HACCP-based Programs for Use on the Dairy Farm

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What’s HACCP?

- **Hazard Analysis**
  - A threat to food safety categorized from 3 areas: biological, chemical or physical

- **Critical Control Points**
  - CCP- (Critical Control Point) a point, step or procedure where a control can be used and a food hazard can be prevented, eliminated or reduced to acceptable levels.
To protect the food supply and assure food safety, the FDA has adopted HACCP as the food safety system.

First developed nearly 30 years ago for astronauts.

Systematic approach to be used in food production as a means to assure food safety.

Endorsed by many national and international scientific groups, corporations, government, agencies and academic organizations.
HACCP

- HACCP focuses on preventing hazards in the food industry, not on catching them when it’s too late

- Think of it as a pro-active solution instead of after-the-fact-fix
HACCP Plan and System

- Five preliminary steps and seven principles

- Preliminary Steps -
  - Assemble the HACCP team.
  - Describe the food and the method of its distribution.
  - Identify the intended use and consumers of the food.
  - Develop a flow diagram which describes the process.
  - Verify the flow diagram.
HACCP: Principles

Principles

- **Principle No. 1.** Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and describe the preventive measures.

- **Principle No. 2.** Identify the critical control points (CCPs) in the process.

- **Principle No. 3.** Establish critical limits for preventive measures associated with each identified CCP.
HACCP: Principles

- **Principle No. 4.** Establish CCP monitoring requirements.

- **Principle No. 5.** Establish corrective action to be taken when monitoring indicates that there is a deviation from an established critical limit.

- **Principle No. 6.** Establish effective record-keeping procedures that document the HACCP system.

- **Principle No. 7.** Establish procedures for verification that the HACCP system is working correctly.
HACCP: steps 1-3

- Assemble the HACCP team.
- Describe the food and the method of its distribution.
- Identify the intended use and consumers of the food

RAW FLUID MILK
- BTSCC ~ 250,000 CELLS/ML
- Lac = 4.8, Pro = 3.3, Fat = 3.8
- Temp ~ 40 F
- SPC = ~ 5000 cfu/ml
- Coliforms – NIL
- PIC = < 3 x 4 SPC

MILK COOPERATIVE
- Human consumption following pasteurization
HACCP: steps 4

- Develop a flow diagram which describes the process

  Healthy Cows → Milking Parlor

  Cow + → Milking Machine

  Raw Milk → P. cooler → Bulk Tank

  Cow Preparation → Milking Machine

  Milking Parlor → Cow Preparation
HACCP: step 5

Healthy Cows → Milking Parlor

Cow Preparation

Cow+ → Milking Machine

Milking Machine

Raw Milk → Plate cooler → Bulk Tank

See next slide

Double 6 Herringbone 1 milker

3 cows at one time
Strip, dip, dry, apply

serviced 6 months, automatic take off
Inflations replaced every 1500 milkings

6 milkings, automatic cleaning
digital temp. recorder
HACCP: principles

- **Principle No. 1.** Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and describe the preventive measures.
  - **Cows** (mastitis, SCC, udder condition)
  - **Parlor** (hazardous const. Stray voltage)
  - **Milker** (training and supervision)
  - **Cow Preparation** (written protocols in practice)
  - **Milking System** (service and maintenance protocols)
  - **Bulk Tank** (bulk tank temp, and recording device)
HACCP: principles

- **Principle No. 2.** Identify the critical control points

  - **Cows**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Ideal udder health targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Milk Somatic Cell Count</td>
<td>&lt; 250,000 cells/ml</td>
</tr>
<tr>
<td>Herd average (actual)</td>
<td>&lt; 200,000 SCC</td>
</tr>
<tr>
<td>Herd average (DHI Linear Score)</td>
<td>&lt; 3.0 LS SCC</td>
</tr>
<tr>
<td>100% of first calvers (DHI)</td>
<td>&lt; 100,000 SCC</td>
</tr>
<tr>
<td>&gt; 85% of herd</td>
<td>&lt; 200,000 SCC</td>
</tr>
<tr>
<td>&gt; 95% of herd</td>
<td>&lt; 500,000 SCC</td>
</tr>
<tr>
<td>Incidence of Clinical Mastitis</td>
<td>&lt; 25 cows / 100 cows / year</td>
</tr>
<tr>
<td># of culls due to udder health</td>
<td>&lt; 5 cows / 100 cows / year</td>
</tr>
</tbody>
</table>
HACCP: principles

- **Principle No. 2.** Identify the critical control points

- **Parlor**
  - Floor - Cleaned and sanitized after every milking
  - Drop hoses - Periodically sanitized and replaced
  - Stray voltage - Checked periodically every 6 months
  - Light - 150 lux units
  - Ventilation - 150 cubic feet/min of air exchange
  - Milking pit - Cleaned, sanitized after every milking
HACCP: principles

Principle No. 2. Identify the critical control points

- **Milker**
  - Cow handling
  - Detecting mastitic cows, identifying and reporting
  - Recognizing the importance of cows treated with antibiotics
  - Proper milking procedures
    - Cow preparation
    - Milking process

- **Milking system**
  - Daily checks on system function
  - Basic understanding on the working of milking machine
HACCP: principles

- **Principle No. 2.** Identify the critical control points

  - **Cow Preparation**
    - **Udder, teat and teat end condition**
      - Cleanliness (manure, feed, bedding)
      - Dry (Wet, chapped)
      - Teat teat end condition (warts, injury)
    - **Milking process**
      - Strip
      - Dip (prep-dip, dip cup)
      - Dry (through cleaning, including teat ends)
      - Apply (apply post-dip)
      - Other factors: **Consistency and repeatability** on each cow
      - Milking time on each cow
HACCP: principles

- **Principle No. 2.** Identify the critical control points

- **Milking System**
  - Checked daily
  - Inspected every 6 months
  - Serviced every year
  - Inflations replaced after 1500 milkings
  - Sanitizer and acid rinse containers inspected and periodically replaced
  - Gaskets and liners inspected periodically and replaced
  - Water temp. recorded periodically
HACCP: principles

- **Principle No. 2.** Identify the critical control points

- **Bulk Tank**
  - Bulk tank temperature, monitored daily
  - Temperature must reach 40°F within 2 h of milking and hold
  - Milk agitator
Estimates of percent infected quarters and losses in milk production due to elevated BTSCC

<table>
<thead>
<tr>
<th>BTSCC/ml</th>
<th>Percent Quarters Infected</th>
<th>Percent Production Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>200,000</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>500,000</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>1,000,000</td>
<td>32</td>
<td>18</td>
</tr>
<tr>
<td>1,500,000</td>
<td>48</td>
<td>29</td>
</tr>
</tbody>
</table>
**HACCP- principles**

**Principle No. 3** Establish critical limits for preventive measures associated with each identified CCP

<table>
<thead>
<tr>
<th>Criteria: <strong>COWS</strong></th>
<th>Critical Limit</th>
<th>Preventive Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows treated with antibiotics</td>
<td>ZERO LIMIT</td>
<td>Label cows and milk them separately not in the parlor</td>
</tr>
<tr>
<td>Cows with chronic mastitis milked along with healthy cows</td>
<td>UNDEFINED Contagious mastitis pathogens in bulk tank milk?</td>
<td>Cows will be identified and milked last Sanitize teat cups between milking</td>
</tr>
<tr>
<td>Criteria: Cows</td>
<td>Critical Limit</td>
<td>Preventive Measure</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Dirty &amp; Soiled Cows</td>
<td>UNDEFINED HIGH SPC and PIC counts</td>
<td>Flame udders</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve farm hygiene and sanitation</td>
</tr>
<tr>
<td>Cows high SCC</td>
<td>&lt; 5 % of all cows in the herd should be ~ 500,000 cells/ml</td>
<td>Identify cows with high SCC, and determine their importance in the herd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All fresh cows will be examined by CMT on the 6th milking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All cows before drying off will be CMT 7 days before drying off</td>
</tr>
</tbody>
</table>
## HACCP- principles

<table>
<thead>
<tr>
<th>Criteria: <strong>Parlor</strong></th>
<th>Critical Limit</th>
<th>Preventive Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hygiene (Teat claws falling on the floor of the parlor)</td>
<td>Milk SPC &gt; 5000 cfu/ml</td>
<td>Through cleaning and sanitization</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria: <strong>Milker</strong></th>
<th>Critical Limit</th>
<th>Preventive Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handling and Milking cows</td>
<td>UNDEFINED</td>
<td>Wear gloves</td>
</tr>
</tbody>
</table>
HACCP- principles

<table>
<thead>
<tr>
<th>Criteria: Cow Preparation</th>
<th>Critical Limit</th>
<th>Preventive Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning of teat ends</td>
<td>SPC &gt; 5000 cfu/ml&lt;br&gt;PIC &gt; 3 to 4 x SPC&lt;br&gt;SSLO &gt; 100 cfu/ml&lt;br&gt;CNS &gt; 1000 cfu/ml&lt;br&gt;Coliforms &gt; 100 cfu/ml</td>
<td>Thorough cleaning of teat &amp; teat ends using an approved pre-dip&lt;br&gt;Fore-strip cows before pre-dipping</td>
</tr>
</tbody>
</table>
## HACCP - principles

<table>
<thead>
<tr>
<th>Criteria: <strong>Milking System</strong></th>
<th>Critical Limit</th>
<th>Preventive Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>DEFINED</td>
<td>Call service agent</td>
</tr>
<tr>
<td>Hygiene</td>
<td>DEFINED</td>
<td>Call sanitarian/ service agent</td>
</tr>
<tr>
<td></td>
<td>SPC &gt; 5000 cfu/ml</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PIC &gt; 3 to 4 x SPC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coliforms &gt; 100 cfu/ml</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria: <strong>Bulk Tank</strong></th>
<th>Critical Limit</th>
<th>Preventive Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>SPC &gt; 5000 cfu/ml</td>
<td>Monitor bulk tank milk temperature</td>
</tr>
<tr>
<td></td>
<td>PIC &gt; 3 to 4 x SPC</td>
<td></td>
</tr>
</tbody>
</table>
**HACCP-principles**

**Principle No. 4.** Establish CCP monitoring requirements

<table>
<thead>
<tr>
<th>Criteria: bulk tank milk</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTSCC</td>
<td>&lt; 250,000</td>
</tr>
<tr>
<td>SPC</td>
<td>&lt; 10,000 cfu/ml</td>
</tr>
<tr>
<td>PIC</td>
<td>&lt; 4 to 4 x SPC</td>
</tr>
<tr>
<td>LPC</td>
<td>&lt; 100 cfu/ml</td>
</tr>
<tr>
<td>Coliforms</td>
<td>&lt; 50 cfu/ml</td>
</tr>
<tr>
<td>Staph aureus</td>
<td>ZERO</td>
</tr>
<tr>
<td>Strep. ag</td>
<td>ZERO</td>
</tr>
<tr>
<td>Mycoplasma</td>
<td>ZERO</td>
</tr>
<tr>
<td>SSLO</td>
<td>~ 1000 CFU/ML</td>
</tr>
<tr>
<td>CNS</td>
<td>~ 1000 CFU/ML</td>
</tr>
</tbody>
</table>
Principle No. 5. Establish corrective action to be taken when monitoring indicates that there is a deviation from an established critical limit.
Bulk Tank Milk Analysis:
A tool for improving milk quality and troubleshooting mastitis in a dairy herd
### Somatic Cells

<table>
<thead>
<tr>
<th>SCC</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>ideal</td>
<td>200,000</td>
</tr>
<tr>
<td>4/16</td>
<td>141,000</td>
</tr>
<tr>
<td>5/2</td>
<td>225,000</td>
</tr>
<tr>
<td>5/19</td>
<td>173,000</td>
</tr>
<tr>
<td>6/5</td>
<td>325,000</td>
</tr>
</tbody>
</table>
Somatic Cells

- **Corrective action**
  - Identify cows with high SCC
    - Early and late lactation
    - Cows with subclinical mastitis
      - CMT all suspect cows
  - CMT all fresh cows by 6\textsuperscript{th} milking
  - CMT all cows 7 days before drying off
  - Make a decision to keep cows in the herd with high SCC
# Standard Plate Count

<table>
<thead>
<tr>
<th>SPC</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>ideal</td>
<td>10,000</td>
</tr>
<tr>
<td>4/16</td>
<td>1,320</td>
</tr>
<tr>
<td>5/2</td>
<td>1,040</td>
</tr>
<tr>
<td>5/19</td>
<td>1,360</td>
</tr>
<tr>
<td>6/5</td>
<td>1,040</td>
</tr>
</tbody>
</table>
Standard Plate Count

Rating based on cfu/ml

<table>
<thead>
<tr>
<th>Good (low)</th>
<th>Acceptable (medium)</th>
<th>Concern (high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10,000</td>
<td>&lt; 20,000</td>
<td>&gt; 20,000</td>
</tr>
</tbody>
</table>

BTM SPC of < 1000 cfu /ml is an indication that milk is from clean and healthy cows.

SPC counts of less than 5000 cfu/ml can be achieved.

SPC of < 10,000 can be achieved by most farms.
Most probable reasons for high SPC

Improper cleaning

*Strep. agalactiae* mastitis

Purchased animals without testing for mastitis

Cows with soiled udders and teats, dirty equipment new milkers?

Inability to cool milk rapidly to less than 4.4 C (40°F)
## Preliminary Incubation Count

<table>
<thead>
<tr>
<th>PIC</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>ideal</td>
<td>10,000</td>
</tr>
<tr>
<td>4/16</td>
<td>1,600</td>
</tr>
<tr>
<td>5/2</td>
<td>4,800</td>
</tr>
<tr>
<td>5/19</td>
<td>14,000</td>
</tr>
<tr>
<td>6/5</td>
<td>2,000</td>
</tr>
</tbody>
</table>
Why are my PI counts high?

1. Cleaning and sanitation of the milking system
2. Poor udder preparation before milking
3. Failure to cool milk rapidly
4. Prolonged storage times
# Laboratory Pasteurization Count

<table>
<thead>
<tr>
<th>LPC</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>ideal</td>
<td>100</td>
</tr>
<tr>
<td>4/16</td>
<td>20</td>
</tr>
<tr>
<td>5/2</td>
<td>20</td>
</tr>
<tr>
<td>5/19</td>
<td>0</td>
</tr>
<tr>
<td>6/5</td>
<td>0</td>
</tr>
</tbody>
</table>
LP Count

Rating based on cfu/ml

<table>
<thead>
<tr>
<th>Good</th>
<th>Acceptable</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>(low)</td>
<td>(medium)</td>
<td>(high)</td>
</tr>
<tr>
<td>&lt;100</td>
<td>&lt;100-200</td>
<td>&gt;200</td>
</tr>
</tbody>
</table>

Unclean milking equipment

Faulty milking machine or worn out parts

Extremely dirty cows
What causes mastitis?

- Bacteria (~ 70%)
- Yeasts and molds (~ 2%)
- Unknown (~ 28%)
  - physical
    - trauma
    - weather extremes
# Contagious Mastitis Pathogens

<table>
<thead>
<tr>
<th></th>
<th>Staph. aureus</th>
<th>Strep. Ag.</th>
<th>Mycoplasma</th>
</tr>
</thead>
<tbody>
<tr>
<td>ideal</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4/16</td>
<td>40</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>5/2</td>
<td>20</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>5/19</td>
<td>20</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
<tr>
<td>6/5</td>
<td>0</td>
<td>Not detected</td>
<td>Not detected</td>
</tr>
</tbody>
</table>
**Staphylococcus aureus**

Type of herd: **closed herd**, suggests the presence of chronic infection; **open herd**, suggests the likelihood of newly purchased animals as one of the possible source of *Staph. aureus*.

**BTSCC** in a herd with high *Staph. aureus* infection, generally ranges from 350,000 - 1000,000 cells/ ml (most occasions 500,000- 600,000 cells/ml).

Management practices that allow spread of *Staph. aureus* in the herd:
1. Milking cows without gloves
2. Cloth towels reused without proper cleaning
3. Milking infected cows along with uninfected cows
4. Poor fly control during summer
5. During winter, milking cows with chapped teats
6. Milking cows with teat and teat end injuries
**Streptococcus agalactiae**

**Type of herd:** closed herd, suggests presence of chronic infection; open herd, suggests both the likelihood of newly purchased animals bringing in the infection.

**BTSCC** in a herd with high *Strep. agalactiae* infection, BTSCC count generally ranges from 500,000-600,000 cells/ml, with high SPC (50,000 to >100,000 cfu/ml).

**Management practices** that allow spread of *Strep. agalactiae* in the herd:
1. Milking cows without gloves
2. Cloth towels reused without proper cleaning
3. Milking infected cows along with uninfected cows
4. No or inadequate teat-dipping practices
**Mycoplasma**

**Type of herd:** **closed herd**, suggests the presence of chronic infections in the herd that would include animals of all ages; **open herd**, suggests the likelihood of newly purchased animals as one of the possible source of Mycoplasma.

**BTSCC** is generally $> 500,000$ cells/ml when there are more than 5 to 10% of the cows with Mycoplasma infection.

**Management practices:**
1. Poor herd health management practices with a history of Mycoplasma pneumonia in the herd including calves
2. Hygroma in adult cattle; cows treated for clinical mastitis do not respond to treatment;
3. Cloth towels and cannulas are reused without proper cleaning and disinfection.
## Environmental Mastitis Pathogens

<table>
<thead>
<tr>
<th></th>
<th>CNS</th>
<th>SSLO</th>
<th>Coliforms</th>
<th>Non-coliforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal</td>
<td>1,000</td>
<td>1,000</td>
<td>50</td>
<td>1,000</td>
</tr>
<tr>
<td>4/16</td>
<td>620</td>
<td>620</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>5/2</td>
<td>960</td>
<td>240</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5/19</td>
<td>900</td>
<td>520</td>
<td>20</td>
<td>180</td>
</tr>
<tr>
<td>6/5</td>
<td>480</td>
<td>1,000</td>
<td>0</td>
<td>20</td>
</tr>
</tbody>
</table>
Environmental Mastitis Pathogens

**BTSCC:**
Streptococci and Strep-like organisms: 250,000-450,000 cells/ml
CNS: 350,000 - 500,000 cells/ml
Coliforms: < 300,000 cells/ml
Non-coliforms: No data

**Milking Procedures:**
No established milking protocol (varies from milker to milker)
Poor udder surface (clipping or flaming not done)
Teat and teat ends not thoroughly cleaned
Milking done on wet teats
Cloth towels reused without cleaning

**Farm Hygiene**
Poor bedding management
Manure removal not done regularly
HACCP- principles

- **Principle No. 6.** Establish effective record-keeping procedures that document the HACCP system.

- Daily Check lists and records
  - Example: bulk tank milk temperature

- Monthly Check lists and records
  - Example: BTSCC and individual cow SCC

- Six Monthly Check lists and records
  - Example: Milking system inspection
**HACCP- principles**

- **Principle No. 7.** Establish procedures for verification that the HACCP system is working correctly.
  - Monthly bulk tank milk reports
DAIRY QUALITY ASSURANCE PROGRAM

Lawrence Hutchinson
Extension Veterinarian

Department of Veterinary Science
The Pennsylvania State University
University Park
NON-MILKING TIME EVALUATION

- Equipment cleaning procedures
- Equipment evaluation
  - Pump
  - Pulsators
  - Regulators
  - Inflations
- Parlor sanitation
- Employee training
CLINICAL MASTITIS

- Organism ?
- Severity ?
- Stage of Lactation
- Parity
- Treatment Response
RISK ASSESSMENT

- Systematic evaluation of farm
  - By groups
  - By area of concern

- Identification and quantification of potential problem, or risk areas
STEPS TO SOLVE MILK QUALITY AND MASTITIS PROBLEMS

- Records
- Milking-time evaluation
- Non-milking time evaluation
- Clinical mastitis
- Risk assessment
RECORDS

- Individual Cow
  - Production level
  - SCC
  - Culture

- Bulk Tank
  - SCC
  - Culture
  - Bacteria types and concentration

- Treatment Protocols
- Treatment Records
- Standard Operating Procedures
MILKING TIME EVALUATION

- Sanitation
- Cow-handling
- Teat preparation
- Unit-on time
- Post-milking: teat dip