CHAPTER 2

LITERATURE REVIEW

Effects of heat stress on production

Temperature and humidity combine to decrease dry matter intake (DMI) in dairy cows as a physiological means of regulating internal body temperature. This is accomplished by decreasing rumen fermentation and the metabolic rate (Moody et al., 1971; Richardson et al., 1961). A reduction in DMI decreases the nutrients available for milk synthesis, milk production declines and many lactation parameters are affected (Bauman and Currie, 1980; Collier et al., 1982; Moody et al., 1971; Smith et al., 1993b). High environmental temperatures also increase the respiration rate and the water intake, which consequently reduces DMI due to gut full (Mallonee et al., 1985)

Because of many dairy cows in hot weather are unable to consume enough feed to meet energy demands during early lactation, they typically mobilize body reserves to maintain their milk production until the intake of feed can match or exceed nutritional requirements (Butler and Smith, 1989; Nebel and McGilliard, 1993), thus, entering a state of negative energy balance (NEB).

In heat stressed dairy cows there is a reduction in DMI (Fuquay, 1981), which prolongs the period of negative energy balance. Negative energy balance leads to decreased plasma concentration of insulin, glucose and insulin-like growth factor-I (IGF-I), and increased plasma concentrations of growth hormone (GH) and non-esterified fatty acid (NEFA)(Lucy et al., 1992; Jolly et al., 1995). All of these metabolic hormones can affect reproduction. Metabolic hormones acting on the hypothalamo-pituitary axis and the ovary probably mediate the inhibitory effects of negative energy balance on postpartum fertility. In dairy cows, the postpartum anovulatory interval is characterized by a variable period of negative energy balance that is reported to modulate the recrudescence of ovarian cyclicity (Butler et al., 1981; Butler and Smith, 1989; Staples et al., 1990).

Effects of heat stress on reproduction

Lactating dairy cows are susceptible to heat stress because of the elevated internal heat production which is associated with lactation. During periods of heat stress, milk production, feed intake, and physical activity are decreased (Fuquay, 1981). At the same time, reproductive ability is compromised (Francos and Macer, 1983; Gwazdauskas, 1985). The exposure of lactating cows to heat stress has been shown to cause a decrease in follicular growth and to reduce serum estradiol (Wilson et al., 1998b). Badinga et al. (1993) and Wolfenson et al. (1995) also concluded that decreased follicular size or decreased dominant follicle function occurred in lactating cows that were exposed to heat stress. Some of the reproductive losses, in heat stressed cattle, are associated with decreased expression of oestrus caused by anoestrus and silent ovulation (Her et al., 1988; Younas et al., 1993). Heat stress delays follicle selection and lengthens the follicular wave having potentially adverse effects on oocytes quality (Badinga et al.1993) and follicular steroidogenesis (Wolfenson et al., 1995)

The detrimental effects of heat stress on the reproductive performance of dairy cows have been well documented. These include a suppressed intensity of oestrus, a reduced preovulatory LH surge and decreased secretion of luteal progesterone (Howell et al.,1994), altered ovarian follicular development (Wilson et al., 1998b), decreased embryo development (Hansen and Arechiga,1999) and lower fertility (Gwazdauskas et al., 1975). In an attempt to minimize these effects, modifications to dairy cattle housing environments have been implemented to alleviate thermal stressors and improve cow comfort, through the use of shade, fans, sprinklers, and evaporative cooling (Younas et al., 1993; Fuquay, 1981; Roman-Ponce et al., 1981). These methods can enhance pregnancy rates significantly (Roman-Ponce et al., 1977; Thatcher et al., 1974).

In addition, timed artificial insemination (TAI) is one strategy that might be used to improve the pregnancy rates of dairy cows under heat stress. The use of TAI offers advantages for inducing reproductive activity in early postpartum and reducing the need for the detection of oestrus. Timed AI might be particularly effective during heat stress because of the increased problems associated with the detection of oestrus. These approaches offer the opportunity to overcome the effects of heat stress on fertility. TAI is a potentially useful reproductive strategy to increase the reproductive function of lactating dairy cows in hot regions of the world. Implementation of TAI increased cumulative pregnancy rates during the hot season. The principle of the TAI protocol used here was to achieve sufficient synchrony of ovulation to allow good pregnancy rates after fixed time inseminations.