Reproductive disorders and their management in cattle and buffalo: A review

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ABSTRACT

Fertility is one of the key determinants in the life time performance of any animal. Gynaecological problems affect adversely the reproductive efficiency. The reproductive problems may be congenital or acquired. Anestrus, repeat breeding, cystic ovarian degeneration, uterine and tubal disorders have been observed as the most common gynaecological problems in cattle and buffaloes. Incidence of cystic ovaries in our country increased with the introduction of crossbred animals, however, its incidence in buffaloes has been recorded low. Improper postpartum care and unhygienic husbandry practices favour uterine infections. Proper and timely diagnosis and judicious use of hormones, viz. progesterone, gonadotropins, GnRH, PGF₂α and non hormonal agents have been advocated for the management of various reproductive disorders in cattle and buffaloes. Possibility of immunological factors leading to infertility has also been explored. Introduction of immunomodulatory drugs concomitant to the present therapeutic approach has been found successful in the management of reproductive disorders. There is a need for a comprehensive approach by involving the modern reproductive technologies for the proper diagnosis and amelioration of various reproductive problems encountered in cattle and buffaloes.

Key words: Infertility, Sterility, Cattle, Buffalo, Management

Livestock sector is an integral component of Indian agriculture. India ranks first in milk production in global world with an annual production of 84.5 MT and growing steadily at a compound annual growth rate of 4–5%. India possesses 187.4 million cattle and 94.13 million buffaloes (Sethi 2003, Joshi et al. 2005). The success of dairy cattle and buffalo husbandry lies in ensuring proper and optimal reproductive rhythm of individual animal in the herd. To breed regularly, the animal has to have functional ovaries, display normal oestrus behaviour, ability to mate, conceive and sustain the embryonic development. Each of these aspects of reproductive function may be affected by the management, disease and genetic makeup of the animal. Impairment in the normal reproductive function results into infertility and sterility leading to economic losses due to widening of dry period, reduced calvings and lactations during the life span of the animal (Agarwal and Tomer 2003). The term sterility is an absolute inability to reproduce, however, infertility either is considered to be synonymous with sterility or more correctly may imply delayed or irregular production of annual live calf. In general, cattle and buffalo heifers should attain puberty at 14 and 24 months of age and deliver a calf by 30 and 40 months of age, respectively. Reproductive disorders interfere to achieve this goal. At any given point of time, animals experiencing reproductive problems should not exceed more than 10%. It is presumed that majority of cattle and buffaloes (18–40%) are culled and reach to slaughterhouse primarily due to infertility. A slaughterhouse study revealed the incidence of reproductive disorders in buffaloes is about 37.5% (Sharma et al. 1993). Although many advancements have been made in controlling reproductive diseases in cattle and buffaloes, serious losses are still going on and as such infertility remains a major economic problem and its incidence appears to be rising in India also. Exact information, however, on the impact of infertility in terms of economic losses in Indian livestock is not available (Gurucharan Singh et al. 2003, Singh et al. 2003, Das et al. 2004). The present review attempts to assess the present status and future prospects of reproductive disorders in cattle and buffalo with greater emphasis on diagnosis and advancement in therapeutic management of these reproductive disorders.

Congenital anatomical disorders

Congenital anatomical disorders are hereditary in origin, affect individual animal in the herd and render the animal sterile. These conditions are rare but if occurs, it is essential to identify affected animals at an earlier stage for their culling from the herd. The parents of affected animals need to be removed from breeding plan to prevent further spread of undesirable genes. Some of important congenital/anatomical
Reproductive disorders are discussed here.

Ovarian aplasia/ovarian agenesis: Absence of one or both ovaries (gonads) are referred as ovarian agenesis, arises due to inherited autosomal dominant gene. Sharma et al. (1980) reported the incidence of gonadal dysgenesis in heifers due to XY karyotype. Fincher (1946) observed the virtual absence of ovaries in three maternal half-sister heifers. The gonadless heifers appear normal until the age of breeding but fail to exhibit oestrus and normal udder development. Such animals are sterile and must be culled as no treatment is recommended.

Ovarian hypoplasia: A congenital abnormality affecting development of the ovaries, is caused by autosomal recessive gene with incomplete penetrance. There is a marked association of gonadal hypoplasia with white coat colour. The hypoplasia may be partial or total, unilateral or bilateral and such animals may be infertile or sterile depending upon the degree or extent of hypoplasia. The ovaries are very small and appear as thin cord-like structures on the cranial border of ovarian ligament and look like steer on palpation. Oocytes and follicles are greatly reduced or absent depending upon severity of condition. The incidence of ovarian hypoplasia in Indian cattle and buffaloes has been reported lower (0.08-4.3%) than the exotic and crossbred cattle (10-23%) (Lagerlof and Boyd 1953, Nair and Raja 1974a, Rao and Sreemannarayana Rao 1982, Kumar and Agarwal 1986). In buffalo heifers especially, small size of normal ovary may erroneously be diagnosed as hypoplastic ovaries. Affected cattle and buffalo heifers do not come into oestrus and remain anestrous. The secondary sexual characteristics are absent due to lack of estrogens. The genital tract remains very small and infantile. Treatment in such cases are not successful and as such affected animals are required to be culled from the herd.

Freemartinism: The word freemartin is made up of free contraction of farrow used to denote an infertile female in Scotland and Martin derived from Gaelic word for cow mart. So freemartin (farrow mart) can be defined as an infertile female with a modified genital tract born cotwin or in greater multiples with a male with which it has exchanged the whole blood having a common placental circulation by fusion of choriallantoic blood vessels/sacs of adjacent heterozygous fetuses through vascular anastomosis (Jun and Sohn 2001). The condition is characterized by atrophy or some degree of masculinization of ovaries (small, grain sized, rudimentary and difficult to palpate). The genital tract especially the portion arising from the paramesonephric duct is markedly arrested in development. The tubular genitalla is ill developed. Uterus is very small and thread like, sometime two tubular structures in the cervical region are palpated, it may be seminal vesicles. Cervix is small, thin and hard. The vagina is also under developed. Vulva may be fairly normal with a prominent clitoris and large tuft of vulval hair. Udder and teats remain small and animal gives look like a steer.

Heifers will be anestrus. Depending on the extent of exposure to androgens, the genital organs may be modified towards maleness or virilisation. In extreme cases, there are well developed epididymes, vasa deferentis and vesicular glands. In cattle about 90–92% twins of unlike sex, the female cotwins are sterile. The frequency of the condition is dependent on the prevalence of the heterosexual twinning. The condition may easily be diagnosed from the breeding history (female born cotwin with male) and clinico-gynaecological examination. The incidence of freemartinism in indigenous and crossbred cattle varies from 0.10 to 0.20% (Narasimha Rao and Suryanarayana Murthy 1980, Sharma et al. 2004). Several theories has been proposed to explain the condition. Lillie’s humor al or hormonal theory (1916) describes that testicular development of male fetus occurs much earlier than the ovaries of female fetus and some chemical substances may pass to female embryo through anastomosing blood vessels of two placentas. This chemical substances was thought to be androgens, inhibiting the development of female gonads and tubular part of genitalia. The vascular anastomosis occurs as early as 30 days of gestation. Ohno and Gropp (1965) proposed that through anastomosis of placental blood vessels primordial germ cells pass from male to female fetus in early prenatal life. This idea of transfer of germ cells came from erythrocyte chimera. Since all cattle freemartins are erythrocyte chimera, there has been an exchange of blood cells between male and female fetus during prenat al life. Blood group analysis and skin graft tolerance are very useful for diagnosis of freemartinism. Both twins have same blood group and tolerance to skin graft due to exchange of fetal blood during prenat al life. Cyogenetic studies proved that freemartins are genetically female. The most accurate method of diagnosis is the demonstration of sex chromosome chimerism in cultured lymphocytes.

Hermaphroditism: Hermaphroditism or intersexuality is one of the major hereditary defects where the diagnosis of sex (intersexes) is confused because of congenital anatomical variations. It is occasionally seen in cattle and buffaloes, however, the condition is most common in goats and pigs. True hermaphrodite is a bisexual manifestation in which testes and ovaries or ovo-testes are present, while pseudohermaphrodite have gonads of only one sex. Pseudohermaphrodite, phenotypically resemble male but having ovaries. True hermaphrodite condition is extremely rare in cattle and buffaloes. Hybrids are the outcrosses and such individual are more or less sterile.

Segmental aplasia of paramesonephric ducts: It is an inherited, congenital defect arises due to segmental aplasia of the mullerian duct (paramesonephric duct) leading to a wide range of anomalies of vagina, cervix and uterus. The incidence of such condition is higher in exotic than Indian cattle and buffaloes. The condition received its name ‘white heifer disease’ due to relatively higher frequency in white short horn heifers. The aplasia may occur in any breed and
anywhere along the duct system, however, cervical area is the most affected. The remainder part of the uterine horn often gets filled up with secretions. Uterine tubes have been identified as a frequent site of congenital defects. More commonly partial or segmental aplasia of the paramesonephric duct occurs. Developmental defects of mullerian ducts lead to various abnormalities of vagina, cervix and the uterus. The ovaries develop cyclic behaviour with normal secretory activity and level of steroids. Sometimes only one uterine horn has a lumen, the other appearing as a narrow, flat band, the condition is referred as uterine unicornis. Animal may conceive provided ovulation occurs from nonaffected side of uterine horn. A more serious type of aplasia occurs when isolated sections of uterine horn are present. Uterine secretions accumulates and causes sac like dilatation of such isolated portions of the tract. Animals with this condition are sterile.

Congenital abnormalities of the cervix include duplication of the lumen of the cervix, each uterine horn connects with the vagina, by a separate cervical canal. Affected animals conceive in normal fashion but show dystocia. In heifers single cervix may open into a double os uteri externum with a dorsoventral postcervical band. In case of uterine didelphys, a double cervix is present, the uterine body is divided and division extends up to the cranial parts of the vagina. This condition, represents a complete failure of fusion of the two paramesonephric ducts. Such animals may conceive provided they have been inseminated in the horn ipsilateral to ovulation. The most common developmental aberration of the female tubular organs/mullerian duct system involves a variable degree of persistence of hymen, appearing as a vaginal constriction in front of the urethral opening, a partition with a central aperture or complete partition between vulva and vagina. In case of complete hymenal obstruction, there is an accumulation of secretions in front of the obstruction causing a fluctuating swelling of variable size and can be palpated per rectally. Animal may develop fever and straining if secretions are infected with pyogenic organisms. This problem may occur in all breeds of cattle but common in white shorthorn heifers due to a sex-linked recessive gene with linkage to the gene for white coat color. Thus, the syndrome of straining and illness after service is known as white heifer disease. Kodagali (1968) recorded imperforate hymen in buffalo heifers and about 0.35% cases of imperforate hymen resulting into mucus formation has been observed in Nangpuri buffaloes (Kaikini, 1978). The prognosis has been reported grave and animal is unfit for breeding.

**Functional disorders**

Anestrus, subestrus, cystic ovarian degeneration and persistent corpus luteum are the major functional disorders in cattle and buffaloes. **Anestrus**: Anestrus, principal symptoms of many conditions affecting oestrous cycle, is one of the most commonly occurring reproductive disorders in cattle and buffaloes. It is defined as absence of periodic manifestation of estrus, with absence of palpable follicular or luteal structures (smooth and inactive/quiescent ovaries called as true anestrus), or absence of normal physiological signs of estrus associated with a corpus luteum (subestrus, physiological anestrus). Apparently anestrus due to persistent CL is mostly associated with uterine pathology (pyometra, fetal resorption, maceration and mummification). Certain cases of retained corpus luteum may be associated with early embryonic death. Anestrus associated with the presence of corpus luteum may be due to positive effect of progesterone secreted by the corpus luteum which exerts inhibitory effect on hypothalamo-hypophyseal axis for the secretions of gonadotrophins. Anestrus is also observed during pregnancy (physiological anestrus), high lactation (lactational anestrus) and for a shorter period following parturition (post partum anestrus). In heifers, it poses a herd problem (pubertal anestrus) possibly due to low plane of nutrition, stress of seasonal transition or extremes of climatic conditions. Incidence of anestrus has been reported higher in buffaloes and indigenous cattle than the exotic or crossbred cattle (25–67% vs 2–20%) (Stevenson and Call 1988, Narladkär et al. 1994, Gurcharan Singh et al. 2003, Pandit et al. 2004).

It is generally accepted that the occurrence of prolonged period of ovarian quiescence and anovulation are mainly due to lowered plasma LH level. Factors that suppress LH pulse frequency are viz., negative energy balance, malnutrition, environmental stress, endogenous opioid peptide, lactational stress, suckling and lower insulin concentration (Parkinson 2001). Anestrus may result due to hypoplasia of ovaries, infantile genitalia, and poor body growth in heifers. The lesser number of primordial follicles, higher rate of follicular atresia and lower level of circulating gonadotrophins in buffaloes have been associated with higher ovarian inactivity (Razdan et al. 1981). High ambient temperature, relative humidity, photoperiod and poor feed supply have been identified as causes of anestrus during summer in buffaloes (Rao and Rao 1968, Agarwal and Tomer 2003). Post service anestrus is very high in buffaloes during summer. Buffaloes show marked seasonality in their reproductive behaviour. Several physiological and environmental stresses singly or in combination affect ovarian function post parturition and most often seen in high yielding dairy cows and buffaloes. High milk production (lactational anestrus), suckling, loss of body weight up to 90 days post calving due to negative energy balance and heat stress along with other environmental stresses, nutritional deficiencies and uterine infections are some of the factors that delay resumption of post partum ovarian activity. Following calving anterior pituitary becomes refractory to gonadotrophin releasing hormone (GnRH). This is due to negative feedback of progesterone operating during pregnancy. Suckling stimulates prolactin secretion which
may reduce ovarian sensitivity to normal levels of gonadotropin. Higher level of prolactin in high yielding animals suppresses GnRH secretion and ultimately reduces production of gonadotropins. The incidence of true anestrus in cattle and buffaloes varies widely depending upon the level of feeding and management. In all India survey, Bhattacharya et al. (1954) reported on over all incidence of anoestrus 7.72% in cattle, however, higher incidence has been reported in buffaloes (26–30%) by several other workers (Kodagali 1968, Pandey et al. 1981, Naidu and Rao, 1982, Purby and Agarwal 1982, Kalkini 1984).

Higher energy intake may reduce the age of puberty and sexual maturity and post partum anoestrus period (Mokashi et al. 1974). A lower level of body weight, total serum protein, blood haemoglobin, blood glucose, blood insulin, inorganic phosphorus, calcium, magnesium, iodine, cobalt, copper, iron, cholesterol, Ca: P ratio, vitamin A has been reported in anestrous cattle and buffaloes as compared to those exhibiting estrus (Patil and Deshpande 1979, Naidu and Rao 1982, Agarwal et al. 1985 Singh and Vadnere 1987, Butler and Smith 1989). Nutritional supplements induces estrus in anestrous cattle and buffaloes (Dabas et al. 1987). Parasitic infection like fascioliasis, theleriosis and schistosomiasis in crossbred and indigenous cows can also cause true anestrus. Blood serum levels of LH, FSH and progesterone have been reported low in anestrus cattle and buffaloes (Singh et al. 1982, Pargankar et al. 1986, Chede et al. 1992).

Anestrus may be diagnosed by per-rectal palpation of reproductive organs. Ovaries of such animals are smooth, small and inactive with the absence of corpus luteum (Agarwal et al. 2004). Follicles usually develop upto prematuration stage and get atretic. Uterus is invariably flaccid. Presence of basal level (0.5–2 ng/ml) of progesterone in the blood samples at an interval of 8–20 days further confirms the diagnosis. True anestrus animals may be treated according to cause, however, there is no single panacea to correct it. If anestrus is due to nutritional deficiency, such animals should be supplemented with high energy ration, concentrates, minerals and trace elements including vit. A. Simple ovarian massage (Acharya 1960) and Lugol’s iodine painting on posterior part of the cervix has been reported to be effective. Various therapeutic agents including hormonal and non-hormonal (herbal) compounds have been used extensively by several workers with varying degree of success in cattle and buffaloes for the restoration of cyclicity in anestrus animals (Glotra et al. 1970, Pant and Sharma 1979, Deshpande 1983, Pattabiraman et al. 1986, Deshpande et al. 2000, Agarwal et al. 2001, Santosh Kumari et al. 2005).

Receptal pretreated with tonophosphan has shown promising results in the management of anestrus in crossbred cattle (Shams et al. 1991). Estrogen therapy now-a-days is not used frequently as it induces anovulatory heat, however, progesterone alone or in combination with estradiol benzoate has been found superior in restoration of cyclicity but with poor conception rate (Pant and Sharma 1979, Agarwal et al. 1985b). Progesterone pessary, PRID (Progesterone releasing intravaginal devices), CIDR (Controlled internal drug release) and norgestomet ear implant, alternate devices for progesterone supplement to avoid daily injection or feeding of progesterone, are effective in the induction of cyclicity in cattle and buffaloes (Sirosis and Fortune 1990, Agarwal et al. 2001). Norgestomet alone or in combination with PMSG, PGF2α, and GnRH have been found superior to induce estrus in anestrus cattle and buffaloes with encouraging results (Luthra et al. 1994, Shanker et al. 1999, Agarwal et al. 2001). The beneficial effect of GnRH for induction of estrus in anestrus cattle and buffaloes with a reasonable degree of fertility have been reported by several workers (Pattabiraman et al. 1986, Nautiyal et al. 1997). Recently, ovysynch programme (GnRH-PG-GnRH) with timed breeding and role of insulin has also been explored for the management of anestrus with encouraging results (Singh et al. 2002, Shukla et al. 2003). Provision of sheds, shade, shower, and wallowing to the buffaloes during summer improves their fertility. Treatment of anestrus is of questionable value if it is due to malnutrition, chronic wasting diseases and senility. The success is also low during non-breeding season.

Subestrus, silent estrus or quiet ovulation: A condition, popularly known as silent heat, in which the genital organs are undergoing the normal cyclical changes and ovulation do occur as confirmed by progesterone profile and rectal examination but overt or behavioural signs of estrus are either not manifested or too weak to be observed. Such cases are frequently reported in buffaloes especially under field conditions. Failure to exhibit the symptoms of estrus may be due to the insufficient secretion of estradiol by the maturing follicles or due to a need for a greater threshold of higher brain centres for manifestation of typical symptoms of estrus. Nutritional deficiencies, over weight, foot lesions may also cause subestrus. Hereditary predisposition of this condition may also can’t be ruled out. Incidence of silent estrus has been reported higher (6–30%) in buffaloes though it is also common in cattle (Agarwal 1978, Pant and Singh 1991). Silent estrus is common during the post pubertal period in heifers and early post-partum in cows, however, in buffaloes seasonality plays an important role. The diagnosis of the condition is based on clinical per rectal examination revealing presence of corpus luteum. Natural or synthetic analogue of PGF2α as a single dose has been used with a reasonable degree of success for management of silent estrus in cattle and buffaloes (Chatterjee et al. 1989, Pant and Singh 1991, Nautiyal et al. 1998, Singh et al. 2001). It should be born in mind that PGF2α is only effective between day 6–26 of the cycle i.e. in the presence of active corpus luteum. The incidence of such condition can be reduced by proper education of farmers about estrus signs, proper record keeping, frequent estrus detection, rectal palpation and use of teaser bulls. The use of various estrus detection aids such
as tail painting, heat mount detectors or pedometers may prove beneficial.

Ovarian cysts/cystic ovarian degeneration/cystic ovaries: Cystic ovarian degeneration (COD) is one of the common affections of ovary of endocrine origin particularly in high yielding dairy cattle. Its incidence in indigenous cattle and buffalo has been recorded low. Genetic predisposition of COD has been reported. The condition has more commonly been observed during second to fifth lactations. Affected animals have one or more persisting fluid filled cavity (cyst) of 2.0 to 2.5cm in diameter combined with cyclic irregularity charactarized by anestrus or nymphomania (Kesler and Garverick 1982, Hooijer et al. 1999). Pathologically, ovarian cyst arises as a result of anovulation of the follicles are divided into two types i.e. follicular cyst (cystic degeneration of the graafian follicle), and luteal cyst (Luteinized cysts). Follicular cysts are anovulatory in nature and may be single or multiple on one or both ovaries tend to be thin walled and have no evidence of luteinization of granulosa cells by the presence of basal progesterone level and can be characterized by nymphomania (persistent estrus). Luteal cysts are also anovulatory in nature. They are thick walled structures with partial luteinization without occurrence of ovulation and appear usually as a single structure and are characterized by anestrus. Abnormal estrus behaviour, varying from lack of estrus to nymphomania is associated with COD. Chronic cases develop sterility hump and adrenal virilism. The cystic corpora lutea is ovulatory in nature and has not been considered pathogenic as it follows normal ovulation, capable for normal progesterone synthesis and do not affect the length of estrous cycle. Luteal cells of the cysts histologically resemble normal cells of functional corpus luteum (Brown et al. 1982). The development of ovarian cysts may be primarily due to deficiency of LH secretion and asynchrony of the hormonal events during the preovulatory period. Clinical investigation reveals lower incidence of COD (0.9–2%) in buffaloes and indigenous cattle than the pure bred and crossbred cattle (5–30%) (Rao and Sreemamaryayana 1982, Kumar and Agarwal 1986). The lower incidence in buffaloes and indigenous cattle may be due to lower stress of milk production. The typical nymphomanic signs and excessive sexual desire as observed in cattle are not usually seen in buffaloes. The real incidence is probably higher in cows since nearly 60% of the cows that develop cyst early after calving reestablish ovarian cycles, spontaneously (Kesler and Garverick, 1982). Blood or milk progesterone assay may be helpful for differentiation of follicular or luteal cysts. Most of the work has been done in cattle and as such information on incidence and therapeutics cystic ovary in buffalo is meagre.

Therapeutic management of ovarian cysts include manual rupture of cyst and use of hormones such as luteinizing hormone, progesterone, gonadotropin releasing hormone and PGF\_2\_\alpha based on type of cysts (Dobson et al. 1977, Kesler and Garverick 1982, Nanda et al. 1988, 1989). Manual rupture of cyst by applying digital pressure per rectum is one of the oldest method for the treatment of ovarian cyst with a recovery rate of 37–45%, however, method is crude, unsafe, remains tendency of reoccurrence. It is injurious to the ovary and may lead haemorrhage and adhesions. Cyst may also be drained with the help of a long needle inserted via ischiorectal fossa. Use of products rich in LH activity has been found most promising treatment of ovarian follicular cyst. It has been found that 1500–3000 IU hCG establishes estrous cycle in majority of cases within 30 days of treatment. Being a glycoprotein hormone of higher molecular weight than GnRH and product from heterologous species, it may lead to antigenic refractoriness on its repeated use. There remains also every possibility of reoccurrence of the cyst. Administration of GnRH causes release of endogenous LH in animals. This property of GnRH led its use as a therapeutic agent in cystic ovarian disorders. Most of the studies showed that recovery and conception rate after GnRH were better than the hCG/LH and manual rupture of cyst. The molecular weight of GnRH (1183 daltons) is low and do not produce any antigenicity which allows its repeated use without loss of potency and danger of anaphylaxis. It has been suggested that the use of PGF\_2\_\alpha given 9–24 days after GnRH may shorten the interval from treatment to first estrus to about 12 days, yielding shorter intervals to conception than the GnRH alone (Jfaiz et al. 1987, Agarwal and Shankar 1998). Heranjal et al. (1979) used successfully synthetic GnRH for management of COD in buffaloes with good fertility. Alternatively, follicular cysts can be treated with progesterone (Nanda et al. 1988). PGF\_2\_\alpha has successfully been used in case of luteal cyst. Prophylactic use of GnRH has shown some success in reducing the prevalence of cyst in the herd. It has been recommended that all cows should be treated with 100–200 µg of GnRH 12–24 days postpartum (Kesler and Garverick 1982).

Periophoritis and oophoritis: Periophoritis is most common pathological condition of ovary in cattle, however, oophoritis (inflammation of ovary) seems to be rare. Incidence of such condition varies from 0.3 to 8.3 percent (Bhattacharya et al. 1954, Kaikini, 1978). Severe bilateral inflammation of ovary may lead to sterility. In unilateral cases, prognosis is guarded. Situation get complicated if mesosalpinx or salpinx is involved. Trauma, rough handling of ovaries during palpation, forced attempt to enucleation of corpus luteum, infections like tuberculosis, brucellosis and manual rupture of cystic ovaries are the most common causes of oophoritis. Suppurative oophoritis may follow severe metritis and perimetritis. Periophoritis is usually chronic and often localized. It is seen as red fibrous and serosal tags attached to the surface of the ovary especially in heifers. Granulomatous periophoritis may occur following tuberculosis and searoria. The affected animals show regular cyclicity but do not conceive.
**Ovarian tumors:** The neoplasms of ovary are rare and hardly account for the failure of estrus. The most common form of tumor in the cow is the granulosa cell tumor leading to anestrus or occasionally nymphomania and show hereditary tendency (Lagerlof and Boyd 1953). Some of the ovarian tumors produce estrogen and androgen and cause nymphomania or anestrus accordingly. These tumors are usually heavy and large in size and located in abdominal cavity. Such animals should not be bred and to be culled. In buffaloes, granulosa cell tumor (0.24%), dysgerminoma (1.9%) ovarian teratoma/dermoid cyst (1.9%) have been recorded (Bhattacharya et al. 1954, Potokar et al. 1982). Other tumors in the bovine ovary include carcinomas, fibromas, thecomas and sarcomas.

**Parovarian cysts:** Parovarian cysts are remnants of the mesonephric duct/wolffian duct, less important in the context of infertility, are occasionally observed around the ovary and oviducts. These cysts may be 1–5 cm in diameter and usually round or oval in shape and often mistaken for cystic ovary or rectal palpation. The incidence of parovarian cyst in cattle has been recorded less than 1% (Ramamohana Rao et al. 1965, Nair and Raja 1974), however, occurrence has been more in buffaloes (Bhattacharya et al. 1954, Kaikini 1974).

**Ovaro-bursal adhesion:** This is a condition where adhesions develop between ovari and ovarian bursa i.e. between mesosalpinx and mesovarium and often such adhesions develop between fimbriae and ovary. Sometime bursa may encapsulate the ovary. The condition has been uncommon in heifers, arises as a result of mis-handling of ovary particularly during manual enucleation of corpus luteum, rupture of an ovarian cyst or due to infections. Abattoir survey revealed higher incidence of ovario-bursal adhesion in buffaloes (10.9% vs 1.8%) than cattle (Dobson and Kamonpataa 1986), however, incidence in clinical surveys in buffaloes ranges from 0.8–2% (Naraisma Rao 1982, Rao and Srimanarayana Rao 1982). The condition affects fertility mainly by interference in tubal motility and leads to repeat breeding.

**Oviductal disorders**

Oviductal disorders occur more frequently and thus constitute as an important cause of infertility in cattle and buffalo. Salpingitis, hydrosalpinx, pyosalpinx, adhesion of salpinx and aplasia of oviduct are the major oviductal disorders. Higher incidence of hydrosalpinx (3.1 vs. 1.0%) have been reported in buffaloes than the Indian and crossbred cattle (Kaikini 1974, Nair and Raja 1974b, Dobson and Kamonpataa 1986). The condition may occur secondary to segmental aplasia of the paramesonephric duct and other anomalies of the reproductive tract and also due to adhesions at the proximal or distal ends of the oviduct. Salpingitis (Inflammation of salpinx) is most common affection of oviduct and its incidence varied from 0.8–4.5% in buffaloes and 0.22–3% in cows (Naraisma Rao 1982). Cattle, and buffaloes suffering with salpingitis may be sterile, depending on the severity of the condition. The condition develops as a result of infection from the uterus following abortion, retained placenta, septic metritis and pyometra. Tuberculosis has also been reported as one of the causes of the fallopian tube lesions. Uterine irrigations with strong antiseptic solutions may escape into oviducts and cause inflammation. Descending infection from peritoneum also cannot be ruled out. The affected tube are enlarged, hard and cord like, and easily palpable per rectum. Cyst like distensions and adhesions may also be observed. A comparatively higher incidence ranging from 0.05 to 13.90% in buffaloes has been reported in abattoir studies (Bhattacharya et al. 1954, Kaikini 1974). Incidence of pyosalpinx has been reported less than 1% in cows and 0.6 to 1.2% in buffaloes (Ramamohan Rao et al. 1965, Sharma et al. 1967). Pyosalpinx usually occurs as a result of severe infection from the uterus and has been associated with adhesions of mesosalpinx and mesovarium. Aplasia of oviduct is very rare. Overall prognosis in affections of the oviduct has usually been unfavourable except in mild infections. Parenteral as well as intrauterine medications of antibiotics may be beneficial. Oviductal disorders can be reduced by gentle handling of the genitalia, proper treatment and control of uterine infections and sexual rest. Affection of oviduct usually remains undetected. A great expertise in rectal examination is required to diagnose the affections of oviduct. Disorders of oviduct affect adversely the process of fertilization by affecting gamete transport, survival of ova and embryo.

**Affections of the uterus**

Uterine infections have been reported as the major cause of infertility or sterility in cattle and buffalo. The condition includes congenital abnormality, endometritis, puerperal metritis, perimetritis and parametritis, pyometra, mucometra or hydrometra, uterine abscesses, retained fetal membranes (RFM) and tumors. Among all, endometritis, RFM and pyometra are the most common conditions encountered under field as well as farm conditions. These diseases share common etiological factors, predispose to one another and, to a large extent, share common treatments. In general, uterine infections can be controlled by hygienic management at calving, AI with disease free semen, careful and proper handling of peri-parturient disorders, early diagnosis and treatment of postpartum complications and sexual rest of 2–3 cycles to the affected animals. Congenital abnormalities in uterus are not very common in cattle and buffaloes. Uterine unicornis, uterine bicornis bocolis/uterine didelphys and caruncular aplasia have been observed in cattle and buffaloes (Ramamohana Rao et al. 1965, Raja Ram and Chandra 1979). Affected animals need to be culled as no treatment is recommended due to hereditary origin of the conditions.

**Endometritis:** Endometritis, inflammation of the endometrium, is the most frequent cause of infertility in cattle
and buffalo especially under field conditions. The most important cause of endometritis is non-specific opportunistic pathogens that contaminate the uterus during the periparturient period. The common pathogens isolated from the endometritis cases are coliforms (E. coli), C. pyogenes, Streptococcus pyogenes, Staphylococcus aureus, Pseudomonas, Bacillus species of bacteria, viruses, fungi and mycoplasma. A variety of the conditions may predispose the uterus to infection. It follows mainly abnormal parturitions, retention of placenta, abortion, dystocia, induction of parturition, genital prolapse, uterine inertia and traumatic lesions in the genital tract. Sometime infection may occur through general circulation. Endometritis may also occur after coitus or AI under unhygienic conditions. The incidence of endometritis has been 25 times higher in cows with RFM than the normal cows. Higher incidence of endometritis has been reported in buffaloes than cows (Dobson and Kamonpatana 1986). It may be due to habit of wallowing in muddy ponds, semi-solid nature of dung, not closely opposed vulval lips with protruding vulval hairs and unhygienic husbandry and improper postpartum care favoring uterine infections. The overall incidence of endometritis has been reported 2.5 to 32% in abattoir studies as well as clinical surveys (Rao et al. 1993, Murgeppa and Dubey 1997, Kulkarni et al. 2002). Endometritis can be diagnosed on the basis of history, clinical symptoms in the form of uterine changes and nature of discharges and confirmed by bacteriological tests and histopathological examinations. Based on uterine changes and nature of discharges, endometritis can be categorized into first, second and third degree. In severe cases there is dribbling of mucopurulent discharge from vulva and vagina, however, in mild cases pus flakes or turbidity may be present in discharges at the time of estrus. The discharge may be white or whitish-yellow mucopurulent (known as leucorrhoea or whites) in post partum animals. The volume may be variable and animals rarely shows any signs of systemic illness. Cyclicity usually may be unaffected. Subclinical endometritis may play major role in the repeat breeder syndrome. The condition may be diagnosed using white side test (Agarwal et al. 2004). Delayed uterine involution, prolonged post partum anestrus and delayed conception are the common sequelae to endometritis. The prognosis is fair to good. The etiology of uterine infections is complex, therefore, microorganism culture followed by drug sensitivity, presence of clinical symptoms and clinico-gynaecological examination should be taken into consideration before attempting any case. A wide range of antiseptics, antimicrobial agents and hormones have been used for the management of endometritis. Estrogen alone or in combination with oxytocin have been used for the treatment of endometritis but not common due to every possibility of the development of ovarian cysts. PGF<sub>2α</sub> has been most successful treatment, provided a CL is present. It brings the animals into estrus which helps in the evacuation of pus from the uterus. Parenteral and intrauterine antibiotic therapy proved beneficial along with PGF<sub>2α</sub> (Chauhan and Takkar 1983, Parkinson 2001). In recent years, use of certain immunomodulatory drugs like E. coli LPS, levamisole, oyster glycogen, leukotriene B, autologous plasma, GM-CSF, immodulen and PMN extract improves the uterine defense mechanisms (UDM) have been explored with encouraging results (Dhaliwal et al. 2001, Yadav and Agarwal 2002).

Pyometra: Pyometra is characterized by progressive accumulation of pus and mucopurulent material in the uterus. It may be associated with persistent corpus luteum. The condition may arise due to death of fetus and subsequent invasion of the uterus by pyogenic organisms, retention of CL of pregnancy, sequelae to chronic endometritis, venereal infection like Trichomonas fetus causing embryonic death and pyometra. There is no systemic illness. Incidence of pyometra has been reported 0.25 to 9.25% in cattle and buffaloes (Bhattacharya et al. 1954, Kaikini 1974, Agarwal 1978). The condition can be diagnosed readily by the flaccid, atonic and symmetrically enlarged uterine horns with or without crepitations and also using transrectal ultrasonography (Agarwal et al. 2004). There will be absence of fetus and the presence of ‘speckled echotexture’ of uterine contents in comparison to black anechoic appearance of normal fetal fluids. The uterine wall is thicker, more doughy and less vibrant feeling, no slipping of allantochorion and palpation of caruncles. PGF<sub>2α</sub> or its analogues has been found beneficial for the treatment of pyometra. It results in regression of corpus luteum, dilatation of cervix and expulsion/evacuation of the purulent fluid/pus with estrus occurring 3–5 days later. In majority of the animals with postpartum pyometra, the one or two treatments of PGF<sub>2α</sub> given 7–20 days apart evaluates the uterus, however, concomitant use of antibiotics may also proved beneficial (Chauhan and Takkar 1983). Animals may get eventually conceived, however, in long standing cases severe degeneration of endometrium may occur reducing the chances of conception.

Mucometra or hydrometra: It is occasionally seen in cattle and buffaloes. The degree of hydration of mucus present in the uterus vary from a watery fluid to thick viscid mucus lead to hydrometra or mucometra. There may be cystic degeneration of the endometrium and atrophy of the uterine wall with varying amounts (30 ml to 5 litres) of viscid mucus. Mucometra is observed in heifers having arrested development of Mullerian duct system. Cervix or vagina which may be defective or missing or also due to persistent hymen. The condition can be diagnosed based on the absence of any signs of pregnancy. The incidence is normally below 1%, however, higher incidence up to 7% has also been reported by some workers in cattle as well as buffaloes (Bhattacharya et al. 1954, Ramamohana Rao et al. 1965, Kaikini 1974, Kumar and Singh 1985). The condition is generally incurable and animals need to be culled.

Puerperal metritis: Puerperal metritis follows usually an
abnormal first or second stage of parturition and especially during severe dystocia. The disease is also associated with uterine inertia, twin births, RFM, prolonged traction and damage to the vulva and/or birth canal. Microorganism colonise the non-involved uterus, producing toxins which are absorbed and produce severe symptoms. The important microorganisms include *A. pyogenes*, group C streptococci, *haemolytic staphylococci*, *coli forms* and gram-negative anaerobes, particularly *Bacteroides* sp. In rare cases, *clostridia* are present which rapidly produce disease which is often serious and fatal. Affected animal shows both local and systemic symptoms followed by toxaemia, septicemia and pyaemia. It is common for the infection to extend through the uterine wall into the peritoneum leading to peritonitis. The uterus contains large volume of toxic, fetid, reddish, serous exudate containing pieces of degenerating fetal membranes and exudate is discharged from the vagina by frequent expulsive straining efforts. The cotyledons are swelled and fetal membranes often remain firmly attached. The treatment requires both good nursing care with vigorous medication. The disease is best treated by systemic administration of broad spectrum antibiotics and supportive therapy includes fluid therapy and non-steroidal anti-inflammatory drugs. The use of oestrogens is contraindicated in cases of acute puerperal metritis. Recovered cases are occasionally observed in cattle and buffaloes, however, among *retained fetal membranes* denote the failure of fetal villi to separate from the maternal crypts due to placental dehiscence, and the aetiological factors, viz. parturitions occurring much earlier or later than the expected date like abortion, stillbirth, dystocia, premature birth, twin births, seasonal factors, imbalance/deficiency of hormones (oestrogen, progesterone, prostaglandins, oxytocin etc.), deficiency of vitamins (A, D) and minerals (Ca, P, Se), uterine inertia, genital infections, chronic wasting diseases, placentitis, infectious diseases like brucellosis, vibriosis, moulds and failure of alloveractivity of fetal membranes by dam are considered as the predisposing factors for RFM (Bhalu et al. 1983, Roberts 1986). The symptoms of RFM are characteristic with hanging membranes or in some cases may retained inside. Systemic illness occur based on severity of infections and time lapsed after occurrence with foul smelling discharge which may be blood stained. Mild cases recover with prompt treatment. However, prognosis is guarded in severe cases which may lead to delayed involution, infertility and sterility due to pyometra, endometritis, perimetritis, salpingitis, ovaritis etc. RFM has been treated using various drugs and hormones. The usual practice is the manual removal of placenta and the best time for this is 24 hr post calving. The effective prophylactic measures besides manual removal include use of ecbolic agents (oxytocin, PGF_{2α}, estrogen, ergot derivatives), b-adrenergic antagonists, proteolytic enzyme-collagenase, calcium preparation, selenium supplementation alone or combination with vit. E and b-carotene, intrauterine and parenteral administration of antibiotics and immunomodulators have been found beneficial in case of retained placenta (Parkinson 2001).

**Perimetritis and parametritis:** These conditions develop secondary to pyometra and metritis. Perimetritis and parametritis are occasionally observed in cattle and buffaloes and are characterized by varying amounts of adhesions between uterus and broad ligaments and other pelvic and abdominal organs. These conditions involve inflammation of the serosa and uterine ligaments and are secondary to severe metritis, douching and perforation of the uterus, non-fatal rupture of rectum, improper evacuation of pus during pyometra and endometritis. Incidence varies from 1–7% in cattle and buffaloes (Bhattacharya et al. 1954, Ramamohana Rao et al. 1965). The prognosis is usually grave and affected animals are often sterile.

**Uterine tumors:** Uterine tumors are common in cows and buffaloes and most of them are benign in nature. Lymphosarcoma, leiomyoma, fibromyomas, adenocarcinoma etc. have been observed in cattle and buffalo and incidence has normally been below 1% (Kaikini 1974). These tumors mostly felt as rounded, firm, hard structures and may resemble to abscesses. It can be easily diagnosed with the use of ultrasonography.

**Retention of fetal membranes (RFM):** Retained fetal membranes also called as retention of placenta (ROP) is the major post parturient problems in cattle and buffaloes. The condition occurs when the normal process of dehiscence and expulsion fail to take place. Normally fetal membrane are expelled within 3–8 hr post calving owing to hormonal and mechanical factors during the third stage of labour, however, if animals fail to do so up to 12 hr, then they are considered as retained. Incidence in cattle and buffaloes varies from 1–20% (Pandey et al. 1981, Pandit et al. 1981, Agarwal et al. 1984). Retention of fetal membranes denotes the failure of fetal villi to separate from the maternal crypts due to placental dehiscence, and the aetiological factors, viz. parturitions occurring much earlier or later than the expected date like abortion, stillbirth, dystocia, premature birth, twin births, seasonal factors, imbalance/deficiency of hormones (oestrogen, progesterone, prostaglandins, oxytocin etc.), deficiency of vitamins (A, D) and minerals (Ca, P, Se), uterine inertia, genital infections, chronic wasting diseases, placentitis, infectious diseases like brucellosis, vibriosis, moulds and failure of alloveractivity of fetal membranes by dam are considered as the predisposing factors for RFM (Bhalu et al. 1983, Roberts 1986). The symptoms of RFM are characteristic with hanging membranes or in some cases may retained inside. Systemic illness occur based on severity of infections and time lapsed after occurrence with foul smelling discharge which may be blood stained. Mild cases recover with prompt treatment. However, prognosis is guarded in severe cases which may lead to delayed involution, infertility and sterility due to pyometra, endometritis, perimetritis, salpingitis, ovaritis etc. RFM has been treated using various drugs and hormones. The usual practice is the manual removal of placenta and the best time for this is 24 hr post calving. The effective prophylactic measures besides manual removal include use of ecbolic agents (oxytocin, PGF_{2α}, estrogen, ergot derivatives), b-adrenergic antagonists, proteolytic enzyme-collagenase, calcium preparation, selenium supplementation alone or combination with vit. E and b-carotene, intrauterine and parenteral administration of antibiotics and immunomodulators have been found beneficial in case of retained placenta (Parkinson 2001).

**Affections of cervix-vagina and vulva**

The disorders of cervix, vagina and vulva affect fertility to a lesser extent in cattle and buffaloes, however, among these cervix is most commonly infected. Atresia of cervix, imperforate cervix, double/triple cervix, cysts and tumors of cervix, kinked cervix and cervicitis are disorders of cervix encountered at varying level in cattle and buffaloes (Bhattacharya et al. 1954, Ramamohana Rao et al. 1965, Kodagali and Kerur 1968, Kaikini 1974, Nair and Raja, 1975). Cysts are occasionally observed in the cervix of cows and buffaloes. There are retention of cysts of the cervical glands, referred as Nabothis cysts or follicles and vary in size from 1.25 to 7.5 cm in diameter and rarely cause infertility. These are large enough and feels as movable or fluctuating mass in the cervix on per-rectal examination. Occasionally cystic dilatation of the cervix in the cattle may
be due to arrested development or fusion of the Mullerian ducts associated with white heifer disease.

Cervicitis, inflammation of the cervix, is most commonly observed in cows and buffaloes and is usually associated with endometritis or vaginitis or both. It is caused by same factors as in case of endometritis. Inflamed cervix is usually edematous, swollen with the mucosa appearing cherry red to dark purple in color and external folds often prolapsed. Chronic cervicitis may lead to fibrosis and permanent enlargement of cervix. Mucopurulent exudate may be seen oozing out from the cervix. It may also occur in wind sucking cows and buffaloes. Forceful introduction of inseminating pipettes or AI guns may cause puncture of the cervix or lacerations in the cervical canal. Normally incidence of cervicitis may vary from 0.5 to 10% or even more in the infertility cases of cattle and buffaloes (Bhattacharya et al., 1954, Nair and Raja 1975, Pandey et al., 1981, Purbeey and Agarwal 1982). Prognosis is usually fair, to good and recovery may take place depending upon the severity of the condition. As cervicitis coexists with endometritis and vaginitis, it is better to treat the entire genital tract as in the case of metritis or endometritis. Treatment with intrauterine and parental antibiotics, Lugol's iodine painting have given good results.

Congenital disorders includes imperforate hymen, double vagina, medium vertical bands, labial agenesis, acquired abnormalities like stenosis and occlusion of the vagina, recto-vaginal fistula, retention cysts in the vulva, tumors of vagina and vulva, inflammation of vagina (vaginitis) and vulva (vulvitis) and granular vulvo-vaginitis (GVV) are the conditions recorded in cattle and buffalo (Bhattacharya et al., 1954, Kaikini, 1974, Kumar and Singh, 1985). These affections may not necessarily impair the fertility. These conditions can be minimized by the use of AI with disease free semen, early attempt and correction of dystocia, prevention of injury to the genitalia during AI and local antiseptic/antibiotic treatment.

Repeat breeding

Repeat breeding animal has normal or nearly normal estrous cycle, estrus periods but fail to conceive with three or more than three inseminations from an apparently normal healthy bull or semen. The clinical examination of such animals do not reveal any definite conditions to explain the failure of conception. Incidence of repeat breeding has been reported 10–25% in cattle and buffaloes (Narladkar et al., 1994, Pandit 2004), however, under field conditions, even higher incidence has been recorded (Agarwal, 1978). The early embryonic death and fertilization failure has been considered as the major causative factors for repeat breeding. Reproductive disorders such as anovulation, delayed ovulation, tubal obstructions, ovaro-bursal adhesions, salpingitis, congenital or acquired defect of ovum or spermatozoa, congenital anatomical defects of genital tract and antisperm antibodies leads to failure of fertilization, however, early embryonic mortality is caused by endocrine dysfunctions, subclinical uterine infections, chromosomal aberrations, nutritional deficiencies, embryonic abnormalities, immunological factors, lactational and environmental stress. Mild to severe degree of genital infection may lead to embryonic mortality. Number of microorganisms have been isolated from repeat breeding cattle and buffaloes (Roberts, 1986). The estrous cycle length is not affected in majority of the cases where repeat breeding is due to failure of fertilization and early embryonic death (day 8–26). However, in case of embryonic death occurring at later stages, the estrous cycle length often gets prolonged.

Table 1. Incidence of the most common reproductive disorders encountered in indigenous and crossbred cattle and buffaloes under field conditions

<table>
<thead>
<tr>
<th>Reference</th>
<th>Species</th>
<th>Place</th>
<th>Anestrus (per cent)</th>
<th>Endometritis (per cent)</th>
<th>Repeat breeding (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selvaraju et al. (2005)</td>
<td>Cows</td>
<td>Tamil Nadu</td>
<td>5.01</td>
<td>7.10</td>
<td>5.59</td>
</tr>
<tr>
<td></td>
<td>Buffaloes</td>
<td>Tamil Nadu</td>
<td>9.09</td>
<td>6.33</td>
<td>4.03</td>
</tr>
<tr>
<td>Pandit (2004)</td>
<td>Cows</td>
<td>Madhya Pradesh</td>
<td>53.05</td>
<td>3.70</td>
<td>1.51</td>
</tr>
<tr>
<td></td>
<td>Buffaloes</td>
<td>Madhya Pradesh</td>
<td>60.83</td>
<td>4.08</td>
<td>0.61</td>
</tr>
<tr>
<td>Das et al. (2004)</td>
<td>Cows</td>
<td>Orissa</td>
<td>15.97</td>
<td>25.08</td>
<td>33.18</td>
</tr>
<tr>
<td></td>
<td>Buffaloes</td>
<td>Andhra Pradesh</td>
<td>30.76</td>
<td>18.73</td>
<td>29.80</td>
</tr>
<tr>
<td>Gurucharan Singh et al. (2003)</td>
<td>Buffaloes</td>
<td>Kerala</td>
<td>65.00</td>
<td></td>
<td>35.00</td>
</tr>
<tr>
<td>Kutty and Ramachandran (2003)</td>
<td>Cows</td>
<td>Maharashtra</td>
<td>45.97</td>
<td>0.74</td>
<td>25.05</td>
</tr>
<tr>
<td>Kulikarni et al. (2002)</td>
<td>Cows*</td>
<td>Andhra Pradesh</td>
<td>49.70</td>
<td>32.80</td>
<td>–</td>
</tr>
<tr>
<td>Rao et al. (1993)</td>
<td>Cows</td>
<td>Punjab</td>
<td>11.90</td>
<td></td>
<td>18.20%</td>
</tr>
<tr>
<td>Narinder Singh et al. (1986)</td>
<td>Cows</td>
<td>Andhra Pradesh</td>
<td>31.00</td>
<td>29.00</td>
<td>–</td>
</tr>
<tr>
<td>Hussain and Muniraju (1984)</td>
<td>Cows</td>
<td>Karnataka</td>
<td>51.00</td>
<td>9.00</td>
<td>–</td>
</tr>
<tr>
<td>Rao and Sreemananarayana (1982)</td>
<td>Buffaloes</td>
<td>Andhra Pradesh</td>
<td>56.36</td>
<td>20.68</td>
<td>–</td>
</tr>
<tr>
<td>Singh et al. (1981)</td>
<td>Cows</td>
<td>Bihar</td>
<td>39.00</td>
<td>9.61</td>
<td>22.69</td>
</tr>
</tbody>
</table>

*Under farm condition; -Incidence not recorded.
Table 2. Important causes of infectious infertility in cattle and buffaloes

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Transmission</th>
<th>Clinical findings</th>
<th>Seroprevalence/incidence</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brucellosis (Brucella abortus)</td>
<td>Ingestion</td>
<td>Abortion in last trimester, retained fetal membrane (RFM), metritis</td>
<td>4 to 10%</td>
<td>Munirathin &amp; Ramasamy (1999)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sandhu et al. (2001)</td>
</tr>
<tr>
<td>Vibriosis (Campylobacter fetus)</td>
<td>Venereal</td>
<td>Embryonic death, abortion (4 to 7 months), endometritis</td>
<td>Less than 0.5%</td>
<td>Nambodripad &amp; Raja (1972)</td>
</tr>
<tr>
<td>Listeriosis (Listeria monocytogenes)</td>
<td>Contaminated food</td>
<td>Abortion in last trimester, RFM, metritis, repeat breeder</td>
<td>3 to 25%</td>
<td>Dutta &amp; Malik (1978)</td>
</tr>
<tr>
<td>Leptospirosis (L. pomona, L. hardjo)</td>
<td>Cutaneous abrasions</td>
<td>Abortion in last trimester, RFM &amp; metritis</td>
<td>4 to 20%</td>
<td>Rambuddhe et al. (2002)</td>
</tr>
<tr>
<td>Trichomoniasis (Trichomonas fetus)</td>
<td>Venereal</td>
<td>Embryonic death, abortion in first trimester, pyometra</td>
<td>11 to 28% of aborted cases</td>
<td>Pareek et al. (1994)</td>
</tr>
<tr>
<td>Neosporosis (Neospora caninum)</td>
<td>Transplacental</td>
<td>Abortion at 3–8 months, still birth</td>
<td>—</td>
<td>Bahena et al. (1987)</td>
</tr>
<tr>
<td>Infecetous bovine rhinotracheitis (IBR)</td>
<td>Aerosol infection</td>
<td>Abortion (mid gestation to term), IPV, infertility</td>
<td>14 to 27%</td>
<td>Newell et al. (2000)</td>
</tr>
<tr>
<td>Bovine viral diarrhea (BVD)</td>
<td>Ingestion, transplacental</td>
<td>Embryonic death, abortion, congenital anomalies</td>
<td>43% of aborted cases</td>
<td>Dubey (1994)</td>
</tr>
<tr>
<td>Mycosis (Aspergillus fumigatus)</td>
<td>Inhalation, ingestion</td>
<td>Abortion (4–9 months)</td>
<td>5% of aborted cases</td>
<td>Rajesh et al. (2002)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sarumathi et al. (2002)</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Tripathi et al. (1998)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Mukherjee et al. (1989)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Pattanaik (2000)</td>
</tr>
</tbody>
</table>

Agarwal and Purdy (1983) recorded the incidence of normal, short, longer (multiples of normal cycles) and irregular longer cycles as 25.5, 3.7, 29.0 and 41.8%, respectively in buffaloes under field condition.

Intratrime antiseptics/antibiotic therapy has been found successful for the establishment of pregnancies in repeat breeding animals. In recent years, use of certain immunomodulatory drugs such as E. coli Lipo polysaccharides (LPS), levamisole, oyster glycogen, leucotriene-B, autologous plasma, PMN-extracts, GM-CSF (Granulocyte-macrophage-colony stimulating factor) and Immodulen (LPS + Propionibacterium granulosum) has been explored for the treatment of endometritis (Hussain and Daniel 1992, Dahiwal et al. 2001, Yadav and Agarwal 2002). These drugs stimulate phagocytosis in the uterus and thereby increases uterine defense. In case of anovulation and delayed ovulation, injection of hCG 1500–3000 IU or GnRH analogue @ 20 µg have been found effective to ensure ovulation (Haranjai et al. 1979). In luteal deficiency, daily injection of 100 mg of progesterone in oil for 2–3 weeks from day 4 will be effective for establishment of pregnancy. Administration of hCG or GnRH 11–23 days after breeding have been found to increase the conception rate in repeat breeding cows (Macmillan et al. 1986). Recently, Insulin has also been found beneficial for CL development and establishment of conception in repeat breeding cows (Selvaraj et al. 2002). Managemental factors play an important role towards the problem of repeat breeding. Animal should be properly fed with balanced ration and they should be kept healthy and free from parasitic, bacterial and viral diseases by employing routine deworming and vaccination schedule. All animals should be observed for estrus atleast twice daily to ensure insemination at an appropriate time. The semen should contain optimum number of progressive motile spermatozoon. Thawing in case of frozen semen should be done very carefully. The insemination should be performed by depositing semen into the uterus under strict aseptic conditions by skilled person only. Repeat breeding can be minimized by changing the bull for breeding, double AI at 12 hr interval, provision of proper housing, shade and wallowing facility (for buffaloes) during summer months.

Specific infectious infertility
Infectious diseases adversely affect reproductive performance either by direct effect upon the reproductive system or via indirect effect on the general health status. Classic venereal diseases like Campylobacteriostis and trichomoniasis have been effectively controlled from the
developed countries by the use of artificial insemination from semen of disease-free bulls. Brucellosis have also been eradicated from western countries by vaccination, blood testing and slaughter. Conversely, other diseases such as IBR-IPV (infectious bovine rhinotracheitis-infectious postular vulgarvaginitis), BVD (bovine viral diarrhoea), listeriosis, tuberculosis and leptospirosis have assumed greater importance, because of their increasing prevalence (Table 2). Estimates of the prevalence of infectious diseases of reproduction largely depend upon the successful diagnosis. The problem of infectious infertility is rampant in cattle and buffalo population. These infectious diseases cause embryonic death, abortion, prolonged calving to conception interval and intercalving period (Chauhan and Telang, 2005).

Seroprevalence of brucellosis and IBR, listeriosis have been reported in Indian cattle and buffaloes (Tripathi et al., 1998, 2001, Murunalin and Rama sastry, 1999, Barbudhe et al., 2002, Rajesh et al., 2002). Cases of vibriosis and trichomoniasis also have been recorded (Pareek et al., 1994, Newell et al., 2000).

Trichomoniasis is an insidious venereal disease of cattle and buffaloes characterized by sterility, early abortion and pyometra (Kirkbride 1990a). The disease is caused by the protozoan, Trichomonas foetus, transmitted by the chronically infected bulls (Pareek et al., 1994). The most common symptom of the disease is infertility characterized by the need for many services per conception and prolonged intercalving periods. Embryonic death and abortion occurs between 1 and 16 weeks post conception. Postcoital or post service pyometra is also observed. Diagnosis can be made by clinical symptoms, isolation of organisms from uterine exudate and preputial washings of bulls. The simplest method to control and eliminate the disease in a herd is to stop all natural services and restrict the AI with semen from disease-free bulls. Immunity to trichomoniasis lasts only for a few months.

Vibriosis is a venereal disease of cattle and buffaloes caused by Campylobacter fetus venerealis and spreads at the time of coitus or through AI with improperly handled and treated semen. It is characterized by infertility with an increased number of services per conception and failure of conception for an extended period. Early embryonic deaths are common and late abortions (>10%) from 4 months of gestation to term are occasionally observed. The animal develops immunity to the infection and will have abnormal gestation period but may remain a chronic carrier (Prasad and Malik, 1966). Longer oestrous cycles ranging from 27 to 53 days and repeat breeding are prominent feature (Dennis, 1986). Diagnosis can be made by history, examination of breeding records, clinical signs, cervical mucus and semen agglutination test, cultural examination of vibrio organisms from cervical mucus or aborted fetus. Prevention of genital contact of infected and non-infected animals, sexual rest for 3 months, incorporation of antibiotics in the processed semen for AI and use of vaccine has substantially helped to reduce the coital infections particularly of vibriosis (Kirkbride 1990a).

Brucellosis, also called as Bang’s disease and contagious abortion, is caused by Brucella abortus spread from the vaginal discharge of an infected animal or an aborted fetus. Brucellosis causes heavy economic losses of calf crop due to abortion, infertility, placentalites and reduction or total loss of milk yield following abortion or post parturient mastitis with delayed involution of uterus. It is estimated that the economic losses in India due to brucellosis is to the tune of Rs 311.47 million every year. The prominent symptoms of brucellosis is abortion or premature birth if the endometrial lesions are severe, but the calf may be carried to full term or still born in mild cases. Abortion may occur at any stage of pregnancy but most commonly in late trimester between 6 to 8 months of gestation (Dennis, 1986). Very often there is acute metritis with foetid, dirty grey brownish red vaginal discharge with retained placenta. The maternal caruncles become necrotic and haemorrhagic with clamped villi usually covered with inflammatory exudate. There is no treatment except vaccination done at calving stage. In Leptospirosis, abortion occurs during convalescent period in pregnant animals about two to five weeks after infection. Abortion may occur at any time but usually during the last trimester especially at 7 months of gestation and followed by still birth, weak calves, RFM and consequently endometritis (Kirkbride, 1990a). Most of the cattle recover after a sexual rest of 3 to 4 months. Diagnosis is by blood test and culture of the organism. Control is by vaccination done 30 to 60 days before replacement heifers are to be bred followed by a yearly booster vaccination.

Genital pathology associated with tuberculosis has been reported in cows and buffaloes (Luktuke and Roy, 1968, Mandal, 1977). Although, the prevalence of viral infertility in cattle and buffaloes in India has not so far been established but incidence are being reported frequently now-a-days. Though the wide prevalence of BVD infection has been established in cattle and buffalo population but there has been no systematic study on the disease and the virus (Pattankar, 2000).

Infectious bovine rhinotracheitis or red nose (IBR-IPV) causes vulvovaginitis, infertility and abortion occurring 20 to 45 days after infection (Afshar and Eaglesome, 1990, Kirkbride 1990a). In India Mehrotra (1977) first reported IBR virus in aborted cases, serological investigations have indicated prevalence of IBR infection in alarming proportion in most of the states of India (Singh et al., 1985, Sarumathi et al., 2002).

Diagnosis is made by fluorescent antibody tests and/or microscopic examination of fetal tissues, blood tests and virus isolation. The use of MLV (modified live vaccines) on non-immune pregnant cows or in contact animals with pregnant cows could possibly cause abortion. An intranasal vaccine
is available that can be used in pregnant cows, if necessary. Some IBR vaccines are not recommended for use in pregnant cows, it is advisable that heifers should be vaccinated 30 to 60 days before breeding. Bovine viral diarrhoea (BVD) virus infection can cause abortion, weak calves at birth, calves with brain damage (cerebellar hypoplasia) or other abnormal fetal development (Kirkbride, 1990a). Diagnosis is by virus isolation and blood tests. Unfavourable reactions frequently follow with the use of MLV BVD vaccines.

Control measure of infectious diseases include hygiene and sanitization of animal houses, regular vaccination, hygienic method of AI with semen from disease free bull, proper disposal of aborted material and genital discharge, proper management of pregnant cows, isolation and treatment of affected animals and vaccination.

**Immunological infertility**

Immunological factors leading to various forms of reproductive disorders is a recent development. Efficiency of immune system to detect the self and non-self develops during fetal life. Male and female gametes in the body possess certain specific proteins (antigens) which are not present on somatic cells. Antigens are also present on hypothalamus, pituitary, gonads, placenta and fetus. Though the nature has provided safeguard mechanism to these cells to be recognized by immune system, but due to breakage in the immunological barriers or injury, viz. blood brain barrier, uterine endometrium, cervical secretions, sialomucin layer between endometrium and trophoblast, it may lead to generation of immune response which can alter their functions and may lead to infertility or sterility. Antibodies can be induced against protein and steroidal hormones, when antibodies are generated due to abnormal situations fertility is depressed or completely inhibited for varying periods of time. Antigens specific to the ovary, its follicles or ova may play an important role in maturation of ovum, ovulation, fertilization and implantation. Autoimmune oophoritis and generation of an immune response against ovum may lead to sterility. The female reproductive tract is capable of generating an immune response to spermatozoa that can result in infertility. Repeated exposure of female genital tract to spermatozoal antigens increases the antisperm-antibody titre and thus increases the chances of immuno-infertility either by prevention of fertilization or early embryonic mortality which may be manifested in the form of repeat breeding (Tripathi et al. 1999). Anti-sperm antibodies in the female genital tract may lead to agglutination, immobilization, impaired cervical mucus penetration, increased phagocytosis of spermatozoa, inactivation of acrosomal enzymes etc. Zona pellucida is cellular gelatinous layer surrounding the mammalian egg. Antibodies against zona antigens may block the fertilization by agglutination of egg, zona-precipitation or by blocking the sperm attachment. Antibodies against embryonic trophoblast increase the possibility of early embryonic death and subsequent threatened abortion.

Till date, no specific treatment is available but breeding rest, changing of sire in breeding programme, administration of immunosuppressants, intrauterine administration of polyclonal antibodies and killed spermatozoa prior to insemination, may be beneficial to get rid of immuno-infertility.

Reproduction appears to be a complex and fascinating process. Impairment in the normal reproductive function results into infertility and sterility. The reproductive problems may be congenital or acquired. The congenital problems have major influence on herd fertility due to its association with undesirable genes. Animals affected with congenital problems are sterile and to be culled to prevent further spread of undesirable genes in the population. Anestrus, repeat breeding, cystic ovarian degeneration, uterine and tubal pathology are considered as the major functional reproductive problems in cattle and buffaloes in organized farms as well as under rural conditions, however, their incidence may vary in different agroclimatic zones. Various hormonal, non-hormonal preparations have been used for the amelioration of different reproductive disorders with varying degree of success. But infertility still remains a major economic problem globally and its incidence appears to be rising in India also. The precise information on the exact economic losses due to infertility in indigenous cattle and buffaloes in India is not available. There is a need to emphasise upon uterine and endocrinological soundness, ovarian health, efficiency in oestrus detection, insemination strategies, disease free quality semen, reduction in embryonic mortality, pre-and post partum health and nutrition. This along with improved management and husbandry practices would help to maintain optimum reproductive efficiency in the herd.

**Future thrust areas**

The future thrust areas to improve management of reproductive disorders in cattle and buffalo are mentioned below.

- There is a need to greater extent to study sexual development, attainment of puberty, sexual maturity and early breeding performances especially in buffaloes and indigenous cattle using reproductive techniques. Molecular (DNA) markers assisted selection and cytogenetic studies linked to gene of interest with major effects on reproduction need to be strengthened for the selection of breedable male/female calves at an early stage. This would help to develop cytogenetic profile and molecular markers for diagnosis of reproductive diseases of genetic and physiological origin to enable to identify animals having reproductive disorders for their culling at an early stage.
- Modern breeding techniques (AI, embryo transfer and allied biotechnologies) need to be incorporated for the improvement in oestrus detection efficiency, artificial
insemination with quality disease free semen, early pregnancy diagnosis and reduction in embryonic mortality.

- Realistic remedial measures for reducing infertility and enhancing fertility need to be emphasized for the effective control of various reproductive disorders.

- Biosafety measures for production of disease free germ plasm (semen, embryo) and registration of all A.I. bulls by a National Society to initiate a certified disease free semen services for the whole nation need to be addressed.

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