:
Integrated Crop-Livestock Systems

- Certain animals are reservoirs for certain pathogens
- What can affect animals shedding in their manure
  - Age (e.g. young animals)
  - Husbandry practices (e.g. stocking density)
  - Diet (e.g. distillers grain)
  - Season (summer)
  - Environmental conditions

Adapted from CDC, NARMS
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- All manures can carry pathogens (causing human illness)
- There is an increased **risk of pathogen spread** via food products (e.g., vegetables, fruits and nuts) when **manure is applied to crop fields**
Livestock on Bio-diversified Farms: Manure & Food Safety Risks

Small-Scale Farm Study

- STEC O157:H57, 1.9
- Campylobacter, 6.9
- Non-O157 STEC, 7.7
- Salmonella, 0.8

Livestock on Bio-diversified Farms: Manure & Food Safety Risks

Small-Scale Farm Study

- Salmonella, 0.8%
- Campylobacter, 6.9%
- non-O157 STEC, 7.7%
- STEC O157:H57, 1.9%

% Campylobacter by Livestock
- Others: 2.3%
- Cattle: 25.6%
- Swine: 23.3%
- Poultry: 44.2%

% Non-O157 STEC by Livestock
- Goats: 12%
- Dairy Cattle: 24%
- Beef Cattle: 28%
- Sheep: 36%
Livestock on Bio-diversified Farms: 
**Manure & Food Safety Risks**

**Soil**

- Pathogens can persist for long periods in the soil:
  - *Salmonella* can persist in the litter applied to fields almost 4 months, can survive up to 2 years
  - *Campylobacter* can persist for about 25 days

- Factors affecting the survival in the soil: livestock species, pathogen, manure type, composition (e.g., humidity, dry matter), soil type, environmental conditions (e.g. season, temperature, rainfall, sunlight)
Livestock on Bio-diversified Farms:  
*Manure & Food Safety Risks*

**Good Agricultural Practices (GAPs)**
- Selection
- Treatment (e.g., composting, Heat treatment)
- Application timing
- Application methods
- Handling and Storage
- Recordkeeping
Livestock on Bio-diversified Farms: 
*Manure & Food Safety Risks*

- The prevention of microbial contamination of crops has been based on **time-interval criteria** between the **application of raw manure** and crop harvesting.
Livestock on Bio-diversified Farms: Manure & Food Safety Risks

The Produce Safety Rule of the Food Safety Modernization Act (FSMA) that was released in 2015 included treatment requirements for manure that depend on how the manure is utilized, but has ‘reserved’ any minimum intervals between the application and the harvest until FDA has conducted a robust risk assessment to better understand the health impacts of the use of manure for the production of produce.

FDA will not take exception to National Organic Program (NOP): requires that untreated animal manure be applied at least 120 days or 90 days prior to the harvest of crops, depending on whether the edible portions come into direct or indirect contact with the treated soil.
Livestock on Bio-diversified Farms: Manure & Food Safety Risks

- Rotational Grazing or Pasture?
- Integration of sustainable practices such as the use of grazing animals in fields destined for produce may introduce additional food safety risks ??
Livestock on Bio-diversified Farms: 
*Manure & Food Safety Risks*

- **Grazing animals, Working Animals and Animal Intrusion**
- Evidence of potential contamination of produce (during growing)?
- Yes (observation of animals, animal excreta or crop destruction)
  - Can be harvested or not based on measures taken during the growing and assessment of the risks/contamination at the harvesting (FSMA § 112.83)
Livestock on Bio-diversified Farms: 
*Rotational Grazing - Sheep*

**Prevalence and Persistence** of the pathogen Shiga-toxin producing *E. coli* (STEC) in sheep and survival of generic *E. coli* & STEC in the soil in rotational grazing systems

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Patterson, L.; Navarro-Gonzalez, N.; Aminabadi, P.; Jay-Russell, M.; Pires, A.; 2016. *Evaluating the persistence of Escherichia coli in the soil of an organic mixed crop-livestock farm that integrates sheep grazing within vegetable field*
Livestock on Bio-diversified Farms:  
*Rotational Grazing - Sheep*

**Prevalence and Persistence** of the pathogen Shiga-toxin producing *E. coli* (STEC) in sheep and survival of generic *E. coli* & STEC in the soil in rotational grazing systems

**Research Field (5 acres)**
- Planted with winter cover crops
- Each field divided into 3 grazing paddocks
- Sheep graze 3-5 days per paddock

<table>
<thead>
<tr>
<th>Field A</th>
<th>Field B</th>
</tr>
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<tbody>
<tr>
<td>Sheep leave March 10</td>
<td>Sheep leave April 6 (Day 0)</td>
</tr>
<tr>
<td>Sheep enter February 28</td>
<td>Sheep enter March 27</td>
</tr>
<tr>
<td>N = 60</td>
<td></td>
</tr>
</tbody>
</table>
Livestock on Bio-diversified Farms: *Rotational Grazing - Sheep*

Mean generic *E. coli* MPN vs. Days Post Sheep
(MPN per 1 gram soil, log10 scale, ex: $10^2 = 100$)

Field A: Cultivated
Field B: Planted with Buried Drip
Field A: Switched to Buried Drip
Field B: Tilled post sheep
Field B: Sheep leave field

Harvest all fields
Livestock on Bio-diversified Farms: Rotational Grazing - Sheep
Small-scale Farms & Urban Animal Ag SURVEY

• Please take a moment to fill out the online survey:
  http://ucanr.edu/survey/survey.cfm?surveynumber=15917

• If you have any questions regarding the survey please contact:
  – Alda Pires (apires@ucdavis)
Thank you

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