Wayamba Journal of Animal Science – ISSN: 2012-578X; P499- P512, 2012
First Submitted September 15, 2012; Number 1347656567

MANAGEMENT OF REPRODUCTIVE PERFORMANCE IN BUFFALO DURING SUMMER SEASON

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The present review addresses the management of reproductive performance of buffalo during summer season. Different factors contribute to this situation; the most important are a consequence of increased temperature and humidity that result in a decreased expression of overt estrus and a reduction in appetite and dry matter intake. Buffaloes with summer anoestrus fail to exhibit oestrus as a result of aberration in the endocrine profile leading to ovarian inactivity. Heat stress causes hyper-prolactinaemia, suppressing the secretion of gonadotrophins, which leads to an alteration in ovarian steroidogenesis during summer. Heat stress produced during summer also affects folliculogenesis, follicular fluid microenvironment and oocyte quality. A large number of hormonal regimens have been used with varying degree of efficacy in terms of oestrus induction and conception rate. A combined strategy of improvement in environment, nutrition and management is pre-requisite for hormonal manipulation in order to improve productivity in summer affected buffaloes.

Key words: Buffaloes; Heat stress; Reproductive performance, and Reproductive hormones

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Buffaloes are the mainstay of dairy industry, especially in Asia and form the frail rural economy in many developing countries across the world. The species is distributed over more than 40 countries of the world (Gordon 1996) and the population increased from 159 million (FAOSTAT 1997) to 177 million (FAOSTAT 2007). Buffaloes are raised in India this probably because there is a higher fat percentage in this milk and because unlike cows, they can be slaughtered. The buffalo has been traditionally regarded as a poor breeder due to having poor fertility in the majority of conditions under which they are raised (Barile, 2005). Domestic buffaloes have a tendency to showing a suspension of sexual activity during summer in almost all parts of the world (Shah 1990) and this is manifested mainly as late maturity, long postpartum anoestrous intervals, poor expression of oestrus, poor conception rates (CR) and long calving intervals. This condition is popularly known as summer anoestrus and incidence of this generally varies between 36.6% and 59.5% (Singh et al. 1989). Buffaloes with summer anoestrus fail to exhibit oestrus as a result of aberration in the endocrine profile leading to ovarian inactivity. Increased day length with high environmental temperature causes hyper-prolactinaemia, suppressing the secretion of gonadotrophins, which leads to an alteration in ovarian steroidogenesis. Heat stress produced during summer also affects folliculogenesis, follicular fluid microenvironment and oocyte quality. Summer anestrus is the major problem occurring in buffaloes caused by many factors and ameliorating or eliminating those factors has proved useful in reducing anestrus in buffaloes with varied degree of success. They are through management, nutritional, breeding and hormonal approaches. In this review, buffalo reproductive performance during summer has been described with special reference to factors responsible, endocrine profile, managemental and therapeutic approaches to ameliorate the condition.

Seasonality in reproductive pattern

The indirect effect of climate on the vegetation pattern seems to be the most influential in the buffalo's natural reproductive productive pattern during summer season. Seasonality in buffalo reproduction has been reported from India, Pakistan and many other parts of the world (Barile, 2005) which has been attributed to environmental factors more directly than the genetic factors (Zicarelli, 1994). Seasonal high environmental temperatures were found to be associated with low breeding efficiency, when estimating the relationship between ambient temperature and breeding efficiency (Cavestany et al. 1985).The photoperiod has a marked influence on the reproductive pattern in the species through the pineal gland secretion that controls the shift between. It was reported that ambient temperature and relative humidity showed a direct effect on breeding efficiency (Roy et al. 1968). Pranee et al. (1996) showed that heat stress reduces the intensity and duration of oestrus at temperature humidity index (THI) >25 in hot and <25 in cold seasons.

Factors affecting reproductive performance of buffalo

Beg and Totey, (1999) and Singh et al., (2000) recent studies on estrous cyclicity and behaviour in the buffalo have been reviewed and considerable variations in reproductive traits of buffaloes have been observed in compared with several factors, such as climate, temperature, photoperiod and nutrition, were indicated as affecting the length of estrous cycle and the degree of heat expression.

Environmental factors

a. Ambient Temperature:

Extreme weather conditions such as cold or heat depress the sexual activity and usually less number of conceptions occurs when the temperature is severe. In hot or cold environment the length of estrous cycle is prolonged and duration of heat become shorter as feed intake is drastically reduced compared to the comfortable environment. Decrease thyroid activity during severe summer may indirectly reduce the reproductive efficiency. Heat stress has a direct effect on the neuroendocrine setup in buffalo (Razdan, 1988) because are very susceptible to thermal stress (Pandey and Roy, 1966) during summer, especially when exposed to the direct sunrays as they have poor cutaneous evaporative cooling mechanism owing to low density of sweat glands. Buffaloes get little protection by virtue of their scant hair coat (Cockrill, 1993) and high relative humidity further accentuates the condition (Misra et al. 1963).The heat stress causes hyper-prolactinemia, reduced luteinizing hormone (LH) frequency, poor follicle maturation and decreased oestradiol production in anoestrus buffaloes (Palta et al. 1997) leading to ovarian inactivity. Summer heat stress has multifarious effects on follicle, follicular fluid and oocytes housed within the fluid (Wolfenson et al. 2000). The heat stress can affect the pregnancy in three different ways and it may affect the establishment of pregnancy and late pregnancy or postpartum period. It may be associated with pregnancy failure. Vale et al. (1989) reported problems of embryonic absorption and abortion in female buffaloes raised in the Brazilian Amazon valley, related with heat stress causing a hyperthermia as part of inadequate management.It was reported by Birgel and Vale (2005) that the blood flow in the heat stressed female animals increased in the proximity of the superficial vessels in detriment of the deep vessels whereas such change in the deep circulatory flow affect the circulation and nutritive supply at the uterus and ovaries level causing an impairment in its normal physiology. Such problem has been well documented in cows managed at tropical and sub-tropical areas where the magnitude of the depression in the conception rate is proportional to the degree of hyperthermia and the disruption in establishment of pregnancy is severe if heat stress occurs around the time of ovulation or early pregnancy.It was found that heat stress altered the oocyte or the reproductive tract so that normal embryonic development was compromised (Hansen, 2003).

It is known that in many mammals male gametogenesis is unable to occur at temperatures characteristic of the body core and heat stress as little as 12 hours disrupts spermatogenesis in the bull. Vale (2004) reported that the male buffalo is also hard affected for local thermoregulation of the testis which involve intricate anatomical and physiological system from the surface area of the scrotal sac, muscular control of the placement of the testis and the countercurrent mechanism of the pampiniform plexus which regulates the blood temperature that enters in the testis. Ohashi et al. (1988) reported that the main cause for the disruption in sperm production of male buffalo raised in the Amazon basin is the heat stress which lead to a testicular degeneration which affect the semen patter which includes a decrease in the sperm number, decreased sperm motility and increased number of abnormal sperm in the ejaculated semen and also affect the sexual libido.

b. Season:

Buffaloes are polyestrous with distinct seasonal variation in display of to estrus, conception rate, calving rate (Singh and Nanda, 1993) and expression of heat being limited to during winter (Sane et al., 1994). It was reported that estrous cycle is controlled by the estrogenic substances and the concentration of the substance in plants or fodders varies according to different seasons of the year. It was also found that in some areas of the world, buffaloes breed throughout the year, but more in the spring and a little less in autumn. Misra and Sengupta (1965) explained that the sex vigour of the buffalo declines during the hot summer and improves with the onset of the colder season.

c. **Light:**

The duration and intensity of light to which the animals are exposed also influence the onset of estrous cycle (Zicarelli, 1997) and information regarding photoperiod is conveyed to the neuroendocrine system by the circadian secretion of melatonin from the pineal gland (Morgan and Williams, 1989). Photoperiodism can be defined as the physiologic response of animals and plants to the variations of light and darkness. It is a product of and a necessity derived from species evolution. The relation between the breeding season and gestation length is such as to allow parturition in a particular species at a time of the year when nutrition and temperature are favorable to survival of both the mother and her offspring. Photoperiodic information has been shown to be the strongest synchronizer of seasonal functions in most species" of mammals (Hofman 2004) and in addition to regulating annual reproductive cycles, photoperiod can control the timing of seasonal shedding. Temperate mammals may be short-day (early spring) or long-day (spring and summer) breeders. Both short-day and long-day breeders may go through a period of photorefractoriness (nonresponsiveness to day length) that may interact with circannual rhythmicity. Long-day breeders cease reproduction either through the action of decreasing day lengths or through the action of long days, themselves inducing a photorefractory state (inability of long days to sustain reproduction) followed by gonadal regression. Buffaloes are polyestrous continuous species and shows estrous all year around, however a seasonal pattern has been reported from different countries of the world (Gangwar, 1980). Such characteristic related as a seasonal polyestrous is more related to the ambient temperature, photoperiod and feed supply. In addition with the possibility of the use of hormonal control of the estrous cycle, seasonal pattern can be overcome and they can bred through the synchronization of the estrous cycle in the year around (Vale et al., 2005).

Nutritional factors

It was found that feed consumption depression is the most important reaction to exposure to elevated temperature during summer in tropical and sub-tropical conditions (Marai et al., 2002). The quantity of consumed nutrients dry matter (DM) intake including crude protein declines and a negative nitrogen balance may occur (West, 1999) during summer due to heat stress. DM digestibility and protein/energy ratio were also found to decrease in heat stress conditions (Moss, 1993). It was reported that digestibility coefficient values for each of DM and crude protein were significantly lower in summer than winter in lactating Murrah buffaloes (Verma et al., 2000). Digestion and metabolism of non-pregnant female buffaloes declined with exposure 2-3 hours to solar radiation at air temperature of 42 °C (Zhengkang et al., 1994) and nitrogen retention decreased significantly under heat stress (Kamal et al., 1962). Buffaloes are generally reared under low input–output management system (Jainudeen 1989) and nutritional stress alters the feedback mechanism between oestradiol and LH surge which reduces the sensitivity of follicles to gonadotrophins in cattle (De Rensis and Scaramuzzi 2003), perhaps, similar information is lacking in buffaloes. Several macro and micronutrients are found to be in a lower order in various types of anoestrus buffaloes (Abou-Zeina et al. 2009). Iron and copper behave in a regular method to be used as an indicator for FSH, LH and oestrogen activity (Desai et al. 1982) and are found in a decreased level in anoestrus buffaloes than cycling animals (Yessein et al. 1994). Phosphorous deficiency (Abou-Zeina et al. 2009), and hypocuprosis because of low copper–molybdenum ratio was reported to cause anoestrus during summer (Randhawa et al. 2004). The serum levels of Zn, Cu and Co are also documented to be low in anoestrus buffaloes (Singh et al. 2006). Although, a large number of studies have been documented in relation to mineral profile in anoestrus buffaloes but are inconclusive. Reports pertaining to similar profile in summer anoestrus buffaloes are meager.

Managemental factors

Management play important role in rearing of buffalo during the summer season. It is a wellknown that buffaloes are weak in oestrus exhibition (Jainudeen 1988) which is further exacerbated during the hot season (De Rensis and Lopez-Gatius 2007). Majority of the buffaloes during summer shows silent oestrus (Chaudhry 1988), characterized by less intense overt signs of oestrus with shorter duration (Jainudeen and Hafez 2000). It was found that buffaloes tend to exhibit oestrus mostly during night or morning hours, which remain unnoticed by most of the farmers. So routine observation help in detection of oestrus in buffaloes (Beg and Totey 1999) leading to prolonged service period during warmer months (Bughio et al. 2000).

Endocrine factors

The increase in body temperature caused by heat stress has direct, adverse consequences on reproductive hormones (Hansen and Arechiga, 1999). Hence, heat stress is a major contributing factor to the low fertility of buffalo in the late summer month. Effects of heat stress on reproductive hormones and other physiological functions are a direct consequence of the increase in body temperature caused by heat stress or of the physiological changes cows undergo to reduce the magnitude of hyperthermia (De Renesis and Scaramuzzi, 2003; Khodaei et al 2003).

The role of melatonin in the regulation of reproductive seasonality is fairly well established in seasonal breeders such as sheep and mare, while a few investigations have been made to clarify the role of this hormone in buffalo reproduction. Seasonal trend in melatonin production has been reported in Italian Mediterranean buffaloes with highest. Prolactin is directly associated with the ambient temperature (Wettemann and Tucker, 1974) and may mediate the seasonal effects on reproduction in buffalo (Singh and Chaudhry, 1992). Buffaloes show hyper-prolactinemia during hot summer months (Singh and Chaudhry, 1992), which is attributed to the seasonal changes in pineal metabolism (Paraneswaran et al. 1983) and hyper-prolactinaemia has been proposed to be a possible cause of summer anoestrus in the species (Singh and Madan, 1989).

Prolactin may block the hypothalamic mechanism responsible for episodic release or inhibit the positive feedback of oestrogen on LH secretion. So it interferes with oestrous cycle and fertility by exerting its effect both at hypothalamus (Sheth et al. 1978) as well as at ovarian level (Sheth et al. 1978) and it also affects ovarian steroidogenesis by altering the number of LH receptors (Sheth et al. 1978). A higher plasma concentration of PRL makes the ovaries refractory to the influence of FSH and LH resulting in anoestrus and this leads to anovulatory oestrous cycle and consequent poor breeding performance in summer (Paraneswaran et al. 1983). The mean serum prolactin levels are reported to be higher in anoestrus buffaloes (Heranjal et al. 1979b) than the basal levels (Heranjal et al. 1979a) in normal cycling buffaloes.

Luteinizing hormone plays an important role in contributing ovarian inactivity in buffaloes during summer months (Razdan et al. 1981) and secretion was lower during summer compared to winter (HeranjalAboul-Ela and Barkawi, 1988). Further, the optimal LH surge was also reported to be absent in anoestrus buffaloes in summer and the decreased in LH level is attributed to the inhibitory action of progesterone and PRL (Singh and Chaudhry, 1992). Buffalo heifers show seasonal changes in the level of circulating FSH which coincide with the pattern of breeding (Janakiraman et al. 1980) and the lowest value was observed during hot months. It was reported that the ratio of FSH to LH is lower in hot summer months compared with peak breeding season (Janakiraman et al. 1980). Anoestrus associated with low thyroid function is common in buffaloes during summer season (Gupta and Dhoble, 1988) and had been postulated that high ambient temperature leads to hypothyroidism, which results in the reduced responsiveness of ovary to pituitary gonadotropins causing summer infertility in buffaloes (Roy et al. 1968). A seasonal pattern of thyroid function was documented in Indian buffaloes with a low thyroid secretion rate and plasma T4 level during hot dry compared to cold season (Khurana and Madan, 1985). The low reproductive efficiency of buffaloes in summer has been attributed to low luteal activity (Madan, 1984) and the mean progesterone level remains lower in low breeding season compared to normal breeding season (Qureshivet al. 2000). The peak P4 concentration was found to bevmuch lower during the summer months than the winter (Harjit and Arora, 1982). Oestradiol concentration is ureported to be low in anoestrus rural buffaloes during summer (Jain, 1988) and under organized herd, anoestrus buffaloes did not show any distinct pattern (Kaur et al. 1983) but Sarvaiya et al. (1993) observed two distinct patterns of oestradiol secretion in anoestrus buffaloes both under organized as well as village condition. The peripheral inhibin levels show a distinct climatic variation in buffaloes, being lower during summer compared to winter, which is attributed to environmental stress (Palta et al. 1997).

A high level of serum corticoids was reported in anoestrus buffaloes exposed to thermal stress during summer (Singhal et al. 1984) and higher level of serum corticoids leads to an altered gonadotropin secretion, which ultimately triggers the state of anoestrus (Singhal et al. 1984).

Management strategy

Various strategies like environmental modification, nutritional, breeding, suckling management technologies and hormonal therapy can be used to improve the reproductive efficiency in buffaloes (Gupta and Das 1999).

Managemental practices

Summer breeding of buffaloes can be successfully carried out by changing farm management practices (Roy et al. 1968) to improve the efficiency of rural buffaloes reared under field conditions (Pant et al. 2002). Protection from direct solar radiation is the principle of real management in the species during hot summer months which includes protection against stress and improving nutritional status of the animals (Sastry and Tripathi 1988).

Reducing heat stress:

It was found that provision of shade, loose housing system and application of water to the body surface by sprinkling or washing or providing wallowing facilities s can reduce the heat stress considerably (Di Palo et al. 2009) in summer. Proper extensive housing system help in reducing the adverse effects on buffalo fertility (Neglia et al. 2009). A higher conception rate was obtained in animals given showers in addition to wallowing facilities (Di Palo et al. 2009) It was also found that showering, splashing, sluicing or spraying of water on the body, appropriate housing and a shift from day to night grazing practices are also improve the reproductive and productive efficiency of the animals (Razdan 1988).

Improving estrus detection methods:

One of the factors that increase the calving-conception interval of buffalo during the hot season of the year is poor detection of estrus. The routine heat detection measures used traditionally in buffalo are inadequate to detect oestrus during summer season (Jainudeen and Hafez 2000) and the system of heat detection during cooler part of the day or night hours using an entire male may improve the efficiency of detection (Acharya 1988). It was reported that estrus behaviour in buffalo has a lower intensity than in cows so it is much more difficult to detect. Acceptance of the male frequent urination, bellowing, valver swelling, Restlessness, bellowing, valver lips appear moist, red, swollen, turgid and stands prominently, wrinkles on the vulva disappear, clear, shiny, stringy odorless mucous discharge sometimes extending from vulva to feet etc. are considered as estrus indicator in buffalo.The presence of a bull in the vicinity of the females will stimulate estrus behavior in buffalo and it is very helpful in silent heat in buffalo. It was found that parading of teaser buffalo bullocks in the shed at least twice during cooler part of the day is the very common practice of heat detection in buffaloes. Teaser buffalo bullocks or vasectomized buffalo bulls or an androgenized animals are fitted with a chin ball marker. They will mark the backs of those buffaloes which they have mounted and will help in detection of heat in buffalo. Painting of tail is a cheap and effective aid and this paint will be rubbed off or at least cracked when the painted cow is mounted by another which help in detection of estrus in buffaloes. KaMaR heat mount detector are glued to hair over the middle just in front of the tail head and pressure of mounting animal squeezes dye from the device due to which color of the area are changed. It will indicate mounting of the animals and will help in detection of estrus in buffaloes.Probable date of incoming heat can be calculated by analyzing the breeding/ reproduction records of the individual buffalo which help in detection estrus in buffaloes. Close circuit television can be used to monitor the buffaloes in sheds which can detect the sexually active buffaloes during estrous period. It was reported that rise in vaginal temperature (about 0.5-0.8^{0}C) is the main characteristic feature of heat in sexually active buffaloes during estrous period. Pedometers based on the grater movement and activity of animals in estrus. It was reported that as compared to normal buffalo, the overall movement as well as activity of estrus buffalo is increased up to 40%. The luteal and follicular function can be controlled by mechanical and hormonal means to synchronize oestrus and ovulation which is required to obtain acceptable pregnancy rates following either AI or embryo transfer in programmes that do not require oestrus detection. The efficacy of the prostaglandin treatment in buffaloes to regress a functional CL has been reported to be dependent upon plasma progesterone concentration, the CL size and the ovarian follicular (Brito et al. 2002). Unsatisfactory response was reported in prostaglandin administration in buffaloes due to short time CLs or insufficient progesterone production (Zicarelli et al. 1988b) but some improvement can be recorded when prostaglandin is followed by GnRH administration (Neglia et al. 2001). Recently, the combined use of GnRH and prostaglandin (Ovsynch) administered for the synchronization of ovulation in cattle (Pursley et al. 1995) was used on buffaloes. Milk progesterone level will be lowered during estrus period and if the decrease level persists for 2-3 days the animal may served. ELISA test or RIA test are the optional for progesterone assay and blood serum or milkt may be used as sample.

Hormonal treatments

Various hormonal treatment regimens are followed to alleviate anestrus to stimulate ovarian activity, estrus behavior in turn leading to ovulation. Different hormones were used either alone or in di erent combinations producing varied degrees of success. Hormonal treatment regimens are being used to either stimulate ovarian activity, induce or synchronize behavioural oestrus or control ovulation (Barile 2005; De Rensis and Lopez-Gatius2007). Progesterone based treatment regimes (PRID, CIDR, CRESTAR, Progesterone injections) either alone (Singh et al. 1983) or in combination with gonadotrophins (Neglia et al. 2003) proved to be very effective in inducing ovarian activity in summer anoestrus buffaloes. CIDR® (Controlled Internal Drug Releasing device). CIDR is a T-shaped device with flexible wings impregnated with1.38 g of progesterone in elastic silicone moulded over a nylon spine. The device is inserted into vagina using a special applicator. A string is attached for easy removal. When the device is inserted into the vagina, progesterone is slowly released over the treatment period. Under the influence of progesterone, normal pituitary gonadotrophin output is inhibited and the ovarian cycle is interrupted. The removal of the device results in the rapid decline of plasma progesterone and the onset of oestrus in animals responding to treatment. It is opined that the higher progesterone level in blood sensitizes the hypothalamus and pituitary to the gonadal feedback. An alternative approach suggested to do away with the acyclicity during summer season is fixed time artificial insemination using PGF2a or its analogues (Singh 2003). The oestrus induction rate achieved with this regimen was reported to be remarkably high albeit with a relatively poor response in terms of conception, attributed to the difference in the interval between PGF2a administration and the commencement of oestrus and ovulation (Baruselli 2001; Zicarelli 2003). Gonadotropin releasing hormone and its analogues were also tried in the resumption of oestrous cycle during summer without any desired success (De Rensis et al. 2005) because of their limited half-life and a wider variation in response contingent upon the follicular size and stage at the time of treatment (Ramoun et al. 2007). Furthermore, it was shown that pretreatment with insulin promotes follicular development, rendering the ovary responsive to its effect (Ramoun et al. 2007; Anand and Prakash 2008). But the exact mechanism by which insulin exerts its influence is not clear at present. Although in cattle, insulin has been reported to increase oestradiol production resulting in a feedback increment in LH release from the pituitary gland (Simpson et al. 1994).

Nutritional management

Feeding strategy for buffaloes during hot climate is imperative in reducing infertility problems. Roughage feeding during night to buffaloes will reduce the heat stress in buffaloes. Moreover feeding green fodders, ad- libitum water and mineral mixture supplementation improve the efficiency of reproduction during summer. Buffaloes if well fed can be detected for oestrus during night in summer for regular breeding (Harjit and Arora 1982). Grazing animals had to be supplemented with minerals particularly with those which are deficient in forages or fodders (Kumar et al. 2003) and the energy balance also had to be maintained in the ration. Feeding buffaloes on roughage during night will reduce the heat load on the animal (Acharya 1988). It was reported that feeding of green fodders or silage or hay, provision for night feeding, grazing only in the morning and late in the afternoon and mineral mixture supplementation can improve the efficiency of reproduction during summer (Sastry and Tripathi 1988). Moreover feeding green fodders, ad- libitum water and mineral mixture supplementation improve the efficiency of reproduction during summer. There are several key areas of nutritional management which should be considered during hot weather. These include formulation to account for reduced dry matter intake, greater nutrient requirements during hot weather, dietary heat increment, and avoiding nutrient excesses. It is important to predict dry matter intake, in order to formulate an adequate diet for buffaloes in a hot environment. The energy requirements of lactating buffaloes also increased under high temperature conditions, but this increase seemed to be caused mainly by the increase in metabolic energy. Low fiber, high fermentable carbohydrate diets lower dietary heat increment compared with higher fiber diets. Although the metabolic energy of dairy buffaloes increases in a hot environment, heat stress depresses feed intake.

Technologies

There are various biotechnologies which are used for enhancing buffalo reproduction. These include artificial insemination, multiple ovulation embryo transfer, in vitro maturation, in vitro fertilization, cryopreservation of oocytes and embryos, production of calves of predetermined sex, cloning, somatic cell cloning, stem cells and their applications, genetic analysis and gene transfer. Application of these biotechnologies has helped in boosting milk production, meat production, improving reproduction, faster growth, controlling diseases and increasing genetic improvement.

a.In vivo and in vitro embryo production

The attention has been focused on the improvement of superovulation protocols and embryo recovery after production of the first buffalo calf by the transfer of in vivo produced embryos (Drost et al. 1983). Ovum pick up (OPU) is known to be a very flexible technique which can be adapted to various physiological conditions, from prepuberal (Techakumphu et al. 2004) to adult (Gupta et al. 2006) cattle and river as well as swamp buffaloes, with and without hormonal stimulation and under different schedules of oocyte collection. Despite continued efforts at improving in vitro conditions for embryo production, reports on pregnancy and calving rates following the transfer of fresh or cryopreserved buffalo embryos are still scarce. The first report of pregnancies following the transfer of fresh in vitro produced buffalo embryos was made by Madan et al. (1994). More recently, similar pregnancy rates following transfer of fresh riverine embryos into F1 river X swamp recipients were reported (Zhang et al. 2007).

b.Cryopreservation

Cryopreservation is an important tool for the management of supernumerary embryos or embryos destined to be transferred under more appropriate conditions and is relevant to the buffalo species. It was reported that synchronization of recipients may not reach the efficient in buffalo so lower number could be available for transfer of fresh embryos. Conventional freezing (Galli et al. 1998) and vitrification (Gasparrini et al. 2001) protocols have been adopted for the cryopreservation of buffalo embryos, whose efficiency can be valued by the rate of restored viability following thawing or re-warming. Pregnancies from conventional freezing (Zhang et al. 2007) and from vitrification (Neglia et al. 2003c) as well as calving from conventional freezing (Galli et al. 1998) and vitrification (Hufana-Duran et al. 2004) have been obtained.

c.Cloning

The first successful cloning by somatic cell nuclear transfer by Wilmut et al. (1997) has paved the way for the commercial application of cloning, and to increased research for the production of cloned embryos and offspring, derived from specialized somatic cells (Forsberg 2005). The same scientific and commercial strategy behind the full exploitation of cloning by somatic cell nuclear transfer in livestock, lies ahead for the buffalo species. Reports on oocyte activation, enucleation and cell fusion were made available recently in buffalo (Simon et al. 2006). Saikhun et al. (2003) demonstrated the viability of reconstructed buffalo embryos by somatic cell nuclear transfer, by reporting the reprogramming of the telomerase activity which was shown to be at negligible levels prior to reconstruction. Pregnancies were obtained following the transfer of cloned embryos derived from buffalo fetal fibroblast, although such pregnancies were not carried beyond day 90 (Saikhun et al. 2004). Fetal development following somatic cell nuclear transfer in buffaloes is limited.

CONCLUSIONS

Buffaloes are seasonal breeder and their reproductive function is affected by environmental factors and there is a decrease in the fertility of postpartum buffaloes inseminated in the summer compared winter. Summer anoestrus is one among the major obstacles hindering the reproductive efficiency in buffalo and causing huge economic losses to the buffalo breeders as well as dairy industry. Various environmental, nutritional and managemental factors are responsible for triggering this condition in buffalo.The plasma levels of LH and estradiol are decreased in heat stressed buffalo and this is one of the factors contributing to low fertility during the hot months of the year. Heat stress may affect the secretion of the gonadotrophins through mechanisms that modify the synthesis or the secretion of GnRH, the responsiveness of the gonadotrophs to the actions of GnRH or the feedback actions of gonadal hormones. Difficulties in estrus detection can be ameliorated by the use of teaser animals, KaMaR and painting the tail-head. Further studies are needed to explore the inhibin status of anoestrus buffaloes during summer and its possible role in the endogenous endocrine milieu contributing to the condition.

A good and sound management is the best approach to tackle the summer infertility while other
interventions like hormonal treatments can be employed with varying success. Attempts should be made to identify effective hormonal regimes for good conception rate rather than better induction of oestrus in summer affected buffaloes.

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