ADDIS ABABA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

MANAGEMENT OF DAIRY CALVES IN HOLETTA AREA, CENTRAL HIGHLANDS OF ETHIOPIA

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DEDICATION

This work is dedicated to my late Father, Onii Serafino. For his love and support to education.

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LISTS OF ABBREVIATIONS

AGID	Agar gel immunodiffusion
APHIS	Animal and Plant Health Inspection Service
$BaCl_2$	Barium chloride
BgVV	Bundesinsttitut für gesundheitlichen Verbraucherschutz und Veterinämedizin
EARO	Ethiopain Agricultural Research Organisation
ECF	East coast fever
ELISA	Enzyme linked immunosorbent assay
EPG	Egg count per gram
FPTA	Failure of passive transfer of antibodies
GTZ	Gesellschaft für Technische Zusammenarbeit
H_2SO_4	Sulphuric acid
HARC	Holetta Agricultural research Centre
IBR	Infectious bovine rhinotrachietis
IgG	Immunoglobulins G
ILCA	International Livestock Centre for Africa
ILRI	International Livestock Research Institute
MCLP	Mixed crop livestock production
MOSDP	Market oriented dairy production
UDP	Urban dairy production
USDA	United States Department of Agriculture
$ZnSO_4$	Zinc sulphate
ZSTT	Zinc sulphate turbidity test

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ABSTRACT

This study was carried out with the primary objective of determining prevalence of failure of passive transfer of antibodies (FPTA) in dairy calves in Holetta area, Central Highlands of Ethiopia.. Other objectives were to determine relationships of some management practices with morbidity and mortality events, and identifying constraints of dairy calf management and health in this area. The study period was 5 months involving 287 calves, 218 of them were born during this period. The calves were from 3 different production systems in the study area. Market oriented specialised dairy production system (MOSDP), mixed crop livestock production system (MCLP) and Holetta Agricultural Research Center (HARC). To determine FPTA, zinc sulphate turbidity tests (ZSTT) was performed on 189 serum samples. A structured questionnaire was administered to 45 farms. Calves were clinically examined regularly, whole blood samples from sick calves were examined for trypanosomes, babesias, anaplasma and theileria. Egg count per gram (EPG) was done to determine the level of infestations of gastrointestinal parasites. Active data on management factors were collected from 38 farms that participated in this study.

The status of passive transfer was first classified as normal (>16mg/ml), partial failure (8-16mg/ml), and complete failure (<8mg/ml), and later dichotomised into failure (<16mg/ml) and normal. Crude FPTA was 32% (Fishers' exact p>0.05). FPTA was 35.5% for calves from HARC, 37.2% for calves from MOSDP, and 18 % for calves from MCLP. But this was not significantly different among production systems (Fishers' exact p>0.05). FPTA was significantly different by farm size, birth season, and dam parity (Fishers' exact p<0.05). It was higher in large farms (35.8% vs 5.9% in medium farms and 29.2 % in small farms). It was 39.1% in calves born during dry season and 25.8% in calves born during wet season. And it was 51.2% in calves of heifers and 27% in calves from dams of more than one parity. FPTA was significantly associated with weaning weight. 85.7% of calves with failure had below average weaning weight.

Morbidity outcomes considered were diarrhoea (scours, gastroenteritis), pneumonia, skin diseases, eye infections, navel infections, urogenital diseases, and debility. Scours was the leading cause of morbidity in all production systems and was highest in MOSDP farms, 51.7% (Fishers exact p<0.05). Skin diseases, eye infections, and debility were also significantly associated with production systems. Morbidity of skin diseases was highest in HARC (14.6%), eye infection was highest in MOSDP (7.3%), and debility highest in MCLP

(31%). Body condition score (BCS) at 1 month of age and at 3 months of age were significantly different (Kruskal Wallis $p<0.05$). BCS at 1 month (median score 5) was better than that at 3 months (median score 4). No blood parasites were seen in samples that were examined. EPG of 97 samples revealed prevalence of endohelminths at 32%. Prevalence of endohelminths was not significantly different among production systems (Fishers' exact $p>0.05$).

Crude calf mortality in the first 3 months was 14.2%. Mortality rate was found to be highest in MOSDP (13.9%). The differences between production systems were significant (Fishers' exact $p<0.05$).

Risk factors of morbidity and mortality (odds ratio >1, $p<0.1$) were passive antibody status, cleanliness of animals, amount of manure, mixing with animals of other herds, water source, colostrum feeding practices, calving assistance, farm size and production systems.

Inadequate routine management practices, inadequate access to water, poor feed resources, poor disease prevention control and management strategies, inadequate housing and lack of record keeping were some of the factors identified to limit productivity and health of calves in this area.

1. INTRODUCTION AND OBJECTIVES

As reported by Winrock International (1992), high population growth and urbanisation has led to an increasing unsatisfied demand for food. Periurban agriculture plays a big role in meeting this demand for food There is evidence of spatial growth and economic importance of urban agriculture in general and specifically livestock production in particular in many African cities and capitals (Mosha, 1991; Shapiro *et al*. 1992; Maxwell, 1994; Baah, 1994). In Holetta area there are 3 defined livestock production systems, namely, mixed crop livestock production system (MCLP), market oriented specialised dairy production (MOSDP), and urban dairy production system (UDP).

Management of calves has marked influences on their health, survival and later productivity. There are many management practises known to affect calf survival. These include nutritional status and health of the dams at the time of parturition, calving difficulties (dystocias), feeding of colostrum, management of infectious diseases in the environment, calibre of personnel managing the calves, feeding and housing (Waltner-Toews *et al*. 1986c). As reported by Heath (1992), most herds have a multitude of pathogens in common, and also the principles of treatment are similar, but the magnitudes of herd problems differ. So what most farms do not have in common is the selection and quality of facilities, personnel, therapeutic regimens, nutritional programs, preventive measures, and degree in which protocol is adhered. All these factors are under the control of management. Therefore it is important to identify management practices that are deleterious to the enterprise especially those that influence risk of calfhood morbidity and mortality. With good management, mortality in live born calves less than 1 month can be reduced to below 3% (Donovan and Braun, 1987). As reported by Kertz (1977), dairy calf' mortality could best be minimised by a comprehensive management program that is followed stringently. Calfhood morbidity and mortality are multifactorial complex equations and are a constraint to sustainable livestock production. Risk factors to mortality and morbidity can be grouped as farm and animal level risk factors. Farm level risk factors include farm size, housing, management policy, feeding and nutrition, preventive medicine, navel treatment and perinatal care. Calf level factors include breed, sex, age, and birth weight (Gitau *et al*., 1994).

As reported by Brenner and Unger-Waron (1996), morbidity and mortality of calves cause serious economic losses to farmers and have direct effects on herd replacement programmes Furthermore calfhood morbidity also adversely affects the survivorship and over all productivity perfomance of a herd (Britney *et al*., 1984). It is reported by Martin *et al.* (1975), that it affects rate of weight gain and days to first calving (Simensen, 1982a; Waltner-Toews *et al*, 1986b; Correa *et al*., 1988). Mortality leads to loss of genetic materials for herd replacements.

One key factor known to affect the health and survival of calves is the management of colostrum. Calves are born agammaglobulinemic and intake of liberal quantities of good quality colostrum within a few hours after birth is essential for initial protection against infection challenges. Colostral immunoglobulins absorbed provide protection against systemic infections. Colostral immunoglobulins absorbed after closure remain in the lumen of the intestine and provide local or lactogenic immunity. This is particularly important for protection against rotaviruses and coronaviruses that cause diarrhoea in calves a few days after birth (Heath 1992). Correct management of calves require that new born calves should be fed 10 to 15 % of body weight with colostrum within the first 12 hours of life (Heath, 1992). Colostral immunoglobulins decline rapidly 2 to 3 days after parturition. Partial or complete failure of transfer of antibodies is a major determinant of liability to neonatal disease and mortality in calves (Gay *et al*., 1988, Odde, 1988). And it is reported that optimal transfer of passive immunity maximises health and growth in calves (Quigley *et al*., 1995). Calves with low passive immunity are at risk of diarrhoea and respiratory diseases (Boyd, 1972; Davidson *et al*., 1981). Passive transfer of colostral antibodies is affected by formation of adequate amounts of concentrated colostrum, adequate immunoglobulins ingestion, and systemic immunoglobulin absorption. Other factors that have been associated with acquisition of maternal immunity by the neonatal calf include presence of the dam, method of colostral feeding, season, age of the dam, and environmental conditions experienced by the neonate (Mohammed *et al*, 1991). Goals of transfer of passive immunoglobulins is to have 80 % calves with serum immunoglobulins more than 5.5 mg/dL

As reported by Mohammed *et al*. (1991), immunoglobulin content of colostrum is influenced by maternal age, parity, breed, nutritional status, premature parturition, premature lactation or premilking, time elapsed after parturition and colostral handling factors. The calf should ingest 80 to 100g of immunoglobulins, and to achieve this requires a healthy and willing mother with acceptable teat and udder conformation, a strong healthy neonate, and a good maternal – neonatal bond (Aldridge *et al*., 1992). Systemic absorption of immunoglobulins occurs within the first 24 hours of birth. This is a function of specialised cells in the jejenum and ileum. Several tests are available to detect failure of passive transfer of antibodies (FPTA) in calves. These tests as reported by Garry *et al.* (1993) include, zinc sulphate and sodium sulphite turbidity test, evaluation of total serum proteins by a refractrometry, quantitation of serum IgG1 concentration by radial immunodiffusion, and a commercially available serum glutaraldehyde coagulation test. Other tests that require specialised laboratories include immunoturbidometry, agar gel immunodiffusion (AGID), serum protein electrophoresis, and enzyme-linked immunosorbent assay (ELISA). As reported by Garry *et al.* (1993), all these techniques in a practical setting should be viewed as approximations. Immunoglobulin concentration although important is only one contributor to calf's disease resistance. There are also non-immunoglobulin defence mechanisms.

The occurrence of disease should be viewed as a complex balance between neonate's resistance and degree of disease challenge. Therefore assessment of other risk factors should be done. In Ethiopia and other African countries, limited published materials are available on feeding of colostrum as an important aspect of calf management and other associated risk factors. Mundubaya *et al.* (1998) reported that factors limiting productivity in small holder farming areas of Zimbabwe were high costs of calf meal, poor feed resources during dry season, lack of knowledge of calf rearing, disease, and inappropriate housing. Nesru (1998) reported that inadequate intake of colostrum, pneumonia and scours were the principal causes of mortality at Adamitulu Livestock Research Center, Ethiopia. He reported mortality of 17.5% within the first 6 months of life

This study, which was conducted within a radius of 15 kilometres from Holetta town, was designed with the following objectives;

- To determine prevalence of failure of transfer of passive antibodies in the study areas using Zinc sulphate turbidity test.
- To determine relationship of management practices with morbidity and mortality events in calves in the different production systems of this area.
- Identify some of the constraints related to dairy calf management and health in urban and periurban locations in the study area.

2. LITERATURE REVIEW

2.1. Growing importance and scope of periurban/urban livestock agriculture

As reported by Smith and Olaloku (1998), important roles of periurban agriculture included provision of employment and income to the unemployed or low-income urban families. It provides supplementary income for the employed poorly paid and middle class urban dwellers, and food security of urban households. It reduces the gap between demand of livestock products in the city and supply from rural areas. For the more intensive well to do farmers, it is a source of commercial and economic activities. The rapid growth of the sector can be attributed to urbanisation, which has led to a rapid increase in food demand and change in food habits. Another factor is economic impoverishment in many African countries, which drastically lowered income and purchasing power of many urban households. Many households were forced to respond by engaging in urban farming to diversify sources of income and improve family nutrition. Evidence of rapid growth of this sector in many African cities has been reported in several studies (Mosha, 1991; Maxwell, 1994; Baah, 1994; Gefu, 1992; Lee-Smith and Memon (1994).

2.1.1 Urban /Periurban livestock agriculture production systems

Smith and Olaloku (1998) reported that this sector usually comprises of conventional animals like cattle for milk, small ruminants and pigs for meat, poultry for eggs and meat. Others like rabbits and snails are becoming popular in some situations. Basically the production systems can be classified as commercial or subsistent. The primary concerns of a subsistent system are mainly to meet family needs with little or no commercial exchanges. Little is done on feeding and healthcare in these systems. The animals fend for themselves. Sometimes they benefit from household kitchen wastes as and when available. Performance remains poor and mortality is high in such a system. In a commercial production system, the primary purpose is to raise animals/animal products to generate income. Depending on their sizes, such commercial enterprises can be small holders or large-scale enterprises.

According to Smith and Olaloku (1998), the main characteristics of dairy production units in Addis Ababa are large-scale production farms with herd sizes of more than 14 crossbred cows and milk yield averaging 3505 litres/lactation/cow. While small-scale producers have an average of 2 crossbred animals yielding an average of 1808 litres/lactation/cow. Many descriptions of typical smallholder urban and periurban commercially oriented livestock production systems in African cities have been made (Debrah, 1993; Baah, 1994; Staal and Shapiro, 1994)

2.1.2. Constraints in urban /periurban dairy production

As reported by many authors (Shapiro *et al.*, 1992; Debrah, 1993; Smith, 1993; Staal and Shapiro, 1994), in all the periurban/urban dairy production systems, performance is not optimal, especially in Africa. This is because of technical, institutional, and policy related constraints

Technical constraints include factors like limited milk production potential of local genotypes, seasonal quantitative and qualitative feed shortages, and poor management and health care. Institutional constraints like a weak infrastructure base and poor support services have been shown to adversely affect output and economic returns of dairy units. Inadequate infrastructure such as poor feeder roads, unreliable power supply, inefficient cooling and processing capacity can discourage production and result in economic losses (Shapiro *et al.*, 1992). Institutional support services like credit facilities, health delivery, input supply and distribution, and technical advisory services are of crucial importance to the successful management of peri-urban dairy units (Smith and Olaloku, 1998). Ties between extension services and research institutions that generate new agricultural technologies are weak and thus the two way communication between the farmers and research workers is poorly developed in most countries (Winrock, 1992).

As reported by Shapouri and Rosen (1992), Staal and Shapiro (1994), government policies play a crucial role in livestock production and therefore not only affect economic environment but also directly affects production, marketing, consumption and external trade in livestock products. Such policy issues as foreign exchange, dairy import, and commodity price policies may constraint or promote the dairy industry perfomance.

2.2. General aspects of dairy calf management

Heath (1992) reported that facilities for raising calves include sufficient space, accommodation, and utensils. And this is determined by size of breeding herd (cows and heifers), duration of breeding season, number of calves to be raised, system of raising the calves and age at which the calves are to be weaned. As described by Goodger and Theodore (1986), the major goals of calf management are; build up of the calf immune system as soon as possible, reduce stress and bacterial challenges to the calf, provide adequate nutrition, provide timely and adequate treatment of diseases. Many dairy farmers lack systematic knowledge of factors vital to good calf management. And many studies have shown that the level of management has a profound effect on mortality and morbidity (Jenny, *et al.*, 1981;Waltner-Toews *et al.*, 1986a/b). The overall goal is to raise healthy young stock for replacement and meat production. The replacement stocks should be ready to breed at 14-16 months, and mortality among newborn reduced to less than 5% (Harris and Shearer, 1992). Information is available how to achieve these goals, but it is usually management efforts that appear inconsistent and haphazard. Starting dairy calves alive and healthy begins with the maternity area. Maternity area should be well bedded and dry. The calving environment should reduce exposure of the cows and newborn calves to infectious disease organisms. And cows at or near calving should be separated and observed frequently (Harris and Shearer, 1992). The calf should be immediately provided good quality colostrum, kept clean, dry and comfortable (Bailey, 1998).

Quigley (2001) reports that if you pay attention to calves in the first day, you will have happier, healthier, and heavier calves.

2.3. Morbidity and mortality in calves

Calfhood morbidity is known to affect the longevity and productivity performance of a herd (Britney *et al.*, 1984). Most studies on morbidity in calves are done in temperate climates. Such results can not be extrapolated to tropical areas where climate, environment and management factors are quite different. Data on morbidity are quite unreliable because it depends on the producers' clinical diagnosis, whether the animal is treated by a vet and on the tendency of the producer to record every illness (Radostits *et al.*, 2000). Morbidity rates vary quite a lot and many studies have been done to describe morbidity rates (Waltner-Toews *et al.*, 1986a,b,c,d; Curtis *et al.*, 1988a,b; Sivula *et al.*, 1996; Virtala *et al.*, 1996). A study by Waltner-Toews *et al.* (1986c), found 20% of calves were treated for diarrhoea and 25% treated for pneumonia between birth and weaning. While a study done by Gitau *et al.* (1994) found crude morbidity rate to be 26.6% with diarrhoea as the most common cause of morbidity.

Mortality leads to economic loss in present value of the calf, loss of genetic materials from the calf for herd improvement. Factors known to influence early mortality in calves are herd size, season, aspects of housing, colostrum immunity, colostrum feeding management, time of separation from dam, navel treatment and herdsman (Waltner-Toews *et al.*, 1986a,b; Sivula *et al.*, 1996). Data on calf mortality vary a lot. A variation of between 1 to 30% from birth to weaning has been reported (Curtis *et al.*, 1988a). An average mortality of 5 to 10% is commonly reported (Collar, 2000). But higher losses of 50-60% have been reported, although such losses are now few due to improvement of management practises (Martin *et al.*, 1975). In a recent study by the United States Department of Agriculture (USDA) reported preweaning mortality of calves born alive was 8.4% and after weaning 2.2%. However in well-managed dairy herds, mortality in calves should not exceed 5%. According to Roy (1980), if abortions are excluded, calf mortality can be divided as perinatal mortality (still birth at 270 days of gestation and mortality during first 24 hours of live), neonatal mortality (death occurring between 24 hours and 28 days of life), older calf mortality (death occurring >28 days).

2.3.1. Causes of mortality and morbidity in calves

2.3.1.1. Abortions still births and congenital defects

This is reported to account for approximately 2 to 3% calf mortality. And some infectious causes of abortions are known to be brucellosis, leptospirosis, *Mycoplasma bovis group 7*, *Neospora caninum*, (Smyth *et al.*, 1999; Hum *et al.*, 2000; Bacsadi *et al.*, 2001; Cavirani *et al.*, 2001; Cortez *et al.*, 2001). Also intrapartum hypoxemia caused by prolonged parturition or wrong calving assistance, and inherited and non inherited congenital defects.

2.3.1.2. Calf diarrhoea and gastroenteritis

Acute diarrhoea is known to cause about 75% of the mortality in dairy calves under 3 weeks (Radostits *et al.*, 2000). The most common causes are enterotoxigenic *E. coli* in the first 3-5 days of life; rotavirus in 7-8 days, coronavirus in 7-15 days, *Cryptosporidium spp.*in 15-35 days, *Salmonella spp.* In several weeks, and coccidia in calves less than 3 weeks. In Ethiopia, Abraham *et al.* (1992) found that the majority of diarrhoea occurred in the first 5 weeks of life. Coronavirus was the major cause of neonatal diarrhoea (38.9%) in the herds studied.

followed by rotavirus with a prevalence of 16.7%, and *E. coli* with 11.1%. He did not detect *Cryptosporidia spp.* and *Salmonella spp.*

Helminthic gastroenteritis usually occurs in calves from 2 months of age and those raised on pastures. Common causes include *Trichostrongylus spp.*, *Ostertagia spp.*, *Nematodirus spp.*, *Bunostomum phlebotomum*, and *Hemonchus contortus* (Radostits, *et al.* (2000). Endohelminths in young animals are responsible for severe changes in the enteric mucosa resulting in failure in absorption, and concomitant malnutrition (Hörchner, 1990). Rubaire-Akiki (1994) reported the age group of 4-21 months as the most susceptible to gastro intestinal parasites. Another study by Tekdek and Ogunsusi (1987) reported a high diarrhoea rate of 81.8% in young calves infected with *Toxocara spp.* But *Strongyloides* were not associated with diarrhoea. In Bangladesh 52% of all diseases in calves were diagnosed as gastroenteritis with overall prevalence of gastrointestinal parasites estimated at 74% (Debnath *et al.*, 1990).

2.3.1.3. Respiratory diseases

Respiratory disease is a known complex caused by many factors such as housing, weather, and infectious agents. Enzootic pneumonia occurs primarily in housed calves over 2 months old. It accounts for about 15% of calf mortality from birth to 6 months of age (Gunn, 1995). Infectious agents causing respiratory diseases include viruses eg. *Bovine respiratory syncytial virus parainfluenza 3 virus, bovine viral diarrhea virus, bovine herpes virus 1, bovine rhinovirus, bovine adenovirus, bovine corona virus* (Uttenthal *et al.*, 1996; Ames, 1997); bacteria eg. *Pasteurella haemolytica, Haemophilus somnus*, and mycoplasma eg. *Mycoplasma dispar, Mycoplasma bovis.* (Van-Donkersgoed *et al.*, 1993). Parasitic pneumonia occurs mostly in calves raised on pastures and mainly caused by *Dictyocaulus viviparous* after about 4-5 months of age (Radostits *et al.*, 2000).

2.3.1.4. Other causes of mortality and morbidity in calves

East coast fever. In East Africa, East Coast fever (ECF), a theileriosis caused by *Theileria parva* is considered the most important livestock disease. It is transmitted by an Ixodid tick, *Rhipicephalus appendiculatus* as the main vector. The disease causes severe economic losses especially in exotic and cross breeds. Morbidity in calves can reach 100%, especially in exotic and cross breed (Norval *et al.*, 1992). Indigenous cattle are also at risk especially when they are subjected to intensive tick control or when they are moved from a disease free area to an endemic area. Intensive tick control means that the calves are not exposed to organisms and consequently do not develop sufficient innate immunity. Losses due to ECF in indigenous cattle arise due to weight loss, poor growth rate, and reduced fertility (Moll and Lohding, 1984). In calves the highest risk group has been reported to be those between the ages of 8 and 16 weeks (Mbassa, 1994). In Uganda it has been reported to kill up to 30% of indigenous calves and up to 100% of untreated exotic/cross breed calves (Unger, 1996).

Nutritional diseases. Sub optimal performance due to nutritional inadequacy is known in calves from birth to 6 months of age. The magnitudes of the economic losses incurred are not available because producers rarely monitor calf performance from birth up to several months. Losses in this category are due to inadequate intake of energy, protein, and vitamins. Also post weaning unthriftiness occurs in calves that have been weaned so early before they can consume adequate dry feed (Hoshimo *et al.*, 1989; Walsh *et al.*, 1993).

2.4. Risks factors of morbidity and mortality in calves

2.4.1. Farm level factors

2.4.1.1. Management personnel

There is a lot of literature showing a strong relationship between the person caring for and feeding calves, and the health and survivability of calves. Speicher and Hepp (1973), found that survival was highest when the owners' wife fed and cared for the calves and survival lower when hired labour was used. Jenny *et al.* (1981) reported the same situation. The reasons for this as were that the owners may be sufficiently motivated to take care of calves (Martin *et al.*; 1975). Another important character of the personnel managing the calves is experience (Hird and Robinson, 1982), with higher mortality reported in herds managed by inexperienced managers and low mortality in herds managed by experienced managers. In contrast, Gitau *et al.* (1994b) that found that more experienced farmers were having more calf health problems and lower weight gains.

2.4.1.2. Calf nutrition and feeding

To get the newborn calf started with sufficient passive immunity requires timing of feeding colostrum in adequate quantity and quality. Following colostral feeding, dairy calves may be fed whole milk, milk replacers or a combination of these depending on availability, practicability, preference and economic considerations (Harris and Shearer, 1992). Details of nutrient requirements of calves are well presented by the National Research Council (1989). The ingredients required for satisfactory growth being energy, protein, fats, minerals, and vitamins. The average digestible energy requirement for maintenance and growth is reported to be 50 kcal/kg body weight and 3 kcal/gram body weight gain per day, respectively (Medina *et al.* (1983). Although there are marked variations reported on the estimated protein and energy requirements of calves, the optimum crude protein levels in calf starters is considered to be about 16%, but lower levels of 12% have often been associated with maximum growth response. These requirements are known to be influenced by body weight gain, body size, age, diet and other factors (Jacobson, 1969).

It is commonly recommended to feed calves two times daily (Roy, 1980; Webster, 1984). But some studies found no differences in morbidity rates in calves fed once a day and those fed twice a day (Andrews and Read, 1983; James *et al.*, 1984). Feeding roughage to calves has been reported to provide protective effects against diarrhoea from about 28 days of age (Roy, 1980).

2.4.1.3. Calf housing

The environment of a calf, in addition to adequate nutrition and other health-related programmes is known to affect calf's health (Brunning-Fann and Kaneene, 1992). Webster (1984) reported that, essential environmental needs of calves are comfort, space, and hygiene. The thermal environment, the physical space such as floors and surfaces must be comfortable. Many studies have shown the effects of different housing on morbidity and mortality in calves (Oxender *et al.*, 1973; Speicher and Hepp, 1973; Simensen, 1982). Details of calf housing requirements and provision of optimal environment for calves have been described (Anderson and Bates, 1984; Turnbull, 1980; Bickert and Herdt, 1985).

2.4.1.3. Herd size

Many studies have indicated that as the herd size increases, mortality also increases (Hartman *et al.*, 1974; Oxender *et al.*, 1973; Speicher and Hepp, 1973; Waltner-Toews *et al.*, 1986b; Wells *et al.*, 1997). On the contrary, Jenny *et al.* (1981), reported that as herd size increased there calf mortality rates decreased. Bruning-Fann and Kaneene (1992), reported that confounding could have been ignored in such studies and that herd size should not have a biological effect on calf health but rather other farm factors like owner attributes or time available to observe and care for the calves should rather be made responsible.

2.4.1.4. Preventive treatment

It is common practise to vaccinate dams 2 to 6 weeks prior to calving in developed countries. Curtis *et al.* (1988b), found that calves whose dams were vaccinated against *E. coli* were 5 times less likely to die within 90 days compared with calves of dams not vaccinated. Vaccination helps the cows' immune system to produce specific antibodies. Generally reducing disease occurrences by vaccinating dams has yielded good results in many studies (Snodgrass, 1984; Jones *et al.*, 1988; Straub and Mawhinney, 1988; Archambault *et al.*, 1988;). However, Waltner-Toews *et al.* (1985), found that the practise of vaccinating cows did not provide protection against diseases in general and diarrhoea in particular. The reason could be that the vaccinated part of the herd protects the unvaccinated part or conversely, that the unvaccinated part so badly contaminates the whole herd that the vaccinates are overwhelmed by the microbial challenge. In a clinical trial, infectious bovine rhinotracheitis (IBR) virus vaccine apparently increased bacterial colonisation of the upper respiratory tract (Woldehiwet *et al.*, 1990). But nothing conclusive was derived from this study, as there were no control group of unvaccinated animals.

Treatment of dams with vitamin A, D, and E is known to have a beneficial effect on health status of calves (Waltner-Toews *et al.*, 1986d). The practise of navel treatment has been recommended for quite some time (Roy, 1980; Goodger and Theodore, 1986). This helps to dry the cord and prevent organisms from entering the body. However, Waltner-Toews *et al.* (1986c) found that as a routine farm policy, navel treatment had no significant effect on mortality rates. At individual animal level the effects depends on substances used.

2.4.2. Calf level factors

Many calf level management factors have been described as risk factors to preweaning mortality and morbidity. Factors that have recently been shown by some authors (Waltner-Toews *et al.*, 1986b; Curtis *et al.*, 1988b; Nielen *et al.*, 1989; Wells, *et al.*, 1996; Nix *et al.*, 1998; Sanderson and Dargatz, 2000) included first colostrum feeding method, timing, and volume. Others were timing of separation from the dam, calving difficulty and twinning, calving location, calf housing, dam parity and health status, navel treatment, and administration of vaccines and vitamins.

2.4.2.1. Age of calf

It is reported in many studies that morbidity and mortality is highest in first few weeks of life (Waltner-Toews *et al.*, 1986b; Speicher and Hepp 1973: Jenny *et al.*, 1981; Martin *et al.*, 1975) in dairy calves. Similar results were observed for beef herds where 39% of calf deaths occurred during the first week (Mcdermott *et al.*, 1994). Radostits *et al.* (2000), stated that approximately 75% of the mortalities of dairy animals occurs under one year of age. But a report from Bangladesh did not relate calf mortality with age (Debnath *et al.*, 1990) and another report by Gitau *et al.* (1994) indicated that calf mortality did not follow age pattern.

2.4.2.2. Sex of calf

Mortality in male calves is reported in many studies to be higher than in female calves (Mulei *et al.*, 1995; Debnath *et al.*, 1995; Haile-Mariam *et al.*, 1993). But other studies did not find significant differences among male and female calves (Nakatudde, 1994; Rao and Nagacenter, 1980).

2.4.2.3. Breed

Susceptibility to diseases is often observed to vary between breeds. Taurine breeds and their crosses are generally more susceptible to diseases when taken to tropical climates. This is mainly due to climatic, disease stress and lack of immunity. Many studies have shown higher mortalities among exotic breeds as compared to locals (Debnath *et al.*, 1990; Haile-Mariam *et al.*, 1993)

2.4.3. Seasonal and climatic factors

Several studies have indicated effects of seasonal changes on mortality and morbidity rates. Curtis *et al.* (1988a), reported that the risks of morbidity was significantly higher in winter than in summer. Waltner-Toews *et al.* (1986b) found that treatment rates for diarrhoea and pneumonia were generally lower in spring and summer than in autumn and winter. Seasonal change include temperatures, humidity, light period and number of rainy days. Their effects on calves are felt when management does not make adequate provision for these (Brenner *et al.*, 1989; Debnath *et al.*, 1990).

2.5. Feeding of colostrum and colostral immunity

Calves are born agammaglobulinemic. The health of newborn calves depends very much on intake of liberal quantities of good quality colostrum within a few hours after birth (Radostits *et al.*, 2000). This is very important in building up of the calf immune system. Colostral immunoglobulins absorbed provide protection against systemic infections. Colostral immunoglobulins ingested after closures of the intestinal barrier remain in the lumen of the intestine provide local or lactogenic immunity. This is particularly important for protection against rotaviruses and coronaviruses that cause diarrhoea in calves a few days after birth. Colostrum also acts as a mild laxative that aids in removing digestive residues from the gut of newborn calves. Colostrum is not only an important source of immunoglobulins but also full of nutrients; vitamins, minerals, energy and proteins that the calf needs to survive and prosper (Quigley, 2001).

Concentration of colostral immunoglobulins decline rapidly 2 – 3 days after parturition. Partial or complete failure of transfer of antibodies is a major determinant of liability to neonatal disease and mortality in calves (Gay *et al.*, 1988; Odde, 1988; Wittum and Perino, 1995; Weaver *et al.*, 2000). Calves with low passive immunity are at risk of diarrhoea and respiratory disease (Boyd, 1972; Davidson *et al.*, 1981). Passive transfer of colostral antibodies is affected by formation of adequate amounts of concentrated colostrum, adequate immunoglobulins ingestion, and systemic immunoglobulin absorption (Stott *et al.*, 1979; Weaver *et al.*, 2000). In general, factors like age at first feeding, method of feeding, volume of good quality colostrum, and seasonal stress affect passive immunity in calves (Heath, 1992).

2.5.1. Formation of adequate amounts of concentrated colostrum

IgG is the predominant colostral immunoglobulin. Concentration of IgG may vary considerably among cows. It is reported to be lower in first and second parity dams than in later parity dams and also decreases as the volume of colostrum increases (Tyler *et al.*, 1999b; Weaver *et al.*, 2000). These effects can be due to genetics, physiological and/or environmental factors. Concentration of colostral immunoglobulins is determined by maternal factors such as age, parity, breed, nutritional status, length of dry season, premature milking, and udder health status (Mohammed *et al.*, 1991). Concentration of IgG also depends on the amount of colostrum produced. Average concentration reported vary between 48-60g/litre with range of 20 to 115g/litre (Pritchet *et al.*, 1991; Quigley *et al.*, 1994). Cows exposed to greater number of pathogens tend to produce colostrum with greater IgG than cows exposed to fewer pathogens. This is the explanation why older cows produce colostrum with more IgG than younger cows. In general, colostrum produced in large volumes will have lower IgG than colostrum produced in smaller volumes (Pritchet *et al.*, 1991).

2.5.2. Adequate immunoglobulins ingestion

Because of concern about colostrum quality that varies a lot, it is now recommended that a calf should be given four litres of colostrum in first feeding (Besser *et al.*, 1991). And this should be immediately after birth, as delayed suckling is reported to be a major cause of failure of passive transfer in dairy calves. Many authors reported that acquisition of immunity by the calf can be compromised by failure of the calf to ingest or absorb colostrum (McGuire *et al.*, 1976; Odde, 1988; Aldridge *et al.*, 1992). Calves that receive sufficient immunoglobulins are known to perform better than calves with insufficient levels (Robison *et al.*, 1988; DeNise *et al.*, 1989). Inadequate intake and absorption of maternal antibodies has been associated with increased risk of disease and death in neonatal calves (Boyd, 1972; Williams and Spooner, 1975; Perino *et al.*, 1993). Wittum and Perino (1995) reported that calves with inadequate IgG concentration were at greater risk of preweaning mortality, neonatal morbidity, and preweaning morbidity. They found and concluded that passive immune status at postpartum 24 hours was an important determinant of health before and after weaning and was indirectly associated with calf growth during the same period.

Method of feeding colostrum has been reported to influence IgG level post suckling. While natural suckling is known to enhance efficiency of absorption of colostral immunoglobulins, it is often associated with failure to achieve adequate transfer of immunoglobulins due to inadequate ingestion of colostrum (Stott *et al.*, 1979; Besser *et al.*, 1991). But the situation of passive immune transfer in suckling calves is reported to improve when immediate assistance to stand and suckle is provided (Petrie ,1984).

2.5.3. Systemic immunoglobulin absorption

It is reported that systematic immunoglobulin absorption occurs up to 24 hours after birth. But maximum absorption efficiency occurs during first 6 to 12 hours and it is reported to decrease by 50% during this period and there may be no absorption at 24 hours (White, 1983; Smith, 1996). Rajala and Castren (1995) reported a decline in serum IgG concentration of 2g/L if colostrum was fed at 30 minutes after birth. It is therefore generally advisable to feed calves colostrum immediately after birth to maximise on acquisition of passive antibodies (Quigley, 2001). Timing of colostrum feeding is important for two reasons, loss of absorptive sites in the intestines and bacterial colonisation of the intestines (Quigley, 2001). Theories suggest that intestinal epithelial cells lose their ability to absorb intact macromolecules after about 24 hours due to maturation of the cells and development of the cellular digestive apparatus. The digestive enzymes degrade IgG prior to degradation (Quigley, 2001).

The intestinal tract of the newborn is sterile at birth. Bacterial colonisation occurs a few hours after birth and this may lead to septicemia. Presence of bacteria in the intestines may actually speed closure, thereby reducing the acquisition of passive immunity (Quigley, 2001).

2.6. Failure of passive transfer of colostral immunoglobulins

On average, failure of transfer of passive antibodies has been reported to range between 15-40% (McGuire and Scott, 1982). While failure of passive transfer of antibodies is a major determinant of neonatal diseases, it is not the sole determinant. There can be no set cut-off point of circulating immunoglobulin as this situation will vary according to different farms, environment, infection pressure and disease type (Radostits *et al.*, 2000). A calfs' risk of contracting infectious diseases that will limit productivity and health is a complex equation in which serum immunoglobulins concentration is only one factor (Garry *et al.*, 1993). Figures are given as a guide for example in dairy calves serum IgG concentration of 500mg/dL is associated with protection against septicemic infections and concentrations of 1000mg/dL or more are considered adequate to offer sufficient protection in most environments. Many studies have used different cut off values to determine failure and status of passive transfer of immunoglobulins (Irwin, 1974; Williams and Spooner, 1975; Besser *et al.*, 1991; Wittum and

Perino. 1995; Tyler *et al*., 1996). The cut off reported for adequate transfer were >800mg/dl. >1000mg/dl and >1600mg/dl. Garry *et al*. (1993) reported that the concept of failure of passive transfer is sound and has proven useful, but the diagnosis and its subsequent recommendations have been confusing. He reported that it is incorrect to assume that the published guidelines are applicable under all management situations and environmental conditions. However, the general tendency is to consider <10mg/ml as failure.

2.6.1. Diagnosis of failure of passive transfer of antibodies

2.6.1.1. Zinc sulphate turbidity test (ZSTT)

This is the most rapid and economical test for the diagnosis of failure of transfer of passive antibodies. It involves the use of zinc sulphate solution mixed with serum. Zinc sulphate causes globulins to precipitate out of solution so that the result can be read directly or spectrosphotometrically (BgVV, 1994). If the optical density of the mixtures is read by spectrophotometer, the IgG concentration can be read from a standard curve.

In sera with more than 400mg/dl of IgG the zinc sulphate precipitates the immunoglobulins and the mixture is turbid. In total failure the mixture is clear (Tizard, 1992). Time, temperature, amount of dissolved carbon dioxide in the zinc sulphate solution, and the amount of hemolysis in the sample influence the amount of turbidity and therefore this variables should be controlled (McGuire and Scott, 1982). However ZSTT has been associated with low specificity and can lead to misclassification of certain calves (Tyler *et al*., 1999).

2.6.1.2. Sodium sulphite

It is inexpensive, easy to perform and relatively accurate (Hopkins *et al*., 1984). Sodium sulphate at an appropriate concentration causes precipitation or salting out of immunoglobulins similar to that of Zinc sulphate. Amount of turbidity caused by interaction between sodium sulphate and immunoglobulins (Ig) are directly proportional to amount of Ig in serum. Primarily, a rough approximations of Ig is measured. Three solutions of sodium sulphite are prepared with distilled water; 14%, 16%, and 18%. Test results are recorded on a 0, 1+, 2+, and 3+ scale. Where 0 is equivalent to absence of turbidity in all 3 tubes. The 1+ is equivalent to observed turbidity using 18% sodium sulphite solution and absence of turbidity using 16% and 14% percent solution. The 2+ is equivalent to observed turbidity using 18% and 16% sodium sulphite solution, and 3+ is equivalent to observed turbidity in all tubes of sodium sulphite solution. At 1+ end point, the sensitivity of sodium sulphite was 0.85 and

1.00 at a 2 or 3 + end. This was higher than zinc sulphate either zinc sulphate or refractometry (Tyler *et al.*, 1996).

2.6.1.3. Glutaraldehyde coagulation test

The use of a 10% glutaraldehyde reagent which coagulates serum Ig in concentration higher than 600mg/dl has been proposed. It is inexpensive, fairly easy to perform, and gives a rough approximation of total Ig (Garry *et al.*, 1993). Unfortunately, it does not coagulate serum less than 400mg/dl and gives equivocal results between 400-600mg/dl (McGuire and Scott, 1982). Otherwise it can be adapted in serum and used as a field screening test to dignose FPT.

2.6.1.4. Total protein assay (refractometry)

This procedure measures refractive index of serum, which is proportionately related to the total protein. Use of refractometry to detect failure of passive transfer (FPTA) assumes that the main changes in the total protein of neonatal calf serum are caused by immunoglobulin absorption (Sandholm, 1974). It is a very fast field test, very cheap, and very easy to use. It provides a reasonably accurate assessment of passive transfer status in moribound calves but a test end point of 5.5g/dL may be preferable in clinically ill calves (Tyler *et al.*, 1999). On a healthy, adequately hydrated calf a serum total protein of 5.3g/dL or greater is associated with adequate passive transfer (Tyler *et al.*, 1996).

Unfortunately it is not selective and easily influenced by hydration status of calves and age, and therefore not the best indicator of Ig absorbed by the calf (Garry *et al.*, 1993). In one study, it was reported to underestimate naturally occuring or added immunoglobulin by one third (Naylor and Kronfeld, 1977). This was attributed to variable fibrinogen content.

2.6.1.5. Single radial immunodiffusion

As reported by McGuire and Scott (1982), this is the most commonly used method to measure IgG1, IgG2, IgA and IgM individually. It is a slow laboratory test, expensive, technically demanding, and require practice for accurate use. It is currently used as a gold standard (Garry *et al.*, 1993). This procedures requires specific sera to each Ig prepared in another species. Antisera to a single class is incorporated into agar and poured onto plates. Holes are punched into agar and the serum to be tested is added. Serum proteins diffuse radially from the hole and form a circular zone of precipitation. The diameter of the circular zone of precipitation is proportional to the concentration of the immunoglobulin to which the antiimmunoglobulin antiserum is directed (McGuire and Adams, 1982).

2.6.1.4. Serum electrophoresis

Total immunoglobulin can be determined by measuring total protein in serum and the percentage of immunoglobulin from electrophoresis of serum on cellulose acetate strips. It can be performed at a commercial laboratory. The test distinguishes albumin from the globulin fraction of serum proteins. Interpretation of the percentage of immunoglobulins is often subjective, otherwise the procedure is reliable (McGuire and Adams, 1982).

2.6.1.5. Others

Commercial latex agglutination tests are available for field measurement of IgG. Other tests available through specialised laboratories include immunoturbidometry, agar gel immunodiffusion (AGID), and enzyme-linked immunosorbent assay (ELISA). These tests can provide very accurate evaluations of selected protein constituents in serum but are not readily applicable in field use (Garry *et al.*, 1993).

2.6.2. Treatment of failure of passive transfer of antibodies

Reports (Hopkins *et al.*, 1984; Weaver *et al.*, 2000) indicate that treating failure of passive transfer of antibodies (FPTA) can only be economical when FPTA is diagnosed in calves before onset of disease. The treatment involves administration of serum or plasma intravenously or intraperitoneally, giving as much colostrum as possible, and administration prophylactically of broadspectrum antimicrobials. This should in combination with keeping the calves in clean environment with low exposure to infectious pathogens.

3. MATERIALS AND METHODS

3.1. Study area and production system

This study was conducted in Holetta area in the central highlands of Ethiopia 38°3'E and 9°3'N, and an altitude of 2400 meters above sea level. The farms included in this study were located within 15 kilometers from Holetta town. Holetta area is characterised by mild subtropical weather, with minimum and maximum temperatures ranging from 2°C to 9°C and 20°C to 27°C respectively. This area experiences a bimodal rainfall pattern with a long rainy season from June to September, and a short rainy season from March to April.The vegetation consists of annual legumes and perennial grass species. The major crops are wheat, barley, lentils, teff (*Eragrostis tef*) and maize. The natural pastures in the area are predorminantly composed of *Andropogon*, *Hyperrhenia*, *Trifolium* and some species of the *Cyperaceae* .

The production system based on a survey carried out in 1992/93 by ILCA (ILCA, 1994), were mixed crop livestock production (MCLP), market oriented specialized dairy production (MOSDP), urban dairy production (UDP). Also included in the study was Holetta Agricultural Research Center (HARC). These farms were known to have pregnant animals.

3.2. Study population

The study population consisted of 287 calves selected from 38 dairy farms. They were crossbreed calves 210 (73.17%), exotic 62 (21.6%), and local 15 (5.23%). Thirty-eight farms were selected by stratified random sampling technique. Stratification was based on the production system from a sampling frame consisting of farms that were involved in a Collaborative Dairy Technology and Cow Traction Project involving Ethiopian Agricultural Research Organisation (EARO) and International Livestock Research Institute (ILRI).

The sample sizes were proportionally allocated. The stratified random samples were calculated using methods appropriate to simple random samples as described by Thrusfield (2000). The following was used: 95% confidence interval with 5% absolute precision, and 30% prevalence.

The desired sample sizes were calculated and adjusted according to approximate size of study population using the following formula.

$$n = \frac{1.96^2 \, Pexp(1 - Pexp)}{d^2}$$

where, n = required sample size

P_{exp} = expected prevalence

d = desired absolute precision.

The formula above is based on an infinitely large population. Since the study population was small then the required sample was adjusted (n_{adj}) according to the following formula:

$$n_{adj} = (N^*n)/(N+n)$$

Where n is sample size calculated based on an infinitely large population from formula above and N is the size of study population.

From the above formulas, n was estimated at 323, and N approximated at 370. So n_{adj} became 173 and when allocated proportionately. The minimum sample sizes required from the different production systems were calculated as follows.

Holetta agricultural research center (HARC)	= 94
Market oriented mixed crop production (MOSDP)	= 42
Mixed crop livestock production (MCLP)	= 37
Total	= 173

UDP was not included because according to sampling frame used it would not be possible to get sufficient samples from which meaningful inferences could be made.

3.3. Study design

The study was a longitudinal one undertaken over a period of 5 months (15th/March/2001 - 15th/August/ 2001). Farm and calf level retrospective data was collected by means of a calf record form for calf data (Annex 2) and a well-structured survey questionnaire (Annex 1). Farm level data obtained included colostrum feeding programmes, feed supplement, assistance at calving, housing, frequency of cleaning calves houses, treatment of sick animals, rearing of calves, water source, mixing with other herds.

Calf level data included date of birth, sex, breed, assistance during parturition, birth time, birth season and health history. That is whether they were treated against diarrhoeas (scours or gastro-enteritis), pneumonia (any respiratory tract disease), skin diseases, debility, eye diseases, urogenital diseases and navel illness.

3.4. Questionnaires survey

A structured questionnaire form was designed and intensively reviewed by a panel of local experts who were familiar with the production system of the study area. The questionnaire was pilot tested on several farms before administration. Questionnaire data were collected from 45 farms. HARC, 1; MCLP, 34; MOSDP 3; UDP, 7.

3.5. Data collection

3.5.1 Serum samples for zinc sulphate turbidity test

About 10 ml of blood sample was aseptically collected from each calf that was born during the study period. Samples were taken when the calves were between 2 and 7 days of age. Jugular blood samples were obtained in plane vacutainers, transported to the laboratories, allowed to stand for 8 hours and centrifuged. Sera was separated the same day if collected in the morning, but separated the next morning after keeping in a fridge if taken in the afternoon. The sera were stored at -20°C until required for zinc sulphate turbidity test.

3.5.2. Zinc sulphate turbidity test methodology

According to BgVV/GTZ (1994), a solution of 205mg zinc sulphate heptahydrate in 1 litre of distilled water was prepared. Prior to the preparation the water was boiled for 30 minutes to remove carbon dioxide. Then the solution was mixed with a magnetic stirer. Six mls of the zinc sulphate solution was pipetted into a clean, clear 10ml test tube of identical size and shape. After that 0.1ml of test or control serum were added.

The mixture was shaken well using vortex and incubated at room temperature (20°C) for 1 hour. Following this, the turbidity (absorbance) of standard and test sera were compared with that of a stable chemical standard, McFarland solution. The chemical standard (McFarland) was prepared according to BgVV /GTZ (1994) from 1% solutions of $BaCl_2$ and H_2SO_4 as shown in Table 3.1.

Below each standard tube the corresponding IgG concentration causing identical turbidity when precipitated in the zinc sulphate test is listed. This chemical standard is stable for at least three months, as it does not undergo biological instabilities.

Table 3.1. McFarland turbidity standard for $ZnSO_4$ test (BgVV, 1994)

Tube	0.25	0.5	1.0	2.0
$BaCl_2$ (1%) [µl]	25	50	100	200
H_2SO_4 (1%) [ml]	9.975	9.950	9.900	9.800
Corresponding IgG conc. [mg/ml]	2	4	8	16

To facilitate the comparison of turbidities it was helpful to use the readability of printed text behind the tube as a measure. Interpretation of passive immunoglobulin status was adopted as done by other authors (Wittum and Perino, 1995). Greater than 16mg/ml was considered adequate and therefore normal transfer, 8-16mg/ml was marginal and therefore considered partial transfer, and <8mg/ml was inadequate and therefore considered failure. For the purposes of dichotomising passive immune status, partial transfer was considered partial failure and so marginal category (8-16mg/ml) and failure category (<8mg/ml) were both considered failure. Consequently cut off for failure was put at <16mg/ml. It is reported that higher concentrations may be needed to ensure optimal health under conditions of poor sanitation (Tyler *et al.*, 1996). And Hopkins *et al.* (1984) reported that zinc sulphate turbidity tests accurately identified immunoglobulin levels of 16mg/ml and above. Basing on this, a decision was made to use the upper limit of category 2. This also allowed some false positives to be tolerated other than false negatives for this study.

3.5.3. Blood samples for parasitology

About 10 mls of whole blood samples were aseptically obtained from older calves (>1 month) showing clinical signs of sicknesses for investigation of hemoparasites. This was to confirm whether hemoparasites particularly trypanosomes, babesias, anaplasma, and theileria could be causing morbidity in this calves after a tentative diagnosis was made based on clinical signs.
For examination of whole blood for parasites, heparinised vacutainer tubes were used. Then Giemsa staining procedures was followed as described by Shah-Fischer and RalphSay (1989).

3.5.4. Fecal samples for helminth egg counts

About 5 to 10 gms of fecal materials were collected from the rectum of each calf sampled for assessment of egg count per gram. The samples were put in plastic containers that were properly labeled with date and time of sampling taken. Farms were stratified by size, and fecal samples taken randomly especially for large farms with many calves in order to avoid selection bias.

McMaster method for egg count was performed as described in Urquhart *et al* (1992). Three grams of fresh faecal material was crushed using a pestle and mortar or 3 teaspoonfuls if feces were diarrheic. This was added in 42ml of water in a plastic container. The mixture was strained using a fine mesh sieve (aperture 250 microns, or 100 to 1 inches). The filtrate was collected agitated and filled in a test tube of about 15ml capacity and flat bottomed. Then centrifuged at 2000rpm for 2mins. The supernatant was poured off, sediment agitated and tube again filled to previous level with floatation solution. The tube was inverted 6 times, and the fluid removed with pipette to fill both chambers of McMaster slide. Pipetting was done rapidly since the eggs are known to rise quickly in the flotation fluid. Both chambers of McMaster were examined under the microscope and to get number of eggs per gram (epg), the total number of eggs or larvae counted under both etched area was multiplied by 50. As described by Hansen and Perry (1994), egg counts per gram (EPG) were ranked as follows; 0 (no eggs), 1 for light infection (50 - 200 eggs), 2 moderate infection (200 - 800 eggs), 3 heavy infections (>800 eggs).

3.5.6. Monitoring and clinical evaluation of calves

Each calf in the study was regularly examined after proper identification. Calves entered the study when they were less than 3 months, and born during the study period. Physical and clinical examinations were done within the first week of life, second week and then monthly for three months as long as they were still within study period. Exceptions were those with serious diseases that warranted closer monitoring and further investigations. It was not possible to monitor all calves for three months of life as some were born later during the study period, which was fixed. A stethoscope was used to take respiration rate and heartbeat. A thermometer to take rectal temperature. Mortality and morbidity were recorded accordingly. Crude mortality rate (CMR) was calculated according to Martin *et al*. (1987).

$$\text{CMR} = \frac{\text{number of dead calves during the period}}{\text{number of live born calves during the 3 months}}$$

Internal time component of 3 months was used to calculate crude morbidity and mortality rates. Although the monitoring period was 5 months, incidence recorded were those occurring from birth to three months. For the purposes of this work pneumonia was defined as any respiratory disease that was diagnosed by clinical examination. Diarrhea was defined as scours and/or gastroenteritis. Eye infection was defined as any type of eye disease. Debility was any loss in body condition that would make the calf to be scored between 1-3. Skin disease was defined as skin condition that was diagnosed based on clinical examination. Urogenital disease was defined based on clinical examination and diagnosis. Navel infection was defined as enlargement of and/or signs of pain on palpation of the navel.

Morbidity rate was calculated using the following formula:

Morbidity rate =No. new cases/(Average population at risk *internal time component).

Body condition scores were given as described by Nicholson and Butterworth (1986) for most study calves on ordinal scale ranging between 1 to 9 (1 for extreme emaciation and 9 obesity). Because calves were monitored over a period of time, body condition scores were given three times where feasible. First score when the calf was one month old, second when it was 2 months old and 3^{rd} when it was 3 months old.

3.5.6. Evaluation of calf management practices

In each of the farms management and environmental factors were ranked according to Lance *et al*. (1992) as above average (1), average (2), below average (3). The following factors were ranked; cleanliness of animals, amount of manure, ventilation, degree of crowding and record keeping. Records of morbidity of calves were assessed based on the observed clinical signs and questionnaires. Furthermore it was recorded whether these conditions were farmer diagnosed/treated or vet/animal health assistant diagnosed/treated.

Aspects of management also looked at were supplemental feeding if provided, whether this was based on commercial concentrates or locally available feed resources. Source of water for the animals and whether they had free access to water or not, and whether calves and/or adult animals mix with other herds or not. Other aspects of calf management assessed included assistance during calving, management of colostrum, and type of calf housing. For colostrum management, time of separation of calves from dam, and whether colostrum was given to other animals and/or humans and how colostrum was fed to calves. Type of calf housing were; whether group pen in calf barn, group pen in cow barn, individual pen in calf barn, individual pen in cow barn or shared facility with adult cattle, shared facility with other animals and/or humans, open fences.

3.6. Data management and analysis

The statistical analysis was done using computer programmes. All the gathered data was entered into Access 97 database. Descriptive statistics was performed using MS-Excel 97 and Stata 6.0 (1984-1999). Levels of significance were tested using Fishers' exact test using Stata 6.0. Risk factors were determined by logistic regression using Stata 6.0. Body condition scores were compared by Kruskal Wallis test using Statgraphics plus 2.1.

4. RESULTS

4.1. Questionnaire data

The results of the questionnaires that were conducted on 45 farms and the characteristics of the 45 farms are summarised in Table 4.1. Three (6.6%) of the farms were large farms, 21 (46.7%) were medium farms and 21 (46.7%) were small farms. From production system point of view, 34 (75.5%) of the farms were from mixed crop livestock production system (MCLP), 15.6% from urban dairy production system (UDP), 3 (6.7%) from market oriented specialised production system (MOSDP) and the remaining 1(2.2%) was Holetta agricultural research centre (HARC). The most common type of calf housing was that calves were found to share facility with other animals and/or humans (28.9%). Most farms did not report free availability of water to calves (91%) and the well was found to be the most common water source (46.7%). Eighty four percent (84 %) of farms had crossbreed, 64.4% had local and only 6.7% had pure exotic breeds.

Table 4.1. Distribution of the major dairy farm variables among the 45 farms in Holetta, 2001

Variables	Frequency (n=45)	Percent
Farm size		
Large	3	6.7
Medium	21	46.7
Small	21	46.6
Production System		
MCLP	34	75.5
UDP	7	15.6
MOSDP	3	6.6
HARC	1	2.2
Type of housing		
Group pen in calf barn	10	22.2
Group pen in cow barn	3	6.7
Individual pen in calf barn	3	6.7
Individual pen in cow barn	1	2.2
Sharing facility with adult cattle	10	22.2
Sharing facility with humans and/or other animals	13	28.9
Open group pen	5	11.1
Water access		
Free access (YES)	4	8.9
Free access (NO)	41	91.1
Water source		
River	17	37.8
Well	21	46.7
Tap/pump	7	15.5
Breed		
Local breed		
Yes	29	64.4
No	16	35.6
Cross breed		
Yes	38	84.4
No	7	15.5
Exotic breed		
Yes	3	6.7
No	42	93.3

MCLP= mixed crop livestock production, MOSDP= market oriented specialized dairy production, UDP= urban dairy production, HARC= Holetta Agricultural Research Center

Table 4.2 summarizes some of the management factors among production systems. Significant differences (Fishers' exact $p<0.05$) were seen in sex, disinfecting of navel, mode of feeding colostrum, time after birth colostrum was fed, who fed colostrum, and whether quantity of colostrum fed was known. Other factors that were significant were water source and water availability.

Table 4.2. Distribution of management factors by production system in Holetta, 2001

	Production system				
Practice	MCLP (n=34)	MOSDP (n=7)	UDP (n=3)	HARC (n=1)	p-value
Management of calves by sex					
Yes	0	1	2	0	0.003
No	34	6	1	1	
Calves mixing with other herds					
Yes	26	4	0	0	0.011
No	8	3	3	1	
Disinfecting navel					
Yes	1	2	1	1	0.008
No	33	5	2	0	
Supplementary feeding					
Yes	29	4	3	1	
No	5	3	0	0	0.323
Treatment against diseases					
Yes	32	5	3	1	
No	2	2	0	0	0.287
Water source					
River	13	3	1	0	
Well	18	3	0	0	0.050
Tap/pump	3	1	2	1	
Free water access					
Yes	1	1	1	1	
No	33	6	2	0	0.013
Time after birth colostrum fed					
<6hours	11	0	3	1	
6-24 hours	1	0	0	0	0.014
Not applicable	22	7	0	0	
Mode of feeding colostrum					
Individually	34	7	1	0	0.000
Pool	0	0	2	1	
Colostrum taken by others					
Yes	16	2	1	0	0.740
No	18	5	2	1	
Who feeds colostrum					
Owner	23	2	0	0	0.011
Employee	11	5	3	1	
Quantity of colostrum					
Known	0	1	2	1	0.000
Unknown	34	6	1	0	

Records of treatment against 6 diseases and debility by production system among farms are shown in Table 4.3. Diarrhoea and pneumonia were the most frequently treated diseases. Thirty-seven (82.2%) reported having treated diarrhoea and pneumonia. This was followed by skin diseases, 16 (35.6%), urogenital infections, 10 (22.2%), navel infections 8 (17.8%) and debility, 3 (6.7%) farms. Treatment against navel infection and urogenital diseases were significantly different ($p<0.05$) among production system. All farms in MOSDP and HARC reported treatment against navel infection. In MCLP most farms 30 (91.3%) did not report treatment against navel infection. All farms in MOSDP and HARC reported treating urogenital infections, while 29 (85.3%) of MCLP farms did not report treating urogenital diseases.

Table 4.3. Distribution of previous treatment against various conditions by production system among 45 farms in Holetta, 2001

Condition	Production system				
Condition	MCLP (n=34)	UDP (n=7)	MOSDP (n=3)	HARC (n=1)	Total (n=45)
Diarrhoea					
Yes	27(79.4)	6 (85.7)	3 (100.0)	1 (100.0)	37 (82.2)
No	7 (20.6)	1 (14.3)	0 (0.0)	0 (0.0)	8 (17.8)
Pneumonia					
Yes	28 (82.3)	5 (71.4)	3 (100.0)	1 (100.0)	37 (82.2)
No	6 (17.7)	2 (28.6)	0 (0.0)	0 (0.0)	8 (17.8)
Skin diseases					
Yes	11 (32.3)	2 (28.6)	2 (66.7)	1 (100.0)	16 (35.6)
No	23 (67.7)	5 (71.4)	1 (33.3)	0 (0.0)	29 (64.4)
Debility					
Yes	2 (5.9)	0 (0.0)	1 (33.3)	0 (0.0)	3 (6.7)
No	32 (94.1)	7 (100.0)	2 (66.7)	1 (100.0)	42 (93.3)
Navel infection					
Yes	4 (8.8)	0 (0.0)	3 (100.0)	1 (100.0)	8 (17.8)
No	30 (91.2)	7 (100.0)	0 (0.0)	0 (0.0)	37 (82.2)
Urogenital infection					
Yes	5 (14.7)	1 (14.3)	3 (100.0)	1 (100.0)	10 (22.2)
No	29 (85.3)	6 (85.7)	0 (0.0)	0 (0.0)	35 (77.8)
Eye infection					
Yes	9 (26.5)	1 (14.3)	3 (100.0)	1 (100.0)	14 (31.1)
No	25 (73.5)	6 (85.7)	0 (0.0)	0 (0.0)	31 (68.9)

MCLP=Mixed crop livestock production,UDP=Urban dairy production,MOSDP=Market oriented specialised dairy, HARC=Holetta Agricultural Research Centre.

4.2. Description of production system

4.2.1. Mixed Crop Livestock Production (MCLP)

This system was mainly small holder dominated. Cattle husbandry was mainly for traction and milk production. The mixed crop livestock farms included in this study had crossbred cows or local breeds. Most of the crossbred cows and the complementary feeding management technologies they adopted were introduced to Holetta area through a collaborative Dairy Technology and Cow Traction project involving the Ethiopian Agricultural Research Organization (EARO) and the International Livestock Research Institute (ILRI). In this study 30 crop livestock farms were randomly selected from a sampling frame which included all such farms with crossbred dairy animals. They had an average of 2 to3 crossbred cows. 71 (24.7%) calves in this study were from MCLP. Of these 55 (77%) were cross breed and 16 (23%) were local breed.

In this system, livestock and cereal production were integrated. Animals were utilized for ploughing, traction, and milk production. The manure was utilized for biofertiliser and fuel. Animals were supplemented with crop by-products for example straw from teff, wheat and barley (85.2% of farms in this study). Animals grazed on pasture 7 to 8 hours a day. The lactating cows were sometimes supplemented with commercial concentrates, native hay, crop by-products, nough (*Guizotia abyssinica*) seed cake, and milling by products. Much of the time, the animals grazed together mixed with other herds during the dry season (78.1% of calves from MCLP farms in this study). The land was preserved during the long rainy season (June to October) for haymaking and individual grazing. The animals were supplied with water from the river (31.3%), well (56.2%), and tap/pump (12.5%) of the calves from MCLP farms in this study. In most cases the newborn calves were housed within the same house of the farmer and family for a period of about 2 months before they were released to graze outside with other calves (45.3% of calves from MCLP farms in this study). In this system, more attention was paid to cereal crop production than livestock production.

4.2.2. Market Oriented Specialised Dairy Production (MOSDP)

The majority of farms in this system had crossbreed, a few with pure exotic, and local breeds animals. For the crosses the blood levels were not known. In this study 68 (23.7%) calves were from this system. Animals were grazed and supplemented with a variety of feed materials. In most cases commercial supplements were given. The most supplementary feeds available were natural hay, wheat bran, middling nough cake (*Guizotia abyssinica*), and cotton seed cake.

These farms used stall feeding and calves were supplied with water from tap (94.1%) and river (5.9%). All the MOSDP farms involved in this study provided some kind of housing for the calves. Rainproof corrugated roof and concrete floor were common. Calves were raised separately, either at one corner of the house or a separate calf barn. All farms from MOSDP system involved in this study had a policy of assisting calving and calves were taken away from their dams immediately after birth and bucket fed.

4.2.3. Urban Dairy Production (UDP)

This system comprises of farms situated within Holetta town. The questionnaire survey involved 7 farms from this system. Most of the animals were cross breed. They used zero grazing or semi-zero grazing by the street side and grazing at public open field. Feed supplementation was a common practise. Depending on availability, feed supplements included natural hay, wheat bran, middling, nough (*Guizotia abyssinica*), cotton seed cake, brewers' waste from local drinks and common salt as mineral supplement. Access to water was limited and animals were supplied with water from the river or well. Separate calf housing was not common. Newborn calves were managed at one corner of housing space of the dam. In many cases calves are kept in the same house where humans lived. Most farmers in this system had a policy of assisting calving. The majority of farmers depended on other sources of income. The farms that were initially recruited from this system were dropped because we could not get calves.

4.2.4. Holetta Agricultural Research Center (HARC)

Because of its unique nature HARC was considered a system on its own. The overall objective of the research at this centre was to cross European breeds of cattle with different combinations of indigenous Zebu from contrasting environmental and farming conditions. Livestock at HARC comprised of crossbreed animals whose levels are known and pure Boran cattle. One hundred fourty eight calves in this study were from HARC. Supplementary feeding based on commercial concentrates was provided. The animals got water from the river while grazing and in the evening tap water. Newborn calves were taken immediately after birth and bucket fed. Calves were housed separately in a calf barn made of corrugated iron roof and wall. The floor was concrete and straw was provided as bedding materials.

4.3. Description of study population

The study population consisted of 287 calves selected from 38 dairy farms (Table 4.4). They were crossbreed calves 210 (73.2%), exotic 62 (21.6%), and local 15 (5.2%). One hundred fifty six were males (54.4%) and one hundred thirty one were females (45.6%). Two hundred eighteen (76%) of the calves were born during the study period and 69 (24%) before the study period. Two hundred and thirty seven (82%) calves were born without assistance and most calves were born during day (56.5%). Only 72 (25.1%) were born of heifers. Most calves were from large farms (74.6%), and 52.3% of calves were from HARC. While 68 (23.7%) and 69 (24%) were from MOSDP and MCLP farms respectively.

Table 4.4. Descriptive variables of the study population in Holetta, 2001

Variable	Number of calves (n=287)	Percentage of calves
Breed		
Exotic	62	21.6
Cross	210	73.2
Local	15	5.2
Sex		
Males	156	54.4
Females	131	45.6
Assistance at birth		
Assisted	46	16.0
Not assisted	237	82.0
Missing information	4	1.4
Birth time		
Day	121	56.5
Night	93	43.5
Birth season		
Wet	118	41.1
Dry	169	58.9
Dam parity		
One	72	25.1
More than one	215	74.9
Farm size		
Large	214	74.6
Medium	41	14.3
Small	32	11.2
Production system		
MCLP	69	24.0
MOSDP	68	23.7
HARC	150	52.3

4.4. Ranking of management factors

Table 4.5 shows variables that that were ranked across the study calves by production system. All the factors considered here were highly significant among production system

(Fishers'exact p-value=0.000). Among MCLP farms of cleanliness of animals and record keeping' was below average, 69.0% and 98.6% respectively. While the amount of manure, degree of crowding, and ventilation was average. They were 59.2%, 67.6%, and 69% of the calves in MCLP respectively.

Table 4.5. Ranks of some management variables among the study calves by production system

Variable	Production system			
	MCLP(%) (N=71)	MOSDP(%) (N=68)	HARC(%) (N=148)	P-value
Cleanliness of animals				
Above average	0 (0.0)	0 (0.0)	0(0.0)	
Average	22 (31.0)	7 (10.3)	148(100.0)	0.000
Below average	49(69.0)	61(89.7)	0(0.0)	
Amount of manure				
Above average	3 (4.2)	0(0.0)	0(0.0)	
Average	42(59.2)	68(100.0)	0(0.0)	0.000
Below average	22(31.0)	0(100.0)	148(0.0)	
Missing value	4(5.6)	0(100.0)	0(0.0)	
Degree of crowding				
Above average	0(0.0)	0(0.0)	0(0.0)	
Average	48(67.6)	68(100.0)	148(100.0)	0.000
Below average	23(32.4)	0(0.0)	0(0.0)	
Ventilation				
Above average	1(1.4)	3(4.4)	0(0.0)	
Average	49(69.0)	65(95.6)	148(100.0)	0.000
Below average	21(29.6)	0(0.0)	0(0.0)	
Record keeping				
Above average	0(0.0)	0(0.0)	148(100.0)	
Average	1(1.4)	68(100.0)	0(0.0)	0.000
Below average	70(98.6)	0(0.0)	0(0.0)	

Among MOSDP calves, the level of cleanliness was below average. While amount of manure, degree of crowding and record keeping were 100% average among MOSDP calves. Sixty nine percent (69%) of the calves from MOSDP had average ventilation. Among HARÇ calves cleanliness of animals, degree of crowding, ventilation was average. Record keeping was above average and amount of manure was below average.

4.5. Calf management practises

Besides management factors that were ranked (Table 4.5), other aspects of management were considered. These included; calving assistance, colostrum and supplementary feeding practises, management of sick calves, housing and rearing of calves, water source and availability.

4.5.1. Calving assistance

Eighty seven percent of calves in this study came from farms that reported calving assistance as a policy. But only 16% of calves in this study were assisted at birth.

4.5.2. Colostrum and supplementary feeding practises

About 64% of calves from MCLP came from farms where time of feeding colostrum was not applicable and this was similar among calves from MOSDP (100%). Because calves were just left with their dams to suckle on their own and sometimes they were assisted to suckle. In HARC calves were bucket fed before 6 hours after birth. The time of feeding colostrum after birth was significantly different among production systems (Fishers' exact p-value<0.05). About 48% of farms assist calves to ingest colostrum and 52% do not. This practise was not differing significantly between production systems and farm sizes (Fishers' exact p-value>0.05). The quantity of colostrum fed to calves was known in HARC. Calves were fed 1.5 litres in the

morning and 1.5 litres in the afternoon daily for 4 days. In all farms in MCLP system, and 85.7% of farms in MOSDP system the quantity of colostrum taken by calves was not known. About fourty seven percent of farms in MCLP and 28.6% of farms in MOSDP systems also give colostrum to others (humans, dogs, cats). This practise was differing significantly between production systems and farm sizes (Fishers' exact p-value<0.05). Supplementary feeding was based mainly on commercial concentrates, native hay, crop by-products, nough (*Guizotia abyssinica*) seed cake, and milling by products.

4.5.3. Housing and rearing of calves

In HARC calves were reared indoors in individual pens in calf barns. Calves were provided bedding materials (straw). They were then continued on liquid milk for 14 days that is when concentrate feeding and roughage was introduced. They were released out to the open to exercise get sunshine and learn to graze pastures. Calves were weaned at 98 days.

In MOSDP and MCLP, many categories of housing were present; group pen in calf barn, group pen in cow barn, individual pen in calf barn, individual pen in cow barn, sharing facility with adult cattle, sharing facility with humans and/or other animals, group in the open. The most common was sharing facility with humans and/or other animals for MCLP (35%) and sharing facility with adult cattle (33%) for MOSDP. Calves were in most cases released to suckle twice a day. Particularly among MCLP, calves were left out to pastures and mixed with animals from other herds when they were 2 months old. The basis of weaning in all farms was age.

4.5.4 Management of sick calves

Treatment of animals against diseases was a practise in 90% of the farms. This was mainly based on farmers' diagnosis (89%), and only 11% was based on vet's/vet assistant's diagnosis. Whether animals were treated or not did not differ significantly among production system and farm size (Fishers' exact p value >0.05).

4.5.5. Water source and availability

Three types of water sources were available for calves, river (37.8%), well (46.7%), and tap/pump water (15.5%). This did not differ significantly between production systems and farm sizes (Fishers' exact p value >0.05). Only 3% of the calves had free access to water. This was significant among production systems (Fishers' exact p value<0.05). In HARC calves had free access to water for a limited period of about 2 hours when calves are let out in open pen where tap water was always available.

4.6. Failure of passive transfer of colostral antibodies (FPTA)

Fig.4.1 shows status of transfer of passive antibodies among 189 calves as determined by zinc sulphate turbidity tests. Complete failure was about 13.8%, partial failure 18.5% and normal transfer 67.7%.

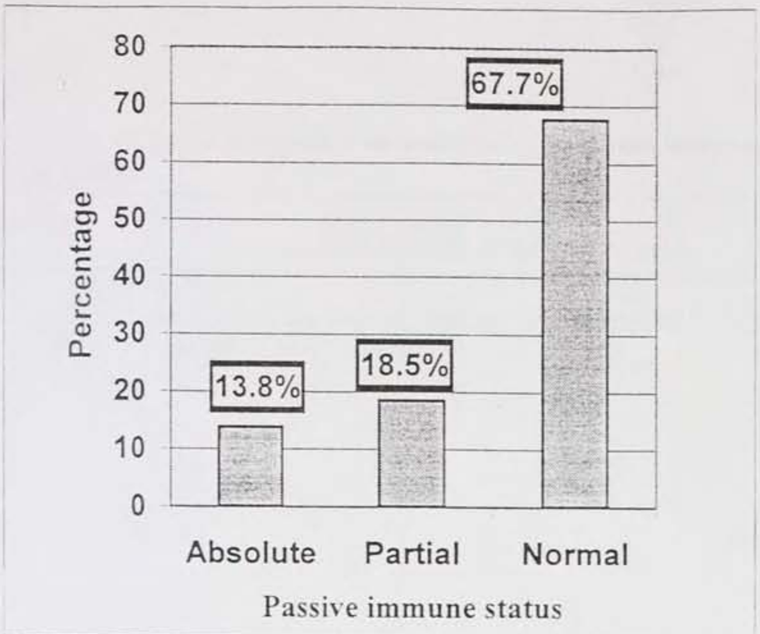

Figure 4.1. Passive immune status of 189 calves in Holetta, 2001

Table 4.6. Status of passive transfer of antibodies by some independent variables in Holetta area, 2001

Variable	Passive transfer of antibody status				
	Total no. of calves (n=189	Normal transfer (n=128)	Partial transfer (n=35)	Complete failure (n=26))	%Complete failure
Farm size					
Large	148	95	30	23	15.5
Medium	17	16	1	0	00.0
Small	24	17	4	3	12.5
Production system					
MCLP	39	32	4	3	7.7
MOSDP	43	27	13	4	9.3
HARC	107	69	18	20	18.7
Sex					
Males	99	68	16	15	15.2
Females	90	60	19	11	12.2
Birth assistance					
Yes	23	15	2	6	26.0
No	166	113	33	20	12.1
Parity					
One	41	20	12	9	22.0
More than one	148	108	23	17	11.5
Birth season					
Dry	92	56	22	14	15.2
Wet	97	72	13	12	12.4
Birth time					
Day	99	68	17	14	14.1
Night	90	60	18	12	13.3

When category of failure and partial failure of Figure 4.1 were added together, total prevalence of failure of passive transfer is shown in Figure 4.2 below. Failure was 32% (confidence interval 25.7-39.4).

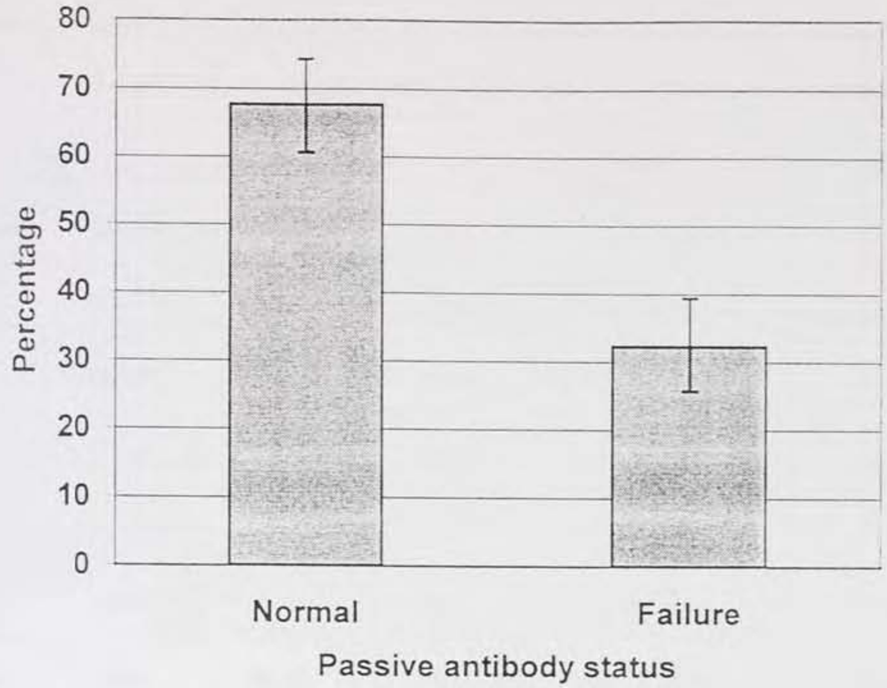

Figure 4.2. Crude prevalence of Failure of Passive Transfer of Antibodies (FPTA) in Holetta calves, 2001

Table 4.7 shows that FPTA was not significantly different between production system, calving assistance, and birth time (Fishers' p value >0.05). But FPTA was significantly different by farm size, birth season, and dam parity (Fishers' p value <0.05). It was 35.8% in large farms and 5.9% in medium farms. It was 39.1% among calves born during dry season and 25.8% among calves born during wet season. And 51.2% in calves of heifers and 27% in calves born from dam of more than one parity.

Table 4.7. Percentages of dairy calves by variables and passive immune status in Holetta area, 2001

Variable	Level	Percentage of calves	%FPTA	95 %Confidence interval for %FPTA	Fishers' exact p-value
Production system	MCLP	20.63	18.0	7.5 - 33.6	0.095
	MOSDP	22.75	37.2	24.9 – 55.6	
	HARC	56.61	35.5	26.5 - 45.4	
Farm size	Large	78.31	35.8	28.1 – 44.1	0.028
	Medium	8.99	5.9	0.1 - 28.7	
	Small	12.70	29.2	12.6 - 51.1	
Season of birth	Dry	48.68	39.1	29.1 - 49.9	0.035
	Wet	51.32	25.8	17.4 - 35.7	
Dam parity	1	21.69	51.2	35.1 - 67.1	0.005
	>1	78.31	27.0	20.1 - 34.9	
Calving assisted	Yes	12.17	34.8	16.4 - 57.3	0.814
	No	87.83	31.9	22.4 - 41.4	
Birth time	Day	52.38	31.3	22.4 - 41.4	0.877
	Night	47.62	33.3	23.7 - 44.1	
Sex	Female	52.38	31.3	22.4 - 41.4	0.877
	Male	47.62	33.3	23.7 – 44.1	

FPTA=Failure of transfer of passive antibodies, MCLP=Mixed crop livestock production system, MOSDP=Market oriented specialised dairy production system, HARC=Holetta Agricultural Research Centre.

4.7. Weaning weight and failure of passive transfer of antibodies

Weaning weight of calves were estimated by production system (Table 4.8). Minimum weaning age was 3 months in the study area. So for this study weight at 3 months was considered weaning weight to make comparison among production systems realistic. There was no significant differences in weaning weight by production system (Kruskal Wallis p value>0.05).

Table 4.8. Mean weaning weight of calves by production system in Holetta, 2001

Production system	Mean wean weight(kg)	Confidence interval
MOSDP	89.5+/-16.9	72.6-106.4
MCLP	70.6+/-5.2	65.1-75.6
HARC	71.4+/8.75	61.6-79.1

MOSDP=Market oriented specialised dairy producion, MCLP=Mixed crop livestock production, HARC=Holetta Agricultural Research Center.

Table 4.9. Passive immune status in calves with below average and above average weaning weight in Holetta, 2001

Weaning weight	Passive immune status(%)	
	Normal	Failure(FPTA)
No. calves above average(%)	29(53.7)	3(14.3)
No. calves below average	25(46.3)	18(85.7)
Total	54(100.0)	21(100.0)

Weaning weight was dichotomised as below average and above average for 75 calves whose passive immune status was known (Table 4.9). There was significant difference between calves with normal transfer and calves with failure (Fishers'exact p value=0.002). Eighteen calves with failure (85.7%) had weaning weights below average. And only 3(14.3%) calves with failure had weaning weights above average.

4.8. Morbidity and mortality

4.8.1. Morbidity rates and passive immune status

A total of 287 calves were registered during the study. Sixty-nine was at the beginning of the study. Thirty-one calves died during the study period and 5 were sold. Table 4.10 shows that crude morbidity of pneumonia was 11.1%, diarrhoea (scours) 26.8%, skin disease 10.6%, debility 15.7%, eye infection 3.1%, navel infection 1.5%, and urogenital diseases 0.8%. Crude morbidity for all diagnoses was 79.7%. As a percent of all cases, diarrhoea remains the leading cause of morbidity in this area followed by pneumonia (Annex 3). Rate of debility is higher than pneumonia but debility is a syndrome not in reality a disease entity on its own.

Table 4.10. Morbidity rates of various disease conditions among the study calves in Holetta, 2001

Condition	No. of new cases	Average population at risk	Morbidity rate
Pneumonia	45	135	45/(135*3)=0.111
Diarrhoea (Scours)	91	113	91/(113*3)=0.268
Skin disease	43	136	43/(136*3)=0.106
Debility	72	120	72/(120*3)=0.157
Eye infection	14	153	14/(153*3)=0.031
Navel infection	7	157	7/(157*3)=0.015
Urogenital disease	4	158	4/(158*3)=0.008
Crude morbidity	165	69	165/(69*3)=0.797

Morbidity of scours, skin diseases, debility, eye infection in the calves were significantly different by production system (Fishers' exact p-value<0.05). Scours (gastroenteritis) was 51.7% in MOSDP, 27.7% in HARC, 11.7% in MCLP. Skin diseases were 5.2% in MOSDP, 14.6% in HARC and 7.9% in MCLP. Debility was 10% in MOSDP, 19.4% in HARC and 31% in MCLP (Figure 4.3). Only scours and debility were significantly different among farm sizes (Fishers' exact p-value<0.05). Scours was highest in large farms (36.6%).

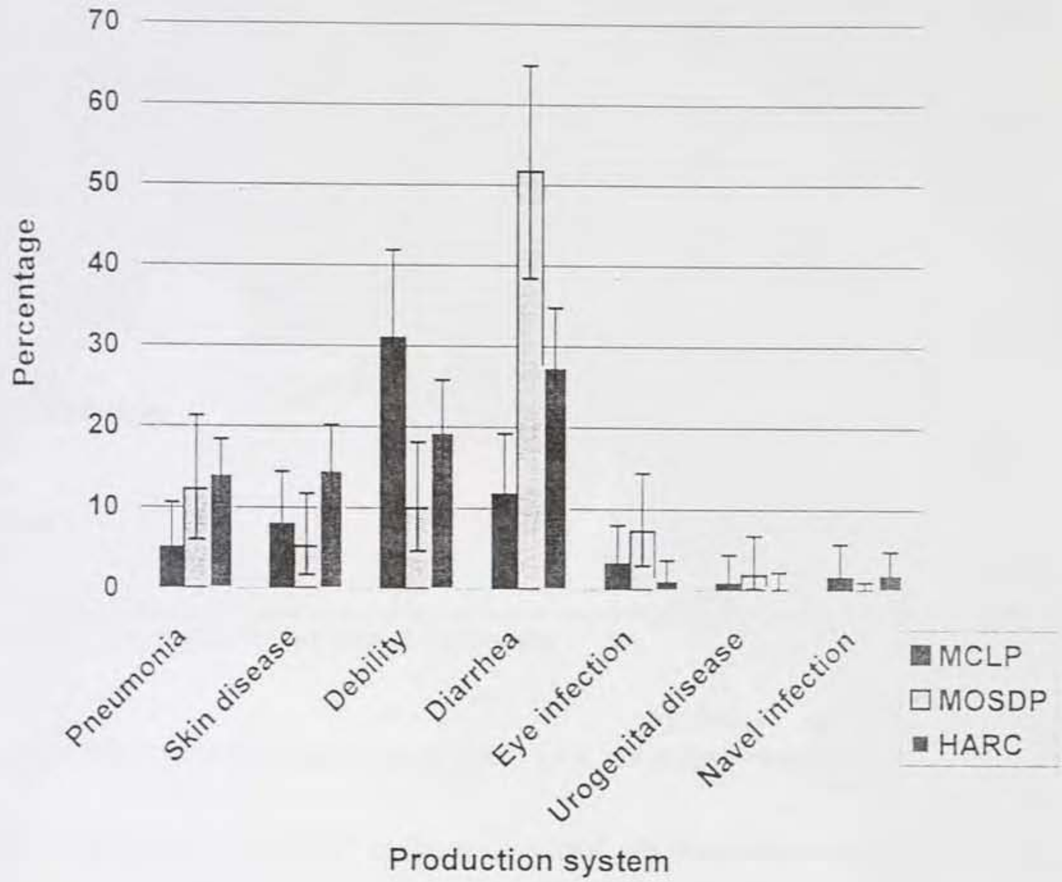

Figure 4.3. Morbidity rates among study calves by production systems in Holetta area in 2001. MCLP=Mixed crop livestock production, MOSDP=Market oriented dairy production, HARC=Holetta Agricultural Research Center

Table 4.11 shows that morbidity of pneumonia, scours, skin diseases were significantly different between passive immune status (Fishers' p-value<0.1).

Table 4.11. Passive immune status (FPTA) and morbidity in Holetta, 2001

Condition	Complete failure (n=26)	Normal (n=163)	Fishers' exact p-value
Pneumonia			
Yes	6	19	0.003
No	20	144	
Scours			
No	9	58	0.098
Yes	17	105	
Urogenital diseases			
Yes	1	2	0.360
No	25	161	
Skin diseases			
Yes	7	18	0.082
No	19	145	
Eye diseases			
Yes	2	7	0.358
No	24	156	
Navel infection			
Yes	0	7	1.00
No	26	157	
Debility			
Yes	4	29	0.842
No	22	134	

FPTA=failure of passive transfer of antibodies.

4.8.2. Mortality rates and passive immune status

Thirty-one deaths occurred during the study period. No death was recorded among farms from MCLP, 16 deaths occurred at HARC and 15 from MOSDP farms. Mortality was significantly different by farm size and production system (Fishers' exact p-value<0.05). It was highest in large farms. No mortality occurred in small farms during this period.

Figure 4.4 shows that mortality rate at HARC was 6.5% (C.I. 3.76-10.35) and in MOSDP farms was 13.9% (C.I. 7.99-21.87). Mortality was significantly different between HARC and MOSDP (p=0.0236).

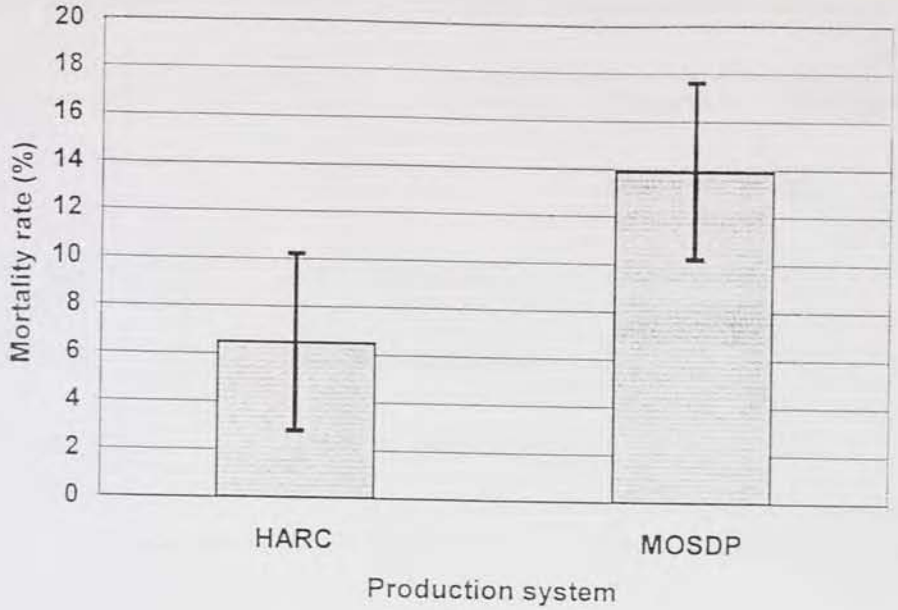

Figure 4.4. Calf mortality rates at Holetta Agricultural Research Centre (HARC) and in Market oriented specialised dairy production farms (MOSDP) farms in Holetta, 2001

Table 4.12 shows that there was significant difference between passive immune status and mortality (p=0.0075).

Table 4.12. Passive immune status in 28 cases of mortality in calves

Passive immune status	No. of deaths	Percentage	95%confidence interval	p-value
Normal	9	32.1	0.148-0.494	0.0075
Complete failure	19	67.9	0.506-0.852	

4.8.3. Egg count per gram

To assess worm burdens among the study calves. Calves were stratified by farm size and stratified sampling was used to get 97 fecal samples. Table 4.13 shows that EPG in the category of light, moderate and heavy infestations with helminthic eggs were 23.7%, 5.2% and 3.1% repectively. When light, moderate, and heavy infestations were added together then crude prevalence of infestation was 32% percent (Confidence interval 22.9-42.2).

Table 4.13 Egg count per gram (EPG) of faecal samples from 97 calves in Holetta, 2001.

.Egg count per gram (EPG)	Clinical interpretation	Frequency	Percent of calves
0 (No eggs)	No infestation	66	68.1
1 (50 - 200 eggs	Light infestation	23	23.7
2 (200 - 800 eggs)	Moderate infestation	5	5.1
3 (> 800 eggs)	Heavy infestation	3	3.1
Total		97	100.00

Table 4.14 Egg count per gram by farm size and production system in Holetta, 2001. Egg count per gram did not differ significantly by farm size and production system (Fishers' exact p-value>0.05).

Variable	Egg count per gram				
Farm size	0(N=66)	1(N=23%)	2(N=5%)	3(N=3)	Total
Large	45(68.2%)	12(52.2%)	3(60.0%)	0(00.0%)	60
Medium	11(16.7%)	5(21.7%)	1(20.0%)	1(33.3%)	18
Small	10(15.2%)	6(26.1%)	1(20.0%)	2(66.7%)	19
Production system					
MCLP	20(30.3%)	10(43.5%)	2(40.0%)	3(100.0%)	35
MOSDP	2(3.0%)	4(17.4%)	1(20.0%)	0	7
HARC	44(66.7%)	9(13.6%)	2(40.0%)	0	55

MCLP=Mixed crop livestock production, MOSDP=Market oriented specialised dairy production, HARC=Holetta Agricultural Research Center.

4.8.4. Body condition scores (BCS)

At 1 month of age BCS were significantly different among production system (Kruskal Wallis, 19.65, p value <0.01). Median of BCS for calves from both HARC and MCLP was 5, and for MOSDP was 4 (Figure 4.5).

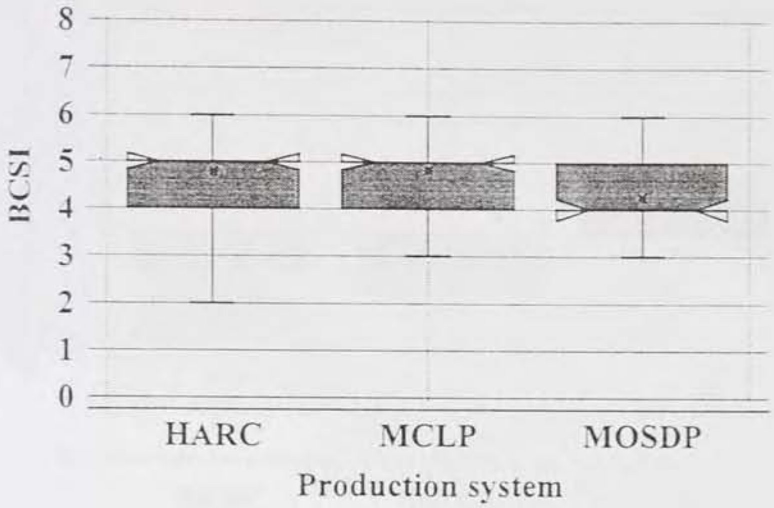

Figure 4.5. Body condition scores of the study calves at 1 month of age by production system in Holetta area, 2001. BCS1=body condition score at one month of age. MCLP=Mixed crop livestock production system, MOSDP=Market oriented specialised dairy production, HARC=Holetta Agricultural Research System

Figure 4.6 shows that median for HARC, MCLP 4 and MOSDP were 3, 4 and 5 respectively. BCS were highly significantly different between production systems (Kruskal Wallis 23.53, p value <0.01).

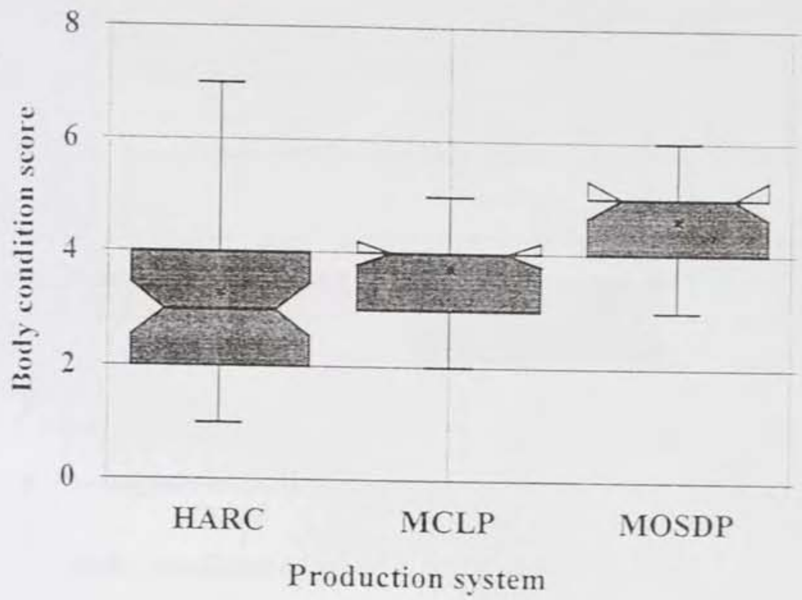

Figure 4.6. Body condition scores of calves at 3 months of age by production system in Holetta in 2001. HARC=Holetta Agricultural Research Centre, MCLP=Mixed crop livestock production, MOSDP=Market oriented specialised dairy production.

The body condition scores between 1 and 3 months of age were significantly different (Kruskal Wallis test=67.81, $p<0.05$). Median body condition score was 5 and 4 for calves at 1 month and 3 months of age respectively.

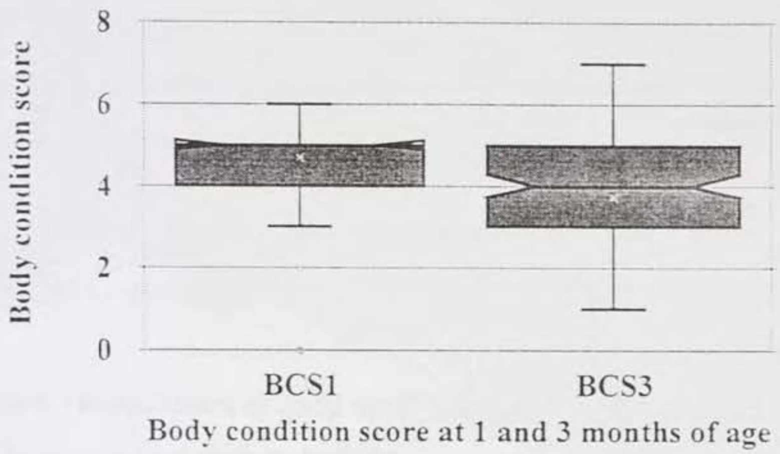

Figure 4.7. Comparision of body condition scores of calves in Holetta at 1 and 3 months of age in 2001. BCS1= body condition scores at 1 month of age, BCS3=body condition scores at 3 months of age.

Median body condition scores (BCS)of calves at HARC and in MCLP farms was 5 at 1 month of age for both, and then dropped to 4 and 3 respectively at 3 months of age (Figure 8). But BCS for MOSDP farms increased from 4 to 5.

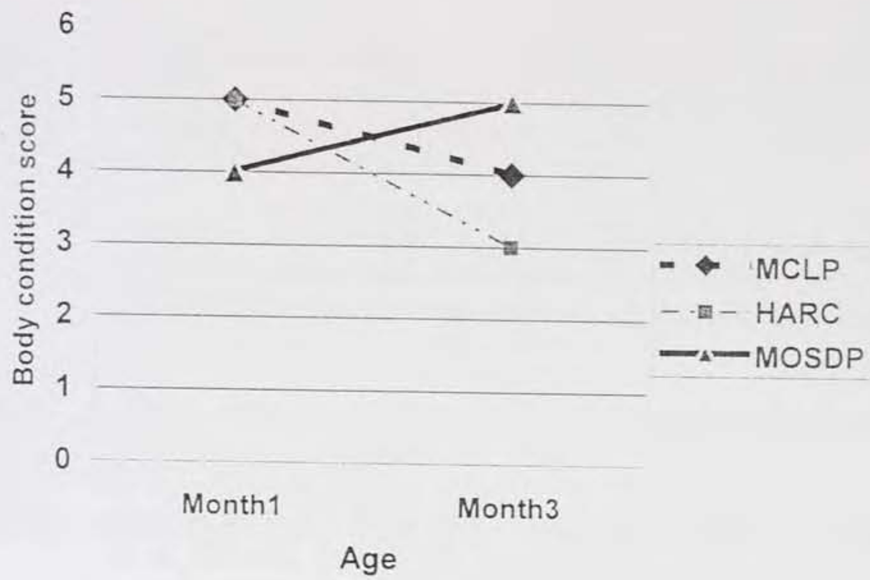

Figure 4.8. Comparision of body condition scores of Holetta calves at 1 and 3 months of age by production systems in 2001

4.8.5 Blood parasites

Giemsa stain procedures were carried out according to Shah-Fisher and Ralph (1989). Sixty-eight samples were examined and all of them were negative for blood parasites.

4.9. Risk factors of morbidity

Logistic regression analysis was done to identify some of the risk factors associated with various morbidity. The identified risk factors that were significant (odds ratios>1, p<0.1) are shown in Table 4.15.

Table 4.15. Risk factors of morbidity in calves at Holetta in 2001

Condition	Risk factors(p<0.1)
Pneumonia	Passive antibody status (O.R., 2.2;C.I., 0.93-5.13), cleanliness of animals (O.R., 3.9; C.I., 1.08-14.53) amount of manure (O.R., 4.0; C.I., 1.10-12.42), mixing with animals from other herds (O.R., 4.9; C.I., 1.16-20.67), production system (O.R., 1.35; C.I., 1.00-1.82).
Scours	Cleanliness of animals (O.R., 2.3; C.I., 1.32-3.93), water source (O.R., 2.3; C.I., 1.37-3.95), mixing with animals from other herds (O.R., 1.9; C.I., 0.97-3.7), colostrum also fed to other animals (O.R., 2.0; C.I., 0.89-4.59), production system (O.R., 1.2; C.I., 1.00-1.54).
Skin disease	Debility (O.R., 1.3; C.I., 1.09-1.63), production system (O.R., 1.2;C.I., 0.91-1.63), amount of manure (O.R., 2.0;C.I., 1.04-3.86).
Eye infection	Passive antibody status (O.R., 10.0;C.I., 2.06-48.61), cleanliness of animals (O.R., 15.1;C.I., 2.66-86.15).
Debility	Calving assistance (O.R., 6.19; C.I., 0.76-50.19), farm size (O.R., 1.5;C.I., 1.05-2.21).

OR=odds ratio, CI=confidence interval

5. DISCUSSION AND CONCLUSION

5.1. Discussion

5.1.2. General considerations

Most of the farms in Holetta area are under Mixed Crop Livestock Production (MCLP) system. Seventy five percent of the farms in this study were MCLP farms. They owned mostly crossbreed and local breed of cattle. Livestock and cereal production are integrated but more attention is paid to crop production. Under this system, management of calves is similar among farms. More attention is paid to calves when they are less than two months but after this calves are let out to graze and mix with animals from other herds. Overall the most common calf housing was sharing facility with humans and/or other animals. For MCLP sharing facility with other animals including humans was 35% of the farms and sharing facility with adult cattle was 33% for Market oriented specialised dairy production (MOSDP). Housing was not shown to significantly affect morbidity and mortality in this study. This could be because the types of housing adequately provide shelter, ventilation, and were on average not crowded. The kinds of materials used for construction of calf housing in this area provide good thermal insulation. These factors, in addition to colostral intake are important for the comfort, survival, and health of calves. What was inadequate with some calf housing was sufficient space and comfortable floor surfaces.

In all production systems, most of the farms (91%) did not provide water freely to calves (average 91%). The most common water source was well for MCLP and MOSDP. Water source for HARC was tap water. Insufficient provision of clean drinking water is known to affect health and productivity of animals. While tap water is the most suitable, water from well can be equally safe provided the well and environment is kept hygienic. However the critical setback is that water from the well must be collected and delivered to the calves from time to time by the farmer. Unfortunately, many times the farmers have other commitments like ploughing, which take much of their time during rainy season, and water is not offered to calves on time and in sufficient quantities. Another important source of water for calves in this area was river (37.8% of all farms). While it may be the only water source available for these farms, water from the river is never safe unless specific treatment is rendered to reduce contamination. Most farms (more than 93%) in this study did not manage male and female calves separately. For MCLP, management by sexes is not important. Management by sexes may be important for MOSDP farmers with bigger farms, where it may be recommended to provide different feeds to various categories of calves. The practice of dipping navel was not a practice in most farms in this study. Although this practice is recommended, many studies have not found significant associations between navel disinfecting and morbidity. Therefore, it can not be recommended in this study. Proper management of maternity facility and calf housing can effectively reduce incidence of navel infection.

Treatment of diseases was a common practice in most farms in all production systems. This indicates that farmers in this area are aware of the importance of controlling livestock diseases and the value of animals in their livelihoods. But it may also reflect the magnitude of disease burdens in animals. The time and amount of colostrum fed was not known for most farms except HARC. To provide an initial immune protection against infectious diseases, colostrum must be fed to calves before 6 hours after birth in sufficient quantity (Wittum and Perino, 1995; Weaver *et al.*, 2000). About 42% reported giving colostrum also to children, other humans and pets. Children or other humans and pets can take colostrum (where this is practised) but this should be after the first day of birth. While colostrum is meant primarily for the calf, its beneficial effects on the health of humans has been documented (Tzipori *et al.*, 1986; Tacket *et al.*, 1992; Clark and Wyatt, 1996). Cleanliness of animals and keeping of records was below average in MCLP. Also cleanliness of animals was below average for MOSDP farms. In HARC amount of manure was below average. Farmers should be advised to clean calf houses more frequently to reduce pathogen pressure. Keeping of records was below average in MCLP and average for MOSDP farms and was above average for HARC. Management of calves requires that all types of records be kept properly.

In Holetta Agricultural Research Center (HARC), calves are reared in individual pens in a calf barn, except for those on experiment. The individual pens provide adequate space but when the calves grow, the space becomes inadequate and the older calves are not so comfortable. The wall and roofing materials is made of iron sheets. This material has poor insulation property and calves are subjected to cold stress especially at night and during cold seasons when temperatures are quite low. There is no provision for additional heating but the situation is assisted by the good insulation properties of the bedding materials provided and the materials used for partitioning calf pens.

In general supplementary feeding was common across all production systems (82.2% of all farms). What is questionable is the timely availability, quality, and quantity of feeds given.

5.1.2. Failure of passive transfer of antibodies (FPTA)

Overall failure of passive transfer of antibodies (FPTA) among the 189 calves was 32%. This falls within the range reported in many studies (McGuire and Scott, 1982), but on the higher side. No report on similar studies in this area is available. By production system, FPTA was 18% in calves from MCLP, 37.2% in calves from MOSDP and 35.5% in calves from HARC. Most farms from MCLP were small and medium farms having between 1-49 animals. It is widely reported that health disturbances are lower in smaller farms than in bigger farms (Waltner-Toews *et al.*, 1986b; Wells *et al.*, 1997). This is because more care and time is spent on individual calves when they are fewer. Farm owners manage also most farms in MCLP. Especially taking care of newborn is left to their wives. Reports indicate that calves managed by their owners', and especially women, face less health problems compared to those managed by employees. (Speicher and Hepp, 1973; Jenny *et al.*, 1981). The owners are usually more motivated and take more care of their enterprises. Moreover on average 48% of farms assist colostrum intake. All these factors contribute to a lower FPTA. An FPTA of 18% can still be lowered if the farmers are made aware that the critical time period is the first 6 hours of birth, and they should endeavour to assist calves ingest not less than 4 litres of colostrum during this period. Where calves are left to suckle their dam, assistance to suckle has been reported to lower FPTA (Petrie ,1984).

Higher FPTA rates in MOSDP of 37.2% can be attributed to the effects of larger farm sizes, breed of animals, use of hired labour, and lack of assisting suckling. The majority of pure exotic calves in this study came from MOSDP farms. These pure calves were all Holstein-Friesian. Previous studies indicated that Holstein generally produce colostrum with lower IgG (Muller and Ellinger, 1981; Tyler *et al.*, 1999). It is also reported that many pure breed animals when in tropical environment do not produce sufficient immunoglobulins compared to local or crossbreed under the same management conditions (Seifert, 1996). Such calves need to ingest large volumes of colostrum in order to attain adequate transfer. Unfortunately there is no practice of measuring quantity of colostrum taken by calves in this systems. It is doubtful if hired labourers pay close attention to calving that occurs at night in order to assist calving and colostrum intake. This study showed that time of birth was a risk factor to FPTA.

In HARC, FPTA was 35.5%. HARC was the largest farm in this study. Factors that could have led to such a high FPTA could be farm size and inadequate quantity of colostrum given within the first 6 hours of life. Calves in HARC are fed only 1.5 litres of pooled colostrum immediately after birth, but it is now recommended that 4 litres of good quality colostrum should be fed to calves within first 6 hours of birth (Besser *et al.*, 1991). FPTA was significant among farm size ($p<0.05$). This was expected, but what was surprising was that rate of failure in medium farms was lower than the rate of failure in small farms contrary to what was expected. Medium farms in this study were coming from MCLP and MOSDP systems and factors explained for FPTA in those systems applied to medium farms. These factors included breed, lack of calving assistance, lack assistance of colostrum intake, timely intake, inadequate quantity and doubtful quality of colostrum.

FPTA was significantly different between birth season. It was 39.9% in calves born during dry season and 25.8% in those born during rainy season. In Holetta area, dry season is associated with stress due to climate, inadequate feeds and insufficient water. Stress and nutritional status are reported to affect concentration of colostral immunoglobulins (Mohammed *et al.*, 1991). Although previous studies indicated significant differences among calves assisted at birth and those not assisted, this study did not find any significant differences (Fishers' exact p value >0.05). This could simply be due to a small number of calves assisted at birth in this study. Studies involving larger number of calves assisted at birth could easily provide a different picture. The sample size used for this work was based on FPTA prevalence not on birth assistance.

This study showed that weaning weight of calves was significantly associated with FPTA. This is in agreements with previous reports (Robison *et al.*,1988; Garry *et al.*, 1992). Calves with FPTA had lower weaning weights. The explanation here is that calves with FPTA cannot effectively manage infection challenges. And a greater portion of nutrient pool is directed towards inactivating and eliminating potential pathogens.

From calves whose passive immune status were determined, pneumonia, scours, and skin diseases were significantly different between FPTA status. In all cases they were higher in calves with complete failure than in calves with normal transfer. This is in agreement with previous studies (Gay *et al.*, 1988; Odde, 1988; Wittum and Perino, 1995). Urogenital diseases, navel infection, eye diseases and debility were not significantly different between passive immune status. Cases of urogenital diseases, navel infection and eye diseases were too few for one to draw any meaningful inference. Passive immunity is known to provide protection mainly against infectious diseases. And not all causes of debility are infectious. In this situation it could be that the number of non-infectious causes of debility was overwhelming infectious causes and it reflected on the non significant difference observed.

The methodology used to determine FPTA in this study was Zinc sulphate turbidity test (ZSTT). Recent publications indicate that ZSTT may lead to misclassifications, especially specificity was found to be low (Tyler *et al.*, 1999; Hudgens, 1996). However for this kind of studies, the first of its kind in this area and where facilities for other tests are not available, ZSTT remains a very useful tool to provide baseline data upon which calf managers can effect changes. The costs of having some false positive animals due to low specificity of ZSTT can not be high in this scenario where changing colostral management policies can be the recommended treatment for FPTA.

All in all an FPTA of 32% in an environment where there are many other stress factors limiting productivity can not be taken for granted. This is an easily preventable risk factor whose effect is widely studied and known. It is a management issue, which can easily be controlled.

5.1.3. Morbidity and morbidity rates

Significant differences were found in morbidity rates of skin diseases, debility, scours, and eye infections. Skin diseases were higher in HARC compared to the other production system. It was 14.6% in HARC, 5.2% in MOSDP, 7.9% in MCLP. This 14.6% for HARC is higher than reported in studies elsewhere. In this study HARC was the biggest farm with over 200 calves under the same management. The effect of farm size could be the biggest contributor to this. Many studies have reported that as farm sizes increase health problems also increases (Waltner-Toews *et al.*, 1986b; Wells *et al.*, 1997). Calves at HARC are housed in individual pens in a calf barn. But everyday they are released for about 2 hours to exercise and enjoy sunshine. That means they come in close contact with each other, especially at watering points. Most skin diseases are contagious and transmitted by contacts. Moreover in HARC there is no separate housing facility for sick calves. That means infection is maintained by infection and re-infection.

Debility was 31% in MCLP, 10% in MOSDP, 19.4% in HARC. The problem with MCLP farms is that supplementary feeding is inadequate both in quality and quantity, especially after 2 months of birth. At this age the calves are released to mix with animals from other herds and acquire infections in this way. In addition there may be a build up of gastrointestinal infections and all these can lead to loss of condition. This study has shown that the body conditions of calves in MCLP are good within first month of life but situation changes significantly by the time they are 3 months old. Calves that are 3 months old are in a poorer body condition.

Incidence of scours was 51.7% in MOSDP, 27.5% in HARC, and 11.7% in MCLP. It was significantly different among production system. This could be due to breed effects, colostral management deficiencies, and hygiene of calving area and poor perinatal care. This study showed that body condition of calves in MOSDP improve by the time they reach 3 months. The MOSDP farms in this study had mostly pure exotic, and crosses with higher exotic blood. It is known that exotic animals are less resistant to tropical diseases compared to local animals under the same conditions of management. This same reason could explain why eye infection was significantly higher in MOSDP as compared to other systems. Also MOSDP had the highest rate of FPTA followed by HARC. FPTA is an important risk factor for morbidity of infectious conditions in young calves.

Morbidity due to pneumonia was 14.1% in HARC, 12.2% in MOSDP, and 5% in MCLP. Morbidity due to navel infection was 2.1% in HARC, 0% in MOSDP, and 1.6% in MCLP. While morbidity due to urogenital disease was 0.4% in HARC, 1.9% in MOSDP, and 0.8% in MCLP. Morbidity due to pneumonia was similar to what was reported in previous studies and it was not different significantly among production systems. Crude morbidity for all diagnosis was 79.9%. This was calculated basing on the number of cases of all diseases included in this study and debility. Calves that had several diseases were included only once. Crude morbidity obtained in this study is higher than reported in studies done elsewhere (Virtala *et al.*, 1996). It expresses the gravity of calf health problems in this area. However this study included debility which is a syndrome in many diseases like chronic illnesses and malnutrition. The importance of debility here is that it is a manifestation of poor health that can not be ignored in the absence of facilities for specific diagnosis.

No presence of blood parasites was detected among the 68 samples examined by Giemsa stain procedures. It was not the objective of this study to determine prevalence of blood parasites in this area. Otherwise a bigger sample size would have been necessary. The intention here was simply to assess to what extent were blood parasites causing morbidity among the study calves. Therefore the conclusion that can be drawn is that blood parasites are not a major cause of morbidity and consequently mortality among calves in this area. Prevalence of gastrointestinal (GIT) parasites was assessed by egg count per gram (EPG). Light infestations was high (23.7%). Overall infestations was 32%. And this was not significantly different among production system and farm size. Inspite of the limitations of EPG procedures (Hansen and Perry, 1994), these results clearly indicated that GIT parasites are a big problem of calves in this area. So proper control strategies should be instituted.

Diarrhoea remains the leading cause of morbidity in this area followed by pneumonia (Annex 3). Rate of debility is higher than pneumonia but debility is a syndrome not reality a disease entity on its own. Crude morbidity for all diagnosis was estimated at 79.7%. This is an indication of how serious disease problems exist in the study area. Morbidity rates reported here are higher than rates reported elsewhere (Curtis *et al.*, 1988a/b; USDA: APHIS: VS, 1993; Gitau *et al.*, 1994b). Crude mortality rate in calves up to 3 months of age was 14.2%. And neonatal mortality (death before 30 days) accounted for 73% of total deaths. Mortality rate reported here is lower than that reported by Nesru (1998) but higher than what is accepted in good management. No mortality occurred in MCLP farms. Mortality was significant between MOSDP and HARC. It was higher in MOSDP farms (13.9%). While older calves in MOSDP were shown to be in good condition compared to younger ones. Higher mortality here was seen in neonatal period (before 30 days). This is a reflection of poor colostral management practices, which was reflected by high FPTA in MOSDP and poor perinatal care. There was a highly significant relationship between passive immunity and mortality. About sixty eight percent of dead calves had complete failure of passive transfer. This is in agreement with previous reports and studies done elsewhere (Vermunt, 1993; Wittum and Perino, 1995; Sivula *et al.*, 1996).

Body conditions of calves were shown to deteriorate with time in HARC and MCLP farms, while in MOSDP farms the body condition improved and this was significant. This is due to differences in management in that calves from MOSDP are generally looked after more fairly compared to the other systems. The primary objectives of MOSDP farmers are to maximise profits by increased milk production. They are motivated by profits and more attention is paid to the animals. While for MCLP farmers, milk production is secondary to crop cultivation. And in HARC many calves are confined for experimental purposes and this is sometimes stressful. Loss of body condition is multifactorial and can be due to management factors, disease challenges and environmental conditions.

5.1.4. Risk factors of morbidity

Risk factors that showed significance for morbidity in this study included passive immune status, cleanliness of animals, amount of manure, animals mixing with other herds, production system, feeding colostrum to other animals and debility. These were factors that were significant with $p<0.1$. Other risk factors (O.R.>1) but not significant included birth time, birth season, assisted calving, and farm size.

Passive immune status (FPTA) was significant for pneumonia and eye infections. Importance of passive immunity is well known and has been described in this work elsewhere. The fact that FPTA status of calves did not show significant relationships with other infections in this study should not be misinterpreted. Sample size for this study was based on study of prevalence of FPTA and probably for other purposes sample size was inadequate. The effect of low specificity of zinc sulphate turbidity test (ZSTT) could have affected test results. And other studies have reported similar results.

Cleanliness of animals was significant for pneumonia, scours, and eye infections. And amount of manure was significant for pneumonia, skin diseases, and eye infections. Cleanliness and amount of manure reflects the hygienic state of the farms and this was below average in MOSDP and MCLP. This is seen in higher prevalence of infections reported in this study. Production systems were significant for pneumonia, scours, and skin diseases. This is due to differences in management practices in the different systems. Feeding colostrum to others was a risk factor to diarrhea (scours). Apart from the passive immunity, colostrum is reported to play an important role in protecting the lumen of gastrointestinal tracts from being occupied by scour causing organisms. In this situation the calves were not fed adequate colostrum to provide this protection as part of colostrum was given to other animals (and some cases humans).

Debility was a significant risk factor to skin disease. Loss of condition that leads to debility has many causes. Skin infection itself can be a cause of debility and debility can predispose to skin diseases. Water source was a risk factor to scours. Scours causing organisms are in the environment. And contamination of water with these organisms can lead to diarrhea. The most common water sources in this area were well and river. These are not necessarily clean sources of water. It is easier to keep the well area clean.

5.1.5. Constraints of calf management

This study has revealed that productivity in these areas are limited by inadequate access to water, high costs of calf meal, poor feed resources, poor disease prevention and control strategies, and inadequate housing facilities. These constraints are similar to those reported by Mundibaya *et al.* (1998). The situation is aggravated by management factors that have been outlined above. To get a new born calf started begins with the dam. The dam must be healthy.

Preventive treatments like vaccinations and administration of multivitamins and mineral supplement is a requirement. The newborn calf must be provided adequate colostrum within first 6 hours of birth and thereafter looking after the calf requires a management programme that is consistent. And this is missing in most farms in this study area. Apart from HARC record keeping was very poor in other farms. Without proper records it is very difficult to monitor performances of individual calves.

5.2. Conclusion and recommendations

From this study it can be concluded that:

- Management of calves in this area still falls below required standards. Failure of passive transfer of antibodies (FPTA) is high. This is purely a management factor that can be controlled without additional costs. While most farmers are aware of the importance of colostrum, they do not know that the critical time is within the first 6 hours of birth. Farmers must therefore be educated to provide adequate quantities of colostrum (at least 4 litres) during this period. And where the calf is left with the dam, it must be assisted to ingest this quantity of colostrum. Farmers should adopt the policy of observing and assisting calvings in case of calving difficulties.
- While colostrum is one factor that affects the health and survival of calves, effective management of environment and adequate nutrition are at least as important as passive immunity.
- Mortality and morbidity reported here is high in most cases. To optimize on productivity of the calves requires that measures must be taken to lower mortality and morbidity. This study has confirmed some of the significant risk factors associated with some morbidity. The implications of other risk factors and morbidity not mentioned here in the study should not be overlooked basing on results of this study. From this study it is clear that management factors have a big role to play in morbidity and mortality. What needs to be done is determining relative priority of each of those factors taking into consideration the economic costs of intervention. That means each system, each farmer may have different set priorities. Wells and Dargatz (1996) mentioned that minimizing death losses are advantageous as long as the measures used to do so are cost effective.
- Arising from this study some constraints to calf management in this area have been identified. The implications of each of these constraints should be looked into in a broader sense requiring multi-sectoral strategies if they are to be brought under control.

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7. ANNEXES

Annex 1: Survey Questionnaire

DAIRY CALVES MANAGEMENT IN PERIURBAN AND URBAN PRODUCTION SYSTEM OF HOLETTA.

NB: Information given in this questionnaire shall be kept confidential.

Date____________

Farm Identification no.______

GENERAL INFORMATION

Farm Structure.
Owners' Name____________________

Address____________________
Telephone____________________

Location of Farm:

	Holetta
Urban	
Periurban Dairy	

Farm Size

(a) Large scale (>50 calves)

(b) Medium scale (5 – 50 calves)

(c) Small scale (<5 calves)

Type of production system

a) Market oriented specialised dairy production

b) Urban dairy production

c) Mixed crop livestock production

Are there pregnant cows that you expect to calve soon? Yes/No

No. Of Animals

(a) Male adults(including bullocks) ______

(b) Female adults(including heifers) ______

(c) Male calves (upto 6 months old) ________

(d) Female calves (upto 6 months old) ________

Breed of Animals.

(a) local

(b) crossbreed

(c) exotic

MANAGEMENT INFORMATION.

(A) Feeding of Calves.

Colostrum Feeding.

Feeding of Colostrum

(a) left with dam to feed on its own

(b) assisted to ingest.

Time of feeding colostrum

(a) immediately after birth (<6hrs)

(b) 6 – 24 hrs

(c) >24 hrs.

Mode of feeding colostrum

(a) individually

(b) pool

Quantity of colostrum

(a) known (estimate in litres)

(b) unknown

Do you have force-feeding policy for colostrum? Yes/No

If yes does it apply to only weak calves or every calf? Every calf/weak calf

Who feeds colostrum? Owner/employee

Do you milk cows - immediately before birth (yes/no)

- or soon after birth (yes/no).

Do adult people consume colostrum ? Yes/No

If no, when after calving do you think milk can be consumed?

(a) 2 or 3 days
(b) > 3 days

Do you give colostrum as well to children, dogs, or cats? Yes/No

Do you think colostrum is good for new born calve? Yes/No

Do you attempt to restrict new-borns from ingesting colostrum? Yes/No

Supplemental Feeding Yes/No

Type of supplemental feeding if provided.

(a) commercial

(b) homemade concentrates

Housing

Type of housing for calves

(a) group pen in calf barn

(b) group pen in cow barn

(c) individual pen in calf barn

(d) individual pen in cow barn

(e) shared facility with adult cattle

(f) shared facility with other animals/humans etc.

(g) Group in open

Frequency of cleaning calves houses

(a) more than once a week

(b) once a week

(c) once a month

(d) others (specify)

(B) Health Management

Treatment of sick animals

(a) yes

(b) no

If yes, treated by

(a) farmer

(b) vet

(c) attendant

(d) others (specify)

What condition (you can tick more than one if applicable)

(a) diarrhea

(b) pneumonia (respiratory tract diseases)

(c) skin diseases

(d) urogenital diseases

(e) debility

(f) eye diseases

(g) navel ill

Do calves have free access to water or not

(a) yes

(b) no

What is your source of water?

a) river

b) well

c) tap/pump

Do you manage male and female calves separately?

(a) yes

(b) no

Do calves and/or their dams mix with animals from other herds? Yes/

No.Dipping of navels in disinfectants ? Yes/No.

Are your calves observed and assisted during delivery ? Yes/No

- immediately after birth___________
- more than 24 hours after birth – 3 months_____
- more than 3 months_____

(e) Preventive treatments (those given to its dam within 6 weeks before birth and those given to the new born without any recognizable disease.

(f) Other treatments

Date	Diagnosis (disease)	Treatment

Annexes 3. Diagnostic classifications of cases in Holetta area in 2001.

Case type	No. Cases	Percentage of Total Cases
Diarheas (Scours or gastroenteritis)	91	32.9
Pneumonias (respiratory diseases)	45	16.3
Urogenital diseases	4	1.4
Skin diseases	43	15.6
Debility	72	26.1
Eye diseases	14	5.1
Navel ill	7	2.6
TOTAL OF CASES	276	

8. CURRICULUM VITAE

1. PERSONAL INFORMATION

First name: TERENCE
Other names: **ODOCH AMOKI**
Sex: MALE
Date of birth : **14/7/1967**
Marital Status: **MARRIED**
No. of Children: **2**
Addresses: - Permanent address(home address): **TEABOLO ABONGODERO - ABOKE , KOLE - APACH DISTRICT, UGANDA**
Contact address: P.O. Box 59, Wobulenzi, Uganda.
E-mail: odochterence@hotmail.com
Nationality: **UGANDAN**
Fathers' name: **ONII SERAFINO**
Fathers' occupation: **TEACHER (deceased)**
Mothers' name: ABEJA JUDITH
Home District: **APACH**
Nationality: UGANDAN

2. EDUCATIONAL BACKGROUND

EDUCATION	YEAR	QUALIFICATION
(A) UNIVERSITY		
(i). Free University, Berlin, Germany/ Addis Ababa University, Ethiopia.	2000 – 2001	Expected MSc in Veterinary Epidemiology
(ii). Makerere University, Kampala, Uganda.	1988 - 1993	Bachelors Veterinary Medicine
(B) SECONDARY SCHOOLS		
1. Kololo S.S.S.	1987 – 1988	U.A.C.E (Advanced Cert.)
2. Dr. Obote College	1984 – 1985	------
3. Lango College	1980 - 1983	U.C.E (Ordinary level)
(C) PRIMARY SCHOOL		
Ayami Primary School	1973 - 1979	--------

PROFESSIONAL QUALIFICATIONS

Master of Science in Tropical Veterinary Epidemiology (Expected) at the Freie Universität Berlin / Addis Ababa University, 2001.

Bachelor of Veterinary Medicine, 1993, Makerere University, Kampala.

OTHER CERTIFICATES

Certificate Biomedical Research Training (June – August 1997).

RESEARCH EXPERIENCE

(i) Management of dairy calves in Holetta area, Central Highlands of Ethiopia. A thesis submitted in partial fulfillment for the degree of Master of Science in Tropical Veterinay Epidemiology at the Freie Universität Berlin and Addis Ababa University, 2001.

(ii) Retrospective analysis of Hospital Data to assess the maternal transfer of HIV/AIDS from mothers to babies, 1997 (unpublished). A manuscript submitted in partial fullfillment for the awards of certificate in Biomedical Research training Makerere University, Kampala.

(iii) Measurement of Antibodies to Rinderpest in Colostrum, in Sera of Cows, and in Calves less than Six months of age by use of ELISA,1993 (unpublished). Manuscript Submitted to Makerere University University in partial fullfilment for the awards of Bachelors Degree in Veterinary Medicine.

PROFESSIONAL WORK EXPERIENCE

(i) Lecturer, Bukalasa Agricultural College , 1994 – 1999

(ii) Resource person in re – training of field extension workers, 1996 - 1998 . A programme which was run by a World bank sponsored project, Agricultural Extension Programme of the Ministry of Agriculture.

(iii) Private Veterinary practice, 1993 – 1994.

OTHER AREAS OF ACTIVE PARTICIPATION:

(i)Registration Official, Constituent Assembly elections, 1993.

(ii) General Secretary, Makerere University Veterinary Students Association.

1992 – 1993.

(iii) Assistant General Secretary, Young Christian Society, Lira Diocese, 1984 – 1985.

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9. DECLARATION SHEET

I, the undersigned, declare that the thesis is my original work and has not been presented for a degree in any University.

Name ODOCH TERENCE AMOKI

Signature [signature]

Date of submission 21/12/2001

This thesis has been submitted with our approval as University advisors.

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Mana Gement of dairy calves in Holetta Area, Central Highlands of Ethiopia

Odoch Terence Amoki