GROWTH AND REPRODUCTIVE PERFORMANCE OF CROSSBRED HEIFERS IN SELECTED AREAS

By

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THESIS

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DECLARATION

I hereby declare that the thesis entitled **"GROWTH AND REPRODUCTIVE PERFORMANCE OF CROSSBRED HEIFERS IN SELECTED AREAS"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that the thesis entitled "**GROWTH AND REPRODUCTIVE PERFORMANCE OF CROSSBRED HEIFERS IN SELECTED AREAS**" is a record of research work done independently by **Sri. Rajeev, R.**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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RAJEEV, R.

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INTRODUCTION

Development of dairying in India during this century has been noticeable. National commission on Agriculture (1976) envisaged tremendous potentiality for cattle development for rapid economic growth and social change. The commission has recommended the replacement of low yielding indigenous cattle with crossbreds. Although the per capita milk consumption raised from 60 ml to 145 ml, through the white revolution, it is only half way to `WHO' target of 285 ml percapita consumption of milk. It is possible to achieve this target with our available cattle population, by effectively exploiting the full genetic potential of existing dairy cattle.

Kerala is basically an agricultural state with emphasis on cash crops and the state has little to claim in the field of cattle keeping whether it be for dairy or draught purpose. In the early sixties, cattle population of Kerala consisted of local non-descriptive animals. Though, the cattle dominated the bovine wealth of Kerala, they were kept traditionally for agriculture operations, with low production trait. Inspite of the low availability of land and fodder the productivity of cattle in Kerala has been augmented through the diffusion and adoption of the cross breeding technology. By means of intensive cattle breeding activities through an extensive and well organised net work of A.I. Centres, Kerala is presently having 2 million crossbred cattle. The percentage of crossbred cattle is lower in the northern districts compared to central and southern regions of our state. The wide spread propagation of high yielding crossbred cattle has necessitated increased dissemination of scientific management practices among the dairy farmers, thereby increasing their awareness on profitable dairying. As dairying is becoming more and more cost benefit oriented, the economic loss suffered on account of poor reproductive performance of crossbred cattle has been given more emphasis. Sound reproductive management is the key for successful dairying.

The success of cattle development depends on proper rearing of calves and heifers since they form the basic unit for future stock. Crossbred cattle demands utmost care from calfhood to puberty to develop them into healthy dairy herds assuring economic viability. The main objective of good management and balanced feeding of the young stock is to obtain optimum growth rate so that they can attain early maturity. Scientific feeding and management needs a lot of information about the essential nutrients that are required for different body functions.

Age at puberty is an important production trait in dairy economics, which is having a carry over effect throughout the economic life span of the milch animals. The interval between birth and first calving is a non-productive stage and must be considered as an overhead cost to the milking herd. In cattle the scientific management system requires heifers to be bred at 14-16 months of age, so that they calve at 24-26 months of age. To optimise the efficient economic returns in a cow-calf production system; heifer should be managed to calve as early as possible so as to lessen the feed and forage required to maintain them. Further longer the productive life of each cow in the herd, the lower will be the replacement rate and smaller the size of the heifer rearing enterprise. This also has an effect not only on lifetime performance but also on the profitability of dairying. For early breeding target, heifers should achieve 2/3 adult body weight of their dam. This may demand supplementary feeding with better nutrients during the early period of their lifetime. The above target can well be achieved by better calfhood and heifer management.

The overall productive efficiency of crossbred cattle has to be built on a strong and sound foundation of scientific reproductive management. Infertility or sterility presents a varied picture from low reproductive efficiency in many grades to complete inability to reproduce.

Normal functioning of the reproductive organs may be detrimentally affected by nutritional deficiencies during critical periods of growth, puberty, gestation etc. Even borderline nutrient deficiencies may be manifested as impaired fertility before other clinical symptoms are apparent.

Nutritional infertility may occur as a result of severe restriction of nutrient intake or deficiencies. Despite numerous research efforts, the intricate relationship between nutrition and reproduction has not been studied in detail. Malnutrition leads to lowered vitality and lessened resistance to diseases but proof of such effects on the reproductive system are few. Infertility due to nutritional causes is usually characterised by a failure of oestrum or cessation of oestrous cycle. Influence of nutrition on reproduction has been recognised for a long time back. The nutritional influences also include effect on attainment of puberty and sexual behaviour. The animal may be showing delayed maturity or low fertility when the ration is deficient both qualitatively or quantitatively. Major contribution of feed are metabolisable energy, protein and fat. Along with these parameters there can also be multiple or single deficiency of major minerals like calcium, phosphorus or other trace minerals.

Relationship between reproductive function and minerals has long been recognised. All essential minerals are required for reproduction because of their cellular roles in metabolism, maintenance and growth. However, these nutrients also may have specific roles and functions in reproductive tissues. The role and requirement of a mineral in a reproductive tissue or cell type may change with the physiological state of the tissue during reproductive cycle and pregnancy.

Specific mineral requirements for optional reproduction in modern dairy cattle have not been fully defined. Further nutrient requirements of reproductive tissues and endocrine systems that account for the constantly changing reproductive stages have not been well defined. Significant advancement in this area need to be based on a fundamental understanding of general nutrient metabolism and the specific role of each nutrient in reproductive tissue. Feeding of mineral mixture not being a regular practice, the main source of minerals in the feed is the concentrates and forage.

Both qualitative and quantitative deficiencies in the feed and fodder would therefore lead to deficiency of calcium, phosphorus and trace elements. The large scale practice of manuring of soil with chemical fertilizers, heavy rain fall and resultant leaching of soil and the changing water management practices in the state upset the ratio of interrelated microminerals in the soil. This could interfere with the assimilation of trace elements by the fodder plants eventhough there is no deficiency in the soil. There is an added possibility of leaching of the soil especially in the hilly tract during heavy monsoons. All these factors can lead to a reduced trace element availability from the green fodder resulting the possible trace element deficiency in cattle.

It is common knowledge that nutritional deficiency can cause retarded growth and development of genital organs resulting in non-functional ovaries in otherwise disease free animals. Therefore the present study was undertaken to investigate the reproductive performance of crossbred heifers under field condition, to correlate certain blood constituent levels in various reproductive orders and to suggest some curative measures.

Review of Literature

REVIEW OF LITERATURE

Crossbreeding indigenous cattle with exotic dairy breeds has been accepted as a tool for large scale improvement of genetic potential of cattle for economic milk production in the country. It is well known that for a livestock enterprise to be economic and viable, its units must be the long and efficient producers, and for the production to be economic the reproduction must be efficient.

Iyer (1978) reported that 70 per cent of reported cases of anoestrum among cows and 90 per cent among heifers were actually `true anoestrum'. Kodagali *et al.* (1978) observed an incidence of 31 per cent of anoestrum and 17 per cent of juvenile genitalia in crossbred heifer. Sharma (1978) observed 36.16 per cent of heifers and 4.3 per cent of cows as true anoestrous. In a field study, Pillai (1980) found an incidence 28.2 per cent true anoestrum and 9 per cent under developed genitalia among crossbred cattle. Mathew and Nampoothiripad (1979) detected 20-51.72 per cent incidence of anoestrum in crossbred heifers at varying blood levels.

Rao *et al.* (1983) in a field survey reported 24.2 per cent crossbred cattle having anoestrous condition, 18.18 per cent with non-functional ovaries and 17.97 per cent with genital hypoplasia, due to underfeeding. Hussain and

Muni Raju (1984) reported the incidence of hypoplasia of genitalia 9.7 per cent in cattle and 15.7 per cent in buffaloes. Kumar and Agarwal (1986) observed that 48 per cent of cattle possess ovarian abnormalities, 3 per cent of the total had inactive ovaries resulting in anoestrus. Kumar *et al.* (1986) reported an incidence of ovarian hypoplasia 1.7 per cent and infantile genitalia 9.5 per cent in Zebu cattle. Rahmathulla *et al.* (1986) observed 5.4 per cent cattle and 29.3 per cent buffaloes showing anoestrum and 4.84 per cent cattle and 3.9 per cent buffaloes with genital hypoplasia. Singh *et al.* (1987) reported a total incidence of anoestrous condition as 45.05 per cent in cattle, out of which 59.82 per cent were in heifers and 36.47 per cent in cows. Iyer *et al.* (1992) found that 30.36% true anoestrum and 12.95% under developed genitalia in crossbred cattle. Bahera *et al.* (1993) observed that 30.9 per cent anoestrous heifers had normal genitalia with non-functional ovaries and 42.06 per cent of heifers with underdeveloped or infantile genitalia.

Management and nutrition

Schefels and Stolla (1985) pointed out the importance of an effective reproductive management for the better reproductive health of the cattle. Similar studies in management were conducted by others (Kharche and Gautham, 1991).

Alderman (1963) established the relation of the mineral status of pasture and other fodder in cattle nutrition with the reproductive disorders. Wiltbank *et al.* (1969) observed a better growth rate in high level of nutrition compared to that of low level. Mathai and Raja (1976) established the significant influence of level of feeding to growth rate, age at puberty and body weight at puberty. Moriera *et al.* (1978) established significant relationship of the level of feeding on growth and puberty. Patkowski and Girschewski (1979) discussed on the roughage feed and importance of minerals in reproduction in heifers. Staigmiller *et al.* (1979) and Sprott *et al.* (1980) reported that those cattle under high level of ration were found to be better in reproduction compared to those under low level. Clinical sign of energy deficiency would be delay the onset of puberty Allenstein (1981). Others also supported the above view through their studies on Symmental and Friesien heifers (Bonnemaire *et al.*, 1983). Cates and Christen (1983) studied the effect of nutrition on the fertility rate of beef cattle and stressed the importance of minerals in the routine feed. (Katchreuter, 1988; Gaines, 1989; Gujar and Shukla, 1990; Kharche and Gautam, 1991) established the role of adequate nutrition in dairy cattle in order to avoid the adverse effect on fertility and also pointed out the essentiality of feeding and efficient management. Billante *et al.* (1991) pointed out the significance of good and adequate nutrition to heifers for early achievement of puberty and onset of heat. Deresz (1992) found that poor feeding, management and health care were the main reasons for the late puberty. Similar observations were made by (Andrada, 1992 and Pandey and Shukla, 1993).

On grading of ration based on quality and quantity of the feeds given to heifer, they had shown better body weight gain and span to puberty for high as well as moderate planes and poor weight gain and longer duration for first oestrum in case of those heifers fed with low and poor plane of nutrition (Burton *et al.*, 1961; King, 1971; Rasby *et al.*, 1991; Patterson *et al.*, 1992).

Hofman and Funk (1992) reported that better plane of feeding not only control the age at puberty and conception but reduce the occurrence of calving complications.

Attempts were taken to formulate a standard diet for better growth and reproductive performance in Europian cattle (Bailey *et al.*, 1958 and Bonsembiante and Billante, 1980).

Sprott *et* al. (1980) reported that neither protein nor energy levels had any effect on the onset of puberty in beef heifers.

Ford (1972) reported the importance of mineral status with the reproductive performance of grazing animals and the importance of mineral supplementation. Amrithkumar *et al.* (1973) estimated the blood minerals in heifers and established the significance of mineral nutrition with reproductive performance. Hidiroglou (1979) supported the above view. Malevana and Ponova (1983) reported the proportional similarities of blood level of minerals with that of mineral content in the feed. Singal and Lohan (1988) established correlation between the low mineral nutrition and anoestrum resulting in infertility in dairy cattle of rural Haryana. Gaines (1989) reported the relationship of better nutrition and maintenance of good reproductive health in dairy herds. Several other research workers (Bertoni, 1990; Barcelos, 1992; Rosa, 1993 and Rupde, 1993) observed a significant difference in the serum values of copper, manganese, zinc, calcium and phosphorus in repeat breeders, anoestrous and normally cycling cattle.

Mills and Jenney (1979) found an inverse relationship between reproductive performance and high concentrate diet.

Elrod and Butter (1993) reported that excess degradable protein in the feed will reduce the fertility in heifer.

Growth and Puberty

Puberty can be considered as a state or a stage of development having become functionally capable of procreating offsprings or as simply as that the moment at which the female first comes to oestrus.

According to Desjardins (1967) average age at first oestrus was 29.7 ± 1.3 weeks in Holstein breed, and ovarian size and weight increased linearly with the age. Ronningen *et al.* (1972) reported the age at first oestrus as 15.6 months in Zebu cattle in East Africa. Linares *et al.* (1974) reported the age at puberty in Criollo cattle as 24.3 months and that of Brahman crosses as 22.1 months. Studies in Bos Indicus showed that by crossbreeding the age at first oestrus was reduced. Rao and Rao (1975) reported that Jersey x Bos Indicus showed an average age at puberty of 22.9 ± 0.9 months. Kracmar (1980) found that at an average age of 474 days Bohemian Red Pied and Danish Red heifers reach the stage of first oestrus. According to Balakrishna *et al.* (1981) the average age at first detectable heat in the Zebu x Holstein cross was 679 days. Later, Rao and Rao (1981) observed first oestrus at 23.3 months of age in Zebu breed (Ongole). Tahir *et al.* (1983) observed that Sahiwal cattle showed first oestrus at an average age of 34 months and in their crossbreeds with Holstein or Jersey this average decreased to 17.5 and 13.7 months respectively.

Body weight is the major factor affecting age at puberty in heifers and established a correlation between body weight and age at puberty (Desjardine, 1967). According to Ronningen *et al.* (1972) Zebu cattle in East Africa attain a body weight of 235.5 kg while showing first oestrus. Mathai and Raja (1976) established that growth rate, age at puberty and weight at puberty were significantly related. Sudarsanan (1979) reported that the crossbred heifers exhibited their first heat when they attained an average body weight of 180 kg. Kracmar (1980) stated that body weight of Bohemian Red Pied and Danish Red heifers at the time of first AI was 368 kg. Meaker *et al.* (1980) found a significant relation between body weight and sexual maturity in Sussex type cattle. Rao and Rao (1981) found the body weight at first oestrus of Jersey x Ongole, H.F. x Ongole and Brown Swiss x Ongole crosses. Smeaton (1981) reported that crossbred heifers attained an average body weight of 201 kg and 221 kg respectively for high and low levels of nutrition. Ferrel (1982) reported that post weaning body weight gain and the onset of puberty were significantly related. According Tahir *et al.* (1983) the body weight at first oestrus of Sahiwal heifers was 247.0 ± 2.00 kg while that of their crosses with Friesen and Jersey were 256.0 ± 3.0 and 221.0 ± 4.0 kg respectively. Balakrishnan *et al.* (1985) found that there is significant correlation between puberty, age and body weight of crossbred heifers. Patel and Deve (1987) reported that average body weight at 1st oestrus were 209 ± 5.59 kg and 252.61 ± 7.06 kg for Jersey and Kankrej crosses and Holstein and Kankrej crosses respectively.

Patterson (1992) found that heifers heavier at weaning reached puberty at younger ages.

Greer *et al.* (1983) did not support the findings that age and weight at puberty were dependent. According to them the body weight at puberty depends on the age at puberty but the age at puberty did not depend on body weight at puberty. Gujar and Shukla (1990) reported that there was negative correlation for birth weight and age at puberty.

Chaturvadi (1972) could not establish any correlation between the individual feeding and group feeding in attaining body weight in Haryana heifers.

There are substantial evidences to show that dietary supplementation of heifers during growth will reduce the interval from birth to first calving (Mathai and Raja, 1976; Koyongomale *et al.*, 1982; Oyedibe *et al.*, 1982). This finding was supported by the fact that heifers that growing fast will cycle earlier and allow easier oestrus detection (Moreira *et al.*, 1978; Kalashinkov, 1980 and Gautheir and Thimonier, 1982).

Manico *et al.* (1982) reported that the heifers supplemented with minerals had exhibited their oestrus sooner than the control animals. Smeaton (1981) found that high level of nutrition had significant effect on early attainment of puberty in beef heifers. The above finding was supported by others (Greer *et al.*, 1983 and Saha, 1989).

Kracmar (1980) reported that mineral supplementation did not improve conception rate in heifers.

Another factor affecting the puberty and the age at first calving was the season of birth in crossbred cattle (Mishra *et al.*, 1977).

The important causes of variation in age at first oestrus and first calving were the season of birth, rainfall and the level of nutrition (Vaccaro and Vaccaro, 1982).

Singh and Tomer (1988) opined that the most important consideration in the growth of dairy heifers are those which influence reproduction. According to him the performance of Haryana heifers in relation to growth rate confirmed that gain in weight and growth of heifers are necessary for timely and optimum reproductive performances. The age at which the heifers begin regular oestrus is significantly related with the body weight gain from birth onwards (Plasse *et al.*, 1968; Short and Bellow, 1971; Arije and Wiltbank, 1974). Smith et al. (1975) reported that higher rate of body weight gain of heifers will shorten their age at first heat. Maynard *et al.* (1979) and Ensminger *et al.* (1990) found that rate of daily body weight gain got reduced while the heifer is getting older. Bonezek *et al.* (1992) observed correlation between growth and body measurements like length and girth with body weight.

Laster *et al.* (1979) however, reported that there was no significant relation between body weight gain and age at puberty.

Mineral nutrition

Lamand and Perigand (1973) in a field survey in France, established correlation of trace element deficiency in ruminants with that of the mineral content in the soil of that particular area.

Calcium

Schmidt (1964) reported that calcium supplementation along with other minerals possesses significant effect on fertility in buffaloes. Morrow (1969) found that calcium deficiency may prolong the interval of the first oestrus. Jaśkowski (1986) reported that low level of calcium may lead to infertility and puerperal disorders in cattle.

King (1971) had fixed an optimum value of serum calcium for normal reproductive function at 9.27 mg/100 ml whereas Maynard and Loosli (1973) reported that normal level of serum calcium for normal reproductive functions was 9 to 12 mg/100 ml.

Salisbury and Vandemark (1961) and Roberts (1971) could find no significant difference between calcium levels of anoestrous cattle and that of normally cycling.

Calcium level in serum remained unaltered between cycling and anoestrous heifers (Parker and Blowery, 1976; Pandiya *et al.*, 1977; Dindorkar and Kohli, 1979; Pillai, 1980). There are similar reports in buffaloes (Samad *et al.*, 1980; Srivastava and Kharche, 1986; Dabas, 1987). Saha (1987) found a high level of calcium in the serum of sub-fertile cows. Saxená (1991) reported that plasma calcium level was not related with age at puberty in crossbred hiefers. Bahera *et al.* (1993) found no correlation between the serum calcium level and the sexual maturity in crossbred heifers.

King (1971) reported that excess calcium may impair the reproductive function.

Yadav (1989) opined a high calcium-phosphorus ratio (4.5:1) in anoestrous buffaloes. Bahera *et al.* (1993) observed significant effect of calcium-phosphorus ratio in delayed maturity.

Phosphorus

Schemidt (1964) observed lowered phosphorus level in animals with delayed sexual maturity and irregular oestrous cycle. Hurley and Doane (1989) reported that the effect of phosphorus on reproduction in cattle may be due to its role on CAMP synthesis.

King (1971) had fixed an optimum level of serum phosphorus for normal reproduction at 5.42 mg/100 ml. According to Maynard and Loosli (1973) the normal level of serum inorganic phosphorus was 4-9 mg/100 ml. Morries (1976) and Pillai (1980) reported that, a serum level of less than 4 mg/100 ml indicated phosphorus deficiency, and opined that 4-8 mg/100 ml serum phosphorus is required for the normal reproductive performance in dairy cattle.

Higher numbers of services per conception have been observed due to phosphorus deficiency (Morrow, 1969; Bodien, 1976). Neelakantan and Nair (1978) assessed the requirement of phosphorus for reproductive function as 10 to 12 gms daily and the additional requirement could be met by incorporating Dicalcium phosphate (DCP) or bone meal in the ration. Scharp (1979) reported that conception rate in dairy cows was improved by phosphorus supplementation and that the serum phosphorus level came to normal in these animals.

Maynard *et al.* (1979) reported lower level of serum inorganic phosphorus in anoestrous heifers and cows than cycling heifers and cows. This was supported by others (Jaskowski, 1986; Dabas, 1987; Mujarrege, 1987; Dutta *et al.*, 1988; Ropstad, 1988; Gaines, 1989; Yadav, 1989 and Behera *et al.*, 1993).

El-Keraby and Abdel-Rahman (1983) reported that the supplementation of monosodium phosphate had significantly reduced the oestrous interval in Friesien cows. Brooks *et al.* (1984) obtained a significant improvement in ovarian activity after supplementation of phosphorus and copper either orally or by injection in phosphorus deficient anoestrous dairy herds.

Similar studies on the supplementation of phosphorus to cattle for correcting anoestrous condition were reported by Dabas *et al.*, 1987 and Jubb and Crough, 1988.

Kiatoko (1978) pointed the relationship of phosphorus content in the forages and plasma phosphorus content.

Brooks *et al.* (1984) reported that the infertile cattle which showed deficiency in serum inorganic phosphorus were found to be those fed with pastures having high calcium-phosphorus ratio grown in soil having low phosphorus level.

Lorek and Okonski (1974) found no correlation between conception rate of dairy cows and phosphorus content of soil and hay. Gonzalez *et al.* (1984) observed no significant relationship for the reproductive status with the phosphorus level in blood; this view was supported by others (Agarwal *et al.*, 1985; Hofer, 1985 and Saxena, 1991). Saha (1987) could not establish any correlation between the low level of inorganic phosphorus in the serum of cattle and that present in the soil or the fodder fed to them. Agarwal *et al.* (1985) and Saxena (1991) reported that plasma level of phosphorus had no relation to age at puberty or fertility in cattle.

Copper

Elweshy *et al.* (1965) observed the importance of copper supplementation in the onset of puberty in buffaloe heifers. Morston *et al.* (1972) found that the copper deficiency completely subdued the breeding performances in heifers and cows. This view was supported by (Pickering, 1975 and Manikkam *et al.*, 1977). Kerkhayera (1974) observed individual variation in the serum copper content of cows even if they were fed the same ration. Homes (1981) found the significance of plasma copper level in the onset of heat in heifers, by producing experimental hypocupraemia. Leech (1982) reported about the bovine copper deficiency in England and Welsh borders. Thomas (1983) observed prolonged oestrous cycle in copper deficient cows. Kappel *et al.* (1984) and Monge (1984) found lowered fertility rate in cattle having primary copper deficiency aggrevated by excess sulphate and molybdenum intake. Barnea *et al.* (1985) found that copper has a role in PGE_2 receptar binding and regulating the level of LH releasing hormone.

According to King, 1971; Maynard and Loosli, 1975 and Pillai, 1980 serum copper level for normal reproduction in cattle was 100 μg/100 ml, and those found below that level were taken as deficient group for copper supplementation. Tanner (1988) established that the serum copper level below 0.6 mg/litre were deficient. Sikka and Mudgal (1988) reported that the normal serum copper level averaged to 76 μg per cent in dairy heifers. Gaines (1989) and Hann (1989) reported anoestrum in copper deficient cattle. Prasad *et al.* (1989) observed a significant difference in the serum copper levels of normally cycling and anoestrous cattle, a level of 70 to 115 mg/100 ml for normally cycling and 52 to 78 mg/100 ml for cattle with acyclic ovaries.

Sarvaiya (1991) reported the importance of serum copper status in reproduction of buffaloe heifers.

Administration of 1 g of copper sulphate once in a week was found very effective in inducing oestrum in anoestrous buffaloe heifers (Elwishy *et al.*, 1966). Smith *et al.* (1975)

found that subcutaneous administration of copper in the form of copper glycinate corrected the copper deficiency in case of cattle. Reddy (1977) reported that the delayed oestrus in the cows due to border line copper deficiency was corrected by supplementation with copper sulphate 0.5 gm orally along with the basal ration. Poole (1978) and Schwarz (1978) found a higher pregnancy rate in copper supplemented group of cows. Schwarz (1978) observed an increase in the plasma copper level by supplementation of copper as copper sulphate compared to those not been supplemented. Pillai (1980) and Ingraham (1987) reported about the correction of subnormal fertility with copper supplementation. Surendra Singh and Vadnere (1987) induced oestrus in anoestrous cows having copper deficiency with supplementation for a maximum period of 21 days.

Demago (1982) reported about copper toxicity in cattle and recommended the safe level of copper in the diet as 100 mg/kg diet. Whitaker (1982) reported that it should appear to be inadvisable to ascribe poor reproductive performance to subclinical hypocuprosis on the evidence of blood copper analysis alone. Luminins (1984) experimentally created higher serum copper level in heifers by administration of 400 mg copper glycinate parantrally and observed a temporary infertility. According to Prasad *et al.* (1989) higher values of serum copper affects the reproduction.

However, there were few studies suggesting that fertility was not related to blood copper concentration (Little John and Lewis, 1960 and Whitaker, 1980). Sharma (1988) studied circulatory levels of trace minerals in normal cyclic and primary infertile Kankrej heifers and opined that there was no significant difference for serum level of copper between the above two groups.

Meldrum (1985) reported cases of apparent copper deficiency in cattle and its correlation with the low copper content in the soil. Nicolon (1986) found that the serum copper content of the adult cattle was related with the soil content of copper and molybdenum. Suttle (1986) reported copper deficiency in grazing ruminants due to low availability of copper in lushgreen pasture and due to high content of molebdenum or sulphur in that pasture.

Bain (1986) investigated the seasonal influence on serum copper level of bovines and found that in higher rainfed areas the copper level has gone down compared to other areas.

Zinc

Papasteriadis (1973) observed zinc deficiency in 3.4 per cent of 925 cattle out of which 65 per cent showed clinical symptoms of deficiency. Manikkam *et al.* (1977) also observed similar finding on zinc deficient cattle. Mahem (1982) found that there was similarity in the symptomatology of zinc deficiency with that of other conditions of malnutrition. Sharma *et al.* (1988) found that there was significantly low serum zinc level in noncyclic heifers compared to that of cyclic ones.

Prasad *et al.* (1989) reported that zinc was associated with progesterone and oestradiol levels in maintaining reproduction, but he could not establish significant difference in serum zinc level between fertile and anoestrous cattle. However got a high zinc level in repeat breeders. Yadav (1989) observed significantly low zinc level in anoestrous buffaloe heifers with smooth quiescent and inactive ovaries. Bahera *et al.* (1993) noticed low serum zinc level in anoestrous heifers in comparison with that of cycling heifers.

Wegner (1973) found that the normal level of serum zinc in cattle was ranging from 85 to 175 μg/100 ml with a mean of 117 ± 39 μg/100 ml. Duffy (1977) found that there was variation in plasma zinc concentration between individuals and also within individuals at different reproductive phases. Prasad *et al.* (1989) reported that acyclic heifers with smooth ovaries showed a serum zinc level of 65.0 ± 14.3 μg/dl. Nickerk *et al.* (1990) grouped the cattle showing a plasma zinc level below 80 μg/dl as zinc deficient. Saxena (1991) reported that heifers with a plasma zinc level of 100 to

290 $\mu g/dl$ were observed to attain puberty faster than those having levels lower than this.

Towers (1981) found that by supplementation of cattle with zinc there was little effect on plasma zinc concentration. Bonomi (1988) noticed significant improvement of deficiency problem due to zinc by supplementing it through cattle feed.

However, Gonzalez *et al.* (1984) and Lavin *et al.* (1988) could not establish any significant relationship between the blood zinc concentration and reproductive status in cattle.

Campbell *et al.* (1974) found that iron supplementation was not having any effect on zinc absorption or its level in serum of young cattle. Schwarz and Kirchgessner (1978) found that by supplementing cows with copper sulphate there was no change in plasma zinc level since copper was not affecting zinc absorption. Parada (1981) stated that high intake of molebdenum was interacting with the absorption of zinc in cattle leading to zinc deficiency. Bonomi (1988) found that there was more chance of zinc deficiency in cattle taking feed with high calcium phosphorus ratio, compared to those taking low calcium phosphorus ratio diet.

Damir (1988) studied about the infertility in cattle due to zinc deficiency and its relationship to the low level of zinc in the pasture.

Kronemar *et al.* (1975) observed a single recessive gene which controlled hereditary zinc deficiency in Dutch Friesien cattle.

Manganese

Dyer and Roja (1965) reported that the daily requirement of manganese for cattle was 20 ppm. Wilson (1966) observed that calcium oxide phosphates in feed act as a conditioning factor resulting in infertility in cattle. Manikkam *et al.* (1977) pointed out that manganese level was significantly higher in plasma of regularly cycling cows than those with reproductive problems. Sharma *et al.*, 1988 and Rupde, 1993 correlated the significance of manganese with cattle infertility.

Underwood (1977) and Georgievski (1981) reported that manganese is directly related with endocrine as well as reproductive function in cattle.

Simeonov *et al.* (1989) reported that heifers with a serum manganese level of below 0.02 ppm showed anoestrous condition.

Under normal circumstances the manganese content of normal pasture was adequate to provide the necessary manganese requirements of 80 ppm in feed (Alderman and Stranks, 1967).

Gonzalez *et al.* (1984) found that manganese level in blood was not showing significant effect on cyclicity or anoestrus in heifers. Prasad *et al.* (1989) reported no significant importance for manganese in reproductive performance of heifers and did not find any significant difference in the serum content of manganese between normal (0.026 ± 0.007 ppm), repeat breeder (0.019 ± 0.009 ppm) and anoestrum (0.015 ± 0.009 ppm).

Negative effect of higher level of manganese on reproduction due to higher manganese content in soil or hay was reported by Lorek and Okaniski (1974).

Soil

Brady (1974) and Thompson and Troeh (1978) reported on the soil mineral status and ways to analyse the exchangeable and available soil mineral fractions. Muralidharan (1992) and Sakeer (1997) studied the macro and micro nutrient status of the laterite soils of northern Kerala and reported that the available phosphorus, copper, zinc and manganese levels found to be within the normal range.

Gupta et *al*. (1979), Reid and Horvath (1980) and Das *et al*. (1994) studied about the soil, plant and animal interactions and reported that soil mineral content directly related to the blood mineral status of ruminants.

Materials and Methods

MATERIALS AND METHODS

With the objective of studying the influence of certain biochemical parameters on fertility in crossbred heifers, an investigation was undertaken among heifers with normal and impaired fertility. One hundred and twelve crossbred heifers aged 1½ years and above selected from different areas of Calicut and Malappuram districts formed the material for the study. They were selected randomly on field visits and by conducting camps. All the heifers were subjected to detailed gynaecoclinical examination to assess the reproductive status and were categorised into different groups.

Out of the 112 animals, 4 suboestrous heifers and 1 with hypoplastic ovaries were not included in the study. Among the remaining 107, thirty three were normally cycling and seventy four were of impaired fertility. From the normally cycling heifers fifteen were selected randomly as control group.

These animals were grouped into different categories as follows:

1. Normally cycling heifers (control): Fifteen heifers with normal oestrous cycle and oestrous period confirmed by per rectal examinations, formed the control group.

2. True anoestrous heifers: Forty one heifers that did not show any clinical or behavioural signs of heat were subjected to repeated detailed clinico-gynaecological examination. Those heifers with normal tubular tract and non-functional ovaries characterised by failure of development of follicles of prematuration size and lacking in a functional/regressing corpus luteum were classified as true anoestrous heifers.

3. Heifers with under developed genitalia: Twenty two heifers with juvenile genitalia with small, quiescent inactive ovaries without any oestrous signs were included in this group.

4. Repeaters: Eleven heifers which showed oestrus at regular interval but not conceived even with three or more AIs formed this group.

The detailed breeding history and informations regarding feeding and management were collected. The experimental and control animals were divided into 3 groups based on their feeding levels.

1. Moderate plane of nutrition: Those heifers getting 0.75 kg to 1.5 kg of concentrate and 8-10 kg green and 1-2 kg straw.

2. Low plane of nutrition: 0.25 kg to <0.75 kg concentrates and <8 kg green or 2-3 kg straw.

3. Poor plane of nutrition: Those heifers fed lower level than above were grouped under poor plane.

The experimental animals were subclassified based on their age viz. 1½ - <2½ years, 2 - <2½ years, 2½ - <3 years and 3 years and above.

In order to obtain the body weight and growth rate of the heifers of different age group, the body measurements (Length and Girth) were recorded at 10 days interval. The body weight in kg was calculated using the standard formula = $\frac{LG^2}{660}$, where `L' is the length of the body in inches from crown to rump and `G', the girth in inches. From the difference in the body weights obtained at `10' day interval the daily weight gain of the individual heifers were found. Body weight of the heifers exhibiting heat signs during the course of experiment were also recorded on the day of heat.

Collection of serum

Approximately 25 ml blood was collected in a test tube from the jugular vein of each animal and the sample was kept in slanting position for clotting and separation of serum.

The clotted blood was kept in a refrigerator for 24 hours. The clear serum was collected in aliquots and stored in a labelled air tight container at 0°C. Slightly discoloured serum samples were centrifuged at 1000 rpm for 5 minutes separated and stored in the same manner for estimation of trace elements. Eighty nine heifers were put for blood collection and estimation of serum mineral status.

Estimation of calcium

Serum calcium was estimated by O-cresolphthalein complekone method using calcium kit in Spectronic-20. Principle of Spectronic-20 is that while light is passing through a coloured solution, the position and the amount of light absorbed by the solution is dependant on its concentration.

For this 0.02 ml of serum (T), 0.02 ml of standard (S) and 0.02 ml of distilled water (Blank (B)) were taken separately and mixed individually with 2 ml each of buffer solution and colour reagent. This was mixed well and allowed for absorbance of standard (S) and test (T) against Blank on a photocalorimeter (Spectronic-20) at 570 nm within 30 minutes.

Serum calcium level in mg% was calculated by applying the following formula:

$$\text{Serum calcium in mg\%} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times 10$$

Estimation of inorganic phosphorus

Inorganic phosphorus level in the serum was estimated using phosphorus kits* employing modified metol method.

Procedures

The various reagents and serum were pipetted into clean dry test tubes and labelled in three groups; Blank, Standard and Test as per the following protocol.

	Blank (ml)	Standard (ml)	Test (ml)
Catalyst reagent	1.0	1.0	1.0
Molybdate reagent	1.0	1.0	1.0
Deionized water	0.1	-	-
Standard phosphorus solution	-	0.1	-
Serum	-	-	0.1
Metol reagent	1.0	1.0	1.0

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* Stangen Immunodiagnostics

They were mixed well and allowed to stand at room temperature for 5 minutes. The absorbance values of test and Standard were measured against Blank in a Spectrophotometer** at 680 nm within 30 minutes.

Serum inorganic phosphorus level in mg was calculated by applying the following formula:

$$\text{Serum inorganic phosphorus in mg\%} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times 5$$

Estimation of trace elements

Copper, zinc and manganese contents of the serum were estimated by Atomic Absorption Spectrophotometry using a perkin elmer 2380 model atomic absorption spectrophotometer.

Principle of atomic absorption spectrophotometry

Every element has a specific number of electrons which are associated with the atomic nucleus in a unique orbital structure. The electrons occupy orbital position in an orderly and predictable way. The most stable electronic configuration of an atom is the "ground state" in which it has the normal orbital configuration and the lowest energy levels.

** Spectronic-20 (Bosch & Lomb)

If light of the right wave length impinges on a free ground state atom, the atom may absorb energy from the light and it enters an excited state in a process known as atomic absorption. The capacity of atom to absorb very specific wave length of light is utilized in atomic absorption spectrophotometry. In atomic absorption the amount of light at the resonant wave length which is absorbed, as light passes through a cloud of atoms, is measured. As the number of atoms in the light path increases the amount of light absorbed also increases in a predictable way. By measuring the amount of light absorbed a quantitative determination of the amount of analyte element present can be made. The use of special light source and careful selection of wave length allow the specific quantitative determination of individual elements in the presence of others.

Estimation of copper

Preparation of sample, standard and blank copper

Preparation of sample

As per the dilution rate recommended by the manufacturers of the AAS (Perkin Elmer), the serum sample was diluted to 1 in 2 by making up 1 ml of serum to 2 ml using deionized water (1 ml).

Preparation of copper standard

Solution containing 4 ppm copper in 10 per cent aqueous glycerol solution was used as the standard for which 0.4 ml of copper stock standard solution containing 1000 ppm copper was made upto volume with 10 per cent aqueous glycerol in a 100 ml volumetric flask.

Preparation of blank

The ten per cent aqueous solution of glycerol in deionized water was used as blank.

Estimation of zinc

Preparation of sample

One millilitre of serum was diluted with 4 ml of deionized water.

Preparation of standard

Solution containing 1 ppm zinc in 5 per cent aqueous glycerol was prepared by making up 0.1 ml of stock standard solution of zinc containing 1000 ppm zinc upto the mark using 5 per cent aqueous glycerol in a 100 ml volumetric flask.

Preparation of blank

The five per cent aquous glycerol solution in deionized water used for the diluting of standard was used as the blank.

Estimation of manganese

Preparation of standard

Whole undiluted serum as such was used for manganese estimation.

Preparation of sample

The 2 ppm solution of manganese used as the working standard was obtained by making up 0.2 ml of stock standard solution of manganese containing 1000 ppm of manganese to 100 ml using 20 per cent aqueous glycerol in a 100 ml volumetric flask.

Preparation of blank

The twenty per cent aqueous glycerol solution (the one used for preparation of manganese working standard) was used as the blank.

Conditions used for the operation of AAS

The AAS was set for operation as per the recommendations of the instrument manufacturers (Perkin Elmer). The standard conditions for atomic absorption of various elements studied are furnished below:

Item	Copper	Zinc	Manganese
Wave length (nm)	324.8	213.9	279.5
Slit SEW (nm)	0.7	0.7	0.7
Flame gases*	A-AC	A-AC	A-AC
Lamp - Hollow cathode	Copper	Zinc	Manganese
Lamp current	15 m A	15 m A	28 m A
Time (seconds)**	0.2	0.2	0.2
Average**	5	5	5

* Air-Acetylene

** Reading taken at every 0.2 seconds and 5 such readings averaged

Working of the instrument

After setting the instrument to the required specifications it was standardized using a reagent blank and the recommended working standard solution for each element. The instrument was then set to register a reading every 0.2 seconds and to display the average of 5 such readings. The working samples were then aspirated into the flame and concentrations in ppm displayed directly were noted. Between samples deionized water was aspirated to clean up the nebulizer system. Concentration of each element in the original serum sample was then computed using necessary dilution factors.

The data obtained was statistically analysed (Snedecor and Cochran, 1967) to correlate with the fertility status of the animal.

Supplementation

Those heifers with impaired fertility showing subnormal serum levels of any of the above minerals were supplemented suitably and their reproductive performance was then followed up. For this purpose animals with calcium <8 mg%, inorganic phosphorus <4 mg%, copper <1 ppm, zinc <1.2 ppm and manganese <0.02 ppm serum levels were considered deficient and were suitably supplemented. Those deficient heifers which were not given supplementation were taken as controls.

Soil analysis

Soil analysis was also done to find the mineral status of the soil at the selected areas.

Sampling

Pooled soil samples were collected from Changaramkulam and Edappal of Malappuram district, Payimbra, Makkada, Olavanna, Vellimadukunnu and Kuruvattoor of Calicut district. Uniformly thick sample was taken from the surface to plough depth.

A `V' shape cut was taken by using spade. Uniformly thick slice of soil, two centimeter in thickness was taken from one side of the cut (from longer side of `V'), samples were taken from a number of spots - 15-20 samples were taken from one acre of land. Samples collected were mixed together and reduced to 1 kg by quartering.

Soil samples were mixed, spread uniformly in the form of a square or rectangle on a clean paper and divided it into 4 equal parts. The opposite corners were rejected. The remaining soil was again spread as a square, and quartering repeated till the convenient sample size (1 kg) was attained.

Samples were spread out on polyethylene sheet and dried in shade. After drying the sample was ground in a mortar, and seived via. 2 mm seiver.

The prepared soil samples were used for the estimation of minerals, (phosphorus by calorimetry and calcium, copper, zinc and manganese by atomic absorption spectrophotometry)

Results

RESULT

A detailed investigation on the influence of feeding and management as well as certain biochemical parameters on the reproductive performance of 112 crossbred heifers selected at random from rural areas of Calicut and Malappuram Districts was carried out. Regular and periodic gynaecological examination and weight recording were undertaken, serum calcium, inorganic phosphorus, copper, zinc and manganese were estimated and effect of supplementation of the respective element to the deficient heifers was evaluated. The data are presented in Table 1 to 24.

The result of the investigations on the reproductive performance of 112 crossbred heifers studied are presented in Table 17 and Fig.1. Out of these 112 animals, 33 (29.5%) were normally cycling while the remaining 79 (70.5%) were of impaired fertility. The various conditions observed were true anoestrum 41 (36.6%), underdeveloped genitalia 22 (19.6%), repeat breeders 11 (9.8%), suboestrum 4 (3.6%) and bilateral ovarian hypoplasia 1 (0.9%). Out of 112 animals, 89 were followed up and they were grouped based on their reproductive status as 41 with true anoestrum, 22 under developed genitalia, 11 repeat breeders and 15 normally cycling control animals.

For studying the gain in body weight of the above heifers they were classified into four age groups as 1½ - <2 years, 2 - <2½ years, 2½ - <3 years and 3 years and above. The growth of the heifers were studied based on the daily body weight gain calculated from the body measurements taken at an interval of ten days (Table 6, 24 and Fig.2). The average daily weight gain of heifers in the first group was 45.5 ± 3.79 g, as against 43.54 ± 2.92 g in the second group, 28.96 ± 3.68 g in the third group and 15.97 ± 3.68 g in the fourth group respectively. There was significant differences in weight gain between the age groups except between group one and two.

Average daily weight gain of heifers belonging to control, anoestrous, underdeveloped genitalia and repeat breeder groups was 55.05 ± 4.2 g, 32.26 ± 2.49 g, 27.33 ± 8.4 g and 24.1 ± 4.8 g respectively. The weight gain of control animals was significantly higher than those of the other three groups (Table 1 to 4 and Fig.3).

Similarly, based on the feeding data collected, the plane of nutrition of heifers were grouped into 3 as moderate, low and poor compared with the existing standards. Out of the 89 heifers 33.7 per cent were under moderate plane, 38.2 per cent low plane and 28.1 per cent under poor plane of nutrition.

The average daily weight gain was 46.1 ± 2.99 g, 30.42 ± 2.62 g and 23.76 ± 3.66 g respectively for those heifers kept under moderate, low and poor planes of nutrition respectively. There was significant difference between weight gain for moderate plane with that of low plane as well as that of poor plane (Table 5 and Fig.4).

Seventy three per cent of normally cycling heifers studied were under moderate plane of nutrition while the remaining 27 per cent received only low or poor plain of nutrition. Major part of heifers of true anoestrum and under developed genitalia heifers were under low and poor planes.

The serum calcium levels of all the 89 heifers were well with in the normal range. Mean serum calcium level in normally cycling heifers was 11.1 ± 0.31 mg%. The corresponding values for true anoestrous, underdeveloped genitalia and repeat breeders were respectively, 10.74 ± 0.13 mg%, 10.8 ± 0.24 mg% and 10.8 ± 0.42 mg%. There was no significant difference in the serum calcium level between the group (Table 2-5 and Fig.5). While the mean serum inorganic phosphorus level of normally cycling heifers was 4.87 ± 0.13 mg%, while that of true anoestrous, under developed genitalia and repeat breeders were 3.83 ± 0.09 mg%, 3.52 ± 0.1 and 4.7 ± 0.15 respectively. It was found that there was significant difference in the level of serum phosphorus level of control group with that of true anoestrous group and under developed genitalia group. Twenty five numbers of true anoestrous heifers and 16 numbers of under developed genitalia cases had phosphorus level below 4 mg% (Table 1-4, 22 and Fig.6).

Mean serum copper level in cycling heifers was with in the normal range (1.26 ± 0.07 ppm), that of anoestrous heifers and heifers with under developed genitalia found subnormal i.e., 0.9 ± 0.04 ppm and 0.71 ± 0.05 ppm respectively. Twenty two numbers of anoestrous heifers and 19 numbers of under developed genitalia cases had shown subnormal copper level. In case of repeat breeders the mean serum copper level was with in the normal range (1.27 ± 0.08 ppm) (Table 1-4, 22 and Fig.7). Significant difference was obtained between serum copper level of control with that of true anoestrous and under developed genitalia.

Mean serum zinc were 1.71 ± 0.05 ppm, 1.61 ± 0.03 ppm, 1.6 ± 0.05 ppm and 1.73 ± 0.06 ppm for cycling heifers, heifers with true anoestrus, under developed genitalia and repeat breeders respectively. There was no significant difference between the groups. The values for manganese were 0.04 ± 0.002 ppm, for all the groups (Table 1-4 and Fig.8).

On comparative study serum biochemistry of some minerals were also related with the plane of nutrition of the respective animal. There was significant difference in the serum level of phosphorus and copper between moderate plane and poor plane of nutrition (Table 12-16, 23 and Fig.9 to 12).

While comparing the serum mineral status of heifers at different age groups, found that there was no significant variation among the groups (Table 7-11, 24 and Fig.13-16).

Supplementation

Fifteen heifers from true anoestrum group were found deficient in phosphorus alone out of which ten were supplemented with phosphorus and five kept as control.

The result obtained from supplementation of phosphorus in 10 numbers of anoestrous heifers deficient in phosphorus alone with dicalcium phosphate for one month period (80 gm/day), 7 numbers showed oestrus (70%), while in the phosphorus deficient non-supplemented control group only 2 numbers (40%) showed oestrus. The difference was found to be highly significant. Two heifers in the treatment group (28.5%) became pregnant while none conceived in control group (Table $18a_1$ and $18a_2$).

Twelve heifers showed subnormal serum copper alone of which four were taken as control. Out of 8 animals supplemented with 1 g of copper sulphate in alternate days for a period of one month, 5 (62.5%) showed oestrus, of which

3 (60%) conceived (Table $19a_1$ and $19a_2$). In control group out of four, only one (25%) came to heat. The difference between the control and the treatment group was found significant.

Ten anoestrous heifers revealed subnormal serum levels of both phosphorus and copper. Of this, seven were treated and three kept as control. These seven heifers were supplemented with a combination of 80 g dicalcium phosphate and 0.5 g copper sulphate daily for a period of one month. Out of them, 5 (71%) showed oestrus, whereas none in the control group came to oestrum. The difference was significant. Of the five responded, two conceived (40%) (Table $20a_1$ and $20a_2$).

In 22 cases of under developed genitalia 16 numbers were found to have a combined deficiency of inorganic phosphorus and copper. From these, 10 animals were treated with a combination of 80 g dicalcium phosphate and 0.5 g copper sulphate for a period of one month and 6 animals were kept as control. Of the heifers supplemented 3 (33.3%) came to oestrum as against 1 (16.2%) in the control group (Table $21a_1$ and $21a_2$).

Soil analysis

Deficiency of serum inorganic phosphorus and copper were noticed in true anoestrous heifers and in under developed genitalia. Therefore soil analysis was conducted to detect whether the deficiency is due to low level of available phosphorus and available copper in the soil of the relevant areas. The phosphorus levels obtained were ranged 0.05-0.06 per cent in average and the available copper levels were 5.32 ppm, 5.38 ppm, 5.42 ppm, 5.37 ppm, 5.44 ppm, 5.30 ppm and 5.4 ppm in the soil samples, collected from Edappal, Changaramkulam, Payimbra, Makkada, Olavanna, Vellimadukunnu and Kuruvattam respectively (Table 25). The soil content of both phosphorus and copper were found to be within the normal range for laterite soil and no significant difference between the samples was noticed (Table 25).

Meteorological data

The meteorological data of the period of study with respect to the relevant areas of Calicut and Malappuram are presented in Table 26 and 27.

The mean values of temperature (maximum and minimum) in degree celsius, rainfall in mm, mean relative humidity in percentage and sun shine in hours for both Calicut and Malappuram did not show any significant difference.

Table 1: DAILY WEIGHT GAIN, PLANE OF NUTRITION,AGE AND SERUM MINERAL STATUS OF NORMALLY CYCLING HEIFERS

Sl. no.	*Daily Wt. gain(g)*	*Plane of Nutrition*	*Age Years*	*Ca mg%*	*P mg%*	*Cu ppm*	*Zn ppm*	*Mn ppm*
1	98.33	M	1.5 - 2	11.20	5.60	1.42	1.62	0.03
2	68.60	M	"	11.80	4.53	1.30	1.87	0.04
3	45.75	L	"	10.70	5.12	1.16	1.62	0.04
4	82.25	M	"	9.60	4.37	1.08	1.29	0.05
5	77.70	M	2 - 2.5	9.10	5.26	1.27	1.50	0.04
6	102.00	M	"	11.90	4.87	1.08	1.90	0.04
7	67.80	M	"	9.40	4.70	1.44	1.61	0.04
8	38.08	M	"	11.60	5.00	1.10	1.25	0.03
9	42.20	M	"	12.50	4.94	1.32	1.88	0.04
10	38.90	M	"	11.70	4.65	1.18	1.91	0.03
11	40.55	L	2.5 - 3	12.70	5.01	1.24	1.90	0.05
12	25.00	M	"	11.00	4.17	1.28	2.10	0.06
13	36.10	M	"	12.80	4.20	1.13	1.48	0.05
14	50.00	L	"	10.70	5.50	1.62	1.90	0.03
15	12.20	L	3 & above	10.00	5.13	1.24	1.80	0.04
Mean	55.03			11.11	4.87	1.26	1.71	0.041
SE	4.20			0.31	0.13	0.07	0.05	0.002

[M - moderate , L - low , P - poor]

Table 2: DAILY WEIGHT GAIN, PLANE OF NUTRITION,AGE AND SERUM MINERAL STATUS OF HEIFERS WITH TRUE ANOESTRUM

Sl. no.	*Daily Wt. gain(g)*	*Plane of Nutrition*	*Age Years*	*Ca mg%*	*P mg%*	*Cu ppm*	*Zn ppm*	*Mn ppm*
1	44.40	L	1.5 - 2	11.90	3.22	0.59	1.60	0.05
2	44.40	M	"	10.30	4.20	0.52	1.42	0.04
3	38.80	L	"	10.90	4.00	1.01	1.61	0.04
4	41.60	M	"	9.80	4.36	0.48	1.30	0.06
5	36.10	P	"	10.10	4.06	0.68	1.45	0.04
6	32.20	P	"	10.70	3.84	1.26	1.85	0.03
7	58.30	M	"	9.90	4.02	0.89	1.99	0.04
8	33.30	L	2 - 2.5	10.70	3.25	1.00	1.80	0.06
9	41.60	L	"	11.00	3.92	0.80	1.72	0.03
10	30.00	M	"	12.60	3.16	0.96	1.60	0.04
11	38.30	P	"	10.60	4.04	1.46	1.61	0.04
12	51.10	M	"	10.40	4.20	1.06	1.29	0.04
13	67.20	M	"	8.90	4.25	0.62	1.24	0.04
14	44.40	M	"	11.10	3.90	1.20	1.98	0.06
15	50.00	L	"	10.00	3.86	1.16	2.06	0.05
16	29.00	P	"	11.30	3.43	1.07	1.42	0.04
17	33.88	L	"	11.60	3.86	0.46	1.68	0.04
18	35.16	L	"	10.20	4.18	1.11	1.73	0.06
19	35.50	L	"	9.60	4.02	0.89	1.48	0.03
20	47.70	M	"	10.60	4.40	0.61	1.52	0.04
21	8.88	P	2.5 - 3	10.90	3.42	0.66	1.26	0.06
22	25.00	M	"	11.20	3.26	1.07	1.71	0.03
23	27.30	L	"	9.80	4.20	0.55	1.35	0.04
24	33.80	P	"	10.30	4.30	0.48	1.75	0.04
25	16.70	L	"	10.70	3.72	1.62	1.86	0.04
26	25.00	L	"	9.20	3.67	1.08	1.92	0.04

(Continued..)

(Table 2 continued)

Sl. no.	*Daily Wt. gain(g)*	*Plane of Nutrition*	*Age Years*	*Ca mg%*	*P mg%*	*Cu ppm*	*Zn ppm*	*Mn ppm*
27	36.60	M	"	11.80	3.61	0.70	1.63	0.04
28	22.80	L	"	10.90	3.70	1.54	1.80	0.03
29	30.38	L	"	11.10	3.91	0.57	1.61	0.04
30	46.10	M	"	11.80	3.28	1.08	1.48	0.04
31	47.20	M	"	11.40	2.67	0.66	1.72	0.06
32	20.50	L	"	11.20	3.90	1.29	1.36	0.06
33	25.50	M	"	10.60	4.50	0.59	1.29	0.04
34	9.50	P	3 & above	10.10	3.65	1.10	1.42	0.04
35	20.55	M	"	11.80	3.92	1.12	1.59	0.04
36	11.10	L	"	11.90	3.65	1.00	1.61	0.04
37	12.70	L	"	11.20	4.82	0.69	1.70	0.04
38	24.40	L	"	10.80	4.03	0.72	1.48	0.03
39	4.40	L	"	10.60	3.25	1.14	1.69	0.05
40	28.80	L	"	10.80	3.90	0.65	1.76	0.04
41	12.70	M	"	10.00	3.48	0.71	1.52	0.06
Mean	32.26			10.74	3.83	0.90	1.61	0.04
SE	2.49			0.13	0.08	0.04	0.03	0.002

[M - moderate, L - low, P - poor]

Table 3: DAILY WEIGHT GAIN, PLANE OF NUTRITION,AGE AND SERUM MINERAL STATUS OF HEIFERS WITH UNDER DEVELOPED GENITALIA

Sl. no.	*Daily Wt. gain(g)*	*Plane of Nutrition*	*Age Years*	*Ca mg%*	*P mg%*	*Cu ppm*	*Zn ppm*	*Mn ppm*
1	28.33	P	1.5 <2	11.80	4.13	1.00	1.62	0.04
2	30.50	P	"	11.92	3.06	0.44	1.41	0.03
3	25.00	P	"	12.00	3.00	0.65	1.89	0.04
4	28.30	L	"	10.80	2.49	0.53	1.60	0.04
5	25.00	P	"	9.80	3.22	0.48	1.52	0.05
6	24.40	P	2 <2.5	12.10	3.02	0.67	1.64	0.03
7	47.22	L	"	11.80	3.58	0.71	1.48	0.05
8	34.40	L	"	10.60	3.79	0.64	1.42	0.04
9	29.40	P	"	11.50	2.96	0.53	1.61	0.04
10	29.40	L	"	9.60	3.80	0.68	1.49	0.05
11	31.10	L	"	10.90	3.45	0.70	1.47	0.04
12	2.70	P	2.5 <3	9.20	3.01	0.40	1.68	0.05
13	38.80	L	"	12.70	3.00	0.58	1.72	0.06
14	33.80	P	"	10.10	3.70	0.69	1.50	0.04
15	56.00	L	"	10.40	3.38	0.61	1.48	0.05
16	28.38	P	"	9.60	4.91	0.82	1.89	0.04
17	15.94	P	"	9.21	4.64	1.12	1.56	0.04
18	28.30	L	"	10.60	4.10	1.01	1.42	0.05
19	12.70	L	"	9.82	2.92	0.65	1.72	0.06
20	22.00	L	3 & above	10.60	4.02	1.20	1.52	0.04
21	19.50	L	"	9.87	4.00	0.65	1.65	0.04
22	10.20	P	"	12.90	3.22	0.90	1.90	0.05
Mean	27.34			10.81	3.52	0.71	1.60	0.04
SE	3.40			0.24	0.10	0.05	0.05	0.002

[M - moderate ,L - low ,P - poor]

Table 4: DAILY WEIGHT GAIN, PLANE OF NUTRITION,AGE AND SERUM MINERAL STATUS OF REPEAT BREEDER HEIFERS

Sl. no.	*Daily Wt. gain(g)*	*Plane of Nutrition*	*Age Years*	*Ca mg%*	*P mg%*	*Cu ppm*	*Zn ppm*	*Mn ppm*
1.00	41.20	L	2 < 2.5	10.80	4.24	1.42	2.00	0.04
2.00	34.62	L	"	11.60	4.10	1.10	1.84	0.05
3.00	40.50	M	2.5 < 3	13.00	4.00	0.98	1.65	0.04
4.00	18.62	P	"	12.00	4.52	1.26	1.42	0.04
5.00	26.54	M	"	8.90	5.61	1.65	1.65	0.04
6.00	20.15	L	"	8.50	5.12	1.00	1.94	0.03
7.00	15.16	L	3 & above	10.26	4.92	1.37	1.69	0.05
8.00	21.00	M	"	11.60	4.64	1.20	1.84	0.04
9.00	12.80	P	"	10.10	4.88	1.12	1.77	0.04
10.00	19.65	M	"	12.10	4.45	1.61	1.74	0.04
11.00	14.85	L	"	9.90	5.26	1.22	1.46	0.03
Mean	24.10			10.80	4.70	1.27	1.73	0.04
SE	4.81			0.42	0.15	0.08	0.06	0.002

[M - moderate,L -low,P - poor]

Table 5: EFFECT OF PLANE OF NUTRITION ON DAILY WEIGHT GAIN (g) IN HEIFERS

Sl No.	*Moderate Plane*	*Low Plane*	*Poor Plane*
1	98.33	45.75	36.10
2	68.60	40.55	32.20
3	82.25	50.00	38.30
4	77.70	12.20	8.88
5	102.00	44.40	33.80
6	67.80	38.80	9.50
7	38.08	33.30	28.33
8	42.20	41.60	30.50
9	38.90	50.00	25.00
10	25.00	33.88	25.00
11	36.10	35.16	24.40
12	44.40	35.50	29.40
13	41.60	27.30	2.70
14	58.30	16.70	33.80
15	30.00	25.00	28.38
16	51.10	22.80	15.94
17	67.20	30.38	10.20
18	44.40	20.50	18.62
19	47.70	11.10	20.50
20	44.20	22.60	28.30
21	42.00	28.10	**
22	36.60	24.40	**
23	46.10	28.30	**
24	47.20	47.22	**
25	25.50	34.40	**
26	20.55	29.40	**
27	12.70	31.10	**
28	40.50	38.80	**
29	26.54	56.00	**
30	21.00	28.30	**
31	19.65	12.70	**
32	**	21.00	**
33	**	22.00	**
34	**	19.50	**
35	**	41.20	**
36	**	34.62	**
37	**	20.15	**
38	**	15.16	**
39	**	14.85	**
Mean	46.10	30.42	23.77
SE	2.99	2.62	3.66

Table 6: DAILY WEIGHT GAIN (grams) IN HEIFERS AT DIFFERENT AGE GROUP

Sl. No.	1.5 < 2 Years	2 < 2.5 Years	2.5 < 3 Years	3 Years & above
1	98.33	77.70	40.55	12.20
2	68.60	102.00	25.00	9.50
3	45.75	67.80	36.10	20.55
4	82.25	38.08	50.00	11.10
5	44.40	42.20	8.88	12.70
6	44.40	38.90	25.00	24.40
7	38.80	33.30	27.30	4.40
8	41.60	41.60	33.80	28.80
9	36.10	30.00	16.70	12.70
10	32.20	38.30	25.00	22.00
11	58.30	51.10	36.60	19.50
12	28.33	67.20	22.80	10.20
13	30.50	44.40	30.38	16.16
14	25.00	50.00	46.10	21.00
15	28.30	29.00	47.20	12.80
16	25.00	33.88	20.50	19.65
17	**	35.16	25.50	14.85
18	**	47.70	2.70	**
19	**	24.40	38.80	**
20	**	47.22	33.80	**
21	**	34.40	56.00	**
22	**	29.40	28.38	**
23	**	29.40	15.94	**
24	**	31.10	28.30	**
25	**	41.20	12.70	**
26	**	34.62	40.50	**
27	**	35.50	18.62	**
28	**	**	26.54	**
29	**	**	20.15	**
Mean	45.49	43.54	28.96	15.97
SE	3.79	2.92	2.82	3.68

Table 7: SERUM CALCIUM LEVEL (mg %) OF HEIFERS IN VARIOUS AGE GROUP

Sl. No.	1.5 < 2 Years	2 < 2.5 Years	2.5 < 3 Years	3 and above
1	11.20	9.10	12.70	10.00
2	11.80	11.90	11.00	10.10
3	10.70	9.40	12.80	11.80
4	9.60	11.60	10.70	11.90
5	11.90	12.50	10.90	11.20
6	10.30	11.70	11.20	10.80
7	10.90	10.70	9.80	10.60
8	9.80	11.00	10.30	10.80
9	10.10	12.60	10.70	10.00
10	10.70	10.60	9.20	10.60
11	9.90	10.40	11.80	9.87
12	11.80	8.90	10.90	12.90
13	11.92	11.10	11.10	10.26
14	12.00	10.00	11.80	11.60
15	10.80	11.30	11.40	10.10
16	9.80	11.60	11.20	12.10
17	**	10.20	10.60	9.90
18	**	9.60	9.20	**
19	**	10.60	12.70	**
20	**	12.10	10.10	**
21	**	11.80	10.40	**
22	**	10.60	9.60	**
23	**	11.50	9.21	**
24	**	9.60	10.60	**
25	**	10.90	9.82	**
26	**	10.80	13.00	**
27	**	11.60	12.00	**
28	**	**	8.90	**
29	**	**	8.50	**
Mean	10.83	10.88	10.76	10.85
SE	0.26	0.20	0.19	0.25

Table 8: SERUM PHOSPHORUS LEVEL(mg%)OF HEIFERS IN VARIOUS AGE GROUP

Sl. No.	1.5 < 2 Years	2 < 2.5 Years	2.5 < 3 Years	3 and above
1	5.60	5.26	5.01	5.13
2	4.53	4.87	4.17	3.65
3	5.12	4.70	4.20	3.92
4	4.37	5.00	5.50	3.65
5	3.22	4.94	3.42	4.82
6	4.20	4.65	3.26	4.03
7	4.00	3.25	4.20	3.25
8	4.36	3.92	4.30	3.90
9	4.06	3.16	3.72	3.48
10	3.84	4.04	3.67	4.02
11	4.02	4.20	3.61	4.00
12	4.13	4.25	3.70	3.22
13	3.06	3.90	3.91	4.92
14	3.00	3.86	3.28	4.64
15	2.49	3.43	2.67	4.88
16	3.22	3.86	3.90	4.45
17	**	4.18	4.50	5.26
18	**	4.02	3.01	**
19	**	4.40	3.00	**
20	**	3.02	3.70	**
21	**	3.58	3.38	**
22	**	3.79	4.91	**
23	**	2.96	4.64	**
24	**	3.80	4.10	**
25	**	3.45	2.92	**
26	**	4.24	4.00	**
27	**	4.10	4.52	**
28	**	**	5.61	**
29	**	**	5.12	**
Mean	3.95	4.03	4.00	4.19
SE	0.18	0.14	0.13	0.17

Table 9: SERUM COPPER LEVEL (ppm) OF HEIFERS IN VARIOUS AGE GROUP

Sl. No.	1.5 < 2 Years	2 < 2.5 Years	2.5 < 3 Years	3 and above
1	1.42	1.27	1.24	1.24
2	1.30	1.08	1.28	1.10
3	1.16	1.44	1.13	1.12
4	1.08	1.10	1.62	1.00
5	0.59	1.32	0.66	0.69
6	0.52	1.18	1.07	0.72
7	1.01	1.00	0.55	1.14
8	0.48	0.80	0.48	0.65
9	0.68	0.96	1.62	0.71
10	1.26	1.46	1.08	1.20
11	0.89	1.06	0.70	0.65
12	1.00	0.62	1.54	0.90
13	0.44	1.20	0.57	1.37
14	0.65	1.16	1.08	1.20
15	0.53	1.07	0.66	1.12
16	0.48	0.46	1.29	1.61
17	**	1.11	0.59	1.22
18	**	0.89	0.40	**
19	**	0.61	0.58	**
20	**	0.67	0.69	**
21	**	0.71	0.61	**
22	**	0.64	0.82	**
23	**	0.53	1.12	**
24	**	0.68	1.01	**
25	**	0.70	0.65	**
26	**	1.42	0.98	**
27	**	1.10	1.26	**
28	**	**	1.65	**
29	**	**	1.00	**
Mean	0.84	0.97	0.96	1.04
SE	0.08	0.06	0.06	0.08

Table 10: SERUM ZINC LEVEL (ppm) OF HEIFERS IN VARIOUS AGE GROUP

Sl. No.	1.5 < 2 Years	2 < 2.5 Years	2.5 < 3 Years	3 and above
1	1.62	1.50	1.90	1.80
2	1.87	1.90	2.10	1.42
3	1.62	1.61	1.48	1.59
4	1.29	1.25	1.90	1.61
5	1.60	1.88	1.26	1.70
6	1.42	1.91	1.71	1.28
7	1.61	1.80	1.35	1.69
8	1.30	1.72	1.75	1.76
9	1.45	1.60	1.86	1.52
10	1.85	1.61	1.92	1.52
11	1.99	1.29	1.63	1.65
12	1.62	1.24	1.80	1.90
13	1.41	1.98	1.61	1.69
14	1.89	2.06	1.48	1.84
15	1.60	1.42	1.72	1.77
16	1.52	1.68	1.36	1.74
17	**	1.23	1.29	1.46
18	**	1.48	1.68	**
19	**	1.52	1.72	**
20	**	1.64	1.50	**
21	**	1.48	1.48	**
22	**	1.42	1.89	**
23	**	1.61	1.56	**
24	**	1.49	1.42	**
25	**	1.47	1.72	**
26	**	2.00	1.65	**
27	**	1.84	1.42	**
28	**	**	1.65	**
29	**	**	1.94	**
Mean	1.60	1.62	1.65	1.64
SE	0.06	0.04	0.04	0.05

Table 11: SERUM MANGANESE LEVEL (ppm) OF HEIFERS IN VARIOUS AGE GROUP

Sl. No.	*1.5 < 2 Years*	*2 < 2.5 Years*	*2.5 < 3 Years*	*3 and above*
1	0.03	0.04	0.05	0.04
2	0.04	0.04	0.06	0.04
3	0.04	0.04	0.05	0.04
4	0.05	0.03	0.03	0.04
5	0.05	0.04	0.06	0.04
6	0.04	0.03	0.03	0.03
7	0.04	0.06	0.04	0.05
8	0.06	0.03	0.04	0.04
9	0.04	0.04	0.04	0.06
10	0.03	0.04	0.04	0.04
11	0.04	0.04	0.04	0.04
12	0.04	0.04	0.03	0.05
13	0.03	0.06	0.04	0.05
14	0.04	0.05	0.04	0.04
15	0.04	0.04	0.06	0.04
16	0.05	0.04	0.06	0.04
17	**	0.06	0.04	0.03
18	**	0.03	0.05	**
19	**	0.04	0.06	**
20	**	0.03	0.04	**
21	**	0.05	0.05	**
22	**	0.04	0.04	**
23	**	0.04	0.04	**
24	**	0.05	0.05	**
25	**	0.04	0.06	**
26	**	0.04	0.04	**
27	**	0.05	0.04	**
28	**		0.04	**
29	**		0.03	**
Mean	0.04	0.04	0.04	0.04
SE	0.01	0.01	0.01	0.01

Table 12: EFFECT OF PLANE OF NUTRITION IN SERUM CALCIUM LEVEL (mg%)

Sl No.	*Moderate Plane*	*Low Plane*	*Poor Plane*
1	11.20	10.70	10.10
2	11.80	12.70	10.70
3	9.60	10.70	10.60
4	9.10	10.00	11.30
5	11.90	11.90	10.90
6	9.40	10.90	10.30
7	11.60	10.70	10.10
8	12.50	11.00	11.80
9	11.70	10.00	11.90
10	11.00	11.60	12.00
11	12.80	10.20	9.80
12	10.30	9.60	12.10
13	9.80	9.80	11.50
14	9.90	10.70	9.20
15	12.60	9.20	10.10
16	10.40	10.90	9.60
17	8.90	11.10	9.20
18	11.10	11.20	12.90
19	10.60	11.90	12.00
20	11.20	11.20	10.10
21	11.80	10.80	**
22	11.80	10.60	**
23	11.40	10.80	**
24	10.60	10.80	**
25	11.80	11.80	**
26	10.00	10.60	**
27	13.00	9.60	**
28	11.60	10.90	**
29	12.10	12.70	**
30	8.90	10.40	**
31	**	10.60	**
32	**	9.80	**
33	**	10.60	**
34	**	9.90	**
35	**	10.80	**
36	**	11.60	**
37	**	8.50	**
38	**	10.30	**
39	**	9.90	**
Mean	11.01	10.69	10.81
SE	0.25	0.22	0.31

Table 13: EFFECT OF PLANE OF NUTRITION IN SERUM PHOSPHORUS LEVEL (mg%)

Sl No.	*Moderate Plane*	*Low Plane*	*Poor Plane*
1	5.60	5.12	4.06
2	4.53	5.01	3.84
3	4.37	5.50	4.04
4	5.26	5.13	3.43
5	4.87	3.22	3.42
6	4.70	4.00	4.30
7	5.00	3.25	3.65
8	4.94	3.92	4.13
9	4.65	3.86	3.06
10	4.17	3.86	3.00
11	4.20	4.18	3.22
12	4.20	4.02	3.02
13	4.36	4.20	2.96
14	4.02	3.72	3.01
15	3.16	3.67	3.70
16	4.20	3.70	4.91
17	4.25	3.91	4.64
18	3.90	3.90	3.22
19	4.40	3.65	4.52
20	3.26	4.82	4.88
21	3.61	4.03	**

Sl No.	*Moderate Plane*	*Low Plane*	*Poor Plane*
22	3.28	3.25	**
23	2.67	3.90	**
24	4.50	2.49	**
25	3.92	3.58	**
26	3.48	3.79	**
27	4.00	3.80	**
28	5.61	3.45	**
29	4.64	3.38	**
30	4.45	4.10	**
31	**	4.02	**
32	**	4.00	**
33	**	3.00	**
34	**	2.92	**
35	**	4.24	**
36	**	4.10	**
37	**	5.12	**
38	**	4.92	**
39	**	5.26	**
Mean	4.27	3.99	3.75
SE	0.12	0.11	0.15

Table 14: EFFECT OF PLANE OF NUTRITION IN SERUM COPPER LEVEL (ppm)

Sl No.	*Moderate Plane*	*Low Plane*	*Poor Plane*
1	1.42	1.20	0.61
2	1.30	1.24	1.26
3	1.08	1.62	1.46
4	1.27	1.24	1.07
5	1.08	0.59	0.66
6	1.44	1.01	0.48
7	1.10	1.00	1.10
8	1.32	0.80	1.00
9	1.18	1.16	0.44
10	1.28	0.46	0.65
11	1.13	1.11	0.48
12	0.52	0.89	0.67
13	0.48	0.55	0.53
14	0.89	1.62	0.40
15	0.96	1.08	0.69
16	1.06	1.54	0.82
17	0.62	0.57	1.12
18	1.20	1.29	0.90
19	0.61	1.00	1.26
20	1.07	0.69	1.12
21	0.70	0.72	**
22	1.08	1.14	**
23	0.66	0.65	**
24	0.59	0.53	**
25	1.12	0.71	**
26	0.71	0.64	**
27	0.98	0.68	**
28	1.65	0.70	**
29	1.20	0.61	**
30	1.61	1.01	**
31	**	1.20	**
32	**	0.65	**
33	**	0.58	**
34	**	0.65	**
35	**	1.42	**
36	**	1.10	**
37	**	1.00	**
38	**	1.37	**
39	**	1.22	**
Mean	1.04	0.95	0.84
SE	0.06	0.05	0.07

Table 16: EFFECT OF PLANE OF NUTRITION IN SERUM ZINC LEVEL (ppm)

SI No.	Moderate Plane	Low Plane	Poor Plane
1	1.62	1.62	1.45
2	1.87	1.90	1.85
3	1.29	1.90	1.61
4	1.50	1.80	1.42
5	1.90	1.60	1.26
6	1.61	1.61	1.75
7	1.25	1.80	1.42
8	1.88	1.72	1.62
9	1.91	2.06	1.41
10	2.10	1.68	1.89
11	1.48	1.73	1.52
12	1.42	1.48	1.64
13	1.30	1.35	1.61
14	1.99	1.88	1.68
15	1.60	1.92	1.50
16	1.29	1.80	1.89
17	1.24	1.51	1.56
18	1.98	1.36	1.90
19	1.52	1.61	1.42
20	1.71	1.70	1.77
21	1.63	1.48	**
22	1.48	1.69	**
23	1.72	1.76	**
24	1.29	1.60	**
25	1.59	1.48	**
26	1.52	1.42	**
27	1.65	1.49	**
28	1.65	1.47	**
29	1.84	1.48	**
30	1.74	1.42	**
31	**	1.52	**
32	**	1.65	**
33	**	1.72	**
34	**	1.72	**
35	**	2.00	**
36	**	1.84	**
37	**	1.94	**
38	**	1.69	**
39	**	1.46	**
Mean	1.62	1.66	1.61
SE	0.04	0.04	0.05

Table 16: EFFECT OF PLANE OF NUTRITION IN SERUM MANGANESE LEVEL (ppm)

Sl No.	*Moderate Plane*	*Low Plane*	*Poor Plane*
1	0.03	0.04	0.04
2	0.04	0.05	0.03
3	0.05	0.03	0.04
4	0.04	0.04	0.04
5	0.04	0.05	0.06
6	0.04	0.04	0.04
7	0.03	0.06	0.04
8	0.04	0.03	0.04
9	0.03	0.05	0.03
10	0.06	0.04	0.04
11	0.05	0.06	0.05
12	0.04	0.03	0.03
13	0.06	0.04	0.04
14	0.04	0.04	0.05
15	0.04	0.04	0.04
16	0.04	0.03	0.04
17	0.04	0.04	0.04
18	0.06	0.06	0.05
19	0.04	0.04	0.04
20	0.03	0.04	0.04
21	0.04	0.03	**
22	0.04	0.05	**
23	0.06	0.04	**
24	0.04	0.04	**
25	0.04	0.05	**
26	0.06	0.04	**
27	0.04	0.05	**
28	0.04	0.04	**
29	0.04	0.05	**
30	0.04	0.05	**
31	**	0.04	**
32	**	0.04	**
33	**	0.06	**
34	**	0.06	**
35	**	0.04	**
36	**	0.05	**
37	**	0.03	**
38	**	0.05	**
39	**	0.03	**
Mean	0.04	0.04	0.04
SE	0.00	0.00	0.00

Table 17. Reproductive status of crossbred heifers

Total No.	Number of heifers in true anoestrum	Under developed genitalia	Repeat breeders	Normally cycling	Sub-oestrus	Congenital bilateral ovarian hypoplasia
112	41 (36.6%)	22 (19.6%)	11 (9.8%)	33 (29.5%)	4 (3.6%)	1 (0.9%)

Table 18 : SUPPLEMENTATION OF MINERAL IN TRUE ANOESTRUS HEIFERS (Dicalcium phosphate 80g)

Table 18 (a1) : Treatment group

SI. No.	*Duration for onset of oestrum(days)*	*AI response*
1	45	conceived
2	60	-ve
3	84	-ve
4	29	-ve
5	47	conceived
6	38	-ve
7	19	conceived
8	no response	
9	"	
10	"	
Mean	46	

Table 18 (a2) : Control group

SI. No.	*Duration for onset of oestrum(days)*	*AI response*
1	79	-ve
2	anoestrous	
3	92	-ve
4	anoestrous	
5	"	
Mean	85.5	

Table 19 : SUPPLEMENTATION OF MINERAL IN TRUE 'ANOESTRUS HEIFERS (Copper sulphate 1.0g)

Table 19 (a1) : Treatment group

SI. No.	*Duration for onset of oestrum(days)*	*AI response*
1	40	concieved
2	32	conceived
3	67	-ve
4	26	conceived
5	73	-ve
6	no response	
7	"	
8	"	
Mean	47.6	

Table 19 (a2) : Control group

SI. No.	*Duration for onset of oestrum(days)*	*AI response*
1	anoestrous	
2	"	
3	"	
4	48	conceived
Mean	48	

Table 20 : SUPPLEMENTATION OF MINERAL IN TRUE ANOESTROUS HEIFERS (Dical.phosphate & Copp. sulphate)

Table 20 (a1) : Treatment group

Sl. No.	*Duration for onset of oestrum(days)*	*AI response*
1	38	concieved
2	42	conceived
3	45	-ve
4	29	-ve
5	86	-ve
6	no response	
7	"	
Mean	48	

Table 20 (a2) : Control group

Sl. No.	*Duration for onset of oestrum(days)*	*AI response*
1	anoestrous	
2	"	
3	"	

Table 21 : SUPPLEMENTATION OF MINERAL IN UDG HEIFERS (Dicalcium phosphate & Copper sulphate)

Table 21 (a1) : Treatment group

Sl. No.	*Duration for onset of oestrum(days)*	*AI response*
1	92	-ve
2	101	-ve
3	no response	
4	no response	
5	"	
6	"	
7	"	
8	"	
9	"	
10	97	-ve
Mean	96.66	

Table 21 (a2) : Control group

Sl. No.	*Duration for onset of oestrum(days)*	*AI response*
1	anoestrous	
2	"	
3	"	
4	74	-ve
5	anoestrous	
6	"	

Table 22 : WEIGHT GAIN AND SERUM MINERAL LEVELS IN DIFFERENT REPRODUCTIVE STATUS

Parameters	Reprod.status			
	Cyclic	*Anoestrus*	*UDG*	*Repeaters*
Ca level(mg%)	11.1 +/-0.31	10.74+/-0.13	10.8+/-0.24	10.8+/-0.42
P level (mg%)	4.87+/-0.13	3.83+/-0.09	3.52+/-0.1	4.7+/-0.15
Cu level (ppm)	1.26+/-0.07	0.9+/-0.04	0.71+/-0.05	1.27+/-0.08
Zn level (ppm)	1.71+/-0.05	1.61+/-0.03	1.6+/-0.05	1.73+/-0.06
Mn level (ppm)	0.04+/-0.002	0.04+/-0.002	0.04+/-0.002	0.04+/-0.002
Daily Wt.gain	55.05+/-4.2	32.26+/-2.49	27.33+/-3.4	24.1+/-4.81

Table 23 : WEIGHT GAIN AND SERUM MINERAL LEVELS UNDER DIFFERENT PLANE OF NUTRITION

Parameters	*Plane of nutrition*		
	Moderate	*Low*	*Poor*
Daily Gain (g)	46.1+/-2.99	30.42+/-2.62	23.76+/-3.66
Ca level(mg%)	11.01+/-0.25	10.69+/-0.22	10.81+/-0.31
P level (mg%)	4.27+/-0.12	3.99+/-0.11	3.75+/-0.15
Cu level (ppm)	1.04+/-0.06	0.95+/-0.05	0.84+/-0.07
Zn level (ppm)	1.62+/-0.04	1.66+/-0.04	1.608+/-0.05
Mn level (ppm)	0.042+/-0.0	0.043+/-0.0	0.043+/-0.0

Table 24 : WEIGHT GAIN AND SERUM MINERAL LEVELS AT VARIOUS AGE GROUP

Parameters	Age in years			
	1.5 < 2	*2 < 2.5*	*2.5 < 3*	*3 & Above*
Daily Gain (g)	45.5+/-3.79	43.54+/-2.92	28.96+/-3.68	15.97+/-3.68
Ca levels(mg%)	10.82+/-0.26	10.87+/-0.20	10.738+/-0.19	10.85+/-0.25
P levels(mg%)	3.95+/-0.18	4.03+/-0.14	3.99+/-0.13	4.19+/-0.17
Cu levels(ppm)	0.84+/-0.08	0.97+/-0.06	0.96+/-0.06	1.04+/-0.08
Zn levels(ppm)	1.60+/-0.06	1.62+/-0.04	1.65+/-0.04	1.64+/-0.05
Mn levels(ppm)	0.04+/-0.01	0.042+/-0.01	0.044+/-0.01	0.042+/-0.01

Table 25. Data on soil analysis for calcium, phosphorus, copper, zinc and manganese at selected areas in Kozhikode and Malappuram districts

Nutrients	Edappal	Changaram-kulam	Payimbra	Makkada	Olavanna	Vellimadu-kunnu	Kuruvattoor	Mean
Calcium (Exchangeable) (%)	0.114	0.12	0.11	0.116	0.12	0.11	0.11	0.114
Phosphorus (Available) (%)	0.053	0.056	0.05	0.055	0.06	0.056	0.053	0.054
Copper (Available) (ppm)	5.32	5.38	5.42	5.37	5.44	5.30	5.40	5.37
Zinc (Available) (ppm)	4.43	4.52	4.47	4.38	4.54	4.47	4.5	4.47
Manganese (Available) (ppm)	96.34	97.1	96.8	101.2	98.82	98.18	99.7	98.30

Table 26. Temperature, rainfall, relative humidity and sunshine recorded in Malappuram District (1994-95)

Year	Month	Temperature (°C)		Rainfall (mm)	Mean relative humidity (%)	Sunshine (hrs)
		Max.	Min.			
1994	October	33.2	23.2	369.8	82.0	5.3
	November	31.3	22.5	90.4	83.0	4.2
	December	32.5	21.3	10.9	76.0	7.1
1995	January	33.5	22.0	-	68.0	8.3
	February	34.7	23.4	-	71.0	7.5
	March	35.1	24.1	-	74.0	6.9
	Mean	33.4	22.75	83.0	75.6	6.5

Table 27. Temperature, rainfall, relative humidity and sunshine recorded in Kozhikodu District (1994-95)

Year	Month	Temperature (°C)		Rainfall (mm)	Mean relative humidity (%)	Sunshine (hrs)
		Max.	Min.			
1994	October	32.7	23.4	410.8	84.0	4.9
	November	32.1	23.2	71.2	81.0	5.1
	December	33.8	22.1	8.6	74.0	7.0
1995	January	33.5	21.4	1.6	69.0	8.2
	February	34.1	23.2	-	72.0	7.6
	March	34.9	24.0	4.2	76.0	6.8
	Mean	33.5	22.88	82.73	76.0	6.6

Incidence of different reproductive conditions

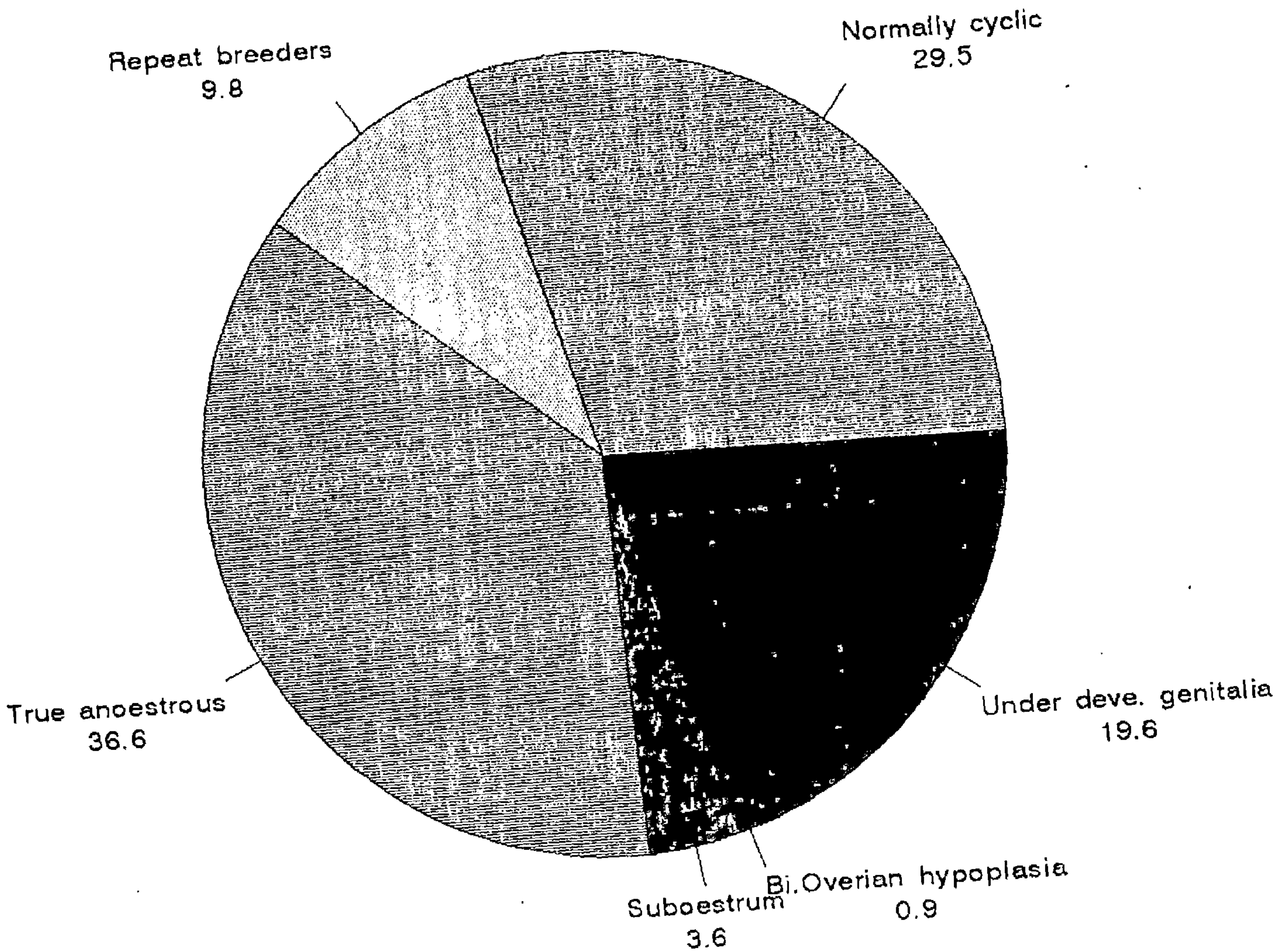

Fig. 1

Daily weight gain in heifers(g) at different age groups

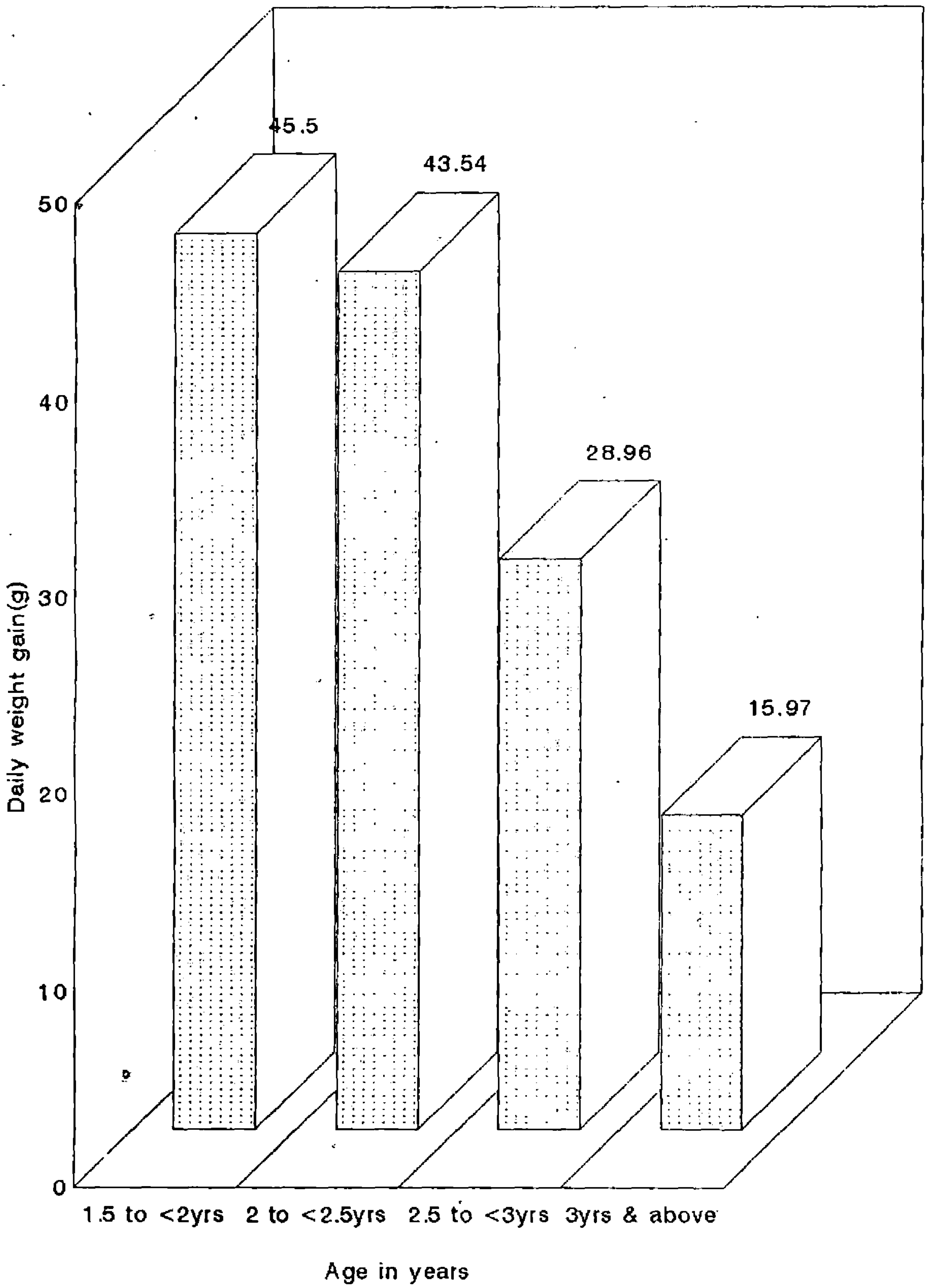

Fig. 2

Daily weight gain in heifers(g) of different reproductive status

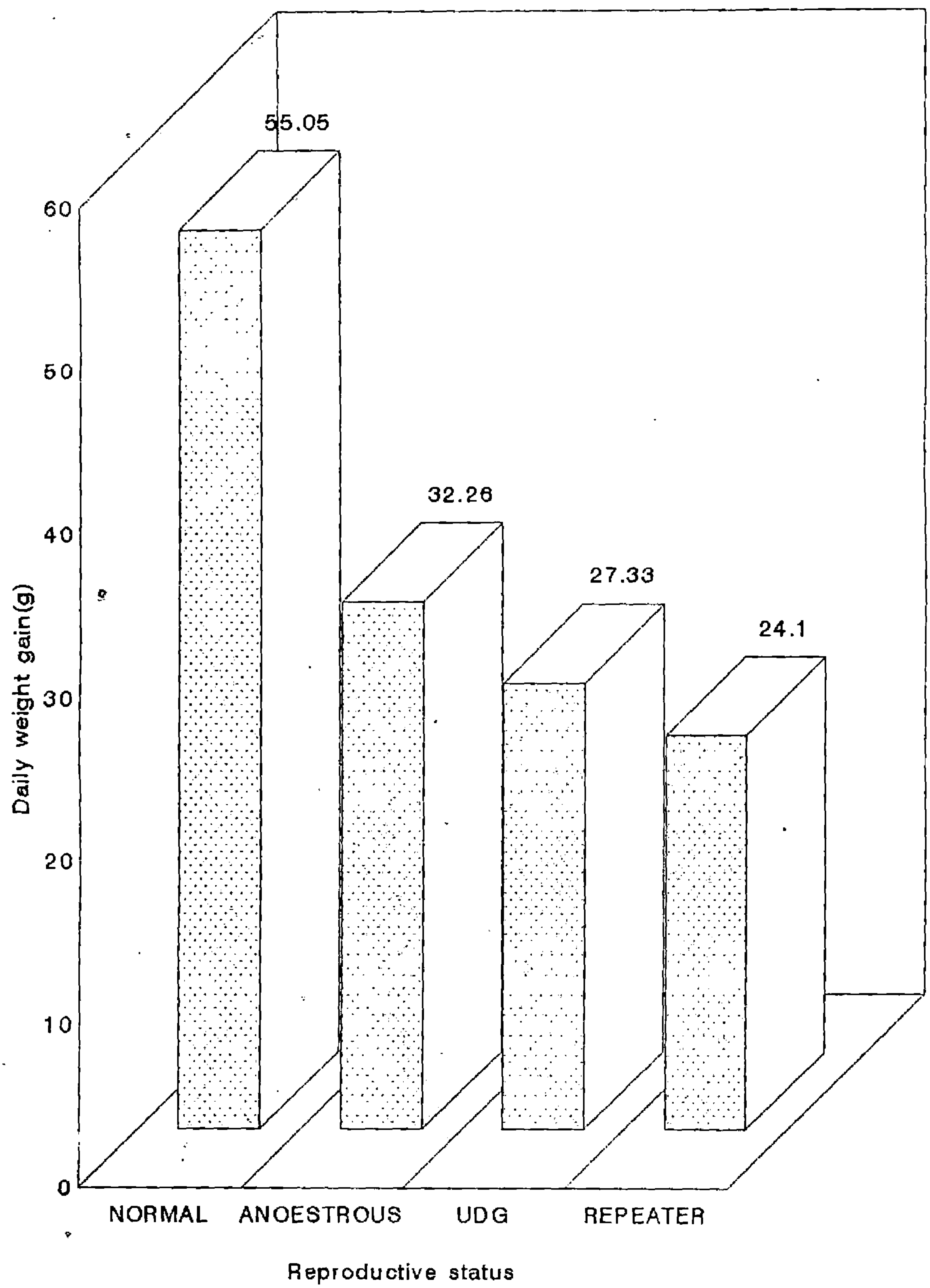

Fig.3

Daily weight gain in heifers(g) under different planes of nutrition

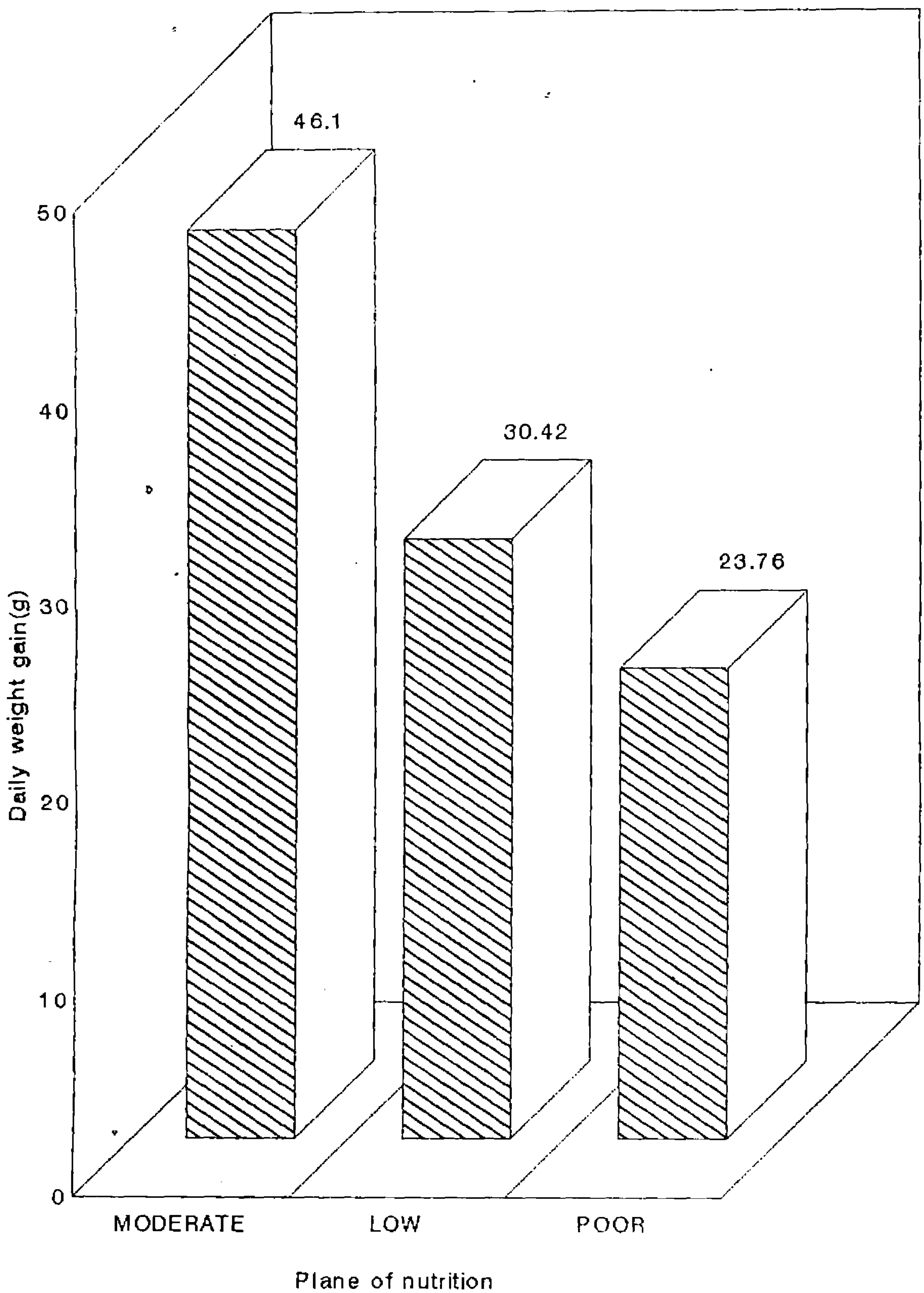

Fig. 4

Serum Calcium level in heifers(mg %) of different reproductive status

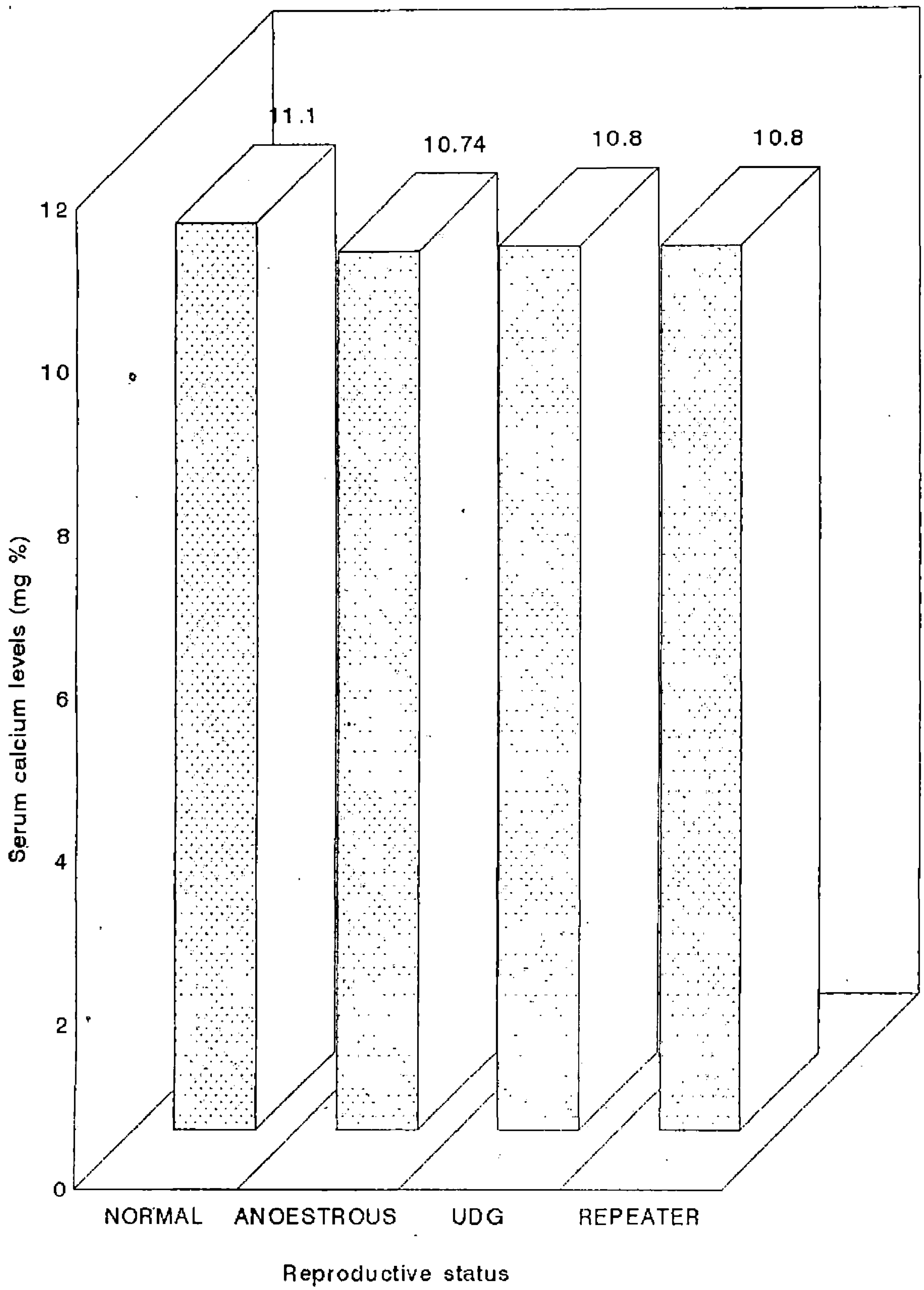

Fig. 5

Serum Phosphorus level in heifers(mg %) of different reproductive status

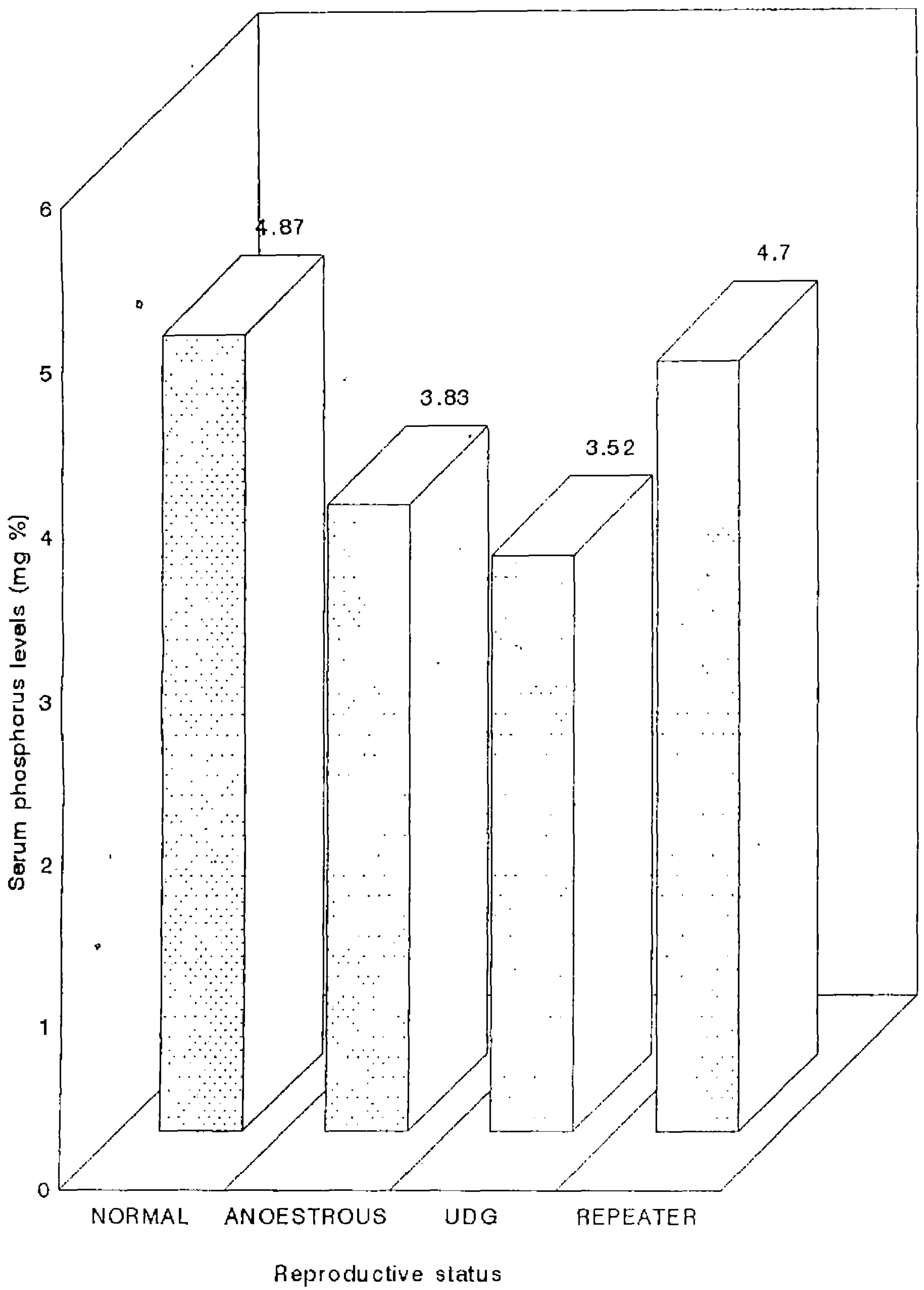

Fig. 6

Serum Copper level in heifers(ppm) of different reproductive status

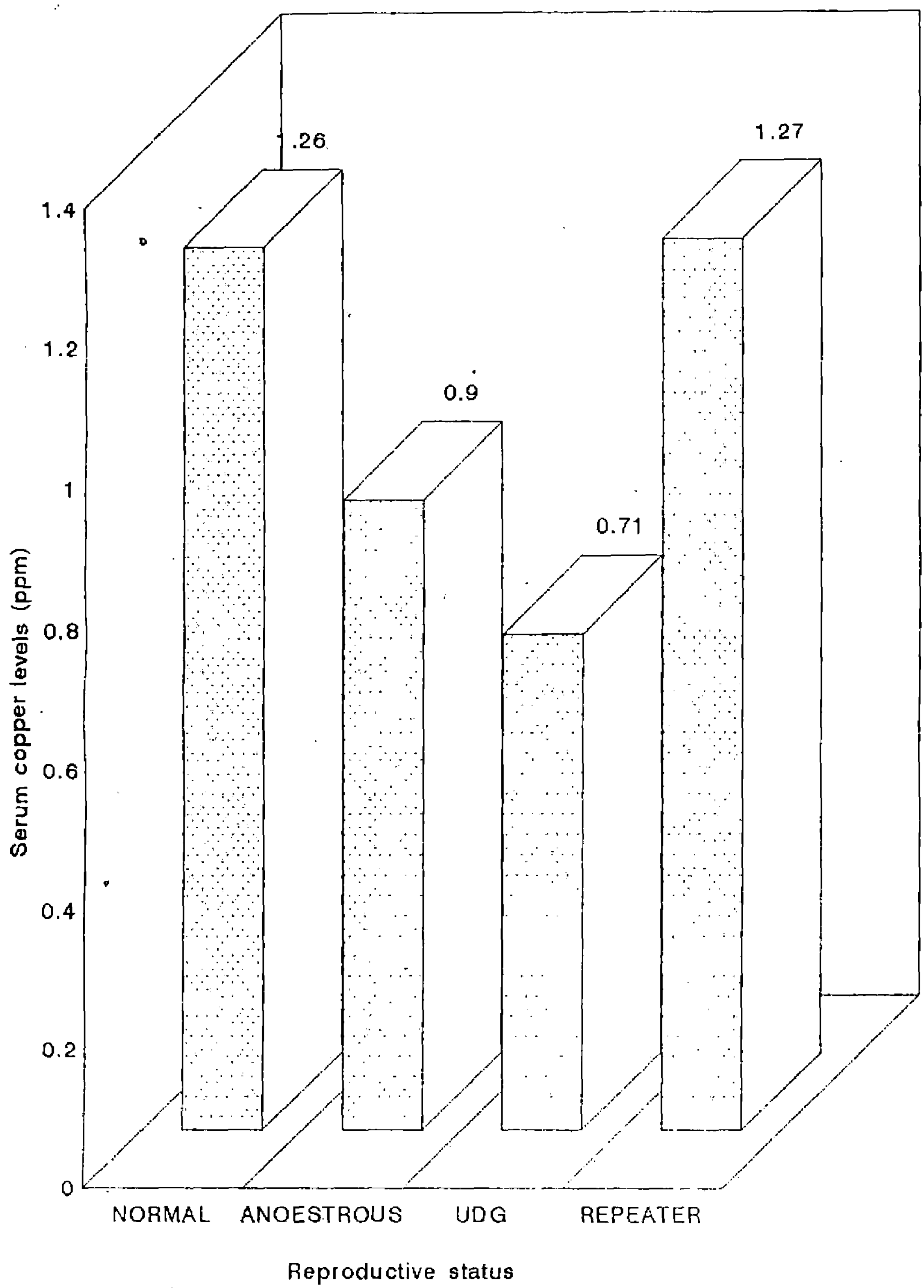

Fig. 7

Serum Zinc level in heifers(ppm) of different reproductive status

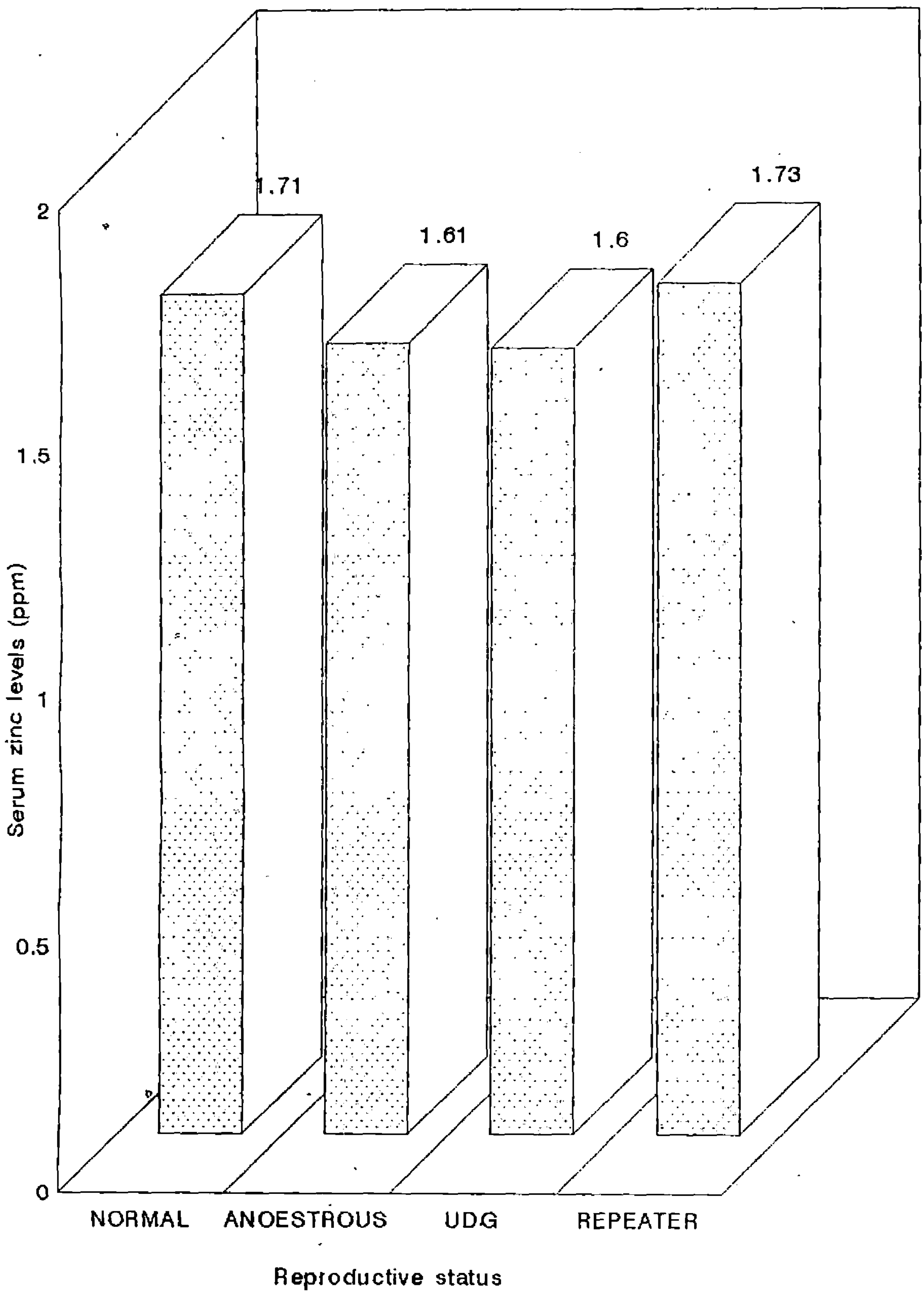

Fig. 8

Serum Calcium level in heifers(mg %) under different planes of nutrition

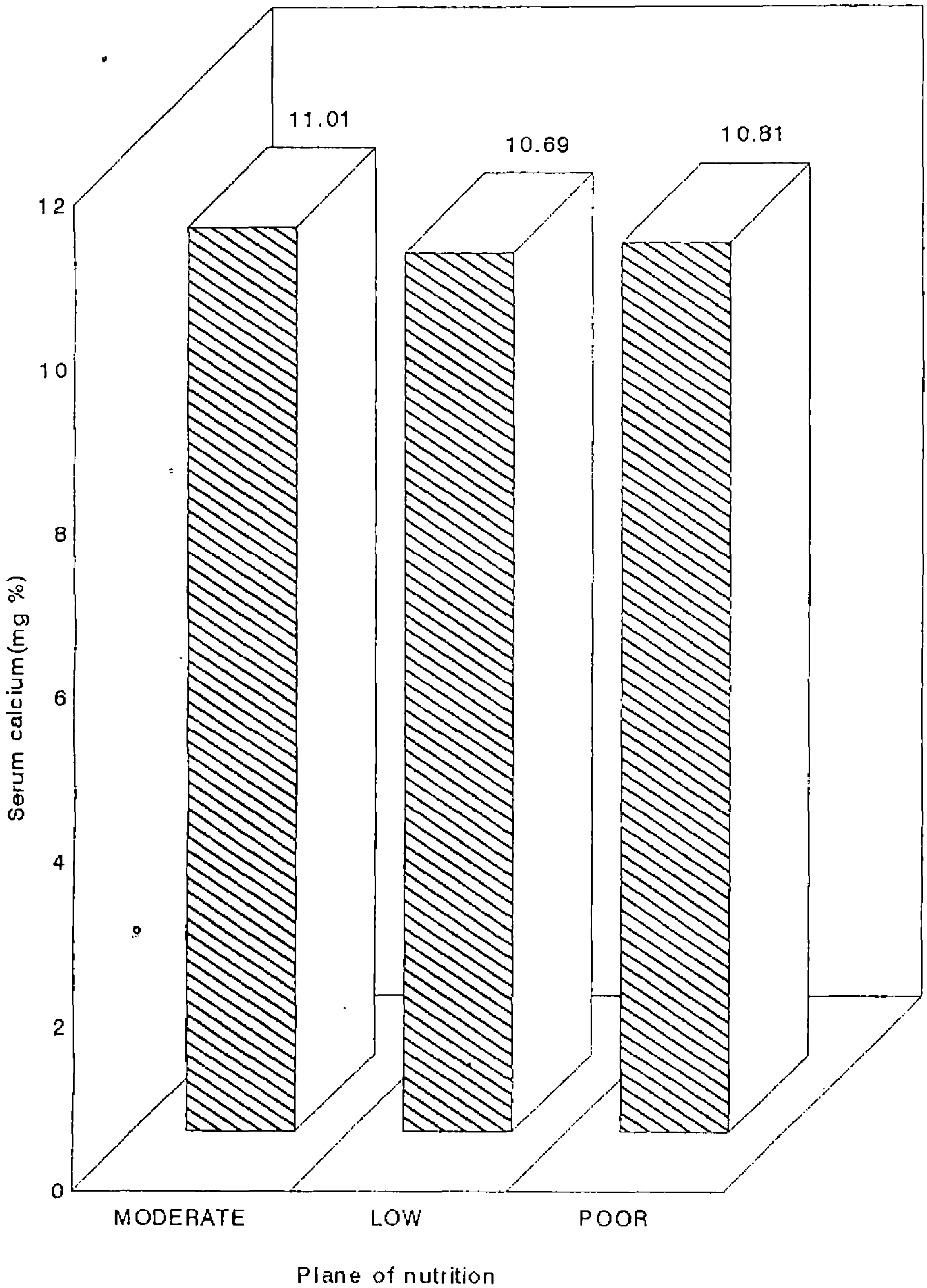

Fig. 9

Serum Phosphorus level in heifers(mg %) under different planes of nutrition

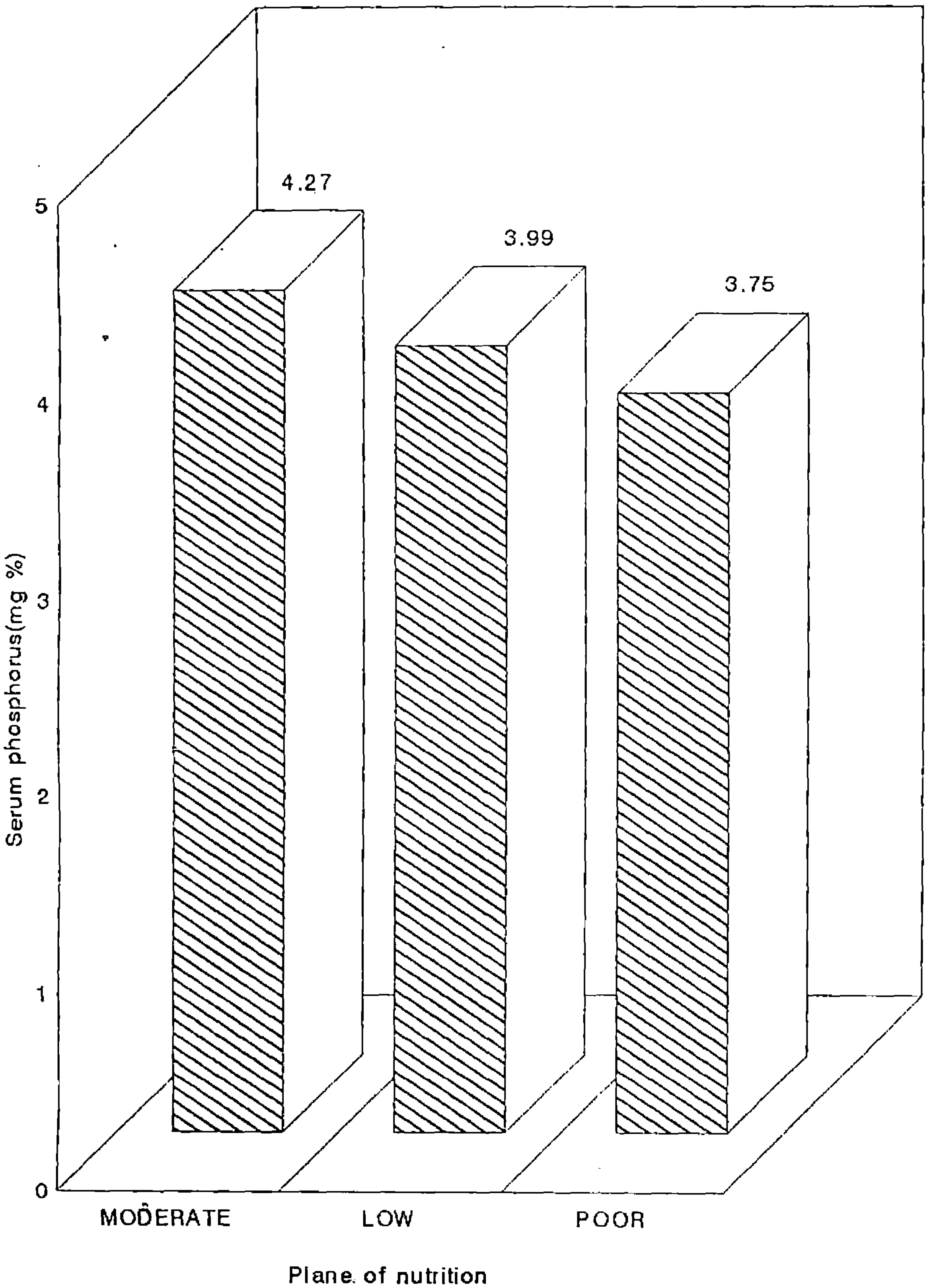

Fig. 10

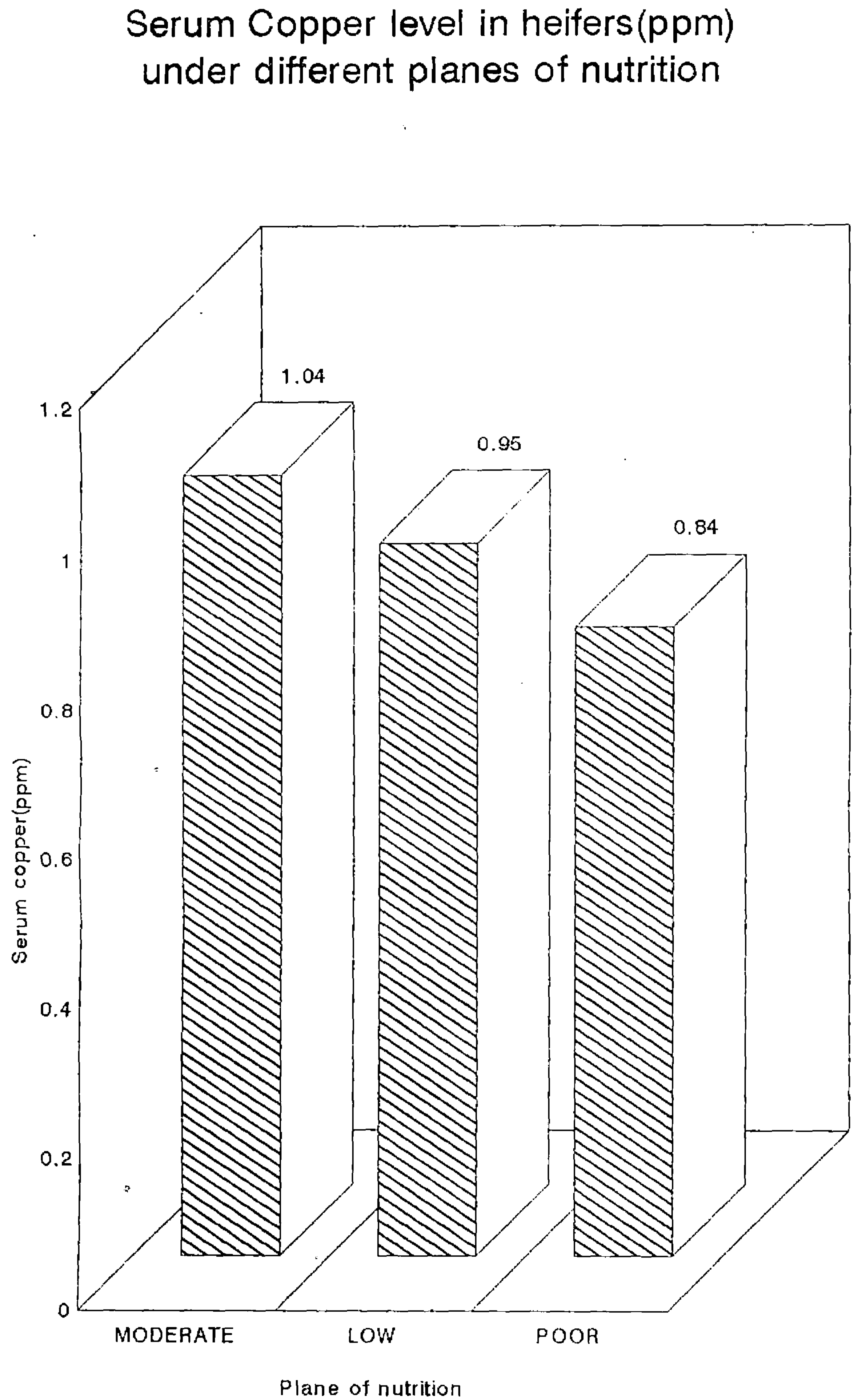
Serum Copper level in heifers(ppm)
under different planes of nutrition
1.04
0.95
0.84
1.2
1
0.8
0.6
0.4
0.2
0
Serum copper(ppm)
MODERATE
LOW
POOR
Plane of nutrition

Fig. 11

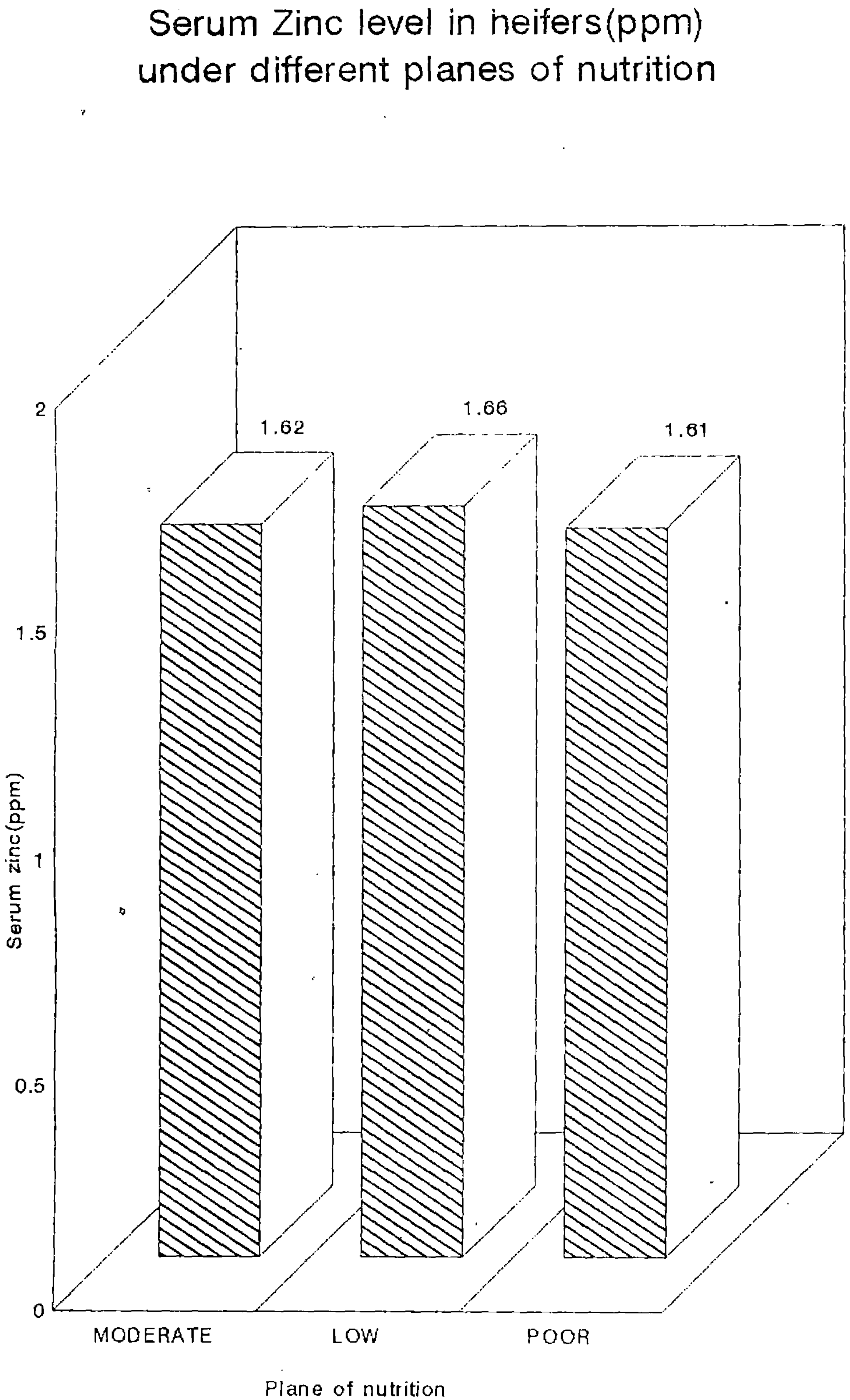
Serum Zinc level in heifers(ppm)
under different planes of nutrition
2
1.5
1
0.5
0
Serum zinc(ppm)
1.62
1.66
1.61
MODERATE
LOW
POOR
Plane of nutrition

Fig.12

Serum Calcium level in heifers(mg %) at different age groups

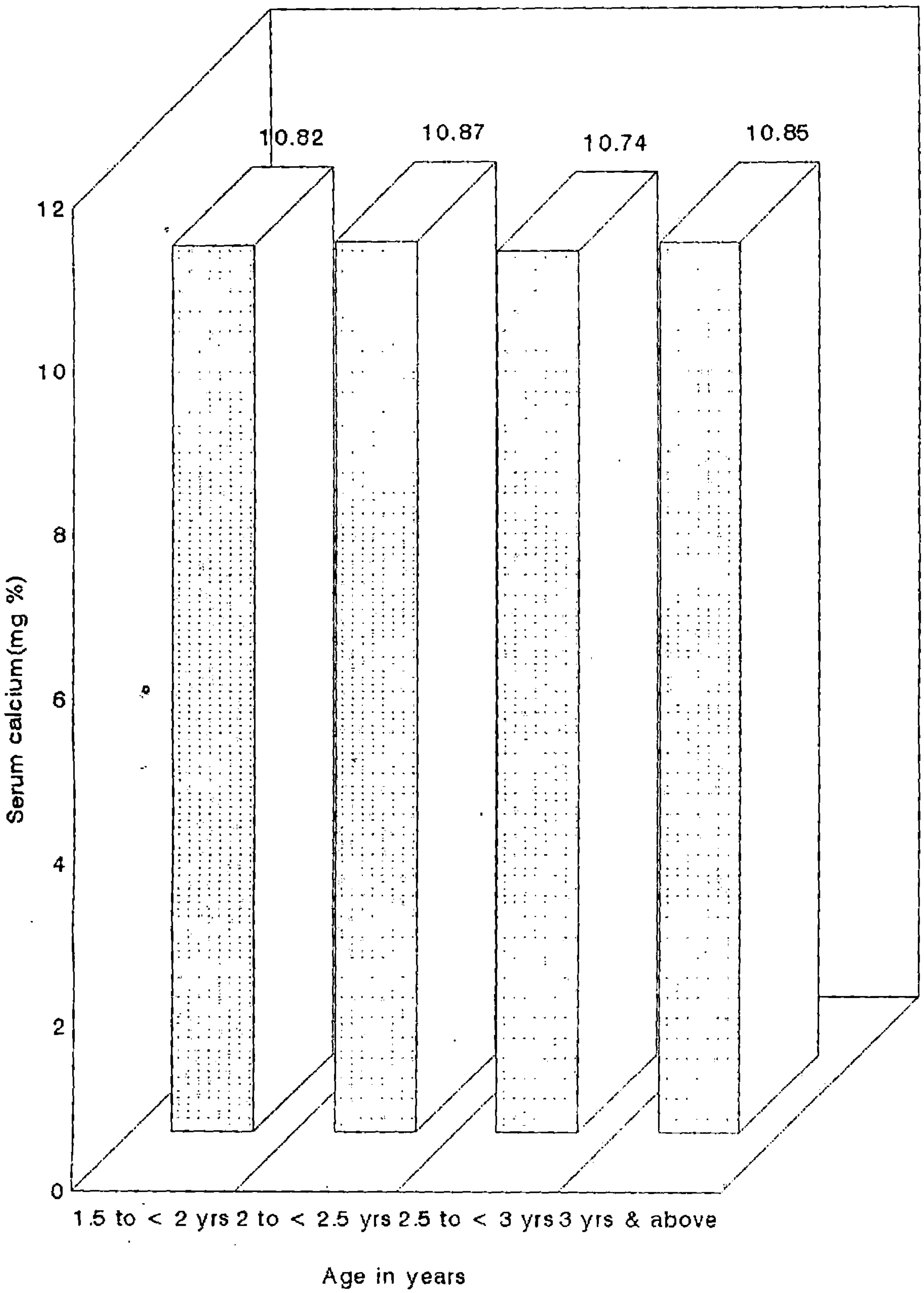

Fig. 13

Serum Phosphorus level in heifers(mg %) at different age groups

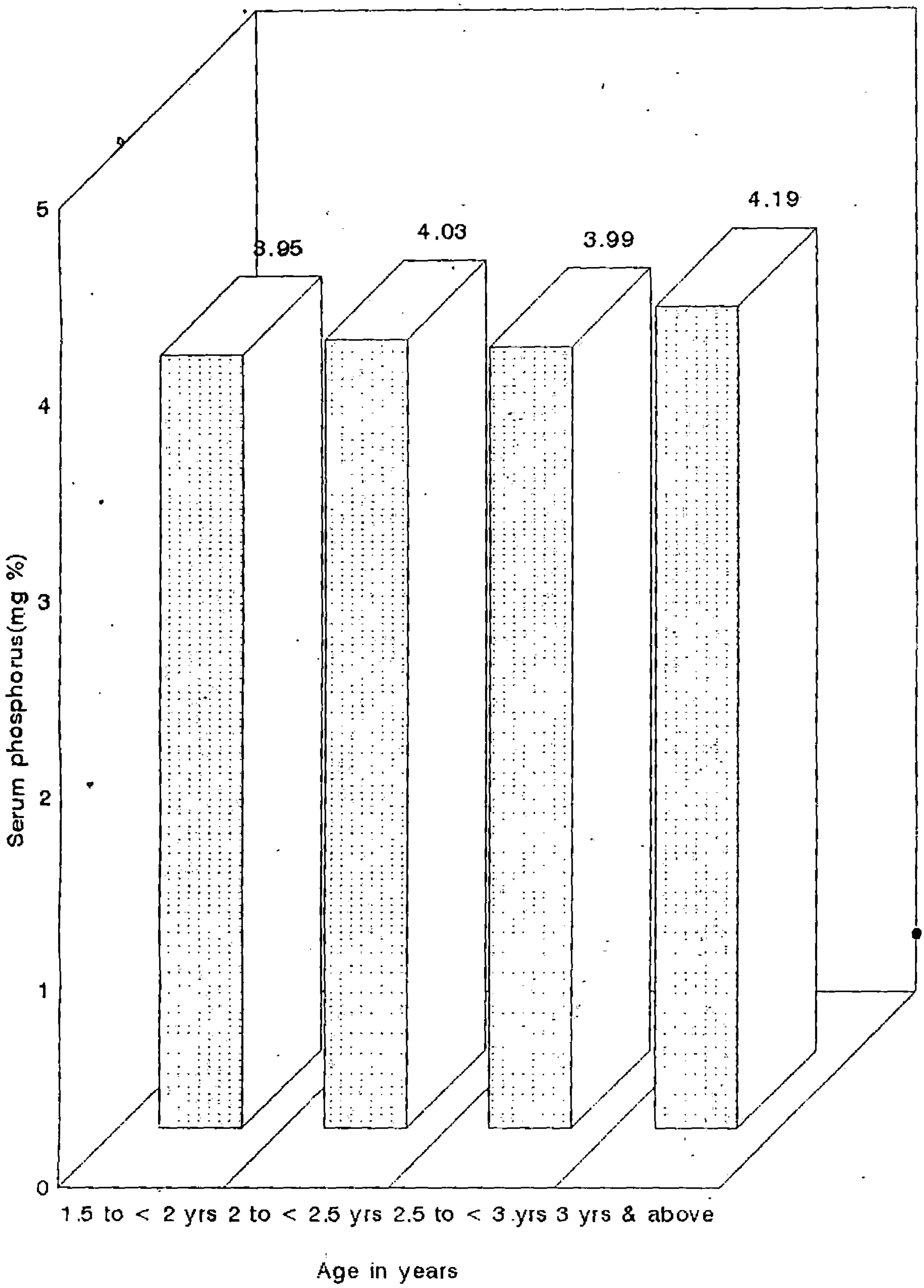

Fig. 14

Serum Copper level in heifers(ppm) at different age groups

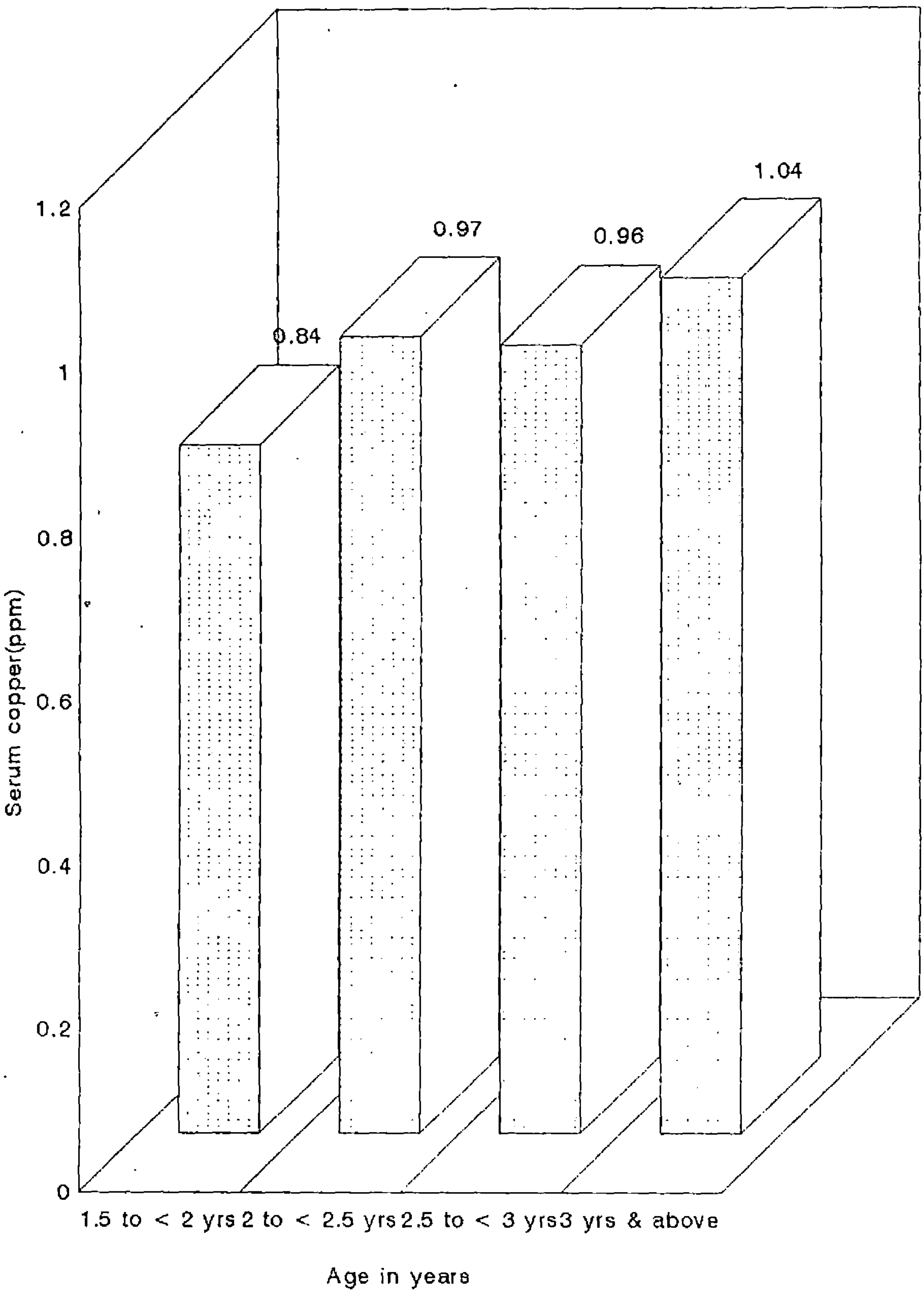

Fig. 15

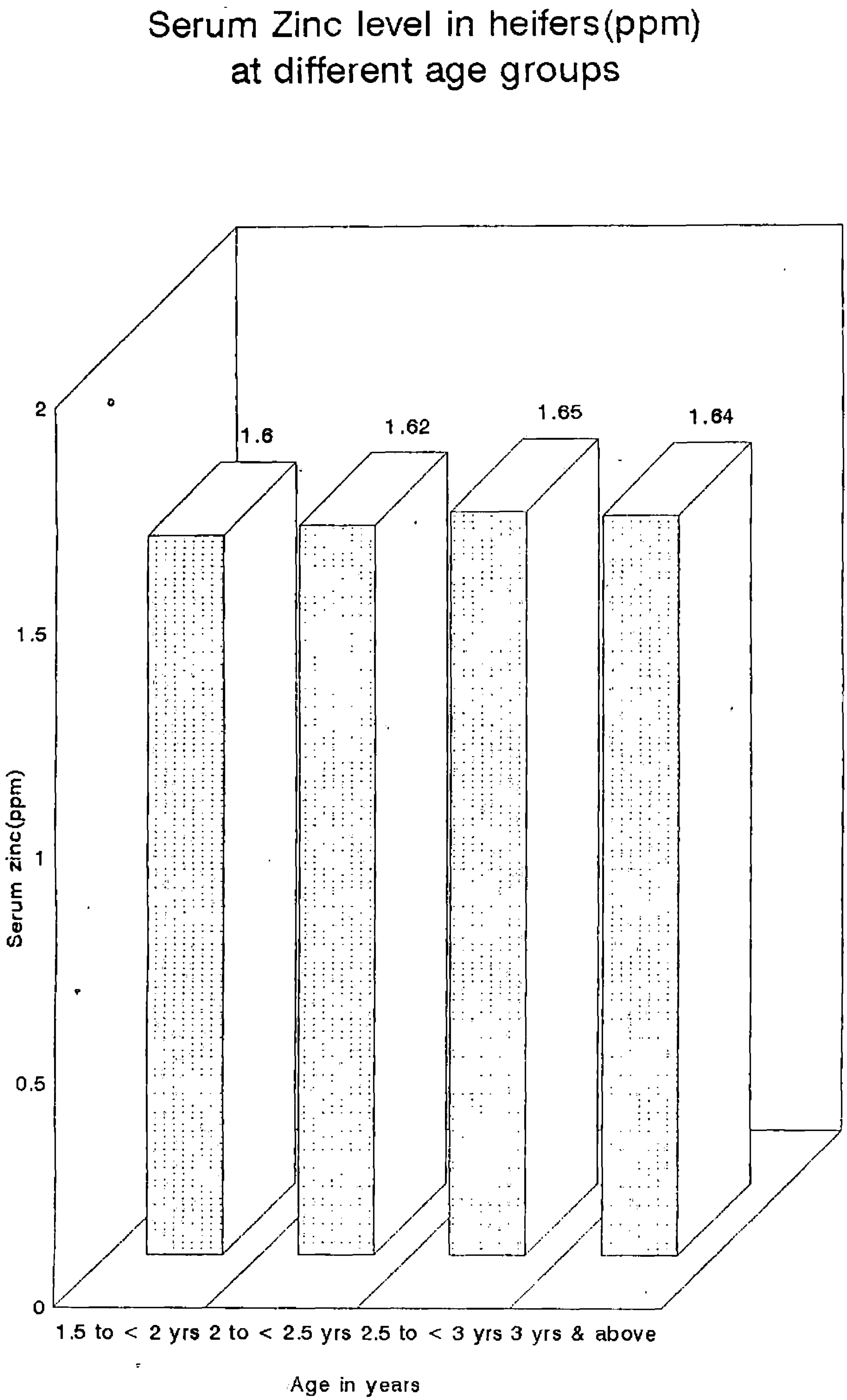
Serum Zinc level in heifers(ppm)
at different age groups
2
1.5
1
0.5
0
Serum zinc(ppm)
1.6
1.62
1.65
1.64
1.5 to < 2 yrs
2 to < 2.5 yrs
2.5 to < 3 yrs
3 yrs & above
Age in years

Fig. 16

Discussion

DISCUSSION

Dairy heifers are the future stocks and they control the future well-being of the livestock industry. Rising costs make it imperative for economic reason that farmers get cattle in reproduction as early in life as possible. Liberal feeding and effective management is essential for easy and quick sexual maturity in heifers. Unfortunately due to economic reasons these unproductive groups were mostly neglected by the farmer. Lack of proper management and feeding of heifers will lead to delayed puberty and a heavy loss to the farmer.

Reproduction in cattle known to be influenced by genetic traits, nutrition, endocrime status and environment. For effective up keeping of the system a proper synergism between anabolic and catabolic reaction is required. In this part mineral nutrition plays an important role. Many of the detailed investigations were undertaken to throw light upon the manner and extent of involvement of different micro and macro elements in the living body and reproductive endocrinology which yielded conflicting results reflecting the complex nature of their involvement in biological systems.

The present investigation was undertaken to assess the reproductive status of crossbred heifers reared by the poor farmers. Of them 89 heifers of different age groups formed the material for the study to assess the rate of growth and role of serum calcium, phosphorus, copper, zinc and manganese in reproduction.

The present study on reproductive status of crossbred heifers revealed an incidence of 36.6 per cent true anoestrum, 19.6 per cent anoestrum due to under developed genitalia, 9.8 per cent repeat breeders, 29.5 per cent normally cycling, 3.6 per cent suboestrum and 0.9 per cent bilateral ovarian hypoplasia.

The percentage of true anoestrum in the present study is in partial agreement with Singh *et al.* (1987) who reported an incidence of 34.4 per cent heifers with true anoestrum. Pillai (1980), Rao *et al* (1983) and Behera *et al.* (1993) reported a lower value of 28.2 per cent, 24.2 per cent and 30.9 per cent respectively. Mathew and Nampoodiripad (1979) reported a wide range of 20 to 51.72 per cent anoestrum in crossbred heifers under varying managemental conditions.

The percentage of occurrence of underdeveloped genitalia among heifers in the present study was 19.6 per cent. Rao *et al.* (1983) reported an incidence of 17.9 per cent underdeveloped genitalia among heifers. Pillai (1980), Kumar *et al.* (1986) and Rahmathulla *et al.* (1986) have observed lower values of 9 per cent, 9.5 per cent and 4.8 per cent respectively while Singh *et al.* (1987) and Behera *et al.*

(1993) reported an incidence of 25.38 per cent and 42.06 per cent respectively. In the present study the percentage of occurrence of underdeveloped genitalia found similar to the observation reported by Rao *et al.* (1985) and Singh *et al.* (1987).

In the present work the percentage of occurrence of suboestrum and bilateral ovarian hypoplasia was 3.6 per cent and 0.9 per cent respectively. Similar observations were reported by Pillai (1980), the percentage of occurrence of suboestrum and bilateral ovarian hypoplasia were 2.2 per cent and 1.3 per cent respectively.

It could be observed that a wide variation existed between the incidence of various reproductive problems of heifers. This could be attributed to the different managemental practices as reported by (Kodagali, 1978; Schefels and Stolla, 1985). The difference in breed also might have contributed for the above variation (Mathew and Nampoodiripad, 1979).

Management and nutrition

In the present study, out of 15 cycling heifers, 11 (73.3%) were under moderate plane of nutrition and the rest of 4 (22.7%) were under low and poor plane of nutrition. Out of

63 heifers with delayed puberty 48 (77.9%) were under low to poor plane of nutrition.

According to Bonnemaire *et al.* (1983), who reported attainment of puberty of 69.4 per cent under good quality ration and 47.6 per cent under poor quality ration, the influence of quality of ration on attainment of puberty was significant. Billante (1991) obtained a wide variation in the percentage of heifers those came to puberty at different plane of nutrition.

The results of the present study established that the plane of nutrition played an important role in the onset of puberty and cyclicity in crossbred heifers. The above fact is in agreement with Moriera *et al.* (1978), Staigmiller *et al.* (1979) and Sprott *et al.* (1980) who reported that those crossbred heifers under better level of feeding attain puberty in shorter duration than those fed with lower level.

Growth and puberty

Growth of crossbred heifers studied was assessed based on the daily weight gain. The average per day weight gain obtained was 45.5 ± 3.79 g, 43.54 ± 2.92 g, 28.96 ± 3.68 g and 15.97 ± 3.68 g for those 1 1/2 to below 2 years, 2 years to below 2 1/2 years, 2 1/2 years to below 3 years and 3 years and above respectively.

Burton *et al.* (1962) obtained 91 lbs, 79 lbs and 70 lbs respectively for 12 to 18 months, above 18 to 24 months and above 24 to 30 months age groups for a period of 8 weeks in Guerency heifers. Wiltbank *et al.* (1969) found an average daily weight gain of 0.82 kg and 0.73 kg for crossbred beef heifers of 6 to 12 months and 12 to 18 months respectively. Balakrishnan *et al.* (1985) reported an average per day weight gain for crossbred heifers as 228 g, 529 g and 338 g respectively for periods before maturity, between I and II and between II and III oestrus cycles.

The present study shows that the rate of growth will be higher in younger age groups than in older ones. It is in agreement with the observation of Burton *et al.* (1962), Wiltbank *et al.* (1969) and Balakrishnan *et al.* (1985).

In the present study the per day weight gain obtained for different feeding planes was 46.1 ± 2.99 g, 30.42 ± 2.62 g and 23.7 ± 3.66 g under moderate, low and poor plane respectively. The difference between the weight gain obtained was found to be statistically significant.

Wiltbank *et al.* (1969) reported a daily weight gain of 0.82 kg and 0.73 kg in beef cattle aged between 6 to 12 months and 12 to 18 months respectively under high level of nutrition while under low level of nutrition the daily weight gain was 0.36 and 0.30 kg respectively. Mathai and Raja (1976) established that the growth rate, age at puberty and weight at puberty were significantly influenced by the level of feeding. Staigmiller *et al.* (1979) also supported the above view by observing a weight gain of 0.63 kg per day and a weight loss of 0.15 kg per day in crossbred cattle kept under optimum plane and low plane of ration respectively. Saha (1989) found an average per day weight gain of 270.5 g, 277.0 g and 233.83 g in crossbred heifers under medium quality, good quality and poor quality ration respectively.

The present study established that the plane of nutrition influenced the growth rate in crossbred heifers.

Calcium

The level of serum calcium obtained in the present study was 11.1 ± 0.31 mg% for control group, 10.74 ± 0.13 mg% for true anoestrum, 10.8 ± 0.24 mg% for under developed genitalia and 10.8 ± 0.42 mg% for repeat breeders. The serum levels of calcium in different categories were not having any significant difference.

In the present study the serum calcium levels were found to be within the normal physiological range. This is in agreement with Maynard and Loosli, who reported that the normal level of serum calcium for effective reproductive function was 8-12 mg%. Further this was in partial agreement with King (1971) who has reported that 9.27 mg% serum calcium level was necessary for optimum reproductive function.

The present study also revealed that there was no significant difference for serum calcium levels obtained in various reproductive disorders. This is in agreement with earlier findings; that the calcium levels of serum remained unaltered between cycling and anoestrous heifers (Pasker and Blowery, 1976; Pandia *et al.*, 1977; Dindorkav and Kohli, 1979; Pallai, 1980; Behera *et al.*, 1987). There are similar reports in buffaloes stating that serum calcium did not exert much influence on reproductive performance of buffaloes (Samad *et al.*, 1980; Srivastava and Kharche, 1986 and Dabai, 1987).

There was no significant difference in the calcium levels between the normally cycling and repeat breeders in the present study. Hence the effect of calcium on reproduction could not be established.

However, Schmidt (1964) reported that calcium supplementation along with other minerals possessed significant effect on the reproductive performance in buffaloes. Morrow (1969) found that calcium deficiency may prolong the interval of the first oestrus. Jaskowski (1985) reported that low level of calcium may lead to infertility and puerperal disorders in cattle.

Phosphorus

Mean level of serum inorganic phosphorus for the normally cycling heifers (control) was found to be 4.84 ± 0.13 mg% which was significantly higher than the values recorded for animals with true anoestrum (3.83 ± 0.09 mg%) and under developed genitalia (3.52 ± 0.1 mg%) level in the control group did not significantly differed from that of repeat breeders (4.7 ± 0.15 mg%).

The mean serum inorganic phosphorus level in the true anoestrous and underdeveloped genitalia were found to be subnormal, while that of repeat breeders was within the normal range. The normal level of serum inorganic phosphorus as described by Mayard and Loosli (1973) was 4-9 mg% whereas Morries (1976) and Pillai (1980) reported that a serum level of less than 4 mg% indicated phosphorus deficiency and the normal range of serum inorganic phosphorus was 4-8 mg% in cattle.

The present observation showed subnormal serum phosphorus level in true anoestrus heifers. This is in agreement with earlier finding of Maynard *et al*. (1979) who reported a lower level of serum inorganic phosphorus in anoestrous heifers [illegible] [illegible] than in cycling ones. Similar findings were reported by others (Ramanarayana, 1978; Bhaskaran and Khan, 1981; Naider and Rao, 1982; Radheshyam, 1982; Jaskawski, 1986; Dabar, 1987;

Mujarrege, 1987; Dutta *et al*., 1988; Repstad, 1988; Gaines, 1989; Yadav, 1989 and Behera, 1993).

Low serum level of inorganic phosphorus in heifers with under developed genitalia was found to be in agreement with Pillai (1980), and Naider and Rao (1982) who reported a low serum inorganic phosphorus in those heifers with juvenile genitalia. This was again supported by Bahera *et al*. (1993).

Repeat breeders showed normal serum level without any significant difference from that of the control group. This was in agreement with Forshell *et al*. (1991) and Saxena *et al*. (1991). However, Prasad *et al*. (1989) and Joy (1992) obtained significant difference in the phosphorus level of normally cycling cattle with that of repeat breeders.

Brooks *et al*. (1984) obtained significant improvement in the ovarian activity after phosphorus supplementations in dairy heifers. Elkeraby (1983) reported that the supplementation of monosodium phosphate had significantly reduced interval between calving and onset of post partum oestrum in Friesien cows.

Kiatoko (1978) observed direct relationship between the phosphorus content in the forages and the serum phosphorus level. However, Gonzalez (1984) observed no significant relationship for the reproductive status with blood phosphorus level. This was supported by others (Agarwal, 1985, Hofer, 1985 and Saxena, 1991).

Phosphorus deficiency affects most cell type as phosphorus is an integral component of nucleic acids, nucleotides, phospholipids and some of the proteins. It is required for transfer and utilization of energy and normal phospholipid metabolism. It is also an integral part of large number of enzymes. The involvement of phosphorus in the phospholipid and CAMP synthesis may be a key to its effect on reproduction. The role of calcium and phospholipid dependent proteinkinase may be crucial in mediating hormone action (Hurley and Doane, 1989). The availability of phosphorus for reproductive function become meagre or scanty leading to anoestrum and imparied fertility. Anoestrum in the present study could be attributed to low serum phosphorus levels since serum inorganic phosphorus in anoestrus heifer was significantly lower than cycling heifers.

Copper

The mean serum copper level for control group (1.26 ± 0.07 ppm) was significantly higher than that of true anoestrous heifers (0.9 ± 0.04 ppm) and that of animals with under developed genitalia (0.71 ± 0.05 ppm). There was no significant difference between the control group with that of repeat breeders (1.27 ± 0.08 ppm).

King, 1971; Maynard and Loosli, 1975 and Pillai, 1980 reported a serum copper level of 1.00 ppm for normal reproductive function.

From the above findings the requirement of normal level of serum copper for the onset of oestrus is established. It is in agreement with earlier findings. Morston *et al.* (1972) reported that, copper deficiency completely subdued the breeding performance in heifers. Homer (1981) reported the significance of plasma copper level in the onset of puberty in heifers. Thomas (1983) found that the serum copper deficiency may prolong the oestrus interval in cattle. Gainer (1989) and Hann (1989) reported anoestrum in copper deficient cattle. Prasad (1989) reported a significant difference in the serum copper level in the normally cycling and anoestrous cattle. Sarvaiya (1991) reported the importance of serum copper status in reproduction of buffaloe heifers.

However Little-John and Lewis (1960), Larson *et al.* (1980) and Whitaker (1980) concluded that cycling and fertility were not related to blood copper concentration. Similarly Sharma (1988) observed no significant difference for serum copper level in normally cycling and anoestrous Kankrej heifers.

Copper as an integral component of metalloenzyme, play a significant role in metabolic functions including those of endocrine organs. Copper is also reported to modulate the PGE_2 receptor binding, thus regulating the release of LH releasing hormone (Barnea *et al.*, 1985).

Since liver acts as a storage organ for copper, serum copper levels register subnormal values only after depletion of liver storage. Because it is required for haemoglobin synthesis, copper can significantly affect reproduction in cattle (Gaines, 1989). In the present study low serum copper levels in the anoestrous heifers and heifers with under developed genitalia clearly indicated hypocuprosis and resultant interference in reproductive function.

Zinc

Mean serum zinc level obtained for the control group (1.71 ± 0.05 ppm) was statistically insignificant with. the level obtained for true anoestrous group (1.61 ± 0.03 ppm), under developed genitalia (1.6 ± 0.05 ppm), and repeat breeders (1.73 ± 0.06 ppm).

Wegner (1973) found the normal serum zinc in cattle ranging from 0.85 to 1.75 ppm with a mean of 1.17 ± 0.039 ppm. Saxena (1991) reported that heifers with plasma zinc level of 1.00 to 2.90 ppm were observed to attain puberty.

The present finding on serum zinc level was in agreement with Gonalez *et al.* (1984) and Lavin *et al.* (1988). However, they could not establish any significant relationship between blood zinc level and reproductive status in cattle. Similarly, Prasad *et al.* (1989) observed no significant difference in serum zinc levels between fertile, anoestrous & repeat breeder. This was again supported by Joy (1995).

Low serum zinc level was reported in anoestrous cattle (Duffy, 1977 and Manikkam, 1977). Sharma *et al.* (1988) found significantly low serum zinc level in non cyclic heifers compared to that of cyclic ones.

Zinc as an integral part of over 200 proteins and enzymes has been attributed several important biological role. Some of these enzymes may be of particular importance in their function on reproductive tissue. A role in reproduction may involve zinc as an essential component or activator of enzyme involved in steroidogenesis. Sterility due to zinc deficinecy has been attributed to defects in prostaglandin metabolism, but the zinc deficiency in ruminants causes a more pronounced impairment of reproduction in the male than in female (Hidiroglou, 1979). However, from the present study no definite conclusion on the role of zinc in true anoestrum, under developed genitalia and repeat breeding could be drawn.

Manganese

Mean serum manganese level in heifers with true anoestrum under developed genitalia and repeat breeders was 0.04 ± 0.002 ppm. The same level was obtained for normal cycling heifers also.

The present reports were in agreement with Gonzalez *et al.* (1984) who found that manganese level in blood was not showing any significant effect on cyclicity or anoestrus in heifers. Similar observation has been reported by Prasad *et al.* (1989), who found no significant difference in the serum content of manganese between normal (0.026 ± 0.007 ppm), repeat breeder (0.019 ± 0.009 ppm) and anoestrous (0.015 ± 0.009 ppm) animals.

However, Manikkam *et al.* (1977) observed significantly higher plasma manganese level in cycling cattle than those with reproductive problems. Sharma *et al.* (1988) and Rupode (1993) correlated the significance of manganese with cattle infertility.

Supplementation

Out of fifteen heifers with true anoestrum showing deficiency in serum phosphorus, 10 were supplemented with dicalcium phosphate (80 gm/day) along with the feed for a period of 30 days and 5 of them were kept as control. From the treatment group 70 per cent exhibited heat signs while only 40 per cent from the control group exhibited oestrum.

The result of the supplementation was in agreement with previous reports of supplementation of minerals. Nelakantan and Nair (1978) suggested the successful supplementation of phosphorus deficient cattle with dicalcium phosphate or bone meal. Scharp (1979) reported regain of cyclicity and conception rate in anoestrous dairy cows after supplementation with dicalcium phosphate. There are many reports on successful phosphorus supplementation. El-Keraby (1983) reported supplementation of monosodium phosphate, had significantly reduced the anoestrum in cows, others also reported on phosphorus supplementation (Dabas *et al*., 1984; Jubb and Gough, 1988 and Arther, 1989).

Many of the gross effects of manganese deficiency can be explained in term of the effect of manganese on mucopolysacharide synthesis (Underwood, 1977). Deficiency also affects several manganese metalloenzymes including hydroxylase, kinase, decarboxylases and transferases, manganese also plays an active role in redox process, growth, reproduction, endocrine function etc. (Georgievskii, 1981).

No definite conclusion on the role of manganese in true anoestrum, under developed genitalia and repeat breeding condition of crossbred heifers can be drawn from the results obtained in the present study.

Out of 10 true anoestrous heifers showing a combined deficiency of serum inorganic phosphorus and copper together seven were supplemented with DCP and $CuSO_4$ (80 gm and 0.5 gm/day). In the treatment group 62.5 per cent showed heat while only 25 per cent from the control group. Difference was found to be statistically significant.

Among 16 heifers with under developed genitalia showing a combined deficiency of inorganic phosphorus and copper together, 10 were treated with 80 gm DCP and 0.5 gm $CuSO_4$ daily along with the feed for a period of 30 days. From the treatment group 30 per cent and from the control group 16.6 per cent showed heat symptom.

There are many reports showing the significance of mineral supplementation for an effective reproductive performance in cattle. Brooks (1983) reported the successful supplementation of phosphorus and copper either orally or by injection. Surendra Singh and Vadnere (1987) reported on the combined deficiency of copper and inorganic phosphorus in cows and was successfully supplemented with 1 gms of copper sulphate and 12 gms of sodium phosphate along with the ration for a period of 21 days.

Among twelve true anoestrous heifers showing subnormal serum copper alone, 8 were supplemented with 0.5 gm of $CuSO_4$ daily for a period of 30 days and 4 were kept as control. From treatment group 62.5 per cent showed oestrus while among the control 25 per cent came to heat.

There are many reports on effective supplementation of copper sulphate in cattle. Elwishey *et al.* (1966) reported on the successful induction of heat on anoestrous buffaloe heifers with 1 gm $CuSO_4$ orally, twice in a week for 5 weeks. Reddy (1977) reported that the delayed oestrus in cattle due to borderline copper deficiency was corrected by copper sulphate supplementation along with the basal ration. Poole (1978) and Schwarz (1978) obtained a higher conception rate in copper supplemented group of cattle. Schevarz (1978) observed an increase in the plasma copper level by the supplementation with copper sulphate. Pillai (1980); Darkar *et al.* (1987) and Ingraham (1987) reported successful supplementation of copper in cattle. Sikka and Mudgal (1988) reported an increase of 0.15 to 0.52 ppm of blood copper level due to supplementation of copper with copper sulphate in cattle

Soil analysis and meteorology

Analysis of soil collected from areas where the heifers exhibit deficiency of phosphorus, copper revealed normal soil phosphorus and copper levels. The phosphorus level obtained was within the range of 17-18.5 ppm in the soil of selected area of Malappuram and Calicut district while that of copper level was 5.30-5.45 ppm.

Saha (1987) could not establish any correlation between the low level of inorganic phosphorus in the serum of cattle and that presented in the soil or the fodder fed to them.

However Books (1984) reported that the infertile cattle showing deficiency of serum inorganic phosphorus were found to be reared in pastures grown in soil having low phosphorus level. Meldrum (1985) and Nicolson (1986) reported the serum copper deficiency in cattle was directly correlated with the available copper content of the soil where the cattle were grazed. Suttle (1986) reported that copper deficiency in cattle due to low availability of copper in the lush green pasture.

The mean values of temperature (maximum and minimum) in degree celcius, rainfall in mm, mean relative humidity in percentage and mean sunshine in hour for both Calicut and Malappuram did not show any significant difference during the period of study.

Summary

SUMMARY

The objective of the study was to assess the growth and reproductive status of crossbred heifers under field conditions and to evaluate the role of calcium, phosphorus, copper, zinc and manganese in the reproductive performance of the crossbred heifers with the aim of evolving suitable corrective measures in case of those with impaired reproductive performance due to subnormal serum mineral status.

On the basis of the infertility camps and field visits conducted at different locations of Malappuram and Calicut districts the reproductive status of 112 heifers was assessed based on repeated gynaecoclinical examination. It was observed that 36.6 per cent was with true anoestrum, 19.6 per cent having under developed genitalia, 29.5 per cent normally cycling, 9.8 per cent repeater, 3.6 per cent with suboestrum and 0.9 per cent having bilateral ovarian hypoplasia. Heifers showing normal cyclicity with healthy and perfectly normal reproductive tract were considered as normally cycling. Those heifers with normal tubular tract and nonfunctional ovaries characterised by failure of development of follicles or corpus luteum were classified as true anoestrous heifers. Those heifers not attained puberty and having juvenile genitalia with small, quiescent inactive ovaries without any oestrual

signs were considered to have under developed genitalia and heifers with no clinical signs of genital abnormality but still did not conceive even with three or more inseminations were grouped as repeat breeders.

Out of thirty three normally cycling heifers, fifteen were taken as control. The heifers with suboestrum and hypoplastic ovaries were also discarded. Eighty nine heifers were taken as the material of the study. Growth rate was recorded by calculating the daily weight gain. The daily weight gain obtained for the different groups were 55.05 ± 4.2 g, 32.26 ± 2.49 g, 27.33 ± 3.4 g and 24.1 ± 4.8 g respectively for normally cycling, true anoestrum, under developed genitalia and repeaters respectively.

Serum calcium and inorganic phosphorus were estimated by employing modified metol method using calcium kit and phosphorus kit. Serum copper, zinc and manganese were estimated by atomic absorption spectrophotometry by using Perkin Elmer 2380 Atomic Absorption Spectrophotometer. The data so generated were analysed by standard statistical procedures.

The serum calcium levels obtained were within the normal range of 8-12 mg%. Normally cycling, true anoestrous, under developed genitalia and repeat breeders registered 11.1 ± 0.31 mg%, 10.74 ± 0.13 mg%, 10.8 ± 0.24 mg% and 10.8 ± 0.42 mg%

serum calcium level respectively and there was no significant difference between the groups.

The serum inorganic phosphorus level in normally cycling heifers was 4.87 ± 0.13 mg% as against 3.83 ± 0.09 mg%, 3.52 ± 0.1 mg% and 4.7 ± 0.15 mg% respectively for true anoestrous, under developed genitalia and repeaters. There was significant difference ($P<0.05$) in the serum phosphorus level between normally cycling with that of true anoestrous and under developed genitalia.

The serum copper level in normally cycling heifers registered a value of 1.26 ± 0.07 ppm which was significantly higher ($P<0.01$) than these recorded in true anoestrous heifers (0.9 ± 0.04 ppm) and heifers with under developed genitalia (0.71 ± 0.05 ppm). There was no significant difference between the copper level of repeaters (1.27 ± 0.08 ppm) with that of normally cycling group.

The serum zinc level obtained was 1.71 ± 0.05 ppm, 1.61 ± 0.03 ppm, 1.6 ± 0.05 ppm and 1.61 ± 0.06 ppm for cycling heifers, true anoestrous, under developed genitalia and repeaters respectively. There was no significant difference between the groups.

The serum manganese level was 0.04 ± 0.002 ppm for all the groups.

Out of fifteen heifers with true anoestrum which showed subnormal serum inorganic phosphorus alone 10 were treated with DCP and 5 kept as control. From the treatment group 70 per cent came to heat while only 40 per cent showed oestrus from the control group.

Out of twelve true anoestrous heifers with subnormal serum, copper alone 8 were supplemented with copper sulphate while 4 kept as control. 62.5 per cent from the treatment group and 25 per cent from the control showed heat signs.

From the 10 true anoestrous heifers with subnormal serum level, both for inorganic phosphorus as well as copper together, 7 were supplemented with DCP and $CuSO_4$ and rest were kept as control. From the treatment group 71 per cent showed heat whereas none from control group exhibited oestrum.

Sixteen heifers with under developed genitalia were found deficient in serum inorganic phosphorus and copper together. Ten animals were treated with DCP and $CuSO_4$ and 6 kept as control, 33.3 per cent heifers from the treatment group and 16.6 per cent from the control group showed heat signs.

From the result of the study it is inferred that daily weight gain was substandard in crossbred heifers under field conditions. It was also observed that serum inorganic phosphorus as well as copper had major role in reproductive status of the heifers. Meteorological data and soil mineral status were not found to influence the serum status of minerals in crossbred heifers.

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GROWTH AND REPRODUCTIVE PERFORMANCE OF CROSSBRED HEIFERS IN SELECTED AREAS

By

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ABSTRACT OF A THESIS

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ABSTRACT

Growth and reproductive status of crossbred heifers under field condition were assessed and the role of calcium, phosphorus, copper, zinc and manganese with reproductive performance was evaluated with the aim of evolving suitable corrective measures in cases of those with impaired reproductive performance due to subnormal serum mineral status.

One hundred and twelve heifers were subjected to repeated gynaecoclinical examination. It was observed that there were 36.6 per cent true anoestrum, 19.6 per cent under developed genitalia, 29.5 per cent normally cycling, 9.8 per cent repeat breeders, 3.6 per cent suboestrum and 0.9 per cent bilateral ovarian hypoplasia.

From the above heifers 89 were randomly selected and classified based on the breeding history and repeated gynaecological examination as 15 normally cycling (control), 41 true anoestrous heifers, 22 under developedgenitalia and 11 repeat breeders. The daily weight gain obtained was 55.05 ± 4.2 g, 32.26 ± 2.49 g, 27.33 ± 3.4 g and 24.1 ± 4.8 g. The above result gave significant difference in weight gain between control animals and other groups. The growth rate of

heifers might have influenced the normal reproductive performance.

Serum samples drawn from 89 heifers were analysed for calcium, inorganic phosphorus and trace elements namely copper, zinc and manganese. Serum calcium and phosphorus were estimated by employing spectronic-20, while trace elements were estimated through atomic absorption spectrophotometer. The serum calcium level obtained was 11.1 ± 0.31 mg%, 10.74 ± 0.13 mg%, 10.8 ± 0.2 mg% and 10.8 ± 0.42 mg% in normally cycling, true anoestrous, under developed genitalia and repeat breeding heifers respectively. The serum levels of all the four groups were well within the normal range and no significant variation among the groups. Hence the influence of calcium on reproduction could not be established.

The serum inorganic phosphorus was 4.87 ± 0.13 mg% in normally cycling heifers (control) as against 3.83 ± 0.09 mg% for true anoestrous heifers, 3.52 ± 0.1 mg% for underdeveloped genitalia and 4.7 ± 0.15 mg% for repeat breeders. The level was significantly lower (<0.05) in true anoestrous and underdeveloped genitalia compared to control group. It can be summarised that hypophosphataemia might be one of the cause for true anoestrum and under developed genitalia.

Among the trace elements estimated the serum level of copper only was found to be significantly varying among normally cycling, true anoestrous and heifers with under developed genitalia. The serum copper in control group heifers registered a value of 1.26 ± 0.07 ppm which was significantly higher (P<0.01) than those recorded for true anoestrous heifers (0.9 ± 0.04 ppm) and heifers with under developed genitalia (0.71 ± 0.05), while no statistical significant variation obtained between serum value of repeat breeders (1.27 ± 0.08 ppm) and the control group. It is therefore reasonable to assume that hypocupraemia as evidenced by lower serum value might have contributed to true anoestrum and under developed genitalia condition and not with that of repeat breeding condition.

The serum zinc and manganese levels of control group were 1.71 ± 0.05 ppm and 0.04 ± 0.002 ppm respectively. The corresponding values for the true anoestrum heifers were 1.61 ± 0.03 ppm and 0.04 ± 0.002 ppm and for heifers with under developed genitalia group were 1.6 ± 0.05 ppm and 0.04 ± 0.002 ppm respectively. These values did not vary significantly from those of control group. The corresponding values for repeat breeders were recorded to be 1.73 ± 0.06 ppm and 0.04 ± 0.002 ppm which did not differ significantly from the values obtained for control group.

The result of supplementation with dicalcium phosphate and copper sulphate to the respective mineral deficient heifers with true anoestrum and under developed genitalia showed that the mineral supplementation could induce oestrum.

The serum mineral status comparison at different level of feeding showed significant difference (P<0.05) in the serum phosphorus level as well as copper level of moderate plane group with that of low and poor plane groups. Hence the effect of plane of nutrition on serum mineral status could be established in case of serum phosphorus and copper.

The soil level of calcium, phosphorus, copper, zinc and manganese found to be well within the normal range. The level of exchangeable calcium and available phosphorus were ranged 0.11-0.12 per cent and 0.05-0.06 per cent respectively. The available copper, zinc and manganese levels obtained were ranged 4.43-4.5 ppm, 5.3-5.44 ppm and 96.34-99.7 ppm respectively. The result showed that the soil mineral content did not influence the serum mineral status.