Impaired reproductive performance of dairy cows can have significant impact on the profitability of dairy operations. The immune system has been shown to play a role in dairy cow reproduction, both indirectly, through the effects of mastitis, metritis, retained placenta, and metabolic diseases; and directly, through actions of immune cells upon the ovary. A properly-functioning immune system may help improve reproductive performance of dairy cattle by reducing occurrence of diseases affecting fertility, and improving immune cell activity.

REVIEW OF DAIRY COW REPRODUCTION

The cow’s estrous cycle is approximately 21 days long. It is divided into two phases which are characterized by changes on the ovary. The follicular phase makes up 20% of the cycle. During this phase the pre-ovulatory follicle on the ovary, which contains the oocyte (or egg), produces estrogen. When estrogen concentrations are high enough, a surge of luteinizing hormone (LH) is released, initiating ovulation. The luteal phase begins after ovulation, when the follicle transforms into a corpus luteum (CL) which produces progesterone to maintain pregnancy. This phase makes up the remaining 80% of the estrous cycle.

Reproductive performance is monitored using several metrics:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
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<tbody>
<tr>
<td>Calving Interval</td>
<td>Period between calvings</td>
</tr>
<tr>
<td>Days Open</td>
<td>Period between calving and confirmed conception</td>
</tr>
<tr>
<td>Services Per Conception</td>
<td>Total services per total number of pregnant cows</td>
</tr>
<tr>
<td>Heat Detection Rate</td>
<td>Percent of eligible cows that are bred</td>
</tr>
<tr>
<td>Conception Rate</td>
<td>Percent of cows bred that are pregnant</td>
</tr>
<tr>
<td>Pregnancy Rate</td>
<td>Percent of cows eligible to become pregnant that are confirmed pregnant</td>
</tr>
</tbody>
</table>

Reproductive performance is affected by both breeding success and pregnancy loss. Typically, gestation lasts 280 days. Up to 40% of pregnancies are lost in first 17 days of gestation. Early embryonic loss occurs from 0 to 15 days of gestation, and is usually not detected since pregnancy loss at this stage does not delay estrus. Late embryonic loss occurs at 16 to 41 days of gestation, and will delay ovulation and thus extend the estrous cycle. Embryonic losses usually occur before pregnancy is confirmed. Abortion occurs between 42 to 260 days of gestation, and stillbirths occur from 260 days of gestation through birth. “Normal” abortion rates are 3% to 5% per year.
INDIRECT EFFECTS OF DISEASE ON REPRODUCTION IN DAIRY COWS

Mastitis is associated with: increased Days Open1;2; greater Services/Conception2; reduced Conception Rate3; reduced Pregnancy Rate4,1; higher incidence of Early Embryonic Death5,6, and greater risk of abortion7,12. Infection of the udder affects the structure and function of the ovaries8 and has also been associated with altered patterns of reproductive hormone secretion9. These effects may be linked to a systemic response by cytokines10 (molecules released by cells that affect actions of other cells, particularly immune cells) which may also lead to pregnancy loss10.

Retained placenta can also have indirect effects upon fertility, including: reduced Conception Rate3; lower Pregnancy Rate4,1; more Services per Conception2; and increased Days Open13. Retained placenta is associated with reduced neutrophil function and lower blood concentrations of interleukin-814 (IL-8, a cytokine that attracts immune cells to sites of infection), and may alter activities of the CL15.

Uterine disease, which includes metritis (inflammation of the entire uterus) and endometritis (inflammation of the uterine lining), is associated with: lower Conception Rate16; reduced Pregnancy Rate11; and increased Days Open17. Uterine disease appears to have the greatest impact on fertility by reducing ovulation rate18 and CL size19 during the first post-partum estrous cycle. Cows with uterine disease also have smaller follicles and lower blood estrogen concentrations20. Cows that develop uterine disease experience reduced neutrophil function around the time of calving21,22.

Metabolic diseases are also associated with impaired reproductive performance.
- Milk fever increases Days to 1st Service21.
- Subclinical hypocalcemia reduces 1st Service Conception22.
- Ketosis increases Days to 1st Service & decreases 1st Service Conception Rate21.
- Mastitis combined with other diseases has greater negative impact on reproduction than any one disease alone23.

IMMUNE CELLS PLAY A DIRECT ROLE IN REPRODUCTION

Immune cells, primarily neutrophils, macrophages, and T-lymphocytes, are required by the ovary for normal ovulation and CL function24. Activities of these immune cells are regulated by the luteal environment, and result in both CL development and regression25. Neutrophils migrate into the early CL (day 1 to 4 of the estrous cycle), in response to IL-8 produced by the CL. Neutrophil numbers and IL-8 concentrations are low at the mid- and late-luteal phase but IL-8 is high at luteal regression. Interestingly, cortisol (a potent, immunosuppressive hormone released in response to stress) acts to block the release and peak of LH from the pituitary gland, which can prevent ovulation.

The immune system has both direct and indirect effects upon reproduction in dairy cows. Reproductive performance may be improved with a properly-functioning immune system.

REFERENCES


