FACTORS AFFECTING CONCEPTION RATES OF DAIRY CATTLE AMONG SMALLHOLDER FARMS IN UASIN GISHU COUNTY, KENYA

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MAY, 2023

DECLARATION

Declaration by the Candidate

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Declaration by Supervisors

This thesis has been submitted for examination with our approval as university supervisors.

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DEDICATION

I dedicate this work to Almighty God for the gift of life and strength to carry on this work, my dear wife Jane and our children Timothy, Faith, Michael and Mark for their encouragement and prayers throughout the period of the study.

ABSTRACT

Smallholder dairy farmers (SDF) in Uasin Gishu County work hard to get the best out of their farms, but evidence shows that dairy farming faces many challenges. One of the indicators of poor production and reproduction in a dairy farm is low conception rate of the cows. The study sought to determine animal and farm factors influencing conception rates in cows kept by SDF in Uasin Gishu County. 216 cows in the three agro-ecological zones (AEZ) of Uasin Gishu County were purposively selected and artificially inseminated using semen of the farmer's choice could be conventional semen (Imported and Kenyan Genetics) or gender sorted semen. The study relied solely on on-farm conditions. Ear tags were used for identification of the selected cows. Pregnancy diagnosis was carried out by trans-rectal palpation at 60-90 days post-insemination. Days open was determined on 116 of the cows that were neither heifers nor animals whose breeding records were absent. Focus Group Discussions (FGD) and interviews of key informants (KI) were held in all the agro-ecological zones and structured questionnaires administered to 423 small holder farmers in a survey. Data collected from the animals was subjected to t-tests to establish the differences within AEZ, breeds, farming systems, and conception status while information from the FGDs and survey were presented descriptively. Mean conception rate for cattle in Uasin Gishu County was 48.2%. Factors that significantly affected conception rate were breed, body condition score and milk yield. Zebu Crosses (74.5%) had significantly higher CRs than that of Friesian (61.1%) and Ayrshire (53.1%). Mean Body condition score 3 had the highest CR of 70.8% and milk yield of above 10 kg per day had the highest CR of 77.6%. The other factors examined in this study; AEZ, parity, age group, AI timing and semen type had no significant influence on the conception rate. The lower highlands had a mean days open (DO) of 206 ± 20 days, which was significantly lower than those of the upper highlands. There was no significant difference of DO across the breeds and among the different production systems. The average DO of 255 ± 17 days of Uasin Gishu County was significantly longer than the recommended 85-110 days. High cost of feeds, poor record-keeping, and inadequate Veterinary services (VS) as gathered from the FGDs and farmers survey, were the most important impediments to high conception rates whereas inadequate veterinary services forced farmers to handle obstetric complications including dystocias, resulting in post-parturient metritis and consequently, prolonged DO. Results of this study show that conception rates are mostly affected by animal and on-farm management factors associated with breed, nutrition and poor record-keeping, and external factors of inadequate veterinary and extension services. It is important that these factors be addressed if the small holder dairy farmers in Uasin Gishu County are to attain the optimum a-calf-per-year-per cow conception rate.
Keywords: Conception rates, Days open, calving intervals.

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

AEZ	-	Agro-Ecological Zone
AHA	-	Animal Health Assistant
ART	-	Assisted Reproductive Technology
AI	-	Artificial Insemination
AISP	-	Artificial Insemination Service Provider
BCS	-	Body Condition Score
BT	-	Body Temperature
CDVS	-	County Director of Veterinary Services
CR	-	Conception Rate
DO	-	Days Open
DMI	-	Dry Matter Intake
DVS	-	Director of Veterinary Services
ET	-	Embryo Transfer
FAO	-	Food and Agriculture Organization
FTAI	-	Fixed-time artificial insemination
GIFT	-	Gamete intra-fallopian transfer
GoK	-	Government of Kenya
ICS	-	intracytoplasmic sperm injection
ICT		Information and Communication Technology
KAGRC	-	Kenya Animal Genetic Resources Centre
KCC	-	Kenya Cooperative Creameries
KI	-	Key Informants
KLBO	-	Kenya Livestock Breeders Organization
KSB	-	Kenya Stud Book

KVB	-	Monitoring and Evaluation
LRC	-	Livestock Recording Centre
MoLD	-	Ministry of Livestock Development
NEB	-	Net Energy Balance
PD	-	Pregnant Diagnosis
SAS	-	Statistical Analysis Systems
SDF	-	Smallholder Dairy Farmer
THI	-	Temperature-Humidity Index
UGC	-	Uasin Gishu County
UoE	-	University of Eldoret
VO	-	Veterinary Officer

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Glory to Everlasting God. Amen

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Kenya is the largest milk producer in Eastern Africa, generating an estimated 4 to 5 billion litres of milk per year from a herd of around 4 million dairy cows (Mungube *et al*., 2014). The dairy subsector contributes 4% of the gross domestic product (GDP) in Kenya (Kios *et al.*, 2018) and eminently plays a crucial role in the national growth by the creation of wealth and in food and nutritional security. Smallholder dairy farming accounts for 80% of total dairy producers and 56% of total milk produced in Kenya (Odero-Waitituh, 2017). It also significantly contributes to the government's Big Four Agenda (Macharia, 2019), particularly in the areas of food and nutrition security, manufacturing, and health (Kios *et al.*, 2018).

The dairy production systems are suffering from a decline in cow fertility due to low conception rates (Walsh *et al.*, 2011). The phenomena takes place in a variety of production systems globally, from continually breeding stocks in the UK and North America to seasonal breeding stocks in Ireland, New Zealand and Australia. Wiltbank *et al*., (2006) reported that the conception rate (CR) for lactating dairy cows has dropped progressively from more than 50% in the 1940s to less than 40% in the 1990s. These rates range from as high as 39% and 52% in seasonal pasture-based systems such as those in Ireland and New Zealand (Pfeifer *et al*., 2015; Macdonald *et al*., 2011) to as low as 30% to 40% in the USA and UK feedlot systems (Walsh *et al.*, 2011).

Milk productivity per cow has continuously grown as a result of better management, better diet, and intense genetic selection (Lucy, 2001). However, this rise has resulted in a corresponding decrease in fertility (Gröhn and Rajala-Schultz, 2000). Understanding phenotypic features in dairy cattle is critical for identifying health and management strategies that will result in the best levels of productivity and reproductive efficiency (Walsh *et al*., 2011). A well-planned crossbreeding program may utilize beneficial qualities of the breeds or strains involved, as well as make use of heterosis for economically important traits (Chebo and Alemayehu, 2012).

There is growing interest in the numerous advantages linked to artificial insemination, whose success cannot be replicated in farms under controlled conditions (Ghozlane *et al.*, 2010). This might be due to the fact that unfavourable genetic trends in all milk production variables imply inadequate selection strategies and/or a lack of adequate breeding selection (Singh and Balhara, 2016). A conception rate of less than forty percent implies inefficiency in AI services, which may be ascribed to a variety of causes (Mekonnen *et al*., 2010; Ghozlane *et al.,* 2010).

A number of factors influencing the effectiveness of artificial insemination include the efficiency of oestrus detection, diet, the environment and stress factors (Singh and Balhara, 2016). In the USA, Gröhn and Rajala-Schultz (2000) pointed out causes of delayed insemination as high milk production, high parity and calving in winter. In South America, differences in the conception rates are also attributable to farm management with specific farm characteristics such as stocking rate, quality of pasture, mineral supplement, and reproductive management (Melo *et al.*, 2012). In Latin America, these factors include poor nutritional levels, heat stress, parasitosis, and evolutionary behavioural strategy against the adverse environment as well as lactation (Osorio-Arce and Segura-Correa, 2010). In India, the observed variations in conception rates result from several factors such as the extent of dependency on livestock, Agro-geology, animal feeding, and social variations (Bhagat *et al*., 2020). In Pakistan, pregnant rates vary on agricultural and environmental variables. Species, breed, milk production and body conditions, lactation stage, heat signals and uterine tones are animal-related elements whereas farming aspects include nutrition and the insemination time (Singh and Balhara, 2016). The factors affecting conception rates in Bangladesh include Body Condition Score (BCS) at calving, age of weaning, suckling rate, livestock rearing system, efficiency in heat detection, duration oestrus with the AI service time, oestrus intensity and the quality of the semen (Shamsuddin *et al.,* 2001).

In Africa, artificial insemination has been the core breeding method to improve the dairy sector (Chebo and Alemayehu, 2012). Kouamo and Sawadogo, (2012) in Senegal and Mekonnen *et al.,* (2010) in Ethiopia found that the conception rates were influenced by feed management, effective heat detection, the timing of insemination, early embryonic death and presence of ovarian cyst, (Nishimwe *et al*., 2015) in Rwanda attributed the variations in conception rates to age, parity, and cattle breed. The problems related to an AI system in Sub-Saharan Africa include technical limitations, lack of financial facility access, and lack of proper knowledge, inadequate transportation facilities, questionable semen quality, poor heat detection, low morale and unreliable service during off-working hours. (Zineddine *et al.,* 2010; Melo *et al.,* 2012; Solomon Gizaw *et al., 2016*; Singh and Balhara, 2016; Nagy *et al*., 2020). Conception rates are also affected by post-parturient diseases and conditions like ketosis, post-parturient paresis, retained foetal membrane, (Chebel *et al.,* 2004).

This study evaluates the efficiency of Artificial Insemination and identifies the factors that influence conception rates in Uasin Gishu County.

1.2 Statement of the Problem

Productivity in the dairy industry is solely dependent on the reproductive performance of the dairy cows which is critically influenced by extent of days open (DO) and the level of conception rates (CR). The period from calving down to the time a cow displays clinical oestrous play a critical role in determining calving interval of which the recommended is a calf per year per cow. The longer the days open impact negatively on dairy farming as farmers incur extra cost of maintaining an unproductive cow. Despite the wide use of artificial insemination techniques, reproductive efficiency among dairy cows in Uasin Gishu County remains low. For instance, Uasin Gishu County rolled out a subsidized Artificial Insemination project to improve her dairy cattle genetic pool, alleviate poverty among smallholder dairy cattle farmers through the sale of increased milk yields, more and up graded heifers, creation of employment and provision of food and nutrition, and finances.

A substantial amount of money has been used to implement the project but to date; the results have been unsatisfactory as seen by high numbers of repeat inseminations due to low conception rates and long calving intervals due to long days open. This has increased the cost of AI services and reduced reproductive performance, making dairy farming a low-profit and unsustainable enterprise, especially among the smallholder farmers. The study sought to investigate extent of days open and conception rate, also determine the factors affecting DO and CR of dairy cattle served by artificial insemination among smallholder dairy farms in Uasin Gishu County, Kenya.

1.3 Justification

Dairy farming is an important economic activity for the majority of the smallholder farmers in Uasin Gishu County as it provides food and nutrition, employment, and income. This industry is heavily dependent on the efficiency of reproduction of the cows. Ideally, the AI technique should guarantee high reproductive efficiency since it sustains or upgrades the pedigree of the herd and is structured to ensure high conception rates. It is therefore important that an evaluation of the technique be carried out to determine the factors influencing its efficiency so that adaption or mitigation efforts can be recommended with accuracy and certainty.

The Government of Kenya has set food and nutrition security as one of the four pillars in the Big Four agenda for the economic transformation of the country. The Ministry of Agriculture, Livestock, Fisheries and Cooperatives is required to come up with policies, regulations and strategies for each agricultural sub sectors. Amongst these is the Agriculture Sector Transformation and Growth Strategy (ASTGS) 2019 to 2029 which has identified the country as having deficiency of milk that might worsen unless intervention strategies are implemented. Many Counties have set up heavily funded AI projects as intervention strategy whose aim is to sustain high milk yields.

The results of this study will be important in informing the policy makers, ministry officials, county government officials of Uasin Gishu County in particular and Kenya in general; on the factors affecting the AI programs and suggesting recommendations on how to improve on the returns from the AI services. The results of this study will also act as baseline information and open avenues for further research on reproductive efficiencies of various livestock production systems in various ecological zones and other related disciplines.

1.4 Objectives

1.4.1 General Objective

To investigate factors that influence Artificial Insemination program in cattle among smallholder dairy farmers in Uasin Gishu County.

1.4.2 Specific Objectives

i. To determine on-farm animal factors that influence conception rates of dairy cattle among smallholder dairy farms served by Artificial Insemination in Uasin Gishu County.

ii. To determine factors contributing to long calving interval in dairy cows among smallholder dairy farms in Uasin Gishu County.

iii. To evaluate the effects of on-farm management-related factors on conception rates of dairy cattle served by Artificial Insemination among smallholder dairy farms in Uasin Gishu County.

1.5 Null Hypotheses

$\mathbf{H_{o1}}$: On-farm animal factors have no significant difference on-conception rates of dairy cattle among smallholder farms served by Artificial Insemination in Uasin Gishu County.

$\mathbf{H_{o2}}$: Length of calving interval does not have any significant effect on the conception rate among smallholder dairy farms in Uasin Gishu County.

$\mathbf{H_{o3}}$: On farm-management related factor has no significant influence in the conception rate among smallholder dairy farms served by Artificial Insemination in Uasin Gishu County.

CHAPTER TWO

LITERATURE REVIEW

2.1 Artificial Insemination Programmes

There are several Assisted Reproductive Technologies (ART) used in cattle breeding worldwide, but only Artificial insemination (AI) is the most widely used because of its recorded effectiveness (Gicheha *et al*., 2019). Other ART include in-vitro fertilization, intracytoplasmic sperm injection (ICS), Embryo transfer(ET), gamete intrafallopian transfer (GIFT), and cryopreservation of which spermatozoa, embryo or oocytes are cryopreserved in liquid nitrogen for use at a later date (Morrell, 2011). Being the most widely utilized ART in cattle breeding in the 20th century, AI has tremendously transformed dairy industry worldwide. In Europe and North America AI utilization is over 90% in intensively kept domestic animals and the only breeding technique in turkey production. It is sometimes employed to conserve rare or endangered species, e.g. primates, elephants (Morrell, 2011;Crowe *et al.,* 2018).

Artificial insemination has received a widespread application in smallholders' dairy systems in the developing countries (Mekonnen *et al*, 2010; Chebo and Alemayehu, 2012). Potential genotypic improvement and production costs benefits are realized in cattle through Al (Vale *et al.,* 2011; Singh and Balhara, 2016)

Productivity of cattle herd is measured by the calving intervals and days open which is optimal if a cow calf down once every year (Radostits *et al.,* 2006). Technically, economically and genetically, AI has proven to be effective in all cattle production systems (Costa *et al.,* 2011). However, major challenge in Tropics have been low fertility of the cows (Osorio-Arce and Segura-Correa, 2010). Deterioration of fertility in cows have been attributed to ever changing genotypic and phenotypic factors

(Walsh *et al.,* 2011), like cows producing highest milk and a larger herd (Lucy, 2001). These contributed to decline reproductive efficiency (Mekonnen *et al.,* 2010) in United States, United Kingdom, Ireland, and Australia (Lucy, 2001), this indicates that the economic productivity of the dairy farmers largely depends on the good conception rates from AI which is the effective Assisted Reproductive Technology (Paul *et al.,* 2013). Most smallholder farms have good dairy cows with desired traits but are not able to attain optimum milk production due to low conception rates (Odero-Waitituh, 2017).

Norman *et al.,* (2009) reported that the conception rates in the United States vary within regions with rates being higher in the Northeast and Southwest at 33% and lowest for the Southeast (26%). Osorio-Arce, and Segura-Correa, (2010) reported conception rates of between 30% to 50% in Latin America, while experimental studies by the use of progesterone hormonal treatment in Brazil, observed conception rates of 46.6% (Demetrio *et al.,* 2007) and 56.5% (Melo *et al.,* 2012; 67.7%Vale *et al.,* 2011). Variation depended on semen or sires used.

In India, Bhagat and Gokhale (2016) reported a conception rate of 56%, however, different Agro-ecological and climatic zone were significantly different. Paul *et al.,* *(*2013) reported that the AI conception rates for cows in Bangladesh averaged 42.7%. Any Conception rates below 30% reported in some context reflect poor reproductive management and the absence of a well-defined policy on herd reproduction (Ghozlane *et al.,* 2010). Empirical studies have reported differing conception rates in several countries in Africa. For instance, Ghozlane *et al.,* (2010) reported that the conception rate in Algeria ranges between 30% and 50%, but an experimental study in a veterinary institute using pure Holstein cows reported a conception rate of 38%

(Zineddine *et al.,* 2010). In Ethiopia, Mekonnen *et al.,* (2010) reported conception rates of 34.5% during a field study while Woldu *et al.,* (2011) observed rates of 48.30% and an average of 27 % (Solomon *et al.,* 2016)

An experimental study with the aid of oestrus synchronization in Dakar, Senegal reported a 44.3% conception rate for Gobra Zebu (*Bos taurus indicus*) (Kouamo and Sawadogo, 2012), and in Rwanda conception rate of 42.2% was reported (Nishimwe *et al.,* 2015).

Genetic improvement programs without laid down breeding policies can be disastrous to the smallholder dairy farms especially where little emphasis is paid on matching the desired traits to the environment (Chebo and Alemayehu, 2012). For example, the degree for the failure of fertilization and for early embryo death range from twenty to forty five percent whereas foetal losses are between eight to eighteen percent and late abortion range can reach four percent (Walsh *et al.,* 2011). Demetrio *et al.,* 2007 attributed to over 70% embryonic loss to non-infectious causes. The reasons of early embryo mortality are based on the failure of the early embryos to grow due to low quality oocytes or unfavourable uterine conditions (Walsh *et al.*, 2011; Kios, 2019). In cattle, apart from non-infectious agents like genetic, physiological, hormonal or environmental factors, infectious pathogenic microbes can cause foetal loss (Walsh *et al.,* 2011).

The greatest practical option to enhance production is cross-breeding of indigenous cattle with highly productive imported cattle. However, clear breeding strategies to sustain genetic improvement at the same time maintain indigenous cattle genetics resources need be put in place (Mekonnen *et al.,* 2010). This is evident in Ethiopia where increased genetic diversity through cross breeding has resulted in high levels of genetic introgression of *B. indicus* and *B. taurus,* with improvement in the production of milk and meat more so where best production management practices are practiced (Chebo and Alemayehu, 2012).

2.2 Effect of Animal Characteristics

Empirical studies have identified several animal-related factors among them are: body condition score (BCS), milk production, oestrus signs and detection (Shamsuddin *et al.,* 2001; Singh and Balhara, 2016), age of the cow (Paul *et al.,* 2013), animal breed (Chebo and Alemayehu, 2012; DeJarnette *et al.,* 2009; parity (Bhagat and Gokhale, 2016; Woldu *et al.,* 2011; Chebel *et al.,* 2004) that affect conception rate.

2.2.1 Effect of animal age variable on conception

Paul *et al.,* (2013) observed a significant difference in the conception rates between the ages of the cow. Accordingly, a cow aged between 3-4 years old had higher conception rates than those having less than three years and/or those having greater than four years, however, cows above seven years of age had the lowest. This was also validated by Nishimwe *et al.,* (2015) who observed that cows with less than 4 years had a higher conception rate than cows aged 4 years and above.

2.2.2 Effect of cow breeds variable on conception rate

Several studies have shown that there are significant differences between the breeds of cows. First, the report shows that there are significant differences between the exotic breeds, and second, that *Bos taurus taurus* (exotic) have a higher conception rate than *Bos indicus* (indigenous) and their crossbreeds Khan *et al.,* (2015*)*. In Bangladesh, Khan *et al.,* (2015*)* reported that conception rate was influenced by breeds with native cattle (64%) intermediate (57%) in Friesian and lowest (53%) in Sahiwal crosses. There are also significant differences in conception rates at first service between the animal breeds with the average conception rates for Holstein heifers being 47% while Jersey heifers at 53% (DeJarnette *et al.,* 2009). These findings are related to the developed dairy production systems in the U.S and other countries which keep only their indigenous animals which are considered to be exotic or non-indigenous in the developing world context.

In the developing countries, Bhagat and Gokhale (2016) and Woldu *et al.,* (2011) reported that crossbreeds (Friesian and Jersey) had a higher conception rate than the indigenous breeds (Gir and Sahiwal). In the Bangladesh context, local indigenous breeds tend to have higher conception rates than the crossbreeds (Paul *et al.,* 2013), while Nishimwe *et al.,* (2015) observed that local indigenous breeds had higher CR when compared to exotic breeds and their crosses. However, Singh and Balhara, (2016) reported that pure and crossbred cows scored low in conception rates as compared to indigenous cows. These differences in findings can be attributable to the adaptability of local and crossbreeds to environmental conditions.

2.2.3 Effect of milk yield variable on conception rate

Conception rates are influenced by the milk productivity of the cow and as reported by Singh and Balhara, (2016) and Shamsuddin *et al.,* (2011), high milk producers tend to have higher CR than low milk producers. Vale *et al.,* (2011) observed that lactating cows tend to have higher CR than non-lactating and heifers. In Bangladesh, Shamsuddin *et al.*, (2001) reported that cows producing more than 5 litres of milk have higher conception rates than those producing less than 5 Litres. However other studies report contrasting findings that show that high producing dairy cows are significantly lower conception rates during the lactation period (Demetrio *et al*., 2007; Mekonnen *et al.,* 2010). Furthermore, Gröhn and Rajala-Schultz (2000) report that milk yield of Holsteins Friesian in the first eight weeks has negligible effect on conception phenomenon only observed in nulliparous or primiparous cows and not in multiparous cows. In Hungary, Fodor *et al.,* (2019) observed that the likelihood of conception rates in Holstein - Friesian greatly decreased in cows which have been lactating for periods over 200 days.

High milk yields are therefore an important element in the delay conception rates in developing world, as corresponding energy requirement to meet day-to-day milk yields is high especially between 4 and 8 weeks postpartum (Walsh *et al.,* 2011). High-performance cows in developed countries are properly fed, housed well and reared in the best management practice which increase their conception rates (Shamsuddin *et al.,* 2001). The poor first-service pregnancy rate in high performance cows may also be linked to the increased energy demand for milk production, causing implantation failure due to decreased blood glucose level. (Mekonnen *et al.,* 2010).

However, Demetrio *et al.,* (2007) attribute any decline in conception rate to the increased energy metabolism associated with rising milk production. Increased production of milk negatively impacts the likelihood of conception, probably by affecting the development of the follicle, fertilization or first embryo. And as milk production increased, embryo transfer technology is becoming more important to bypass the negative effects on the probability of conception Wiltbank *et al*., (2006).Kios *et al.*, (2019 reported that embryos produced in lactating cows had lower quality than those produced in non-lactating cows or heifer. In a different context, Walsh *et al.* (2011) found that the growth (up to day 7) of cow's oocytes of high genetic value for milk production is lower than that of medium-genetic cow oocytes, regardless of their actual output.

Thus, the breeding efficiency in lactating cows decreased as the average production of milk increase (Demetrio *et al.,* 2007). In addition, in the preceding lactation, highly milk producing cows were more likely than low milk producing cows to have retained after birth, early clinical metritis, anoestrous, cystic ovarian disease, and other infertility Gröhn and Rajala-Schultz (2000). In many other instances, the reproductive efficiency differs with the breed of the cow and as reported by Chebo and Alemayehu (2012), Jersey Crossbred dairy cows have shorter calving interval than the Friesian Crossbred cows, which shows that jersey crosses have superior breeding efficiency. Uddin *et al.* (2012) and Shamsuddin *et al.,* (2001) also observed that local indigenous cows have a lower reproductive efficiency as illustrated by the inherent long interval from calving to the first service.

2.2.4 Effect of parity variable on conception rates

The conception rates are influenced by the parity of the cow such that heifers and younger cows tend to have higher conception rates than their multiparous counterparts (Schenk *et al.,* 2009). This is supported by the findings in the developed country context of America and Europe which showed that nulliparous dairy heifers have higher conception rates than older lactating dairy cows (Vale *et al.,* 2011; Walsh *et al.,* 2011). DeJarnette *et al.,* (2008) also noted that the first and second parity cows achieved higher conception rates than cows of third or greater parity while Chebel *et al.,* (2004) observed that multiparous cows had lower CR than primiparous cows. According to Badinga *et al.,* (1985) heifers were observed to have a higher pregnancy rate of around fifty per cent compared to lactating cows; Vale *et al.,* (2011) showed that the lowest conception rate among primiparous cows was almost fifty per cent compared to nulliparous and lactating cows. According to Paul *et al.,* (2013) heifers or nulliparous cows have a higher likelihood of conceiving from an AI service than younger or older cows and further, Norman *et al.,* (2009) intimated that the first- and all-breeding CR declined 2 to 4 percentage units.

Multiparous cows tend to have greater levels of conception than both heifers and primiparous cows in Asian and African countries, though Woldu *et al.* (2011) in particular documented the increase in conception rate until the third parity and then start decreasing in fourth or more parities. Likewise, Nishimwe *et al.,* (2015) reported that multiparous with parity of 4 to 6 had higher conception rates than cows with lower or higher parity. Bhagat and Gokhale (2016) indicated that multiparous cows at parity three have higher conception rates than those in second, fourth, and more, and lastly the nulliparous animals or Heifers. Woldu *et al.,* (2011) reported that nulliparous heifers tend to have a lower conception rate (34.3%) than cows at advancing parities. Fodor *et al.,* (2019) reported that the likelihood of conception was 8% lower in cows in parity 3 and above compared to primiparous cows.

2.2.5 Effect of body condition score variables on conception rates

The body condition score (BCS) of the animal influences the conception rates such that cows with high BCS had significantly higher conception rates than those with lower BCS (Paul *et al.,* 2013). In particular, studies have identified different levels of BCS $\geq$ 3.5(Shamsuddin *et al.,* 2001; Kouamo and Sawadogo, 2012), BCS $\geq$ 4(Vale *et al.,* 2011) that are satisfactory for good conception rates. Similarly, the BCS range for desired conception rate is between two and half to four (Vale *et al.,* 2011), while Kouamo and Sawadogo (2012) reported that cows with BCS of 3.5 have almost sixty percent conception rate higher than others but a body condition score of between 2 to 3 has merely thirty percent conception rate (Singh and Balhara, 2016). Peri and postpartum loss of BCS adversely influence the fertility of cows (Adrien *et al.,* 2012).

Body Condition Score directly affects fertility since nutrients are primarily aimed at maintaining the life of the cow and developing foetus' nutritional need and there after surplus are only accessible for reproduction of the species (Vale *et al.,* 2011). The healthy physical status of cows indicated by the higher BCS $\geq$ 3.5 is thus maintained only if there is a sufficient nutritional to avert the high negative energy balance owing to milk production (Shamsuddin *et al.,* 2001). BCS is phenotypically and genotypically linked to reproductive performance and supports the notion that reproductive status is affected by poor BCS (1.5-2.5). Impaired oocyte competency is linked to lower BCS (Walsh *et al.*, 2011).

The first 100 days in milk, BCS loss must be minimised. Cows should have a BCS at calving of 2.75–3.0 and a loss of BCS of not more than 0.5 between the calving and the first service is recommended (Walsh *et al.,* 2011). Cows with extreme low BCS or those suffer excess BCS loss in the first 100 days in milk have delayed resumption of ovarian cyclicity hence less likely to ovulate resulting to long calving interval and prolonged days open subsequently affecting conception rate negatively (Walsh *et al.,* 2011).

Young cows have higher energy demands for development/growth and milk secretion and may have a higher Negative Energy Balance (NEB) than multiparous cows because, in addition to the energy and nutrient demand for production, they usually eat less and require energy for growth, which compromises their reproductive performance (Walsh *et al.*, 2011). Calving intervals and days open in primiparous cows is often longer than in multiparous cows because multiparous cows are more adaptive to reinitiating postpartum cyclicity (Fodor *et al.*, 2019).

Cows entering high NEB State exhibit significant changes in hormonal, metabolic, and physiological status. At the same time, experience increased oxidative stress leading to low immunity and inflammatory response exposing them to infections (Walsh *et al.,* 2011). Therefore, superb nutritional management of in-calved cows is vital to cover the negative energy balance caused by foetal development. This will lead to shorten calving interval and days open positively influencing conception rate (Shamsuddin *et al.,* 2011). Dairy cows exposed to increased heat suffer from heat stress leading to reduced appetite aggravating negative energy balance symptoms subsequently greater BCS loss especial in early postpartum period (Walsh *et al.,* 2011).

2.2.6 Effect of oestrus signs variables on conception rates

Conception rate is further influenced by magnitude of oestrous signs which include the behavioural attributes, mucus consistency from external genitalia, and uterine tone. However, the passage of mucous through external genitalia and high uterine tone are the most reliable oestrus signs (Singh and Balhara, 2016). In addition, efficient heat detection provides correct timing of insemination at appropriate ovulation times which positively influence conception rate (Gröhn and Rajala-Schultz, 2000).

Conversely, cows with slight or imperceptible vulvar swelling, no genital discharge, and slight or imperceptible uterine tone tend to have lower conception rates (Shamsuddin *et al.,* 2001). Detection of oestrous signs through visual observation aided by use of tail paint has achieved 70% efficiency with some individual herd rates ranging 25% to 96% (Shamsuddin *et al.,* 2001).

2.2.7 Effect of insemination time variables on conception rates

The timing of insemination on observed heat or hormonal induced heat has significant effects on conception rates (Ghozlane *et al.,* 2010). Insemination at standing oestrus is more likely to yield higher pregnancy rates (Badinga *et al.,* 1985). The timing of insemination greatly influenced conception rate with cows inseminated 5 to 18 hours after the start of oestrous having higher chance of conceiving than one served 19 to 32 hours (Singh and Balhara, 2016; Mekonnen *et al.,* (2010); Shamsuddin *et al.,* (2001) recommend that cows should be inseminated between 12 and 16 hours after the first heat sign. Anything below 12 hours or above 18 hours may be considered too early or too late and may fail in the AI service, hence the rule applies that when an oestrus sign is detected in the a.m., servicing should be done in the p.m. Knowing the time of insemination is crucial as it ensure that healthy, viable spermatozoa are present at the uterine horn when unfertilized egg arrives. Any too early/late AI service is a common cause of infertility due to early embryonic death since fertilization is likely to take place outside fallopian tube and that resulting in longer herd calving interval (Mekonnen *et al.,* 2010).

Several psychological events have an impact on oestrus expression in cows, and these elements are categorized as either animal or farm related factors. Animal related factors include silent heat, anoestrus, age, parity, milk yield, Lactation stage and health status while farm related factors include level of farm management, nutrition, season and production system (Roelofs *et al.,* 2010). In comparison to extensive systems, the obvious signs of the oestrus in cows are manifested clearly in intensive system, grazing cows on heat exhibited fewer mounts per unit hour as compared to housed cows. While cows housed in concrete floor have shorted duration of exhibiting oestrous behaviour to those having access to both concrete floor and exercise yard. Cows producing over 39.5 kg per day have shorter oestrus duration and less overt oestrus signs than cows producing less (Walsh *et al.,* 2011). Indigenous cows (Bos *indicus)* display less oestrus signs for a shorter duration than it is in Bos *taurus taurus* (Shamsuddin *et al.,* 2001).

Other animal variables include the most prevalent reproductive diseases main causes of sub-fertility include anoestrus, repetitive breeding, cystic ovarian diseases, uterine and tubal illnesses (Citek *et al.,* 2017). These reproductive disorders include dystocia in primiparous cows, retained after birth, and cystic ovarian diseases in multiparous cows (Fodor *et al.,* 2019). Clinical endometritis reduces the conception rates by approximately 20% (Walsh *et al.,* 2011) and so it the occurrence of diseases such as milk fever (Chebel *et al.*, 2004).

2.2.8 Effect of Semen on conception rate

Conception rate is a function of semen used (Melo *et al.,* 2012) and is an important determinant of calf sex (Norman *et al.*, 2010). The conception rates differ according to the quality of semen used and as indicated by Melo *et al.,* (2016) the variation can range from 41.8% to 67.7%. The most important semen characteristic influencing conception rate is the semen quality which is exhibited by the spermatozoa characteristics such as morphology must be above 70% normal, progressive motility, and molecular and functional traits (Walsh *et al.,* 2011; Mekonnen, 2010). In some cases, the low-quality management of some frozen semen batches arises during the cryopreservation process at the laboratory level as well as by the negligent handling of the thawed semen by inseminator Melo *et al.,* (2016).

As indicated by Shamsuddin *et al.,* (2001), the use of frozen semen has a significantly higher conception rate than the use of chilled semen and locally produced semen irrespective of whether they are frozen or chilled – preserved. Whereas the chilling or preservation of the semen does not affect the conception rates, higher conception rates are obtained from good quality semen (Singh and Balhara, 2016). In other instances, the use of chilled semen yields better conception rates than frozen semen (Singh and Balhara, 2016). Equally, low fertility has been attributed to the processes involved in the freezing of semen which in some cases damages sperm (Singh and Balhara, 2016; Melo *et al.,* 2012).

The sire from which the semen is drawn influences the CR (Nishimwe *et al.,* 2015; Shamsuddin *et al.,* 2001) and as indicated by Kouamo and Sawadogo, (2012), certain sires have better conception rates than others. Pure Friesian bulls having higher conception rates than crossbreed Friesian or Sahiwal crossbred (Shamsuddin *et al.,* 2001; Bhagat and Gokhale, 2016). There is also a significant variation in conception rates between sires for the sexed semen (Borchersen and Peacock, 2009).

Extent of semen sorting have a large effect on the conception rate of cows and heifers (Norman *et al.,* 2010). In overall, conception rate for gender sorted semen breeding was 17%less as compared to convection semen indicated in the conception rate for cows will reached 30% for conventional semen and 25% for gender sorted; while was 30% less in Holstein heifers evidenced by 56% conception rate for conventional and 39% for gender sorted semen. Differences in conception rate between breeding with gender sorted and conventional semen are not the same in different practices: for example, 33% for gender sorted semen and 59% for conventional in Switzerland, 45% and 56%, respectively, in the United States, and 49%and 62%, respectively, in Denmark, with gender sorted semen 56, 79% and 80 as fertile as conventional semen in Switzerland, Denmark and in USA, respectively (Norman *et al.*, 2010). DeJarnette *et al*., (2008) report that conception rates of heifers are greater than those of cows for gender sorted semen. In the United States, the conception rates in heifers for the sexed semen are on average approximately 75% of those obtained by using conventional semen (DeJarnette *et al.*, 2009).

Conception rate across services generally declined as parity increased for both conventional semen (32 to 26%) and sexed semen (27 to 21%) breeding (Schenk *et al.*, 2009).

For financial consideration, female sorted semen should be primarily be used in heifer breeding as it only need 2.6 service per conception as compared with 4.0 for adult cows (Norman *et al.*, 2010).

2.2.9 Effect of other psychological events on conception rate

Several psychological events have an impact on oestrus expression in cows, and these elements are categorized as either animal or farm related factors. Animal related factors include silent heat, anoestrus, age, parity, milk yield, Lactation stage and health status while farm related factors include level of farm management, nutrition, season and production system (Roelofs *et al.,* 2010). In comparison to extensive systems, the obvious signs of the oestrus in cows are manifested clearly in intensive system, grazing cows on heat exhibited fewer mounts per unit hour as compared to housed cows. While cows housed in concrete floor have shorted duration of exhibiting oestrous behaviour to those having access to both concrete floor and exercise yard. Cows producing over 39.5 kg per day have shorter oestrus duration and less overt oestrus signs than cows producing less (Walsh *et al.,* 2011). Indigenous cows (Bos *indicus)* display less oestrus signs for a shorter duration than it is in Bos *taurus taurus* (Shamsuddin *et al.*, 2001).

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2.3 Effect of days open

Days open refers to the period between calving and first service whether the cow conceives or not, while calving interval is the period from one calving to the next. Calving interval (CI) and days open (DO) influence the reproductive performance of dairy cattle (Muraya *et al.*, 2018). Radostits *et al*., (2006) reported that even though CI was variable with small herd size, it remains the appropriate measure in contemporary reproductive performance. Days open could be related to the management of the individual farming system and the quality and quantity of feeds available (Melo *et al.*, 2012). Each farm differs in soil quality, management, workforce, and herds. In a study, Melo *et al.,* (2012) established that a significant difference in DO exists between farms. To obtain one calf per year per cow, the optimal CI should be 12-13 months and days open should be 85-110 days (Radostits *et al*., 2006). The reproductive performance of dairy cows is greatly influenced by the management of periparturient conditions. A rapid increase in production of milk in the recent years has negatively affected fertility in dairy cow (Esposito *et al*., 2014). There is, therefore, a need to enhance the proper management of dairy cows especially during early postpartum period which also helps in checking high level of milk production and fertility of dairy cattle. Peri and post parturient clinical or subclinical infections and disorders negatively influence dairy cow fertility. In some cases, culling is based on increased calving intervals, which emanated from decreased conception rate therefore automatically increased days open. Maizon *et al* (2004) found that periparturient conditions like difficult calving, retained placenta, abortion, metritis, cystic ovarian disorders, and other diseases increase conception interval and prolong days open eventually reducing conception rates meaning that optimal life productivity of a cow is not attained. Other abnormal conditions during calving like dystocia, stillbirth, and some cases twin calving are thought to prolong duration of days open. Bell & Roberts (2007) found on the survey that an increased days open period was associated with the calving assistance technique. On average, dystocia increases days open by more than two times and conception interval by over eight units (Fourchon *et al*., 2000). Fertility is also affected negatively by twin calving as shown by Berry *et al*., (2007). Stillbirth and abortion negatively influence fertility by increasing days open subsequently reduce the conception rate (Inchaisri *et al*., 2010).Reproductive track disorders such as retained placenta ,ovarian dysfunction, endometritis, uterine prolapse, and metritis are the most common uterine disorders causing abnormally long involution period and poor endometrial regeneration subsequently prolonging days open and increased calving intervals (Buják *et al.,* 2018). Retained placenta (RP), increases the risk of other reproductive disorders (Buják *et al.*, 2018) and is associated with increased days open. Disruption of normal ovarian function or delayed regeneration of the endometrium may result in uterine infections in the reproductive system giving rise to unfavourable uterine environment for fertilization and foetal development leading to early embryonic death if at all conception takes place thereby negatively affecting dairy cow fertility (Földi *et al*., 2006). Dairy cow’s fertility is negatively influenced by the presence of Puerperal metritis which not only increases days open but also reduces the conception rate (Földi *et al*., 2006; Buják *et al*., 2018). Rufino *et al* (2009), reported that decreased fertility of dairy cows in central highland Kenya was as a result of insufficient feeds due to low or no diet supplementation. Lameness in dairy cows commonly due to claw horn, disruption lesion, sole ulcer and white line disease are serious animal welfare issues which reduce reproductive efficiency and milk production due to increased days open resulting to early culling of the affected cows (Bicalho *et al.,* 2007)

2.4 Effect of Environmental Variables

The conception rates are also influenced by extraneous factors such as seasonal weather patterns (Zineddine *et al.,* 2010; Bhagat and Gokhale, 2016), inseminator's technician efficiency (Melo *et al.,* 2012; Paul *et al.,* 2013), herd management (Ghozlane *et al.,* 2010), farmer characteristics (Bhagat and Gokhale, 2016), agro-ecological zones (Singh and Balhara, 2016) and accessibility and availability of the AI services (Nishimwe *et al.,* 2015). Studies have detected seasonal differences in breeding efficiency in dairy cattle and these effects are more pronounced for lactating dairy cows than for nulliparous heifers (Badinga *et al.,* 1985). High heat stress negatively affects conception rates of dairy cattle, this is more evident when high heat load is exposed shortly before or after service (Zineddine *et al*., 2010), Conception rate is reduced when cows are exposed to heat stress with a temperature over 29 °C between 50 and 20 days before service Chebel *et al.,* 2004. Wiltbank *et al*., (2006) reported a reduction in the conception rate only during the summer in lactating dairy cows, while Bhagat and Gokhale, (2016) observed higher conception rates during the springtime as compared to winter or summer. Drost *et al.,* 1999 and Lucy, M. C.

(2002) carried out a study on the effects of heat stress on conception rates using three methods; artificial insemination, embryo transfer, and in vitro generated embryos. The study showed that conception rates at day 22 did not vary among the three groups at 60.7% for AI; 60.4% for embryo transfer; and 54.2% for embryos generated in vitro. However, on the CR on day 42, the embryo generated in vitro service had the lowest rate at 18.8%, followed by AI at 21.4%, and lastly, embryo transfers at 35.4%. This showed that heat stress has a significant effect on conception rates. The data generated indicate that pregnancy rates are decreased if cows are exposed shortly pre or post -service to a high Temperature Humidity Index (THI). Particularly in Week 1 but have no effects in future weeks (Zineddine *et al.,* 2010). Lactating cows in particular likely to have higher body temperature (BT) due to higher ambient temperatures than nulliparous cows (Demetrio *et al.*, 2007). Extreme high ambient temperatures have several adverse impacts on physiological processes necessary for sustainability of pregnancy after successful fertilization (Zineddine, *et al*., 2010; Morton *et al.,* 2007).

Reductions in the conception rate during heat stress appear to be due to an oocyte problem (Wiltbank *et al*., 2006). The oocytes and early embryonic development stages are highly sensitive to heat stress; therefore, high ambient temperatures limit the rate at which embryos progress (Demetrio *et al.*, 2007). Rates of embryonic mortality are high in “normal” cows and maybe even higher in cows whose AI service is poorly timed with ovulation stage and cows that are having fixed timed insemination (Lucy, 2001).

Reduction in conception rates have been associated with high ambient heat especially around the day of service (Zineddine *et al*., 2010; Morton *et al.*, 2007). This is supported by evidence that shows that cows not exposed to heat stress close to AI serve is 67–69% more likely to conceive than those exposed to extreme heat stress (Chebel *et al.,* 2004). Reduced reproductive performance during heat stress emanate from increased negative energy balance as a result of reduced appetite affecting normal dry matter intake (DMI) (Zineddine *et al*., 2010). Farm related stress including feeding and high disease incidences in crossbreed cows contribute to low productivity evidence by heifers taking extremely long period to reach maturity, presence of high repeat breeders, while herd management problems, poor oestrus detection skill by livestock owners and insemination time are the crucial factors that determine the level of success of AI program (Mekonnen *et al.*, 2010).

Increased body temperature due to exposure to heat loads arising from solar radiation, atmospheric pressure, and day length at oestrus or following insemination may affect conception (Badinga *et al.,* 1985). High ambient temperature reduced duration and intensity of oestrus especially in high-producing cows and this is a limiting factor to conception (Walsh *et al.*, 2011).

The conception rate varies according to the artificial inseminator's technical efficiency (Melo *et al.,* 2012) in many developing countries of Asia and Africa, particularly, in India (Bhagat and Gokhale (2016), Bangladesh (Paul *et al.,* 2013), Ethiopia (Mekonnen *et al.,* 2010), Pakistan, (Singh and Balhara, 2016) and it may range from 0 to 100% for the diploma holders to degree holders. In India, Bhagat and Gokhale (2016) reported that the lower educational levels and certificates of practice with commensurate longer periods had higher conception rates than those with shorter times and higher educational levels of post-graduate levels of education. This is attributable to the long working experience and skill thus, the general, conception rate decreased with an increase in the inseminator's education level. However, a study done in Pakistan reported that there are no differences in conception rates between the inseminators (Shamsuddin *et al.,* 2001).

In Kenya, conception rates are also influenced by poor artificial insemination techniques (Mungube *et al.,* 2014). The differences in the conception rates based on the technical skill of the inseminator is traced to several reasons; the experience, the organizational commitment to the AI program, education levels of the inseminator, animal hygiene at the time of insemination, and other personal attributes of the inseminator (Melo *et al.,* 2012). The technical experience of insemination also shows that individuals with higher service experience had higher conception rates during insemination than individuals who had lesser experience (Paul *et al.,* 2013). Sometimes, poor oestrous detection skills by farmers and herd attendants are common human errors in AI of cows in intensive production systems (Shamsuddin *et al.,* 2001).

It is generally recommended that the animals should be inseminated between the middle and the end of the oestrous period because inseminations carried out after ovulation, resulting in lower pregnancy rates (Singh and Balhara, 2016). Further, semen should be deposited in the bifurcation of the uterine body just inside the internal cervical opening as this helps improve the success rates in AI service. The timing of insemination is critical if cows are to be inseminated at spontaneous oestrus, this can be achieved by regular and keen observation of cows for longer periods (Lucy, 2001).

In most cases, the responsibility for detecting oestrus and servicing falls on-farm owners/employees who may be overwhelmed by the cows or the lack of knowledge on the oestrus signs (Lucy, 2001), thus, poor detection of oestrus may be due to the lack of commitment of the farmer (Bhagat and Gokhale, 2016) or the breed of the animal. The detection of oestrus signs is more difficult in Bos *indicus* (Zebu indigenous cows) than in Bos *taurus taurus* because of these physiological conditions (Woldu *et al.,* 2011).

The farmer characteristics include economic status (Bhagat and Gokhale, 2016), education levels (Nishimwe *et al.,* 2015) among other variables. In a study, Nishimwe *et al., (*2015) indicated that the farmers having basic education levels have a low conception rate for their farms. Further, farmers who kept records observed higher conception rates than their counterparts who did not. Bhagat and Gokhale (2016) reported that the economic status of the farmer influencing the CR. Poor Indian farmers were more likely to observed higher conception rates than well-off farmers. This fact is attributable to the livelihood dependence of cattle as opposed to farmers with other alternative sources of livelihood. Other extraneous variables influencing the CR are the accessibility and availability of the AI services. In Rwanda, Nishimwe *et al.,* (2015) reported that farmers who lived closer to the AI services observed higher conception rates than their counterparts who were distantly located from the AI service. This fact could be explained by the time of the AI service to the onset of oestrus signs in the animal.

Other extraneous environmental factors are the weather/climatic condition during the insemination and as indicated by Shamsuddin *et al.,* (2001) animals seem to highly conceive during the period where pasture and forage are plentiful as opposed to periods of shortages. Paul *et al.,* 2013 reported a significant association between seasons of AI and conceptions rates in Bangladesh with inseminations done in spring

(March to April) being higher than those done in the summer (May – July) season. Thus, the insemination done in spring were 1.7 times than those done in summer and this could relate to the availability of the forage and feeds during the spring with other difference being associated with heat stress during summer. The conceptual rate tends to vary according to the field and experimental studies (Singh and Balhara, 2016).

2.5 Effect of Dairy Production System

The CR is also related to farm and herd management (Melo *et al.*, 2012) and as indicated by Shamsuddin *et al.*, (2001) and Woldu *et al.*, (2011), cows managed intensively tend to have higher conception rates than those reared extensively. Conception rates are also higher in animals whose ration was supplemented with concentrates and lower in those fed on roughage and/or grazing (Singh and Balhara, 2016). Conception Rates could be related to the management of the individual farming system and the amount of vegetation or shaded areas (Melo *et al.*, 2012). In a study, Melo *et al.*, (2012) established that a significant difference in CR exists between the farms. Each farm differs in soil quality, management, manpower, and herds. Inadequate nutrition, poor health and genetic quality of animals are markers of poor reproduction rates. It affects the physiological activities of the animal body and interfaces with the regular operation of the reproductive tract (Vale *et al.*, 2011). Poor nutrition is frequently referred to as the cause of inadequate fertility (Singh and Balhara, 2016). Factor for poor AI effectiveness could be insufficient recording systems, absence of heat-detection aid, improper AI techniques, unavailability of insemination service during weekends and holidays, very few experienced inseminators, poor management of dairy cattle and early embryonic death (Mekonnen *et al.*, 2010; Anzar, M., *et al*., 2003).

Herd management also impacts the conception rates in that it influences the detection of oestrus signs and the timing of insemination (Ghozlane *et al.,* 2010). Usually, heat detection is done either by physical observation either by the herdsmen, farmhand, or the owner (Mungube *et al.,* 2014). Farms with smaller herds are more efficient in the detection of oestrus signs more than farms with large herds. In certain situations, the decline in breeding efficiency in the milk industry can be ascribed to curve effects of learning where farms grow and try to regulate reproduction using smaller herd approaches. Sudden increase in herd size may negatively affect conception rates since reproductive management system in place was intended for a smaller herd. With modern large herd size proper reproductive management need be put in place, which include among other effective heat detection tool, proper recording and traceability system and effective AI techniques (Lucy, 2001).

2.6 Dairy Production in Kenya

Kenya is an agricultural economy country with dairy sub-sector alone contributing 14% of Agricultural Gross Domestic Product (GDP) with yearly growth rate of 4.1%, and represents 3% of the 18% global production by Sub-Saharan Africa, (Odero-Waitituh, 2017; Kibiego *et al*., 2015).

There are approximately 12 million cattle population in Kenya, with 25% being zebu crossbreed dairy cows while the rest dairy cattle consist of exotic breeds, crosses between exotic and local breeds, and local breeds mainly kept under intensive, semi-intensive and free-range systems (Odero-Waitituh, 2017). The most common dairy cattle kept are Ayrshire, Friesian, Guernsey, Jersey, and majority is their crosses (Kibiego *et al.,* 2015). However, the most commonly reared dairy cattle are usually Ayrshire or Friesian or their crosses with local Zebus (Mugambi *et al*., 2015). The dairy farmers keep a mix of dairy cattle breed, with 25 % keeping only Holstein-Friesian, 21% keeping only Ayrshire, and 28% keeping the zebu crosses. The majority of these dairy farmers constituting 70 % smallholder farmers who keep less than 10 cattle (Kios *et al*, 2018).

Normally the estimated milk production for the free-range systems ranges 1300 Kgs and 4000 Kgs per cow per year (Odero-Waitituh, 2017) depending on the level of management in place and Agro-ecological zones, may go up to 4585kg per cow per year in high potential areas (Mugambi *et al*., 2015). In the Kenyan highlands, dairy production is 44% zero-grazing, 33% semi-zero grazing, and 23% free-ranging systems with enhanced milk productions through improved feeding, better management and use of desired dairy genetic (Odero-Waitituh, 2017).

Ever increasing human population has also shown increased demand for dairy products, therefore to meet this high demand an enhance farm income, food, and nutritional security an appropriate breeding technique needs to be adopted by providing access to desired dairy breeds (Gicheha *et al*., 2019). However, lack of established breeding policy in the country poses a lot of challenges on effective dairy breeds genetic improvement program coupled with various factors which include among others, diminishing farming land size (Bebe *et al*., 2003), lack of systematic identification and records leading to inbreeding, farmers organizational shortcoming (Gicheha *et al*., 2019)and some neglected wasting animal diseases of economic importance like bovine paratuberculosis (Omega *et al*, 2019a, b; Okuni *et al.*, 2020).

In the semi-arid eastern Kenya, prevalence of Vector-borne diseases including theileriosis, Anaplasmosis and red water disease is high with theileriosis risks at 30% and accounts for over half of all disease incidences. Other diseases included respiratory infections, Anaplasmosis, udder and related diseases, Foot and Mouth Disease (FMD), and infectious bovine keratoconjunctivitis accounting for 22%, 13%, 8%, 6%, and 4% respectively. These diseases majorly the theileriosis and other vector -borne diseases are associated with huge death rates and exorbitant cost of treatment and control by use of chemo-therapy and acaricides, **(**Mungube *et al*,.2014)**.** Occurrence of such livestock diseases are threat to the sustainability in viability and productivity of dairy industry by direct economic losses through high cost of treatment, low productivity and closure of market resulting to loss of trade opportunities (FAO 2006).

Major constraints faced by smallholder dairy farmers is accessibility to veterinary services and artificial insemination, however it was noted that smallholder farms in Kenya use AI, own bulls and hired bull at rate of 16.4%, 23% and 61% respectively, meaning majority use bull for breeding (Odero-Waitituh, 2017). But AI use was exceptionally high at 32% to 44% in Kenya's central highlands (Muia *et al.*, 2011).

Before introduction of the Structural adjustment program (SAP) by World bank in early 1990s,AI run smoothly in Kenya from 1946 and more rapidly after launching of fully government supported subsidized AI program, however on SAP introduction, AI services was privatized ,became costly to farmers hence it declined rapidly (Mbithe, 2017). Currently, several breeding improvement organizations exist in Kenya and this includes Kenya Stud Book (KSB), Livestock Recording Centre (LRC), and Kenya Livestock Breeders Association (KLBA) (Odero-Waitituh, 2017). In Kenya, dairy cattle, needs an average of 1.5 AI inseminations to conceive (MoLD 2010). The Kenya Animal Genetic Resource Centre (KAGRC) formerly Central Artificial Insemination Station (CAIS) produces about 500,000 semen doses per year

(Mungube *et al.*, 2014). This signifies a shortage of semen for the 4 million dairy cows in Kenya.

High prices of AI services are one of the constraints to smallholder farmers (Odero-Waitituh, 2017). Artificial insemination charges per cow per insemination averaged Ksh 1620 (USD$ 20) (Mungube *et al.*, 2014). In Eastern Kenya, the average cost of locally produced convectional semen is Ksh 1060 (US$ 13), while imported gender sorted semen was slightly high at an average of Ksh. 6000-8000 (US$ 71-94). While using breeding bulls costed between Ksh 500 to 1000 (US$ 5.0 -10) (Mungube *et al.*, 2014). National AI costs range between Ksh 800-3000 (US$ 10 to 38) per cow per AI for the locally produced convectional semen and up to Ksh 10000 (US$ 125) for imported convectional semen (FAO,2011.). The average cost of AI using Kenyan convectional semen is US$ 15and for imported convectional semen US$ 40 (Odero-Waitituh, 2017). This made the AI services expensive and unreliable. However, with the advent of devolved government from 2010, many County Governments including Uasin Gishu County introduced subsidized AI services through farmer dairy cooperatives (Katothya and Lee, 2016). Uasin Gishu County is primarily a dairy farming region in which smallholder and large-scale farmers depend for their livelihoods and source of income. Dairy cow productivity heavily relies on the ability of the cows to reproduce which is determined by conception rates.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Site

The study was carried out in Uasin Gishu County, Kenya. The County is made up administratively of six Sub-Counties namely: Ainabkoi, Kapseret, Kesses, Moiben, Soy, and Turbo. It borders Trans Nzoia County to the North, Kericho County to the South, Baringo County to the southeast, Elgeyo Marakwet County to the East, Nandi County to the southwest, and Kakamega County to the west (Akenga *et al.*, 2018). The region has an estimated human population of 1,163,186 (Kenya National Bureau of Statistics, 2019) as shown in Table 3.1 and Figure 3.1.

Table 3.1 Population and distribution of households in Uasin Gishu County

Sub-County	Human Population	Land area (sq. km)	Population Density (No./sq. km)	Number of households	Average household size	The population of Dairy cattle	The population of Beef cattle
Ainabkoi	138,184	492.9	280	34,892	3.9	106,866	10,687
Kapseret	198,499	299.3	663	59,746	3.3	39,354	3,935
Kesses	148,798	731	204	34,653	4.3	34,323	3,432
Moiben	181,338	769.8	236	59,749	3.8	68,974	6,897
Soy	229,094	667.6	343	53,784	4.2	52,170	5,217
Turbo	267,273	431.4	620	75,139	3.5	40,747	4,074
Total	**1,163,186**	**3,392.2**	**343**	**304,943**	**3.8**	**424,432**	**34,242**

Source: (Kenya National Bureau of Statistics, 2019)

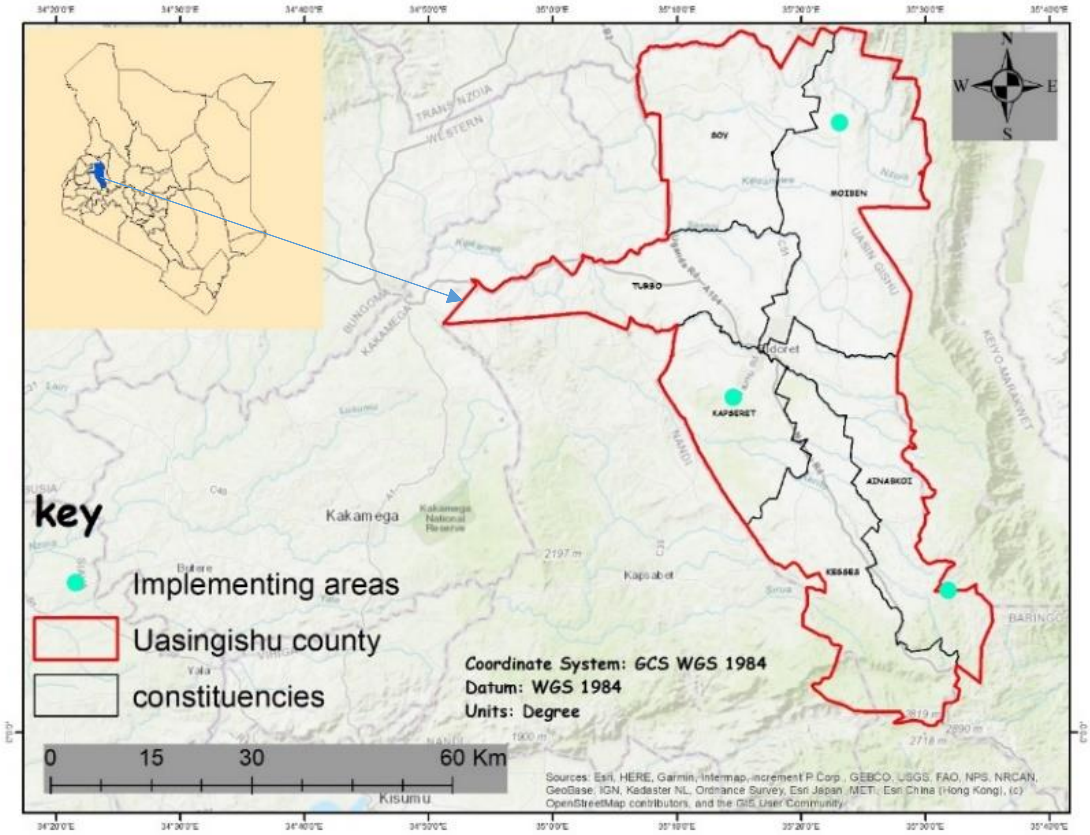

Figure 3.1: Map of Uasin Gishu County showing the six (6) sub counties

The total land of Uasin Gishu County is 90% (299,500ha) arable and 8.9% (29,802ha) forest cover (both indigenous and plantation), with the rest being non–arable hilly and rocky terrain (Akenga *et al.*, 2018). The County has three main distinct Agro-ecological zones (AEZs) namely; lower highlands (LH) ranging from LH2 to LH4, upper midlands (UM3), and upper highlands (UH) representing UH1 and UH2 (Jaetzold *et. al.*, 2010). The Lower Highlands (LH2) zone has a yearly average rainfall of 1150 – 1220 mm, annual mean temperatures of 15.7˚C–15.10˚C, and an altitude of 2350-2450m above sea level (ASL). The areas under LH3 have annual rainfall of between 900-1300 mm and annual mean temperatures of 18.0 ˚C -15.10 ˚C with altitude ranging between 1950-2450m ASL. The areas falling under LH4 have annual rainfall of 900-1100 mm and annual temperatures of 16.3 ˚C -18.0 ˚C with altitude ranging between 1950-2250m ASL. The Upper Midlands (UM4) has an annual rainfall of 1000-1400mm and annual mean temperatures of 18.0˚C -20.5˚C and an altitude ranging between 1550-1950 m ASL. The remaining parts of the County that constitute the Upper Highlands (UH2 and UH3), receive annual rainfall of between 1100-1400 mm and annual mean temperatures of 13.0 ˚C -15.0 ˚C and fall within the altitude range of between 2350 - 2750 m ASL (Akenga *et al.*, 2018) as demonstrated in Table 3.2.

Table 3.2: The three Agro-ecological zones in Uasin Gishu County-Kenya

S/No	Agro-ecological zones	Altitude range (M ASL)	Rainfall range (mm)	Temperature range (°C)	Sub counties
1	Upper highland (UH1-UH2)	2350-2750	1100-1400	13.0-15.0	Ainabkoi, Kesses
2	Upper midland 3 (UM3)	1550-1950	1000-1400	18.0-20.5	Soy and Moiben (Section touching Eldoret town) and Kapseret
3	Lower highland 3 and 4 (LH3 and LH4)	1950-2350	900-1300	15.1-18.0	Lower Soy, Moiben,

Key: MASL= Meters above Sea Level
mm = Millimetres
°**C** = Degrees Centigrade

The study was carried out across the three Agro-ecological zones in Uasin Gishu County in the three most dominant improved cattle breeds kept, that were, zebu crosses, Friesian and Ayrshire (Mabonga and Ogallo, 2018). Experimental work and survey were carried out and both qualitative and quantitative data collected and analysed.

3.2 Study Design

A farm was considered to be a smallholder dairy farm if it had 1-10 head of cattle while large farms had more than 10 head of cattle (Kios, et al., 2018). Using this categorization, 70% of the dairy farms in Uasin Gishu County were smallholder while

30% were large-scale. A total of 216 smallholder dairy cattle were used in the study by purposively selecting and inseminating the first 24 dairy cattle of each of the three predominant improved breeds (Zebu crosses Friesian and Ayrshire) to come on oestrus. The semen used was dependant on farmer's preference selection and was either Conventional Imported Semen (CIS), conventional Kenyan genetic semen from Kenya Animal Genetics Resource Centre (KAGRC) or imported sex-sorted semen (SSS). Animal feeding, housing management system, and semen selection were not altered in the farms where the cows had been selected since the study relied on real on-farm situations. The age of the selected animals was obtained either from farm records, farmer interviews, or by dentition (Torell *et al.*, 2003) (Appendix 1) while parity was obtained from farm records. Body condition scores (BCS) were determined through palpation of specific animals' body parts and visual assessment using a scale of 1 to 5 (Bewley *et al*., 2008). Data was collected for days open (breeding interval), which is the period from calving down to the time clinical oestrus signs are observed and the cow is either served or not. Days open and inter-calving intervals were determined using farm records and farmers' interviews.

3.2.1 Animal Factors affecting conception rate

Farmers reported cattle manifesting clinical oestrus signs to competent Artificial Insemination Service Providers (AISPs) who visited the farms, took history from farmer/herds attendant, checked the records and visually examined the animals. True oestrus was confirmed by checking the animal's behavior for instant standing heat (cow stand when mounted), vulva tone and clear mucous secretion from external genitalia. The cow was then served using semen of the farmers' choice. Insemination was carried out according to the Morning-afternoon (am-pm) or afternoon-morning (pm-am) procedure (Graves *et al*., 1997). Briefly, a cow that started showing clinical oestrus in the morning (a.m. detection of oestrus) was served in the evening (p.m. insemination) whereas AI service was carried out in the morning if oestrus was detected in the evening (p.m. detection of oestrus) as summarised in Table 3.3.

Table 3.3 Insemination times after heat detection

Oestrus detection	AI servicing
Morning (a.m.) time period	Afternoon (p.m.) time period
Afternoon (p.m.) time period	Morning (a.m.) time period

Other information recorded included the time clinically oestrous started to AI service time and exhibited oestrous signs as observed by the farmers or the farm managers. The time oestrus started (date and time) and artificial insemination conducted (date and time) were recorded. Other data details of the farmer (name, contact, level of education, gender, age), cattle (breed, age, parity, BCS, stage of lactation and the average amount of milk produced per day, time oestrus began or was cited, time AI was done, date it calved down) and farm (AEZ, farming system, type of the semen used, animal housing and size of the herd kept) were recorded. All inseminated heifer/cows were checked for non-return signs on 18-22 days post AI. Only first service pregnancy was considered. Pregnancy diagnosis was done by trans-rectal palpation of uterine contents on day 60-90 post AI to all individual heifers/cows which had been served and results recorded as conceived or not conceived in the data collection sheet. The independent variables considered were breed, parity, age, body condition score, milk yield, and semen categories.

The conception rate was calculated using the following formula:

$$\text{Conception rate} = \frac{\text{Number of cows detected to be pregnant}}{\text{Number of cows inseminated}}(100)$$

3.2.2 Days open

Out of the 216 animals selected in this study, only 116 qualified for determination of days open. All cows that were heifers and those with missing or inconsistent values was purged out. Days open was taken to be the period between the day of calving and the day of the first oestrus after calving. Data was subjected to independent two-sample t-tests to establish significant differences within variable categories. The variables included AEZ, breed, farm system, and current conception status (parity).

3.2.3 On-farm management factors affecting conception rates

3.2.3.1 Focus group discussions

Focus group discussions were used to gain an in-depth understanding of social information by getting data from a purposively selected group of persons (Nyumba *et al*., 2018). Two focus group discussions were held in each Agro-ecological zone. Each focus group discussion had six to eight individuals' participants composed of youth, females and males sourced from the membership of the dairy cooperative societies. This was aimed at getting collective views including their experiences and beliefs. The procedure used was adapted from (Krueger and Casey, 2015) on designing and conducting focus group interviews (Appendix II). Discussions were based majorly on the following themes: -

•Impact of AI services to smallholder dairy farmers as breeding tool.

•How to improve dairy cow productivity through AI use with increased conception rates as a key indicator.

•The average calving intervals and factors contributing to the existing scenario in the on-farm level.

Commonly understood languages by majority either English, Kiswahili or native which varied from one region to another was used so that primary information and in-depth experience was not missed. Three Veterinary Officers (VO) from the six-dairy selected cooperative societies in the study area attended to affirm or disaffirm some of the key issues raised in the FGDs within their area of jurisdiction. Focus Group Discussions aided in fine-tuning structured questionnaires used in the study.

3.2.3.1 Administration of questionnaires

To ensure that the sample obtained was representative of the area under study and to avoid possible biases of a regular sample (Titus, 1993), a parallel transect mapping was used in selecting the sample size of 423 farmers (households) at a random interval from a population of 10,348 calculated using Yamane (1967) formula below.

$$n = \frac{N}{1 + N(e)^2}$$

Where, n is size of sample

N is the target population under study

e is the probability of error

The sample size calculation assumed a 95% confidence level and 5% sampling error. Therefore, the sample size of the farmers was determined as follow: -

$$n = \frac{10348}{1 + 10348(0.05)^2}$$

$$n = 384\ farmers$$

An additional 10% was added to the sample size to cater for any non-responses or spoilt questionnaires, hence, making the total number of farmers interviewed to be 423. All the 3 Veterinary Officers and 8 AI service providers from the study area were selected as Key Informants. All the respondents were prepared in advance by being given explanation on the purpose of research, introductory letter (Appendix III) was presented or read out to the respondents before the questionnaires (Appendix IV) were administered to the selected and willing smallholder dairy farmers (Appendix V). Six Key Informants from the selected cooperative societies were interviewed (Appendix VI).

3.3 Data Analysis

The data generated was entered in a Microsoft Excel Worksheet (Appendix VII) and analysed using the SAS logistic procedure with a stepwise model selection option with 0.05 variable entry or exit probability threshold. Descriptive data analysis (Appendix VIII- XII) was carried out using the IBM SPSS procedure. Maximum likelihood parameter estimates and their standard errors were obtained and tested for model entry or exit using the Chi-square test. Model fit was tested using the likelihood ratio statistic. Odds ratio estimates and 95% confidence limits were given for each effect in the model.

The residual Chi-square test provided evidence for model saturation or otherwise and the stepwise process was terminated when no additional effects met the $p < 0.05$ significance level for model entry.

Parameter estimates for the final model were reported as well as model fit statistics. Odds ratios contrast for categories within predictor effects and the predicted probability of success were worked out. Data was compiled and amalgamated into a single dataset consisting of the binary response variable conception status and eight explanatory variables as follows: -

Y = Conception status: 1= conceived 0= not conceived

X_1 =Breed: 1=Ayrshire, 2=Friesian, 3= Zebu Cross

X_2= Age group in years: 1=2-3, 2=4-5, 3=6-7, 4=>7

X_3= Body condition score: 2, 2.5, 3

X_4=Parity: 1, 2, 3, 4, 5=5-7

X_5=Milk yield group in kg: 0=dry, 1=1-5, 2=6-9, 3=>9

X_6= AI timing in hours from first heat signs: 1=1-7, 2=8-10, 3=11-18, 4=>19

X_7= Semen type: 1=Import Ayrshire, 2= Import Friesian, 3=KAGRC Ayrshire, 4= KAGRC Friesian

X_8= Farming System: 1= Semi-intensive, 2= Intensive

CHAPTER FOUR

RESULTS

4.1 Limitations

Most smallholder dairy farmers frequently changed their herd workers. This was attributed to poor pay and unfavourable working conditions and greatly affected record keeping and efficiency on the farms. In many farms, record keeping was either insufficient or missing all together, and this made it difficult to obtain some vital information such as age and history of the cows on the farms. Two selected farms in Zone 1 (Upper Highland Agro-ecological zone) were abandoned in the study after Foot and Mouth Disease (FMD) broke out and quarantine imposed on the affected farms. New farms had to be selected to replace these and this caused some delays. Six cows (one in AEZ 1, two in AEZ 2 and three in AEZ 3) that had been selected for the study were sold before pregnancy diagnosis was carried out. However, new animals were selected to replace them.

Most of the smallholder farmers did not have cattle restraining facilities like crushes or cutes. This posed challenges while inseminating or carrying out pregnant diagnosis. Since the study was carried out during the early phase Covid-19 pandemic, some farms restricted entry for fear of contracting the novel disease. This delayed the study in four farms in AEZ 2.

4.2. Conception rate

The conception rate (CR) was found to be 48.2% in Uasin Gishu County as demonstrated in Figure 4.1 below.

Figure 4.1 a. Pregnancy Diagnosis done no crush

Figure 4. 1b. Ascertaining conception through manual pregnancy diagnosis.

The mean conception rate for each variable (Table 4.1) showed that regions AEZ 1, 2 and 3 had CR of 62.9%, 61.7%, and 62.3% respectively. Based on breed, the CRs were: Ayrshire 53.1%, Friesian 61.1%, and Crossbreed 74.5%. On Body condition score (BCS): 2, 2.5, 3 had CR of 44.7 %, 62.5% and 70.8% respectively, while milk yield level in kg: dry, 1-5kg, 6-9kg and >9 kg per day had CR of 77.6%, 55.3%, 57.1% and 60.0% respectively,

Parities of 0, 1, 2, 3, 4 and ≥5 had CR of 77.8%, 43.5%, 66.7%, 43.5% and 66.5% respectively. CR based on age group in years was 2-3 years, 72.6%, 4-5years 51.9%, 6-7 years 60.8% and above 7 years, 62.8%. Based on hours after oestrus detection, CRs for 1-7.5 hours, 8-10.5 hours, 11-18 hours and >19 hours were 55.0%, 55.3%, 71.4% and 64.6% respectively. Semen used and their CR was as follows: Imported Ayrshire, 54.8%; Imported Friesian, 68.9%; KAGRC Ayrshire, 58.7%, and KAGRC Friesian, 63.8%.

Table 4.1 Response frequencies on effect and conception proportions for all study variables:

Variable	Values	Response Y		Total	Proportion Conceived
		0	1	n	
Zone	1	23	39	62	62.9%
	2	23	37	60	61.7%
	3	26	43	69	62.3%
Breed	Ayrshire	30	34	64	53.1%
	Friesian	28	44	72	61.1%
	Zebu Cross	14	41	55	74.5%
Age group	>3 years	17	45	62	72.6%
	4-5.5 years	26	28	54	51.9%
	6-7.5 years	20	31	51	60.8%
	>7 years	9	15	24	62.5%
Body condition Score	2	26	21	47	44.7%
	2.5	18	30	48	62.5%
	3	28	68	96	70.8%
Parity	0	10	37	47	78.7%
	1	14	13	27	48.1%
	2	23	26	49	53.1%
	3	6	21	27	77.8%
	4	13	10	23	43.5%
	≥5	6	12	18	66.7%
Milk yield/day	0 kg	11	38	49	77.6%
	1-5 kg	21	26	47	55.3%
	6-9 kg	30	40	70	57.1%
	≥10 kg	10	15	25	60.0%
AI timing	1-7.5 hours	18	22	40	55.0%
	8-10.5 hours	21	26	47	55.3%
	11-18 hours	16	40	56	71.4%
	>19 hours	17	31	48	64.6%
Semen type	Imported Ayrshire	14	17	31	54.8%
	Imported Friesian	14	31	45	68.9%
	KAGRC Ayrshire	19	27	46	58.7%
	KAGRC Friesian	25	44	69	63.8%
Farm system	Semi-intensive	54	90	144	62.5%
	Intensive	18	29	47	61.7%

The results of the fitted model in Table 4.2 sorted out variables to significant and non-significant.

When Null hypothesis **β**=0 by the Likelihood ratio test, the Null hypothesis is accepted, however $\beta_{0=}$253.097-234.345 =18.752 is greater than 0, therefore Null Hypothesis is rejected (Table 4.2).

Table 4.2 Test of global null hypothesis β=0 by the Likelihood ratio test:

Criterion	β_0	$\beta_0,\beta_1,\beta_3,\beta_5$
AIC	255.097	242.345
SC	258.349	255.354
-2 Log L	253.097	234.345

The fitted model results as indicated in Table 4.3 below for breed, body condition score and milk production level were found to be F=18.7518, df=3 p=0.0003<0.05 while for Age group, Parity, AI timing, Semen type, and Farming system were F=0.6568, df=5, p=0.9853>0.05

Table 4.3 Chi-square results of the fitted model

Chi-square	DF	Pr>Chi-Sq
18.7518	3	0.0003
Residual Chi-square	DF	Pr>Chi-Sq
0.6568	5	0.9853

The three-predictor variables (Breed, BCS and Level of milk production) in Table 4.4 shows the logistic regression analysis estimate Odds ratio for CR in cow as χ^2 (3) = 18.7518, p= 0.0057< 0.05 for the three variables while on individual, breed, (p=0.0165< 0.05), Odds Ratio (OR) was 0.616, BCS had p=0.0022< 0.05 OD was 0.312, whereas the level of milk production p=0.0491< 0.05, OR was 1.371

Table 4.4 Logistic regression analysis to estimate Odds ratio for Conception Rate in cows.

Effect	Parameter Estimate	SE	Chi-square	Pr>Chi-Sq	Odds ratio	95% confidence Limits
Intercept	3.0154	1.0905	7.6464	0.0057		
X_1	-0.4848	0.2021	5.7533	0.0165	0.616	0.414-0.915
X_3	-1.1637	0.3803	9.3646	0.0022	0.312	0.148 -0.658
X_5	0.3155	0.1604	3.8718	0.0491	1.371	1.001 -1.877

Result for the three variables Breed, Body Condition Score and milk yield level is elaborated in Figure 4.2a, b and c, below. Where: -X_1 =Breed: 1=Ayrshire, 2=Friesian, 3=Crossbreed cows had CR of 53.1%, 61.1%, and 74.5% respectively. Whereas X_3= Body condition score (BCS): 2, 2.5, 3 had CR of 44.7%, 62.5% and70.8% respectively while Milk yield level in kg: 0=dry, 1=1-5Kg, 2=6-9Kg, 3=>9Kg had CR of 77.6%, 55.3%, 57.1% and 60.0%respectively

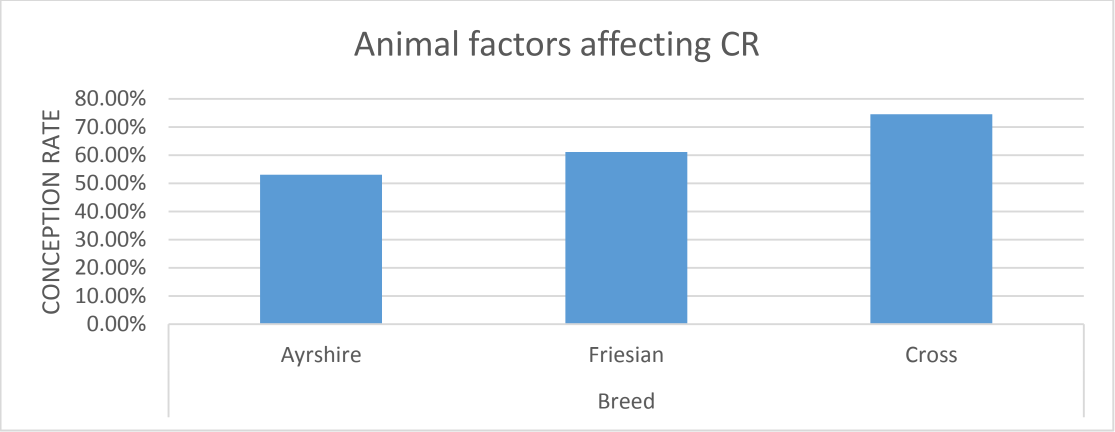

Figure 4.2 a. Qualitative variable Breed effect on the Conception Rate in cows

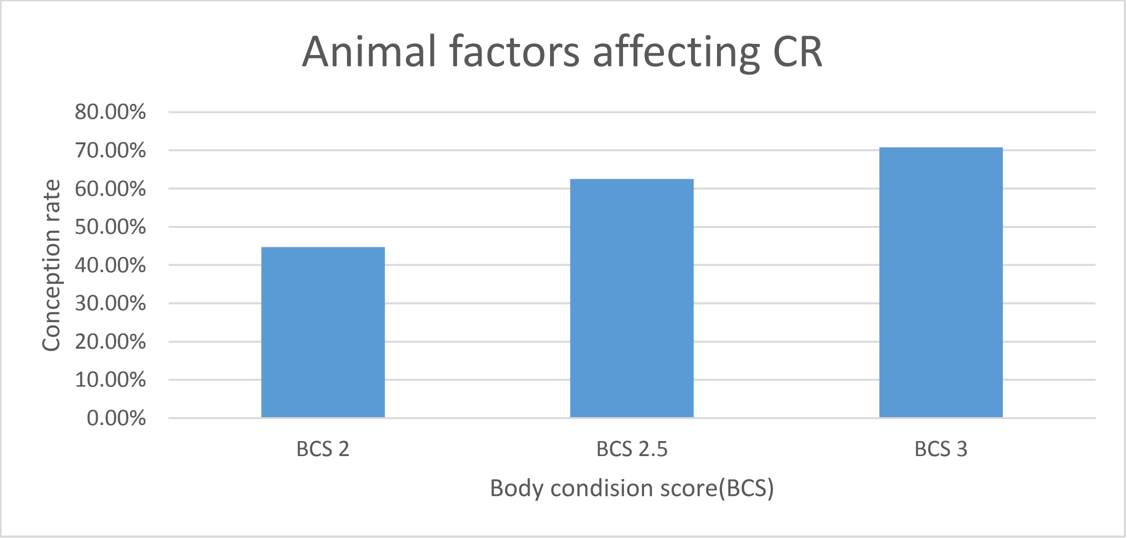

Figure 4.3 b. Qualitative variable Body Condition score (BCS) effect on Conception Rate in cows

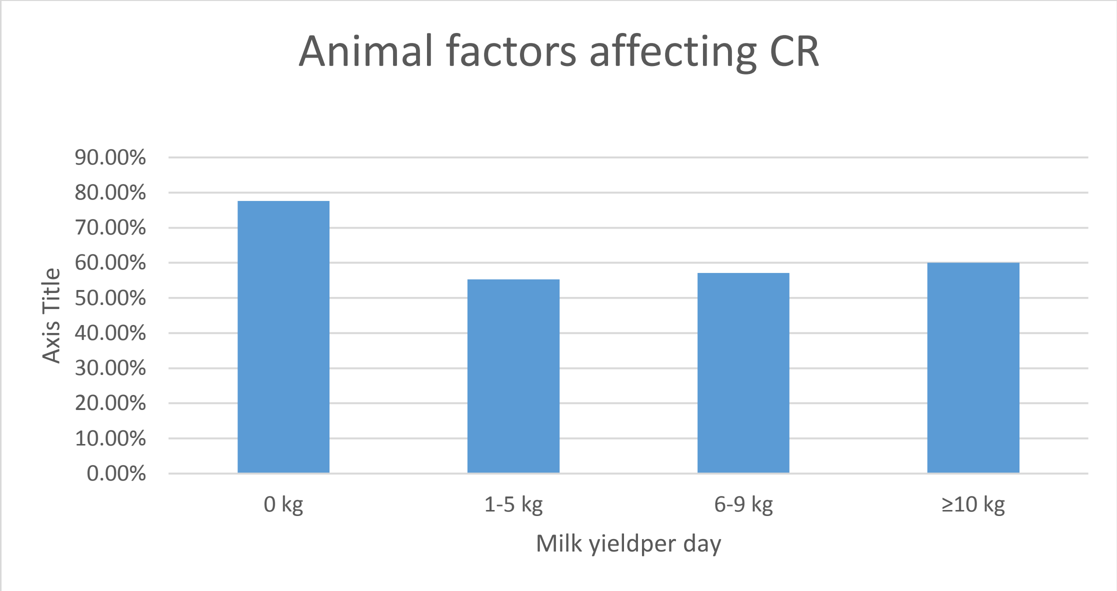

Figure 4.4 c. Qualitative variable Body Condition score (BCS) effect on the Conception Rate in cows

4.3 Effect of days open on the conception rates

The days open, as illustrated in Table 4.5, averaged 255 ± 17 days but with a range of between 232 and 768 days. The mean days open for Zone 1 was 303 ± 35, while for Zone 2 it was 281 ± 34 days and for Zone 3 it was 206 ± 20 days.

Among the breeds, the mean days open for Ayrshire (A) was 264 ± 30 days, Friesian (F), 258 ± 28 days and zebu Crossbreed (C), 244 ± 24 days. Among the farming systems, the mean days open in Intensive farming was 227 ± 34days and in Semi intensive farming was 260 ± 20 days. The mean days open for cows confirmed conceived (in-calf) was 237 ± 21 days while for cows confirmed not conceived was 279 ± 27 days.

Table 4.5. Mean values of days open for zone, breed, farming system and conception outcomes and contrasts between categories.

Variable	Category	N	Mean	SE	Comparison	t-statistic	Df	Significance
Zone	1	37	303	35	1 v 2	0.453	64	0.652
	2	29	281	34	1 v 3	2.434	59	0.018
	3	50	206	20	2 v 3	2.033	77	0.045
	Overall	116	255	17				
Breed	A	38	264	30	A v F	0.147	76	0.884
	F	40	258	28	A v C	0.478	74	0.634
	C	38	244	30	F v C	0.346	76	0.730
Farm System	Int	28	227	34	Int v Semi-int	0.821	108	0.414
	Semi-int	82	260	20				
Conception	Y=0	51	279	27	0 v 1	1.269	114	0.207
	Y=1	65	237	21				

Key:

- Zone (Agro-Ecological Zone AEZ), 1= AEZ 1. 2=AEZ 2. 3= AEZ 3
- Breed: A=Ayrshire, F=Friesian, C=Zebu crossbreed.
- Farming System: Semi-Int= Semi-intensive, Int= Intensive
- Y = Conception status: 1= conceived 0= not conceived.

4.4. Effects of farm-related factors on conception rates

4.4.1 Focus Group Discussions

Six focus group discussions (FGD) were held in the three AEZs in the study area where a total of forty-four participants attended as shown in Table 4.6. Out of forty-four participants, majority (73%) were adult male, 14% adult females and 13% youth of either gender. The participants confirmed from their own experiences that calving intervals were generally more than twelve months, most high milk-yielding cows in subsequent lactation periods suffered from post parturient conditions which included ketosis, milk fever, retained placenta and metritis, resulting to extended days open and consequently, prolonged calving intervals.

Table 4.6. Focus Group Discussions response by participants

Dairy Cooperative Society	Male	Females	Youth	Total
Ainabkoi	6	1	1	8
Taragoon	6	1	1	8
Tarakwa	5	0	2	7
Tuiyo	5	2	0	7
New progressive	4	2	2	8
Sirikwa	6	0	0	6
Total	**32**	**6**	**6**	**44**

According to the FGDs, artificial insemination was the preferred breeding method dairy cattle. There was consensus that the County AI project had positively impacted on the livelihoods of the smallholder farmers in particular and the County dairy industry in general. Indicators for this were increased milk bulking in all six sites in the study area from initial 200kg per day to currently average 1500kg per day, sale of improved heifers from KSh 15,000 (US$138) to current average price of KSh 90,000 (833US$) (CDVS 2020) and more vibrant exportation of cattle and milk outside the County.

For the AI project to succeed 60% felt that extension services and regular training from County Government and other stakeholders' agencies in animal-related fields was needed. The biggest challenge identified in the FGDs was cost of feed and they felt that this could be solved by farmers preparing home-made ratios for their livestock using locally available raw materials and resources in the farms. This, however, would require training and investment in relevant infrastructures.

Animal attendants with little or no skills were employed in the dairy farms. Turnover in employment was also high and these factors resulted in insufficient record keeping and compromised good management practice in those farms. Suggested solution to this was that only trainable persons with at least basic education should be employed as farm workers.

In order to improve on dairy husbandry, more than three quarters of the participants suggested that the County Government could assist in developing reference farms and Farmer Training Centres where the farm workers and smallholder dairy farmers would be going regularly for practical trainings.

On the best word to use for invitation, majority coined a Kiswahili phrase, "*Ng'ombe bora ni kutumia mbegu bora*." Translated: - Quality dairy cow begins with using quality semen.

Majority participants revealed that the main challenge faced in breeding was prolonged calving intervals, where the average calving intervals was more than 24 months with only a few being able to get a calf per year per cow. Almost all the participants needed more information and awareness on the variety of bull semen, few needed free semen, while some saw farmers' dairy cooperative societies as the solution. Almost all the participants desired a stable and high milk price while more than a third needed deployment of more inseminators.

4.4.2 Survey of smallholder farmers

The selected farmers were evenly distributed among the Agro ecological zones such that in AEZ 1, they were 139 (32.8%), AEZ 2, 133 (31.5%) and in AEZ 3 they were 151 (35.7%), giving a total of 423, of these farmers 353 (83.60%) were male and 70 (16.40%) females. On animal production systems, 40 (9.4%) of the smallholder dairy farmers (SDF) surveyed practiced intensive production systems, 288 (68.2%) did semi-intensive systems, while 95 (22.4%) carried out extensive systems. 277 (65.4%) of the farmers used KAGRC semen at a cost of KSh. 1,200 (US$11) per insemination, 135 (31.8%) used imported conventional semen costing KSh. 2,000 (US$ 19) per insemination while 11 (2.9%) used sex-sorted semen costing KSh. 6,000 (US$ 57) per insemination.

As shown in Table 4.7, there was a significant difference amongst the farming systems with the semi-intensive system being the most popular ($p=<0.05$). The difference in cost of insemination was not significant between the highest (sex sorted) and the lowest (KAGRC) semen ($p=0.311>0.05$).

Table 4.7. Percentage effect of on-farm management factors on conception rate

Variable	Categories	n	%	ANOVA	p-value	Tukey's
Agro-ecological zone	1	126	32.8	.335	.563	
	2	121	31.5			
	3	137	35.7			
	Total	**384**	**100.0**			
Gender of the farmer	Male	321	83.6	0.419	.518	
	Female	63	16.4			
	Total	**384**	**100.0**			
Animal production system	Intensive	36	9.4	12.33	.000	0.6111
	Semi-intensive	262	68.2			0.5382^{a}
	Extensive	86	22.4			0.2558^{b}
	Total	**384**	**100.0**			
Cost of the semen	KSh 1,200	251	65.4	1.031	.311	
	KSh 2,000	122	31.8			
	KSh 6,000	11	2.9			
	Total	**384**	**100.0**			

$^{a, b,}$ means with the same letter superscript in a column are not significantly different ($p<0.05$).

Table 4.8 shows the results of odds ratios amongst the on-farm farm variables in farming systems, Zones, Gender and semen costs. χ^2 (4) = 22.40, p 0.0002< 0.05. Farming systems had Odds ratio (OR) =.4099059, p=0.00<0.05, meaning extensive system practice had 0.4099059 higher chance of conception compared to intensive or extensive practice, Zones had OR=1.005819, P=.1290116>0.05 which is interpreted as AEZ III had1.005819 more chance of conception as compared to AEZ 1 and II. Gender OR=.8323872, P=.2380519>0.05 cattle reared by female folk had 0.8323872 conception rate as compare to one managed by male and Costs OR=.8001461, p=.157431>0.05. The cost had no significant influence on conception rates.

Table 4.8 Effect of on-farm factors on conception rates in cows

Number of observations = 384				**Log likelihood = -254.71455**		
LR χ^2 (4) = 22.40				p – value = 0.0002		
Pseudo R^2 =0.0421						
Variable	Odds Ratio	Std. Err.	T	P	[95% Conf. Interval]	
Constant	8.546925	5.251175	3.49	0.000	2.563523	28.49591
System	.4099059	.0842317	-4.34	0.000	.2740126	.6131938
Zone	1.005819	.1290116	0.05	0.964	.7822405	1.2933
Gender	.8323872	.2380519	-0.64	0.521	.475218	1.458001
Cost	.8001461	.157431	-1.13	0.257	.5441178	1.176645

Figures 4.3a,b,c,and d below summarises farmer-related factors where 98% of farmers in study area used the cell phone as the main mode of communication while only 2% communicated through writing. 70% relied on Artificial Insemination Service Providers to choose the bull semen for them whereas 30% made the selections, mostly using bull catalogues. On record keeping, 52% had insufficient records while 30% had no records, only 18% kept sufficient records. 53% of smallholder dairy farmers did irregular feed supplementation to the cows while 45% had regular supplementation and 12.% never gave any supplementation.

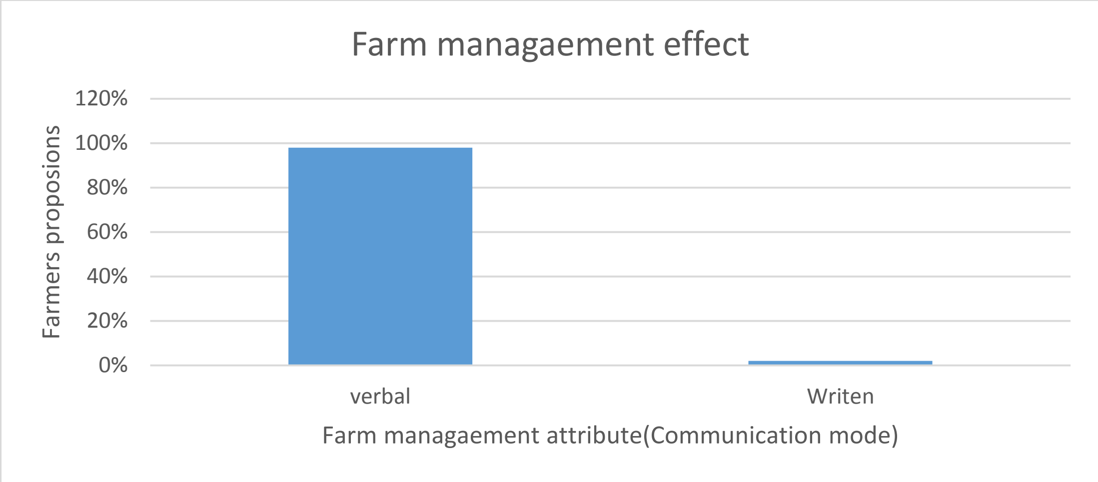

Figure 4.5a. On-farm management factors affecting conception rates in cows

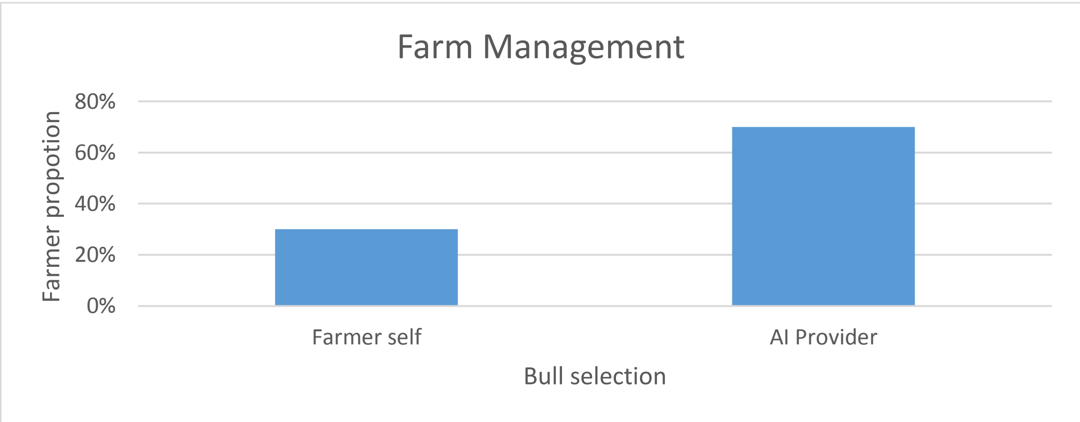

Figure 4.6 b. On-farm management factors affecting conception rates in cows

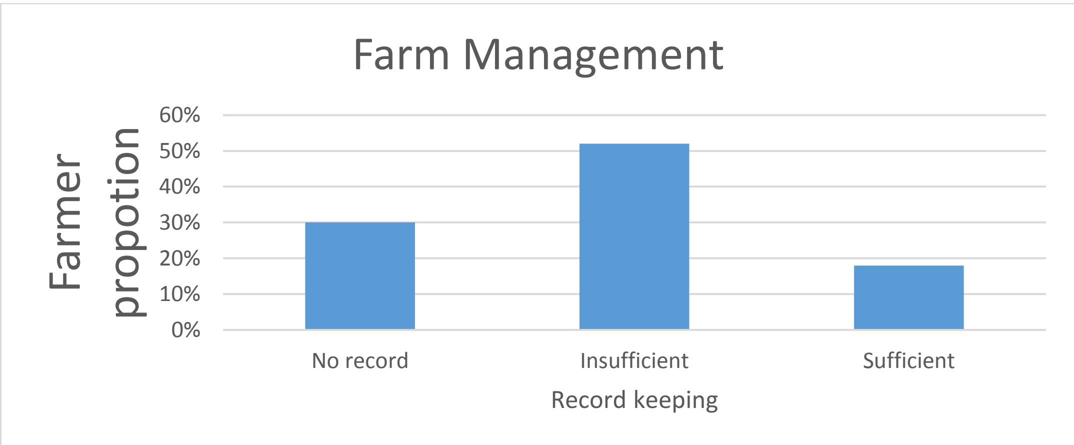

Figure 4.7c. On-farm management factors affecting conception rates in cows

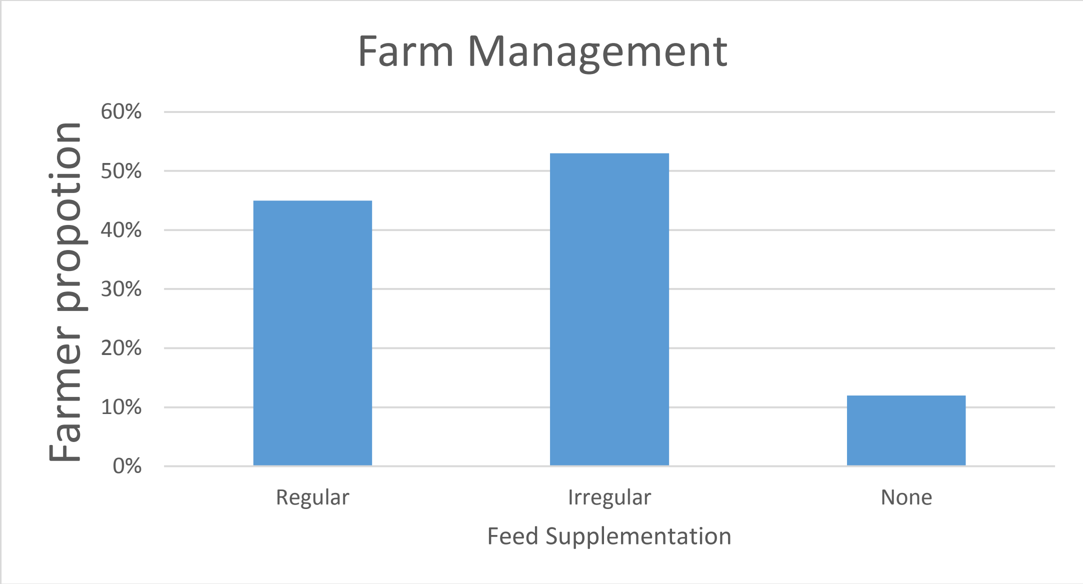

Figure 4.8d. On-farm management factors affecting conception rates in cows

Farmer factors that influenced conception rates are summarised in Table 4.9. Whereas 308 (73%) of Smallholder dairy farmers affirmed that AI project had impacted positively on their livelihood, 115 (27%) felt that it had no impact. 351 (83%) of the SDFs used family labour where majority were women while 71 (17%) used employed labour. Of which 56 (81%) of the employed labour force had no basic education and only 15 (19%) could read and write (had basic education). Only 43 (10%) of the SDFs had their cows calved down annually while 346 (90%) indicated that their cows calved down once in two or more years. 232 (55%) of smallholder SDFs felt milk price was too low while 190 (45%) said the milk prices fluctuated frequently. All SDFs felt that cost of animal feeds was exorbitantly high.

Table 4.9 The result of effect of farmer on CR in cows at on farm situation

Factor	Effects	Number of respondents	Percentage respondents
AI impact	Positive	280	73%
	Neutral	104	27%
	Negative	0	0
Source of labour	Self	318	83%
	employ herdsman	71	17%
Herdsman	With basic education	15	19%
	No basic education	56	81%
Calving interval	Annually	38	10%
	more than one year	346	90%
milk selling price	Deplorable	211	55%
	Fluctuate	173	45%
	Stable	0	0%
cost of feed	very high	384	100%
	Fair	0	0%
	Low	0	0%

Vector-borne disease East Coast Fever (Theileriosis) was the most important (46%) livestock disease reported followed by Anaplasmosis (15%) mastitis, Pneumonia, FMD, LSD infectious bovine keratoconjunctivitis (eye conditions) and foot rot were 14%, 13%, 3%, 2% and 2% in that descending order respectively (Figure 4.4).

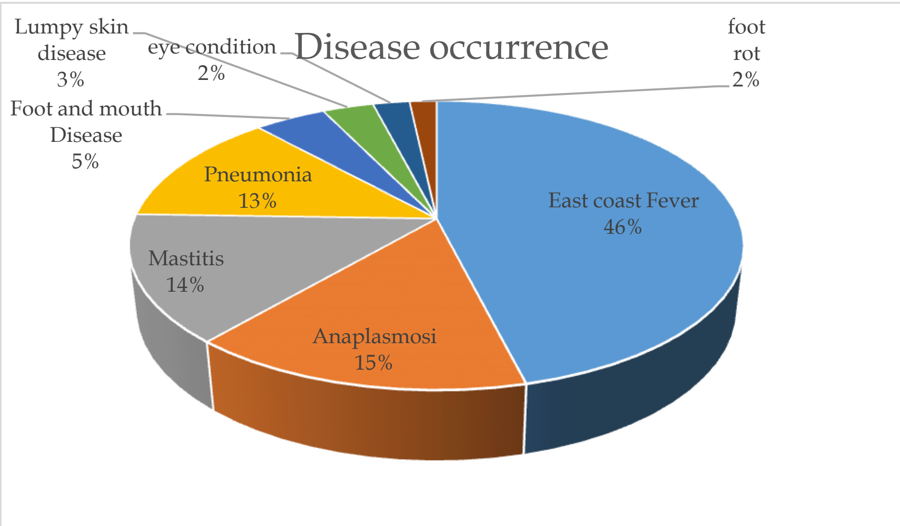

Figure 4.9. Percentage occurrence of livestock diseases in Smallholder farms

Figure 4.5 shows how farmers rated the impact of artificial insemination on their livelihood. 3.4%, 12.4%, 38.5%, 23.2% and 22.4% felt its impact was deplorable, poor, fair, good and excellent respectively. However, 59.9% of respondents indicated that conception rates in artificially inseminated animals were fair, 10.2% said they were excellent and only 1.8% felt they were too low. To 53.1% of the farmers, calving intervals of animals artificially inseminated was fair, to 2.10% it was excellent and to 1.6% it was too low.

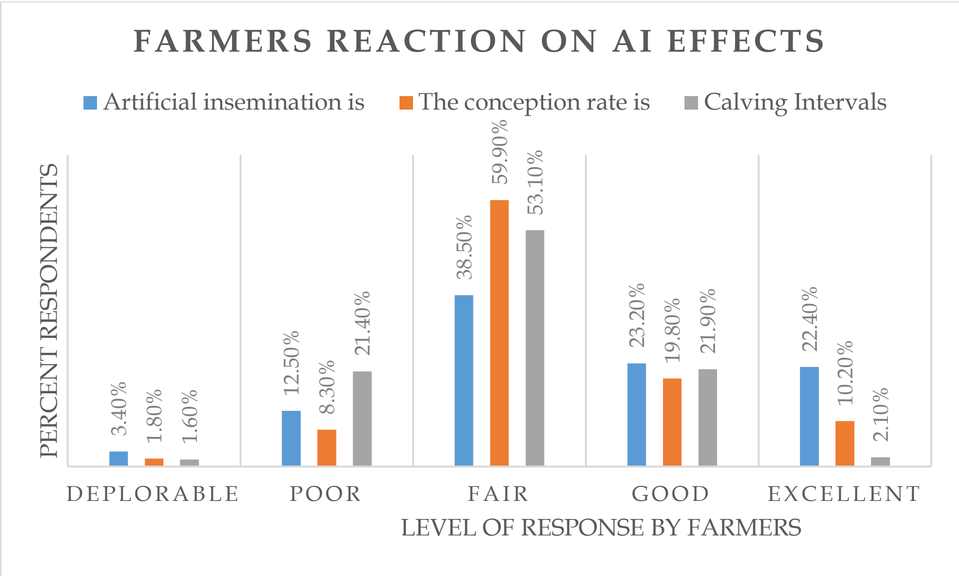

Figure 4.10. Impact of Artificial Insemination on livelihood of farmers

Table 4.10 summarises the attributes of the AISPs that affect the conception rates in the on-farm situation. Half of the AISPs were 30-40 years old, with the rest being split equally between those younger and those older. 75% of the inseminators were technically qualified to carry out insemination services, 25% had experience of over 20 years in continuous practising while all of them had reliable means of mobility by having versatile Finding on table 4.10 denotes that majority of the AISP had long field experience which mean had mastered the art of AI insemination also age wise they had developed AI to be their carrier. Also had a reliable mean of mobility to reach to their clients on good time.

Table 4.10 Attributes of inseminators (AISPs) that affect conception rates in cows

Attribute	Effect	Respondents	Percentage
Age	<29 years	2	25%
	30-40 years	4	50%
	>40	2	25%
	Total	**8**	**100%**
Education level	AI Certificate	2	25%
	AHA and AI certificate	6	75%
	Total	**8**	**100%**
Experience	1-5years	2	25%
	11-15 years	4	50%
	>20 years	2	25%
	Total	**8**	**100%**
Mobility	Motorcycle	8	100%

Figure 4.6 below shows 80% of the AISP were rated good and 20% rated excellent to response to farmers call for insemination. On suppling the farmers with required breed type 90% were rated good and 10% excellent while in the conception rates 75% were rated good and 25% fair.

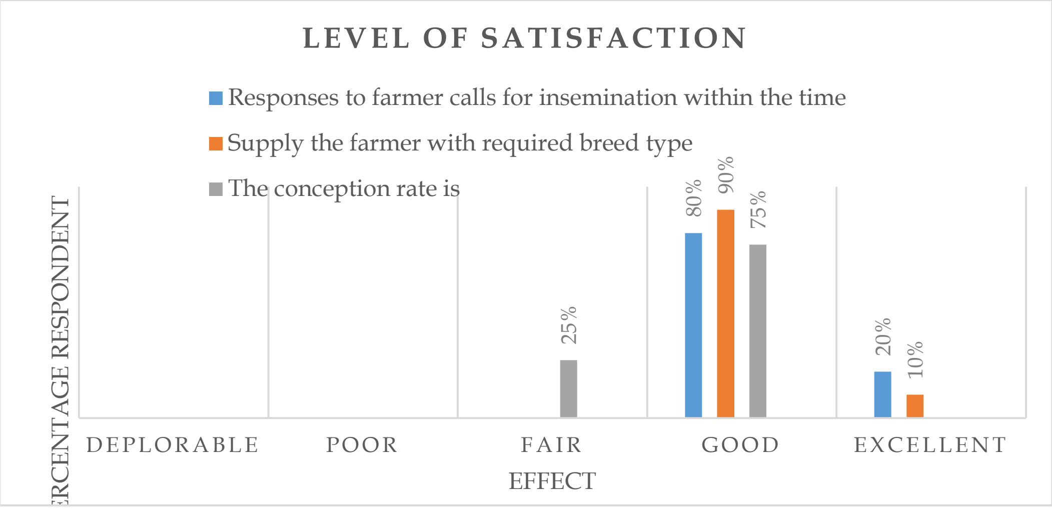

Figure 4.11. Ratings of farmers over services rendered by Artificial Insemination Service Providers.

CHAPTER FIVE

DISCUSSION

5.1 Animal factors influencing conception rate

The three variables; breed, body condition score and milk production levels (F=18.7518, df=3 p=0.0003<0.05) significantly influenced conception rate as compared to the other five variables (AEZ, parity, Age group, AI timing, Semen type/cost F=0.6568, df=, 5 p=0.9853>0.05) which had no significant influence on the conception rate of cows amongst smallholder dairy farming in Uasin Gishu County.

Friesian breed had a conception rate of 53.1%, Ayrshire 61.1% and zebu-crossbred cows recorded the highest conception rate of 74.5%. The same observation was made in India by Singh and Balhara, (2016) who reported that Crossbred cows had higher conception rates than pure breeds. Paul *et al.,* (2013) observed that local indigenous cattle breeds tend to have higher conception rates than the crossbreeds in the Bangladesh context. Nishimwe *et al.*, (2015) in Rwanda observed that local indigenous breeds had higher CR as compared to exotic breeds and their crosses.

Conception rates in zebu-crossbreeds are higher probably due to their better adaptability to local environmental and management conditions. For instance, they can withstand challenges like high heat load exposure, tracking long distances in harsh condition searching for water and pastures. Most of the crossbreeds in this study had African Zebu or Sahiwal genes which are indigenous cattle well adapted to the terrain and environmental conditions of Uasin Gishu County. The Odds ratio revealed that crossbred cattle had a 0.616 times higher chance of conception than Friesian and Ayrshire cows. Culturally, Uasin Gishu farmers have reared indigenous cattle for many decades, and the crossbreeds have therefore undergone several cycles of crossbreeding (between indigenous and exotic cattle) by use of either AI services or bulls from elite farms.

Body condition score positively influenced conception rate. The study established that cows with an average BCS of 3 had a higher Conception rate of 70.8%, those with a BCS of 2.5 had a CR of 62.5% and those with a BCS of 2 had the lowest CR of 44.7%. Similar studies by Shamsuddin *et al*., (2001) and Kouamo and Sawadogo (2012) showed that cows with a BCS of 3.0 had higher conception rates than those with lower BCS. Vale *et al*., (2011) recommended a higher BCS of 4 but indicated that the minimum BCS score for conception should be 2.5. Higher BCS indicates that the cow got enough to feed and nutrition, resulting in enough nutrients for body maintenance, production in terms of milk, and reproduction energy. As the BCS increased from 3, the Odds ratio indicated that the CR increased by 0.312.

Body Condition Score has a direct influence on fertility since animal's body gives more priory of available nutrients to basal metabolism and secondly to the growing foetus need then lastly for other reproductive and productive need (Vale *et al.,* 2011). However, most of the primiparous (first parity) cows had BCS less than 2.5 with a corresponding lower CR (44.7%.3%). This could probably be because, at this age, the cow still needed more nutrients for growth even as it produced milk, hence the likelihood of suffering from a negative energy balance. Primiparous cows often experience lower energy balance than their multiparous counterparts because, in addition to the energy and nutrient demand of lactation, they usually eat less and require energy for growth, which compromises their reproductive performance as opposed to multiparous cows which are more adaptable to reinitiating postpartum cyclicity Walsh *et al.,* (2011). This is the reason why multiparous have shorter calving intervals as compared to primiparous cows (Fodor *et al.,* 2019).

Dry cows and heifers had a better conception rate at 77.6% as compared to lactating cows. This was validated by the studies of DeJarnette *et al.,* (2008). Schenk *et al.,* (2009), Walsh *et al.,* (2011); and Vale *et al.,* (2011) all of whom found that heifers had higher conception rates than those that had given birth previously. It is probable that heifers do not need nutrients for production, but only for maintenance, growth, and reproduction. They are therefore less likely to suffer from NEB as compared to their milk-producing counterparts. The study revealed that cattle with parity 0 (Nulliparous), 1 (Primiparous) 2, 3, 4 and >5 (Multiparous) had CR of 78.7%, 48.1%, 53.1%, 77.8%, 43.5%, and 66.7% respectively, even though cows at parity 4 had the lowest CR this could be likely be related to the small sample size used at this stage ,however of much importance are primiparous cattle which dropped drastically from 78.7% (nulliparous) to 48.1%,this may be attributed to the fact that at this stage more nutrients are needed for basal metabolism, growth and reproduction. Also, at this stage two incisors (cutting), milk teeth are shade and permanent one start to erupt hence these cows if not given any feed supplementation may not get enough while grazing and therefore high chance of experiencing high negative energy balance.

Parity had no significant influence on CR and this could be attributed to the fact that farmers give better management practice to high milk producing cows regardless of their age and conception rates. Indeed, milk yield significantly influenced CR. Singh and Balhara, (2016) and Shamsuddin *et al.,* (2001) reported that high milk producer cows tend to have higher CR than low milk producers. Vale *et al.,* (2011) observed that lactating cows tend to have higher CR than non-lactating and heifers. In the present study, dry cows had CR of 78.7%, which was the highest as compared to milk yielders of 1-5Kg (55.3%), 6-9Kg (57.1%) and >9kg (60%). Milk-yielders of more than 9 kg per day had a higher conception rate than the lower yielders, a finding that was also reported in Bangladesh by Shamsuddin *et al.,* (2001). This is probably due to the fact that farmers tend to feed this group of animals with more nutritious feed in order to maximize production and enhance their daily income from the sale of milk. However, Demetrio *et al.,* (2007) and Mekonnen *et al.,* (2010) reported contrasting findings that high producing dairy cows have significantly lower conception rates during the lactation period and attributed this to high nutrient demand due to the increased metabolism that is associated with milk secretion.

Agro ecological zones, age group, AI timing and semen type/costs had no significant influence on CR among cows in smallholder dairy farms. Cows of age group 2-3 years had highest CR of 72.6%, followed by >7 years at 62.5%, 6-7 years at 60.8% and the least was 4-5 years with 51.9%. These results agreed with findings by Nishimwe *et al.,* (2015) who observed that cows less than 4 years old had higher conception rates than older ones. However, Paul *et al.,* (2013) found a significant difference in the conception rates between cows aged 3-4 years old and those less than three years and/or those older than four years.

Semen quality is determined by the spermatozoa characteristics such as sperm count, morphology, viability and molecular and functional traits (Walsh *et al.,* 2011; Mekonnen, 2010) and these greatly influence conception rate. The semen used in the study was cryopreserved in liquid nitrogen (-196°C) and this, according to Shamsuddin *et al.,* (2001), gave it a significantly higher conception rate than semen which is chilled. Singh and Balhara, (2016) observed that high CR can be attained by using quality semen. The conception rate in the study which ranged from 54.8% to 68.9% for all semen used was comparable to that of Melo *et al.,* 2012, who obtained a range from 41.8% to 67.7% in their study. Friesian breed in the study area had a higher CR of 63.8% to 68.9% as compared to Ayrshire breed at 54.8 to 58.7%, irrespective of whether the semen had been imported or sourced locally from KAGRC. Shamsuddin *et al., (*2001); Bhagat and Gokhale, (2016) obtained similar results and reported that pure Friesian bulls had higher conception rates than all other breeds and crossbreeds.

Even though insemination time had no significant influence on CR, it was noted that insemination carried out 11-18 hours from the start of clinically manifested oestrous gave the highest CR of 71.4%. This was partly supported by (Shamsuddin *et al.,* 2001) who reported that cows served on average at 19 hours after being detected in oestrus have a higher conception rate than those served after 24 hours. However, with fixed time AI service cows served 6 to 8 hours have higher conception rate (Lucy, 2001).

The farming system had no significant influence on CR. However, semi-intensive farming systems had higher CR than intensive ones. Shamsuddin *et al.,* (2001) and Woldu *et al.,* (2011) on the contrary, found that cows managed intensively tend to have higher conception rates than those reared extensively. However, it is likely that in the present study, most smallholder dairy farmers also plant crops like maize and interchange between intensive and extensive systems, depending on the season and availability of pastures. It was observed that most households that practiced intensive farming did not do it well as the animals were not supplied with sufficient and quality nutrients and water, and the housing was not comfortable. Semi-intensive systems, on the other hand, were provided with feed in the morning and taken out for grazing later in the day.

Exploration of the distribution of days open revealed great evidence of departure from normality although the top five extreme values had a mean of 768 compared to the bottom five values mean of 44. Overall, mean days open level of 255± 17 days is much higher than the generally recommended value of 85-110 days (Radostits *et al.,* 2006). Even if the top five extreme values are removed, the mean value is still as high as 232. On average, the days open for smallholder dairy cows in Uasin Gishu County is 255± 17 days, implying that the calving interval was about 542 days. This is an indicator that the reproductive performance was poor which could be worse, with the likelihood of high mortality of calves resulting from the high incidence of vector-borne diseases, especially East Coast Fever. Consequently, farmers might be unable to produce enough replacement stock. Bebe *et al.,* (2003) and Muraya, *et al* (2018) observed that in central Highlands of Kenya, smallholder dairy enterprise was characterized by long calving interval of about 633 days and high mortality of young stocks. Increased calving intervals and days open negatively influence conception rate (Howlader *et al.,* 2019). The low conception rate of 48.2% obtained in the present study confirms this assertion.

Esposito *et al*., (2014) found that the proper management of dairy cow especially during the first 100 days postpartum help in maintaining the reproductive performance of the dairy, but in our case, this is likely not be emphasized leading to both post parturient clinical and subclinical diseases and disorders which influenced fertility. During focus group discussion as, Key Informants revealed that high yielder cows in subsequent lactation experienced frequent retained placenta (RP) leading to long calving intervals and prolonged days open. According to Han and Kim, (2005) and Buják *et al.,* (2018) RP occurs with a frequency of 4–18% increasing the risk of other reproductive disorders, and is associated with increased days open. This was supported by Maizon *et al*., (2004) who found that periparturient conditions like difficult calving, retained placenta, metritis, endometritis, cystic ovarian disorders, and other uterine infections reduced the conception rate and increased the days open. Bell and Roberts (2007) found out that an increased duration of days open was associated with the calving assistance technique of which in our study this could likely be a contributing factor to the long days open based on the low number of animal health service providers which included only three Veterinary Officers (VO) and six Animal Health Assistants (AHA). Therefore in most cases, farmers were likely to be turned into calving assistants which may lead to reproductive track trauma hence subsequent uterine infections in the reproductive system leading to delayed regeneration of the endometrium (Földi *et al*., 2006).

An unsupplemented diet likely could have been a contributing factor to long days open since only 45% of the farmers gave regular supplementation. This was supported by Rufino *et al* ., (2009), reported that decreased fertility of dairy cows in central highland Kenya was as a result of insufficient feeds due to low or no diet supplementation.

Feeding takes up over 70% of dairy enterprise input costs, this variable is the single largest contributor to farm losses since it implies that a cow will be fed for more than 200 days with no returns. This also means that cows have fewer opportunities to produce replacement heifers hence not realizing the full life potential reproductivity and productivity of the cow. A well-managed dairy cow needs to give birth to a calf every 12-13 months with recommended days open of 85-110 days (Radostits *et al*., 2006), but this will not be attained with the recorded average days open of 255± 17 days in the study. Long days open lead to unnecessary extra costs of buying replacement stock, which may compromise biosafety in the farm as it may be the conduit for the introduction of disease-causing pathogens of economic importance for instance bovine paratuberculosis (Omega *et al*, 2019a) which is quite difficult to eliminate once introduced to the farm unless the whole infected herd is eliminated by slaughter then disposed by burning or burying followed by thorough disinfection and resting of the farm for over a year. Introduction of new herd could also be a source of undesirable genetic traits and other vices in the farm. The lactation cycle of a dairy cow with long days open will not be optimum and the overall productivity and reproductivity will be less than expected. Most farmers who notice that their cows take too long to conceive after the last calving tend to cull and dispose them at lower price (Inchaisri *et al.*, 2010).

All Focus Group Discussions indicated that the AI project in Uasin Gishu County had impacted positively on their livelihoods, evidenced by increased collection and milk bulking from 200kg per day to 1500kg at the various established chilling plants located at dairy farmer cooperative societies premises. Members were able to receive increased price of milk from KSh 25 (US$ 0.23) to current average price of KSh 40 (US$ 0.37) per kg from the sale of bulked and chilled milk and also from sale of heifers at a better price from initial average cost of KSh 15,000 to KSh 90,000 - 150,000 (US$833-1,400) (CDVS 2020). This implied that families got enough milk for home consumption which provided sufficient food and nutrition to the family.

On the gender aspect, 73% of smallholder dairy farmers were male, 12% female, and 15% youth. This indicated that smallholder dairy farming was a male-dominated occupation. The source of labour played a key role in the conception rate of cows with 83% of the smallholder dairy farms offering their labour (the respondent and the family members) of which female folk was the key player. 17% employed herdsmen of whom 81% of them had no formal education. Proper record keeping was a challenge and the ability to detect a cow on heat and report to the AISP in good time was also a problem which could have influenced conception rates.

Establishment of reference farms by county Government and other key stakeholders was considered as a solution where smallholder dairy farmers and their herdsmen can attend practical trainings on regular basis. This could be established within the cooperatives or use some of the well-established smallholder dairy farms which are in every village in study area.

Use of the Kiswahili word by 65% of FGDs" Kulisha Ng'ombe bora ni kutumia mbegu bora." Meaning: - Quality cow is a product of good and quality semen indicated that majority had impressed the use of quality semen. However, it was established that even though good quality semen was available only 10% of the participants had their cows having a calf annually, with 90% reporting that their cows calved down once in two or three years which was the major basis of culling. This supported the finding in the study where days open period was found to 255 ± 17 days. The prolonged calving intervals were attributed to many factors which included among others: - poor feeding, late reporting of cows on oestrus, post parturient conditions for instance ketosis fever and metritis, and difficult calving (Dystocia).

Dystocia led to general trauma or stress to the reproductive tract, especially when the farmers try to assist the cow remove the calf. The methods used by farmers are often crude, septic and injurious to the cows. Which in turn predisposed the animals to uterine infection. The consequence of this is that the uterus takes a long period to heal, leading to prolonged post-parturition recuperation (Coleman *et al*., 1985). During pregnancy diagnosis by rectal palpation, most cows with prolonged DO were diagnosed with pyometra and some had cystic ovarian diseases. There was the possibility that some of the cows may have had subclinical metritis, especially if they had other underlying diseases such as paratuberculosis infections (Omega *et al*, 2019a, b;Okuni *et al*., 2020).

The key informants in all Zones observed that high milk producing cows in the preceding lactation had longer days open, attributed to the tendency of having retained placenta and in some cases, Ketosis and other periparturient disorders. Because of persistent secretion of large quantities of milk throughout lactation period, many farmers found it hard to dry them off in the recommended period creating more reproductive complications.

From the study, most smallholder dairy farmers did not steam up (giving enough quality feeds during the dry period) their cows due to high cost of feeds, hence the likelihood for the cows to suffer from NEB was eminent. Walsh *et al.,* (2011), found that owing to the development of the foetus, proper dietary management for pregnant cows tends to alleviate completions brought about by negative energy balance. Gröhn and Rajala-Schultz (2000), noted that retained placenta, premature metritis, silent heat, ovarian cyst and other issues related to infertilities from the previous lactation had likely been maintained in these high producing cows.

Extensive extension services by county Government veterinary and livestock production officers including other officers from animal related agencies was critical and could be a solution to major challenges faced by smallholder dairy farmers.

Smallholder dairy farmers played a key role in determining CR. Most farmers (98%) used their cell phones to communicate to AISPs meaning they had telephone contacts for the preferred AISPs, therefore getting AISPs in good time was possible. It was established that most smallholder farmers had no prior knowledge of the bull they needed as only 30% chose the bull with traits they desired (from the bull catalogue) while 70% depended on AISP to choose for them which in most cases gave what was available at that point in time. Ninety percent of the AISPs were rated as good for supplying farmers with the desired semen type. Only 10% were rated as excellent. Although this had no direct bearing on the CR, it contributed to failure to attain the initial goal of the County to improve the dairy genetic pool by offering the desired traits. This was made worse by the fact that only 30% of farmers kept good records which was reported by Nishimwe *et al.*, (2015), that record keeping was critical in influencing Conception rates in small scale dairy farms in Rwanda.

Whereas the present study showed that BCS significantly influenced CR, the survey results showed that only 45% of smallholder farmer gave regular feed supplementation to the cows and 12.5% gave no supplementation. This was unanimously attributed to the high price for farm inputs especially animal feeds.

Vector-borne diseases were found to be the most important livestock diseases in the study area, with theileriosis (ECF) rated highest at 46.1% and Anaplasmosis, 15.5%. Other diseases included Mastitis 14.2%, pneumonia 12.8%, FMD 4.5%, LSD 3.2%, infectious bovine keratoconjunctivitis (Eye conditions) 2.3% and Foot Rot 1.7%. The findings are in part consistent to Mungube *et al.*, (2014), who showed that Pneumonia, Anaplasmosis, FMD and eye problems were rated at 22%, 13%, 8%, 6%, and 4% respectively, whereas theileriosis was assessed as high at 56.1%, respectively. Presence of such diseases may have contributed to low conception rate as sick animals especially incalf one are likely to abort or have early embryonic death. With high disease incidence cases of early embryonic death could be high and, in most cases, may go undetected by farmers contributing to long calving intervals. Also, farmers tend to use little resource within their disposal for veterinary treatment instead of payment of AI services. Recovering animals from such diseases take long to reach normal reproductive state hence prolonged days open subsequently long calving intervals.

Conception rates may be influenced by Artificial Insemination Service providers (AISP) in terms of mobility and field practising experience. All the 8 AISPs who served in the area under study owned motorcycles, implying that mobility was not a big challenge. This was confirmed by 80% of the farmers who reported that the response by the AISPs to their calls for AI services was good while 20% believed it was excellent which was a good indication of farmers' satisfaction of the AI services offered.

Experiences of AISP influences CR, as supported by Anzar, M., *et al*. (2003) who found that Inseminator's skills critically influence CR as is build up over time in active practice. This was evidenced in AEZ 1 which had the highest conception rate of 62.9%, followed by AEZ 3 with 62.3% and AEZ 2 (61.7%). The 2 AISPs in AEZ 1 had each over 20 years of continuous practicing experience despite having only certificate in AI (CDVS, 2020). AEZ 2 with the least CR had AISPs with only 1-5 years of experience.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

1. The conception rate (CR) of dairy cattle among smallholder farmers in Uasin Geisha County is 48.2%. This rate is affected by several factors: -

   a. The animal factors that affect CR were breeds, BCS, and Level of milk production
   b. Crossbreed cattle had higher CR than pure-bred ones
   c. Cattle with a good body condition score (BCS) of 3 or more on the scale of 1 to 5 (with 1 being a severely emaciated animal and 5 being an obese animal) had better conception rates than those with a BCS of 2.5 or less.
   d. High milk yielder cows had higher CR.

2. The average days open (DO) in Uasin Gishu County was 255± 17 days which was higher than the normal expectation of 85-110 days. Factors influencing DO included: -

   a. The management of dairy cattle in the First 100 days in milk.
   b. High incidence of Vector borne diseases.
   c. Poor record keeping.

3. The on-farm factors that affect CR were: -

   a. The system of production with the semi-intensive system doing well, followed by intensive and lastly extensive farming.

b. Herdsmen employed had no or little basic education could not make any written records or detected animal on heat.
c. Women were key players yet they had little on decision making.

4. Uasin Gishu County Government-subsidized AI project has had a positive impact on dairy cow breeding and milk yield among smallholder dairy farmers hence improved their livelihood.

6.2 Recommendations

1. To increase conception rates and productivity, veterinary and extension services among smallholder farmers should be intensified.

2. Uasin Gishu County Government needs to establish a functional and sustainable breeding policy and strategy which will ensure maximum production from the dairy sector.

3. To enable the sustainability of the County Government-sponsored Subsidized AI Program, an effective County body responsible for coordinating, evaluating, and monitoring AI services, farm records, and livestock breeding programs should be created.
4. A more intensive and extensive study should be carried out with a larger variety of semen types, cattle breeds, and farming systems to obtain information that can be used to inform policy on dairy farming in the County.

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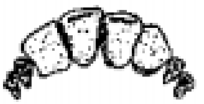
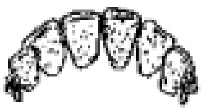
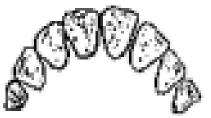
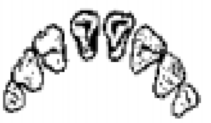
APPENDICES

Appendix I: Determination of cattle age

Diagram 1. Handy guide to determining the age of cattle by the teeth		
	At birth to 1 month	Two or more of the temporary incisor teeth present. Within first month, entire 8 temporary incisors appear.
	2 years	As a long-yearling, the central pair of temporary incisor teeth or pinchers is replaced by the permanent pinchers. At 2 years, the central permanent incisors attain full development.
	2-1/2 years	Permanent first intermediates, one on each side of the pinchers, are cut. Usually these are fully developed at 3 years.
	3-1/2 years	The second intermediates or laterals are cut. They are on a level with the first intermediates and begin to wear at 4 years.
	4-1/2 years	The corner teeth are replaced. At 5 years the animal usually has the full complement of incisors with the corners fully developed.
	5 to 6 years	The permanent pinchers are leveled, both pairs of intermediates are partially leveled, and the corner incisors show wear.
	7 to 10 years	At 7 or 8 years the pinchers show noticeable wear; at 8 or 9 years the middle pairs show noticeable wear; and at 10 years, the corner teeth show noticeable wear.
	12 years	After the animal passed the 6th year, the arch gradually loses its rounded contour and becomes nearly straight by the 12th year. In the meantime, the teeth gradually become triangular in shape, distinctly separated, and show progressive wearing to stubs. These conditions become more marked with increasing age.
Source: R.F. Johnson. The Stockman's Handbook by Ensminger, 2nd ed., page 539.		

Appendix II: Focus Group Discussion procedure and questions

• FGD Participants in every dairy cooperative society were six to eight participants made up of: -chairman uniquely eleven out of twelve were retired senior servants with a background in agriculture more so animal husbandry with exception of Taragoon Dairy cooperative society who was a businessman but a leading dairy farmer, three leading farmers of which one was of different sex for all gender inclusivity, one youth dairy farmer, and any two head of a section in the dairy cooperatives.

Venue seven had good board rooms and 5 had specific open fields or veranda routinely used for meetings which gave a serene environment for the discussions

The Researcher was the moderator and had skills in agricultural extension therefore was able to skilful steer the discussions.

After the standard welcoming remarks, the chairman (who had been keenly been briefed on the purpose, the intent of the meeting, and who gave the permission for the discussion to be done. The Moderator gave an overview of the meeting and ground rules were set and agreed upon by all of which was COVID -19 preventative measures as per Public Health requirement which included mask must be worn throughout and safe distance maintained, time taken for any discussion was maximum of two hours and no answer was wrong.

Appendix III: Guidelines on FGD

1. How have you (participants) involved in the breeding program more so the use of AI services in the dairy society?

2. Think back over the last years of the breeding program in the county right before the advent of devolution, what particular changes have this county subsidized AI project brought to the society?

3. For the Subsidized AI project to succeed what do you think needs to be done?

4. Suppose you were to invite some participants to witness a milestone in the AI project, what will you say in the invitation?

5. Suppose that you were in charge and could make the program better what would you do?

Appendix IV: Introduction letter

University of Eldoret

P.O. Box 1125-30100, ELDORET, KENYA
Tel: 0722461135
E-mail: joseph.omega@uoeld.ac.ke

SCHOOL OF AGRICULTURE & BIOTECHNOLOGY
Department of Animal Science and Management

REF: UoE/ANS/STA/027/Vol 2/54 **DATE:** 28th July, 2020

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

RE: INTERVIEWS BY PHILIP K BIAMAH FOR RESEARCH PURPOSES

Our student, Dr. Philip Kiplel Biamah of Registration Number AGR/PGA/03/12 is carrying out his Master of Science in Animal Production research project in Uasin Gishu County. The title of his project is *'**Factors Affecting Conception Rates of Artificial Insemination Service among Smallholder Dairy Farms in Uasin Gishu County, Kenya.**'*

As part of his research activities and data collection, Dr. Biamah will carry out interviews orally to key informants, in Focus Discussion Groups and in written through questionnaires to selected farmers. He will also inseminate selected cows as recommended and approved in his research project proposal.

This is to kindly request you to assist Dr. Biamah carry out his research work in whichever way he will request.

Rest assured that all the information collected by Dr. Biamah or his research assistants will be used only for academic purposes and will be treated with utmost confidentiality.

Thanking you in advance for your positive response and cooperation.

Yours faithfully,

Dr. Joseph A. Omega, PhD.
Head of Department
Department of Animal Science and Management

cc -County Commissioner, Uasin Gishu County
-Dean, School of Agriculture and Biotechnology, UoE

University of Eldoret is ISO 9001:2015 Certified

1

Appendix V: Questionnaire for Farms

Data Collection Form for Farms

Questionnaire
Number..**Date**...

Enumerator Name……………………………Number: ………………………………
Sub-County............................Ward.................................Location...............................
Sub-location................................Village...
Name of the farmer (i.e., the person interviewed)...
…………………………………Mobile Phone No..
Farm Reference Number......................**Cow Reference Number**..............................
Signature of Enumerator...

CERTIFICATE OF CONFIDENTIALITY AND CONSENT

Confidentiality and consent for data collection process for the research title "*Factors affecting conception rates of artificial insemination in smallholder farms in Uasin Gishu County*"

Your answers are completely confidential

Your name will never be used in connection with any of the information you give me.

You do not have to answer any questions that you do not want to answer.

It is important that you answer all questions but you may end this interview at any time.

The purpose of asking these questions is for us to share what you know about factors affecting conception rates while using AI service in dairy cattle and how to improve on them. The information you provide will help us understand the challenges if any in your area and what best methods will be used to improve on conception rate to make dairy farming profitable. The interview will take about 30 minutes and I will appreciate your help in responding to these questions accurately.

Would you be willing to participate?

☐ Yes

☐ No

Reason____

Signature of the interviewee____

Indicating that an informed consent has been given verbally by the respondent.

Note: *A household comprises of household members who have stayed together in the same residence for the last 6 months.*

Please fill the questionnaire as honestly and objectively as possible by ticking/crossing in the appropriate boxes or filling in the spaces provided.

Section One: Respondent's demographic characteristics

1. **Sex of the farmer?**

   Male [ ] Female [ ]

2. **Duration in dairy farming activity?**

   1 to 7 Years [ ] 8 to 14 Years [ ]

   15 to 20 Years [ ] over 21 Years [ ]

   Above 20 Years [ ]

3. **Who manage your farm activities?**

   Employee [ ] Self [ ] Both

4. **How many heads of cattle do you have? (**Please indicate the number**)**

   Bull calves [ ] Bull [ ]

   Heifers [ ] Cows [ ]

5. **Mode of providing information to you AI provided**

   Verbal (phone) [ ] Written [ ]

6. **Who Selects the semen used in your farm**

   Self [ ] AI Provider [ ]

7. **What are the constraints faced to using the preferred type of semen?**

   Cost of AI [ ] Scarcity [ ]

   Lack of information [ ]

Other reasons..

Section B. Farming Systems

8. The nature of the farming systems?

   Intensive [ ] semi-Intensive [ ] Extensive [ ]

9. Feed supplementation

   Regular [ ] Irregular [ ] None [ ]

10. Type of semen used in the farm for the last 12 months

    Imported [ ] KAGRC [ ] Sexed [ ]

11. **Do you keep farm records?**

    Yes [ ] No [ ]

    If yes, what type?

    Milk records only [ ] milk records and all farm activities [ ]

12. What is the commonest disease on your farm?

    East coast Fever [ ] Anaplasmosis [ ] Mastitis [ ] Pneumonia [ ] FMD [ ]

    LSD [ ] Eye Condition [ ] Foot rot [ ]

13. The average duration of calving to serving...

Section F Farmer's Knowledge on artificial insemination

Please rate the level of satisfaction choosing the most appropriate choices that best represent your view/opinion: 1. **Deplorable; 2. Poor; 3. Fair; 4. Good and 5. Excellent**

		1	2	3	4	5
1	Artificial insemination is					
2	The conception rate is					
3	Calving interval is					

Please suggest two ways in which AI services can be improved:

…………………………………………………………………………………………

Thank you for your time

Appendix VI: AISP information

The questionnaire is designed to gather information on the respondent's demographic characteristics

PLEASE EITHER TICK THE APPROPRIATE OPTION

Sex of the provider?

Male [ ]   Female [ ]

14. Age in years?

Less than 25 Years [ ]   25 to 35 years [ ]

36 to 45 years [ ]   above 45 Years [ ]

15. Highest level of educational

AI certificate only [ ]   AHA & AI Certificate level [ ]

16. How many years have you provided AI services in Cattle?

Less than 5 Years [ ]   6 to 9 Years [ ]

1o to 19 Years [ ]   more than 20 Years [ ]

17. What is your mode of mobility?

Bicycle [ ]   Motor cycle owned [ ]

Motor cycle hired (Boda) [ ]   Vehicle [ ]

18. Employment status

Self-employed [ ]   Dairy Cooperative [ ]

County Government [ ]   Other...

19. Most Preferred type of semen by farmers

Imported [ ]   KAGRC [ ]   Sexed [ ]

Section Two: Artificial insemination provision

Please rate the level of satisfaction by choosing the most appropriate choices that best represent your view/opinion: 1. **Deplorable; 2. Poor; 3. Fair; 4. Good, and 5. Excellent**

		1	2	3	4	5
1	Responses to farmer call for insemination within the time					
2	Supply the farmer with the required breed type					
3	The conception rate is					

Please suggest two ways in which AI services can be improved:

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………….. …………………………………………………………….

Thank you

Appendix VII: Dairy cooperatives in the study site

The number of dairy farmers, AISP, and cattle in each the selected dairy cooperative at different agro-ecological zone. There is one VO in each AEZ total of 3

384 farmers

Agro-Ecological Zones	Sub-County	Ward	Dairy Co-operative	No. of AI providers	No. of Farmers	No. of Cattle	No. of farmers selected
Upper highland	Ainabkoi	Ainabkoi/ Olare	Ainabkoi FCS	1	2156	36942	88
		Tarakwa	Taragoon	2	1240	10022	51
Upper Midland 3 (UM3)	Soy	Kipsombe	Tarakwa	1	1588	8050	65
	Kapseret	Megun	Tuiyo	1	1673	6802	68
Lower highland (LH3 and LH4)	Moiben	Moiben	Moiben (New progressive)	1	2548	13710	104
	Soy	Ziwa	Sirikwa	2	1143	7095	47
Total				**8**	**10348**	**82621**	423

Appendix VIII: Summarized data collection table

ZONE	COW	X1	X2	X3	X4	X5	X6	X7	X8	Y
1	1	1	3	2	4	1	4	3	1	0
1	2	2	2	3	2	0	4	4	1	0
1	3	1	4	2	5	1	4	2	1	1
1	4	1	1	2	0	0	2	1	1	0
1	5	2	1	3	0	0	2	4	1	1
1	6	3	4	2.5	3	1	2	2	1	1
1	7	3	3	3	3	1	3	2	1	1
1	8	3	4	2	5	1	4	2	1	0
1	9	1	2	2	3	1	2	3	1	1
1	10	3	3	2.5	4	1	3	2	1	1
1	11	1	2	2	1	1	4	1	1	0
1	12	2	2	2.5	2	2	4	4	1	1
1	13	3	3	3	3	2	2	4	1	1
1	14	2	1	3	0	0	3	4	1	1
1	15	2	2	3	2	2	2	4	1	1
1	17	3	1	2	0	0	2	2	1	1
1	18	1	1	3	0	0	2	3	1	1
1	19	3	4	3	5	1	1	1	1	1
1	21	3	1	2	0	0	3	3	1	1
1	22	2	3	3	3	2	2	4	1	1
1	23	2	4	2.5	5	0	3	3	1	1
1	24	2	3	3	2	1	2	4	1	1
1	25	1	1	2	0	0	4	3	1	1
1	26	1	4	3	4	3	3	3	1	1
1	27	1	4	2.5	3	2	3	1	1	1
1	28	3	3	2.5	3	1	2	1	1	1
1	29	2	2	3	2	1	3	4	1	1
1	30	2	2	3	2	2	3	3	1	0
1	31	1	2	2.5	2	1	2	1	1	0
1	32	2	4	3	4	2	3	2	1	1
1	33	1	1	2.5	1	1	2	3	1	1

1	35	2	2	2	2	1	4	4	1	0
1	36	1	2	2	3	1	3	1	1	0
1	37	1	1	2	0	0	2	3	1	1
1	38	1	3	3	2	1	2	1	1	0
1	39	2	2	2	2	1	2	4	1	0
1	40	2	4	3	5	1	2	4	1	1
1	41	1	4	2	5	1	3	3	1	0
1	42	2	3	2	3	1	2	4	1	0
1	43	3	2	3	2	2	4	3	1	1
1	44	3	1	2.5	0	0	4	4	1	1
1	45	3	3	2.5	4	1	1	4	1	0
1	46	2	3	3	2	2	1	4	1	0
1	47	2	3	3	4	1	2	4	1	1
1	49	3	1	3	0	0	4	2	1	1
1	51	1	1	3	0	0	2	1	1	1
1	52	2	3	2	5	3	3	2	1	1
1	53	3	2	2	2	3	3	4	2	1
1	54	3	3	2	2	1	4	1	1	1
1	55	1	1	2	0	0	2	1	1	1
1	56	1	3	3	2	2	4	3	1	0
1	57	1	1	2	0	0	3	4	1	0
1	58	2	3	3	3	3	3	2	1	0
1	59	2	2	2.5	2	3	3	4	1	0
1	60	3	3	3	3	2	2	4	1	1
1	62	3	2	3	2	3	2	4	1	1
1	63	1	3	3	4	3	1	4	1	1
1	64	3	1	2	0	0	4	1	1	0
1	65	3	2	2	1	2	3	4	1	0
1	66	2	4	3	4	2	3	4	1	0
1	67	1	2	2	2	2	3	4	1	1
1	68	2	1	2	1	2	1	4	1	0
2	69	2	2	3	2	3	1	4	2	0
2	70	2	3	3	1	2	2	4	2	0
2	71	3	4	3	5	3	2	4	2	0

2	72	1	1	2.5	0	0	1	3	1	1
2	73	1	1	3	0	0	4	3	2	1
2	75	1	1	3	0	0	1	3	1	1
2	76	3	2	3	0	0	1	1	2	1
2	77	3	2	2	2	2	4	3	1	1
2	80	1	1	3	0	0	3	1	2	0
2	82	2	1	3	0	0	2	4	1	0
2	83	2	1	2.5	1	2	2	4	1	1
2	84	3	2	2	1	1	3	2	2	1
2	85	2	3	2	4	1	2	4	1	0
2	86	3	1	3	0	0	2	4	1	1
2	87	3	2	3	2	3	2	4	2	1
2	88	2	3	2.5	3	2	2	4	2	1
2	89	1	2	3	2	3	1	1	2	1
2	90	3	1	2.5	1	2	4	4	1	0
2	91	2	3	2.5	4	3	3	2	2	1
2	92	1	1	3	1	3	2	1	2	1
2	93	3	3	2.5	4	3	4	4	2	1
2	94	1	1	2.5	1	3	3	3	2	0
2	95	1	2	3	3	3	4	1	2	0
2	96	1	3	3	3	2	2	3	2	1
2	97	2	3	3	3	2	3	2	1	1
2	98	1	1	3	0	0	4	3	1	1
2	99	3	1	3	0	0	1	4	2	1
2	100	1	1	3	0	0	2	3	1	1
2	101	1	1	3	0	0	2	1	1	1
2	102	3	4	2	4	2	3	4	2	0
2	103	2	4	2.5	5	2	4	2	2	1
2	104	2	4	3	5	2	4	2	2	1
2	106	1	3	2.5	2	2	1	3	2	0
2	107	1	1	3	0	0	4	3	1	0
2	108	2	1	2.5	0	0	1	2	1	1
2	111	3	2	3	2	1	1	2	1	1
2	112	2	3	3	3	3	2	2	2	1

2	113	2	1	3	0	0	2	2	2	1
2	114	3	3	3	2	2	3	4	1	1
2	116	1	4	3	5	2	4	1	1	0
2	117	1	3	2.5	3	2	4	3	2	1
2	118	2	1	3	0	0	3	4	1	0
2	120	1	3	2	4	2	3	3	1	0
2	121	1	1	3	0	0	3	1	2	1
2	122	3	1	3	0	0	4	4	1	1
2	123	2	2	3	2	3	4	2	2	1
2	124	2	2	2.5	2	3	2	2	2	0
2	125	3	3	3	4	3	2	2	2	0
2	126	1	2	3	1	1	2	2	2	0
2	127	3	2	2.5	1	2	2	3	2	0
2	128	3	1	3	0	0	4	4	2	1
2	129	2	1	3	0	0	3	4	2	1
2	130	2	1	3	1	1	3	2	2	0
2	131	2	2	2.5	1	2	4	2	1	1
2	133	3	1	3	0	0	2	2	2	1
2	134	2	1	3	0	0	3	4	1	1
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2	136	2	3	2.5	3	2	4	4	1	1
2	137	1	1	2.5	0	0	4	3	1	0
2	138	1	1	3	0	0	4	3	1	0
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3	141	1	2	2.5	2	1	4	2	1	1
3	142	3	1	2.5	1	2	2	4	1	1
3	143	1	2	2	2	2	2	2	1	1
3	144	3	1	2.5	1	1	1	1	1	0
3	145	1	1	2	1	2	3	2	2	0
3	146	3	1	3	0	0	1	1	1	1
3	147	3	3	2	4	1	1	1	1	1
3	148	2	4	3	5	2	3	4	2	1
3	149	1	1	2	1	1	4	3	2	1

3	151	2	1	2	1	2	2	2	1	1
3	152	3	1	2	0	0	1	1	1	1
3	153	2	4	2.5	5	2	3	2	1	1
3	154	2	1	2	0	0	2	2	1	1
3	155	2	2	2.5	3	3	2	2	2	0
3	156	2	2	3	2	2	1	4	1	0
3	158	3	3	2	2	1	2	3	1	1
3	159	1	3	2	4	2	3	4	2	0
3	160	3	3	2	3	2	4	4	1	1
3	161	3	2	2	2	2	4	4	1	0
3	162	3	2	2	2	1	1	3	1	0
3	163	1	4	2	4	2	1	3	1	0
3	164	1	2	3	2	2	4	1	1	0
3	165	2	2	3	2	2	1	4	1	1
3	166	1	3	2.5	5	2	3	1	1	0
3	167	3	4	2.5	5	2	4	1	1	1
3	168	3	2	2.5	2	0	3	3	2	1
3	171	2	2	3	2	1	4	4	1	1
3	172	3	2	2.5	2	2	4	3	2	1
3	173	2	2	2.5	2	2	4	3	1	0
3	174	2	1	3	0	0	1	4	1	1
3	175	2	2	2.5	1	2	3	1	1	0
3	176	2	2	3	2	1	4	4	1	1
3	177	1	3	3	3	1	1	4	1	1
3	178	2	2	3	2	2	2	2	1	1
3	179	2	1	3	0	0	4	4	1	1
3	180	1	3	3	2	2	4	3	1	1
3	181	3	1	3	0	0	1	3	1	1
3	182	2	2	3	2	2	4	3	1	1
3	183	2	2	3	1	1	3	4	1	1
3	185	2	3	2.5	2	2	2	4	1	0
3	186	1	3	3	3	2	1	4	1	1
3	187	2	3	2	4	1	1	4	1	0
3	188	3	3	3	4	2	1	1	1	0

3	189	1	3	2.5	3	1	1	3	1	0
3	190	3	2	3	3	1	3	4	2	1
3	191	3	3	3	4	2	1	3	1	0
3	192	1	4	3	5	1	3	2	1	0
3	193	1	4	2.5	5	2	1	2	1	1
3	194	2	2	2.5	2	1	3	2	1	0
3	195	2	3	3	3	2	4	2	1	1
3	196	1	3	2.5	2	1	1	2	1	0
3	197	2	4	2	4	2	4	4	1	0
3	200	2	1	2	1	2	3	2	1	0
3	201	3	4	2.5	5	2	1	4	1	1
3	202	2	3	2.5	4	1	1	2	1	1
3	203	2	3	3	3	2	1	4	2	1
3	204	1	2	2	2	2	1	3	1	0
3	205	2	1	2	0	0	1	2	1	0
3	206	2	1	3	0	0	2	4	1	1
3	208	1	3	3	4	2	3	1	1	1
3	210	1	1	2.5	1	3	2	1	1	1
3	211	3	1	3	0	0	2	2	1	1
3	212	1	2	3	2	3	1	3	2	0
3	213	1	1	2.5	0	2	1	3	1	1
3	214	1	2	3	2	2	1	3	1	0
3	215	3	1	3	1	3	2	3	1	1
3	216	1	1	3	1	3	3	3	1	1

Key

Zone=AEZ:1=AEZ 1,2=AEZ2,3=AEZ3

Y = Conception status: 1= conceived 0= not conceived

X_1 =Breed: 1=Ayrshire, 2=Friesian, 3=Cross

X_2= Age group in years: 1=2-3, 2=4-5, 3=6-7, 4=>7

X_3= Body condition score: 2, 2.5, 3

X_4=Parity: 1, 2, 3, 4, 5=5-7

X_5=Milk yield group in kg: 0=dry, 1=1-5, 2=6-9, 3=>9

X_6= AI timing in hours from first heat signs: 1=1-7, 2=8-10, 3=11-18, 4=>19

X_7= Semen type: 1=Import Ayrshire, 2= Import Friesian, 3=KAGRC Ayrshire, 4= KAGRC Friesian

X_8= Farming System: 1= Semi-intensive, 2= Intensive

Y = Conception status: 1= conceived 0= not conceived

Appendix IX: T-Test groups=Breeds

```
T-TEST GROUPS=BREED ('A' 'C')
  /MISSING=ANALYSIS
  /VARIABLES=DAYSOPEN
  /CRITERIA=CI (.95).
```

T-Test

Notes

Output Created		16-APR-2021 16:46:33
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=BREED ('A' 'C') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.03
	Elapsed Time	00:00:00.05

[DataSet1]

Group Statistics

	BREED	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	A	38	264.16	183.658	29.793
	C	38	243.92	185.749	30.133

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	T	df
DAYS OPEN	Equal variances assumed	.230	.633	.478	74
	Equal variances not assumed			.478	73.991

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.634	20.237	42.375
	Equal variances not assumed	.634	20.237	42.375

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-64.196	104.670
	Equal variances not assumed	-64.197	104.670

```
T-TEST GROUPS=BREED('A' 'F')
 /MISSING=ANALYSIS
 /VARIABLES=DAYSOPEN
 /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		16-APR-2021 16:49:31
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=BREED('A' 'F') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

[DataSet1]

Group Statistics

	BREED	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	A	38	264.16	183.658	29.793
	F	41	259.85	175.795	27.455

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	T	df
DAYS OPEN	Equal variances assumed	.885	.350	.106	77
	Equal variances not assumed			.106	75.896

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.916	4.304	40.446
	Equal variances not assumed	.916	4.304	40.514

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-76.234	84.842
	Equal variances not assumed	-76.388	84.997

```
T-TEST GROUPS=BREED('C' 'F')
 /MISSING=ANALYSIS
 /VARIABLES=DAYSOPEN
 /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		16-APR-2021 16:50:49
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=BREED('C' 'F') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00

[DataSet1]

Group Statistics

	BREED	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	C	38	243.92	185.749	30.133
	F	41	259.85	175.795	27.455

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	T	df
DAYS OPEN	Equal variances assumed	.171	.680	-.392	77
	Equal variances not assumed			-.391	75.684

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.696	-15.933	40.678
	Equal variances not assumed	.697	-15.933	40.764

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-96.933	65.068
	Equal variances not assumed	-97.127	65.262

Appendix IX: T-Test groups=system

```
T-TEST GROUPS=FSYSTEM('SINT' 'INT')
 /MISSING=ANALYSIS
 /VARIABLES=DAYSOPEN
 /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		16-APR-2021 16:55:00
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=FSYSTEM('SINT' 'INT') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

[DataSet1]

Group Statistics

	FSYSTEM	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	SINT	82	259.77	181.184	20.008
	INT	28	227.39	177.472	33.539

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	T	df
DAYS OPEN	Equal variances assumed	.097	.756	.821	108
	Equal variances not assumed			.829	47.628

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.414	32.375	39.456
	Equal variances not assumed	.411	32.375	39.054

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-45.834	110.585
	Equal variances not assumed	-46.163	110.914

```
T-TEST GROUPS=FSYSTEM('SINT' 'EXT')
 /MISSING=ANALYSIS
 /VARIABLES=DAYSOPEN
 /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		16-APR-2021 16:56:35
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=FSYSTEM('SINT' 'EXT') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00

[DataSet1]

Group Statistics

	FSYSTEM	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	SINT	82	259.77	181.184	20.008
	EXT	7	327.57	182.612	69.021

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	.032	.858	-.950	87
	Equal variances not assumed			-.944	7.047

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.345	-67.803	71.383
	Equal variances not assumed	.377	-67.803	71.863

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-209.685	74.079
	Equal variances not assumed	-237.501	101.895

```
T-TEST GROUPS=FSYSTEM('INT' 'EXT')
 /MISSING=ANALYSIS
 /VARIABLES=DAYSOPEN
 /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		16-APR-2021 16:57:37
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=FSYSTEM('INT' 'EXT') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

[DataSet1]

Group Statistics

	FSYSTEM	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	INT	28	227.39	177.472	33.539
	EXT	7	327.57	182.612	69.021

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	.136	.715	-1.329	33
	Equal variances not assumed			-1.305	9.056

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.193	-100.179	75.395
	Equal variances not assumed	.224	-100.179	76.738

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-253.571	53.214
	Equal variances not assumed	-273.610	73.253

Appendix X: AI DATA ANALYSIS

AI DATA D5 ANALYSIS 16:19 Thursday, April 21, 2021 1

The LOGISTIC Procedure

Model Information

Data Set	SASUSER.D5
Response Variable	Y Y
Number of Response Levels	2
Model	binary logit
Optimization Technique	Fisher's scoring

Number of Observations Read	191
Number of Observations Used	191

Response Profile

Ordered Value	Y	Total Frequency
1	0	72
2	1	119

Probability modeled is Y='0'.

Stepwise Selection Procedure

Step 0. Intercept entered:

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

-2 Log L = 253.097

Residual Chi-Square Test

Chi-Square	DF	Pr > ChiSq
18.6248	8	0.0170

Step 1. Effect X3 entered:

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

AI DATA D5 ANALYSIS 16:19 Thursday, April 21, 2021 2

The LOGISTIC Procedure

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	255.097	248.279
SC	258.349	254.784
-2 Log L	253.097	244.279

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	8.8181	1	0.0030
Score	8.8565	1	0.0029
Wald	8.6136	1	0.0033

Residual Chi-Square Test

Chi-Square	DF	Pr > ChiSq
10.3311	7	0.1706

NOTE: No effects for the model in Step 1 are removed.

Step 2. Effect X1 entered:

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	255.097	244.320
SC	258.349	254.077
-2 Log L	253.097	238.320

AI DATA D5 ANALYSIS 16:19 Thursday, April 21, 2021 3

The LOGISTIC Procedure

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	14.7768	2	0.0006
Score	14.5287	2	0.0007
Wald	13.5974	2	0.0011

Residual Chi-Square Test

Chi-Square	DF	Pr > ChiSq
4.5744	6	0.5994

NOTE: No effects for the model in Step 2 are removed.

Step 3. Effect X5 entered:

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	255.097	242.345
SC	258.349	255.354
-2 Log L	253.097	234.345

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	18.7518	3	0.0003
Score	18.0188	3	0.0004
Wald	16.6061	3	0.0009

Residual Chi-Square Test

Chi-Square	DF	Pr > ChiSq
0.6568	5	0.9853

NOTE: No effects for the model in Step 3 are removed.

The LOGISTIC Procedure

NOTE: No (additional) effects met the 0.05 significance level for entry into the model.

Summary of Stepwise Selection

Step	Effect Entered	Removed	DF	Number In	Score Chi-Square	Wald Chi-Square	Pr > ChiSq	Variable Label
1	X3		1	1	8.8565		0.0029	X3
2	X1		1	2	5.8904		0.0152	X1
3	X5		1	3	3.9371		0.0472	X5

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	3.0154	1.0905	7.6464	0.0057
X1	1	-0.4848	0.2021	5.7533	0.0165
X3	1	-1.1637	0.3803	9.3646	0.0022
X5	1	0.3155	0.1604	3.8718	0.0491

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
X1	0.616	0.414	0.915
X3	0.312	0.148	0.658
X5	1.371	1.001	1.877

Association of Predicted Probabilities and Observed Responses

Percent Concordant	66.4	Somers' D	0.361
Percent Discordant	30.3	Gamma	0.373
Percent Tied	3.3	Tau-a	0.170
Pairs	8568	c	0.680

Appendix X: T Test-Zones

```
T-TEST GROUPS=ZONE(1 2)
 /MISSING=ANALYSIS
 /VARIABLES=DAYSOPEN
 /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		22-APR-2021 22:35:12
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	116
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=ZONE(1 2) /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00

[DataSet1]

Group Statistics

	ZONE	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	1	37	303.14	211.246	34.729
	2	29	280.69	183.876	34.145

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	.098	.756	.453	64
	Equal variances not assumed			.461	63.250

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.652	22.445	49.536
	Equal variances not assumed	.646	22.445	48.703

Independent Samples Test

		t-test for Equality of Means 95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-76.515	121.406
	Equal variances not assumed	-74.872	119.763

```
T-TEST GROUPS=ZONE(1 3)
  /MISSING=ANALYSIS
  /VARIABLES=DAYSOPEN
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		22-APR-2021 22:36:49
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	116
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=ZONE(1 3) /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

[DataSet1]

Group Statistics

	ZONE	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	1	37	303.14	211.246	34.729
	3	50	205.54	141.702	20.040

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	4.062	.047	2.578	85
	Equal variances not assumed			2.434	59.147

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.012	97.595	37.857
	Equal variances not assumed	.018	97.595	40.096

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	22.325	172.865
	Equal variances not assumed	17.368	177.822

```
T-TEST GROUPS=ZONE(2 3)
 /MISSING=ANALYSIS
 /VARIABLES=DAYSOPEN
 /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		22-APR-2021 22:37:56
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	116
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=ZONE(2 3) /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00

[DataSet1]

Group Statistics

	ZONE	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	2	29	280.69	183.876	34.145
	3	50	205.54	141.702	20.040

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	3.201	.078	2.033	77
	Equal variances not assumed			1.898	47.398

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.045	75.150	36.960
	Equal variances not assumed	.064	75.150	39.591

Independent Samples Test

		t-test for Equality of Means 95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	1.554	148.746
	Equal variances not assumed	-4.480	154.779

```
T-TEST GROUPS=BREED('A' 'F')
  /MISSING=ANALYSIS
  /VARIABLES=DAYSOPEN
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		22-APR-2021 22:38:35
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	116
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=BREED('A' 'F') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

[DataSet1]

Group Statistics

	BREED	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	A	38	264.16	183.658	29.793
	F	40	258.15	177.691	28.095

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	.774	.382	.147	76
	Equal variances not assumed			.147	75.455

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.884	6.008	40.916
	Equal variances not assumed	.884	6.008	40.951

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-75.483	87.499
	Equal variances not assumed	-75.563	87.579

```
T-TEST GROUPS=BREED('A' 'C')
  /MISSING=ANALYSIS
  /VARIABLES=DAYSOPEN
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		22-APR-2021 22:39:12
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	116
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=BREED('A' 'C') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

[DataSet1]

Group Statistics

	BREED	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	A	38	264.16	183.658	29.793
	C	38	243.92	185.749	30.133

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	.230	.633	.478	74
	Equal variances not assumed			.478	73.991

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.634	20.237	42.375
	Equal variances not assumed	.634	20.237	42.375

Independent Samples Test

		t-test for Equality of Means 95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-64.196	104.670
	Equal variances not assumed	-64.197	104.670

```
T-TEST GROUPS=BREED('F' 'C')
 /MISSING=ANALYSIS
 /VARIABLES=DAYSOPEN
 /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		22-APR-2021 22:40:00
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	116
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=BREED('F' 'C') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00

[DataSet1]

Group Statistics

	BREED	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	F	40	258.15	177.691	28.095
	C	38	243.92	185.749	30.133

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	.132	.717	.346	76
	Equal variances not assumed			.345	75.303

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.730	14.229	41.151
	Equal variances not assumed	.731	14.229	41.199

Independent Samples Test

		t-test for Equality of Means 95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-67.731	96.189
	Equal variances not assumed	-67.837	96.295

```
T-TEST GROUPS=FSYSTEM('SINT' 'INT')
  /MISSING=ANALYSIS
  /VARIABLES=DAYSOPEN
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		22-APR-2021 22:40:46
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	116
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=FSYSTEM('SINT' 'INT') /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

[DataSet1]

Group Statistics

	FSYSTEM	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	SINT	82	259.77	181.184	20.008
	INT	28	227.39	177.472	33.539

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	.097	.756	.821	108
	Equal variances not assumed			.829	47.628

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.414	32.375	39.456
	Equal variances not assumed	.411	32.375	39.054

Independent Samples Test

		t-test for Equality of Means 95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-45.834	110.585
	Equal variances not assumed	-46.163	110.914

```
T-TEST GROUPS=PD(0 1)
  /MISSING=ANALYSIS
  /VARIABLES=DAYSOPEN
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		22-APR-2021 22:41:26
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	116
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=PD(0 1) /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.03
	Elapsed Time	00:00:00.03

[DataSet1]

Group Statistics

	PD	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	0	51	279.45	194.217	27.196
	1	65	236.63	168.904	20.950

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	1.441	.232	1.269	114
	Equal variances not assumed			1.247	99.559

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.207	42.820	33.754
	Equal variances not assumed	.215	42.820	34.330

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-24.047	109.687
	Equal variances not assumed	-25.292	110.933

Appendix XII: Logistic Regression

```
GET DATA
  /TYPE=XLS
  /FILE='D:\DATA FILES\IMPRINT\DATA\Philip\AIdata.xls'
  /SHEET=name 'Sheet5'
  /CELLRANGE=full
  /READNAMES=on
  /ASSUMEDSTRWIDTH=32767.

Warning.  Command name: GET DATA
(2101) The column contained no recognized type; defaulting to "Numeric[8,2]"
* Column 12

Warning.  Command name: GET DATA
(2101) The column contained no recognized type; defaulting to "Numeric[8,2]"
* Column 13

Warning.  Command name: GET DATA
(2101) The column contained no recognized type; defaulting to "Numeric[8,2]"
* Column 14

Warning.  Command name: GET DATA
(2101) The column contained no recognized type; defaulting to "Numeric[8,2]"
* Column 15
EXECUTE.
DATASET NAME DataSet1 WINDOW=FRONT.

SAVE OUTFILE='D:\DATA FILES\IMPRINT\DATA\Philip\AIdataD5.sav'
  /COMPRESSED.
LOGISTIC REGRESSION VARIABLES Y
  /METHOD=FSTEP(LR) X1 X2 X3 X4 X5 X6 X7 X8
  /SAVE=PRED LRESID
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
```

Logistic Regression

Notes

Output Created		21-APR-2021 16:36:22
Comments		
Input	Data	D:\DATA FILES\IMPRINT\DATA\Philip\AIdataD5.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	191
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing
Syntax		LOGISTIC REGRESSION VARIABLES Y /METHOD=FSTEP(LR) X1 X2 X3 X4 X5 X6 X7 X8 /SAVE=PRED LRESID /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
Resources	Processor Time	00:00:00.06
	Elapsed Time	00:00:00.11
Variables Created or Modified	PRE_1	Predicted probability
	LRE_1	Logit residual

[DataSet1] D:\DATA FILES\IMPRINT\DATA\Philip\AIdataD5.sav

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	191	100.0
	Missing Cases	0	.0
	Total	191	100.0
Unselected Cases		0	.0
Total		191	100.0

a. If weight is in effect, see classification table for the total number of cases.

Dependent Variable Encoding

Original Value	Internal Value
0	0
1	1

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted		
			Y		Percentage Correct
			0	1	
Step 0	Y	0	0	72	.0
		1	0	119	100.0
	Overall Percentage				62.3

a. Constant is included in the model.
b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	.502	.149	11.325	1	.001	1.653

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	X1	5.707	1	.017
		X2	1.049	1	.306
		X3	8.857	1	.003
		X4	1.621	1	.203
		X5	3.310	1	.069
		X6	.064	1	.801
		X7	.132	1	.716
		X8	.010	1	.922
	Overall Statistics		18.625	8	.017

Block 1: Method = Forward Stepwise (Likelihood Ratio)

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	8.818	1	.003
	Block	8.818	1	.003
	Model	8.818	1	.003
Step 2	Step	5.959	1	.015
	Block	14.777	2	.001
	Model	14.777	2	.001
Step 3	Step	3.975	1	.046
	Block	18.752	3	.000
	Model	18.752	3	.000

Model Summary

Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	244.279[a]	.045	.061
2	238.320[a]	.074	.101
3	234.345[a]	.094	.127

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Classification Table[a]

Observed			Predicted		
			Y		Percentage Correct
			0	1	
Step 1	Y	0	26	46	36.1
		1	21	98	82.4
	Overall Percentage				64.9
Step 2	Y	0	27	45	37.5
		1	19	100	84.0
	Overall Percentage				66.5
Step 3	Y	0	25	47	34.7
		1	17	102	85.7
	Overall Percentage				66.5

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	X3	1.076	.367	8.615	1	.003	2.933
	Constant	-2.304	.962	5.734	1	.017	.100
Step 2[b]	X1	.480	.200	5.775	1	.016	1.615
	X3	1.107	.374	8.763	1	.003	3.024
	Constant	-3.305	1.077	9.424	1	.002	.037
Step 3[c]	X1	.485	.202	5.753	1	.016	1.624
	X3	1.164	.380	9.365	1	.002	3.202
	X5	-.316	.160	3.872	1	.049	.729
	Constant	-3.015	1.090	7.646	1	.006	.049

a. Variable(s) entered on step 1: X3.
b. Variable(s) entered on step 2: X1.
c. Variable(s) entered on step 3: X5.

Model if Term Removed

Variable		Model Log Likelihood	Change in -2 Log Likelihood	df	Sig. of the Change
Step 1	X3	-126.549	8.818	1	.003
Step 2	X1	-122.140	5.959	1	.015
	X3	-123.662	9.003	1	.003
Step 3	X1	-120.143	5.941	1	.015
	X3	-122.008	9.671	1	.002
	X5	-119.160	3.975	1	.046

Variables not in the Equation

			Score	df	Sig.
Step 1	Variables	X1	5.891	1	.015
		X2	.944	1	.331
		X4	1.118	1	.290
		X5	3.955	1	.047
		X6	.286	1	.593
		X7	.024	1	.877
		X8	.368	1	.544
	Overall Statistics		10.331	7	.171
Step 2	Variables	X2	1.237	1	.266
		X4	1.336	1	.248
		X5	3.937	1	.047
		X6	.334	1	.563
		X7	.071	1	.790
		X8	.499	1	.480
	Overall Statistics		4.574	6	.599
Step 3	Variables	X2	.103	1	.748
		X4	.031	1	.860
		X6	.385	1	.535
		X7	.036	1	.851
		X8	.028	1	.866
	Overall Statistics		.657	5	.985

```
LOGISTIC REGRESSION VARIABLES Y
 /METHOD=FSTEP(LR) X1 X2 X3 X4 X5 X6 X7 X8
 /SAVE=PRED LRESID
 /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
```

Logistic Regression

Notes

Output Created		21-APR-2021 16:45:09
Comments		
Input	Data	D:\DATA FILES\IMPRINT\DATA\Philip\AIdataD5.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	191
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing
Syntax		LOGISTIC REGRESSION VARIABLES Y /METHOD=FSTEP(LR) X1 X2 X3 X4 X5 X6 X7 X8 /SAVE=PRED LRESID /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
Resources	Processor Time	00:00:00.05
	Elapsed Time	00:00:00.05
Variables Created or Modified	PRE_2	Predicted probability
	LRE_2	Logit residual

[DataSet1] D:\DATA FILES\IMPRINT\DATA\Philip\AIdataD5.sav

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	191	100.0
	Missing Cases	0	.0
	Total	191	100.0
Unselected Cases		0	.0
Total		191	100.0

a. If weight is in effect, see classification table for the total number of cases.

Dependent Variable Encoding

Original Value	Internal Value
0	0
1	1

Block 0: Beginning Block

Classification Table[a,b]

Observed			Predicted		
			Y		Percentage Correct
			0	1	
Step 0	Y	0	0	72	.0
		1	0	119	100.0
	Overall Percentage				62.3

a. Constant is included in the model.
b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	.502	.149	11.325	1	.001	1.653

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	X1	5.707	1	.017
		X2	1.049	1	.306
		X3	8.857	1	.003
		X4	1.621	1	.203
		X5	3.310	1	.069
		X6	.064	1	.801
		X7	.132	1	.716
		X8	.010	1	.922
	Overall Statistics		18.625	8	.017

Block 1: Method = Forward Stepwise (Likelihood Ratio)

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	8.818	1	.003
	Block	8.818	1	.003
	Model	8.818	1	.003
Step 2	Step	5.959	1	.015
	Block	14.777	2	.001
	Model	14.777	2	.001
Step 3	Step	3.975	1	.046
	Block	18.752	3	.000
	Model	18.752	3	.000

Model Summary

Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	244.279[a]	.045	.061
2	238.320[a]	.074	.101
3	234.345[a]	.094	.127

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Classification Table[a]

Observed			Predicted Y 0	Predicted Y 1	Percentage Correct
Step 1	Y	0	26	46	36.1
		1	21	98	82.4
	Overall Percentage				64.9
Step 2	Y	0	27	45	37.5
		1	19	100	84.0
	Overall Percentage				66.5
Step 3	Y	0	25	47	34.7
		1	17	102	85.7
	Overall Percentage				66.5

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	X3	1.076	.367	8.615	1	.003	2.933
	Constant	-2.304	.962	5.734	1	.017	.100
Step 2[b]	X1	.480	.200	5.775	1	.016	1.615
	X3	1.107	.374	8.763	1	.003	3.024
	Constant	-3.305	1.077	9.424	1	.002	.037
Step 3[c]	X1	.485	.202	5.753	1	.016	1.624
	X3	1.164	.380	9.365	1	.002	3.202
	X5	-.316	.160	3.872	1	.049	.729
	Constant	-3.015	1.090	7.646	1	.006	.049

a. Variable(s) entered on step 1: X3.
b. Variable(s) entered on step 2: X1.
c. Variable(s) entered on step 3: X5.

Model if Term Removed

Variable		Model Log Likelihood	Change in -2 Log Likelihood	df	Sig. of the Change
Step 1	X3	-126.549	8.818	1	.003
Step 2	X1	-122.140	5.959	1	.015
	X3	-123.662	9.003	1	.003
Step 3	X1	-120.143	5.941	1	.015
	X3	-122.008	9.671	1	.002
	X5	-119.160	3.975	1	.046

Variables not in the Equation

			Score	df	Sig.
Step 1	Variables	X1	5.891	1	.015
		X2	.944	1	.331
		X4	1.118	1	.290
		X5	3.955	1	.047
		X6	.286	1	.593
		X7	.024	1	.877
		X8	.368	1	.544
	Overall Statistics		10.331	7	.171
Step 2	Variables	X2	1.237	1	.266
		X4	1.336	1	.248
		X5	3.937	1	.047
		X6	.334	1	.563
		X7	.071	1	.790
		X8	.499	1	.480
	Overall Statistics		4.574	6	.599
Step 3	Variables	X2	.103	1	.748
		X4	.031	1	.860
		X6	.385	1	.535
		X7	.036	1	.851
		X8	.028	1	.866
	Overall Statistics		.657	5	.985

Appendix XII: GET

```
  FILE='D:\DATA FILES\IMPRINT\DATA\Philip\AIdata.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
CROSSTABS
  /TABLES=Y BY X1 X4 X7 X8
  /FORMAT=AVALUE TABLES
  /STATISTICS=CHISQ
  /CELLS=COUNT ROW COLUMN
  /COUNT ROUND CELL
  /BARCHART
  /METHOD=EXACT TIMER(5).
```

Crosstabs

Notes

Output Created		16-APR-2021 14:36:07
Comments		
Input	Data	D:\DATA FILES\IMPRINT\DATA\Philip\AIdata.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	214
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each table are based on all the cases with valid data in the specified range(s) for all variables in each table.
Syntax		CROSSTABS /TABLES=Y BY X1 X4 X7 X8 /FORMAT=AVALUE TABLES /STATISTICS=CHISQ /CELLS=COUNT ROW COLUMN /COUNT ROUND CELL /BARCHART /METHOD=EXACT TIMER(5).
Resources	Processor Time	00:00:04.87
	Elapsed Time	00:00:03.51
	Dimensions Requested	2
	Cells Available	174762
	Time for Exact Statistics	0:00:00.81

[DataSet1] D:\DATA FILES\IMPRINT\DATA\Philip\AIdata.sav

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Y * X1	214	100.0%	0	0.0%	214	100.0%
Y * X4	214	100.0%	0	0.0%	214	100.0%
Y * X7	214	100.0%	0	0.0%	214	100.0%
Y * X8	214	100.0%	0	0.0%	214	100.0%

Y * X1

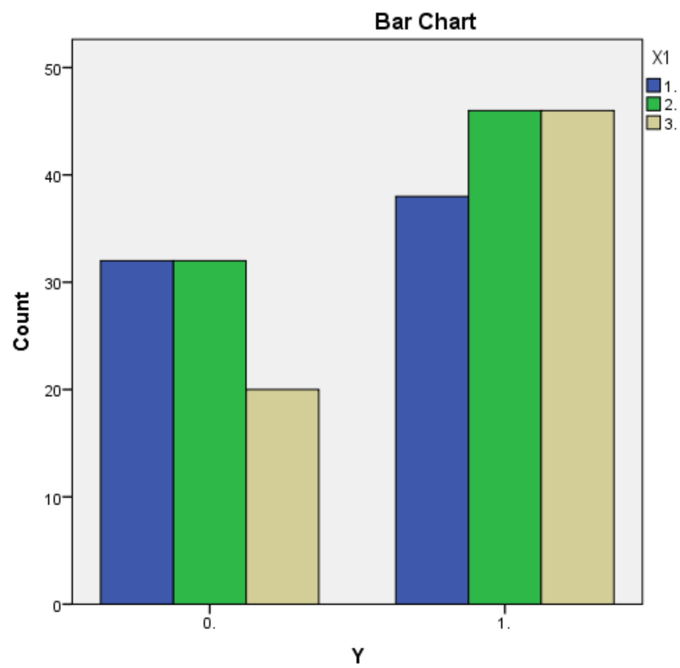
Crosstab

			X1			Total
			1.	2.	3.	
Y	0.	Count	32	32	20	84
		% within Y	38.1%	38.1%	23.8%	100.0%
		% within X1	45.7%	41.0%	30.3%	39.3%
	1.	Count	38	46	46	130
		% within Y	29.2%	35.4%	35.4%	100.0%
		% within X1	54.3%	59.0%	69.7%	60.7%
Total		Count	70	78	66	214
		% within Y	32.7%	36.4%	30.8%	100.0%
		% within X1	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	3.545[a]	2	.170	.172
Likelihood Ratio	3.601	2	.165	.172
Fisher's Exact Test	3.555			.172
N of Valid Cases	214			

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 25.91.



Y * X4

Crosstab

			X4					
			0.	1.	2.	3.	4.	5.
Y	0.	Count	15	14	28	8	13	3
		% within Y	17.9%	16.7%	33.3%	9.5%	15.5%	3.6%
		% within X4	27.8%	48.3%	47.5%	26.7%	54.2%	27.3%
	1.	Count	39	15	31	22	11	8
		% within Y	30.0%	11.5%	23.8%	16.9%	8.5%	6.2%
		% within X4	72.2%	51.7%	52.5%	73.3%	45.8%	72.7%
Total		Count	54	29	59	30	24	11
		% within Y	25.2%	13.6%	27.6%	14.0%	11.2%	5.1%
		% within X4	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

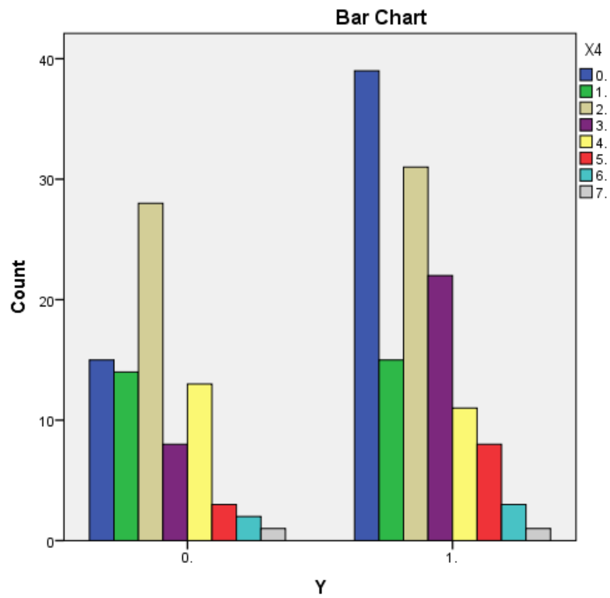
Crosstab

			X4		Total
			6.	7.	
Y	0.	Count	2	1	84
		% within Y	2.4%	1.2%	100.0%
		% within X4	40.0%	50.0%	39.3%
	1.	Count	3	1	130
		% within Y	2.3%	0.8%	100.0%
		% within X4	60.0%	50.0%	60.7%
Total		Count	5	2	214
		% within Y	2.3%	0.9%	100.0%
		% within X4	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	10.630[a]	7	.156	.148
Likelihood Ratio	10.791	7	.148	.191
Fisher's Exact Test	10.908			.122
N of Valid Cases	214			

a. 5 cells (31.2%) have expected count less than 5. The minimum expected count is .79.



Y * X7

Crosstab

			X7					
			1.	10.	2.	3.	4.	5.
Y	0.	Count	1	3	1	2	11	9
		% within Y	1.2%	3.6%	1.2%	2.4%	13.1%	10.7%
		% within X7	25.0%	50.0%	50.0%	100.0%	40.7%	23.1%
	1.	Count	3	3	1	0	16	30
		% within Y	2.3%	2.3%	0.8%	0.0%	12.3%	23.1%
		% within X7	75.0%	50.0%	50.0%	0.0%	59.3%	76.9%
Total		Count	4	6	2	2	27	39
		% within Y	1.9%	2.8%	0.9%	0.9%	12.6%	18.2%
		% within X7	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

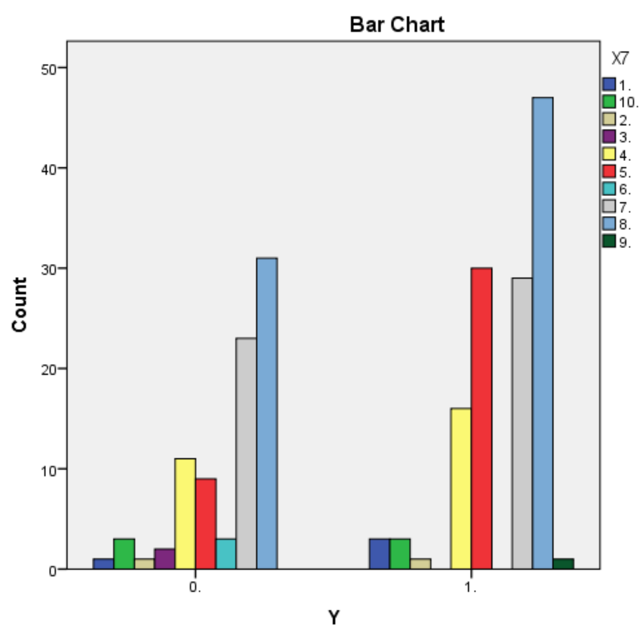
Crosstab

			X7				Total
			6.	7.	8.	9.	
Y	0.	Count	3	23	31	0	84
		% within Y	3.6%	27.4%	36.9%	0.0%	100.0%
		% within X7	100.0%	44.2%	39.7%	0.0%	39.3%
	1.	Count	0	29	47	1	130
		% within Y	0.0%	22.3%	36.2%	0.8%	100.0%
		% within X7	0.0%	55.8%	60.3%	100.0%	60.7%
Total		Count	3	52	78	1	214
		% within Y	1.4%	24.3%	36.4%	0.5%	100.0%
		% within X7	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	13.965[a]	9	.124	.095
Likelihood Ratio	16.259	9	.062	.105
Fisher's Exact Test	13.418			.088
N of Valid Cases	214			

a. 12 cells (60.0%) have expected count less than 5. The minimum expected count is .39.



Y * X8

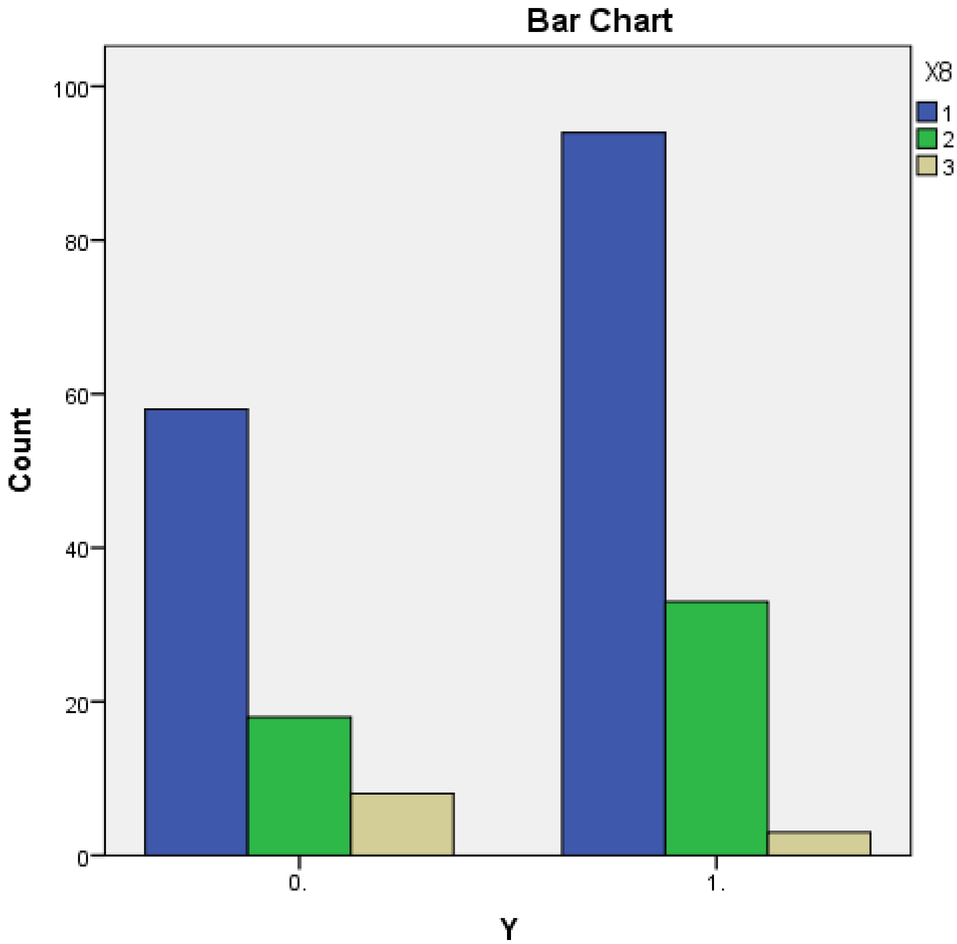
Crosstab

			X8			Total
			1.	2.	3.	
Y	0.	Count	58	18	8	84
		% within Y	69.0%	21.4%	9.5%	100.0%
		% within X8	38.2%	35.3%	72.7%	39.3%
	1.	Count	94	33	3	130
		% within Y	72.3%	25.4%	2.3%	100.0%
		% within X8	61.8%	64.7%	27.3%	60.7%
Total		Count	152	51	11	214
		% within Y	71.0%	23.8%	5.1%	100.0%
		% within X8	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	5.581[a]	2	.061	.059
Likelihood Ratio	5.478	2	.065	.081
Fisher's Exact Test	5.314			.069
N of Valid Cases	214			

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.32.


Bar Chart
X8
1.
2.
3.
Count
100
80
60
40
20
0
0.
1.
Y

Appendix XIII: T-TEST GROUPS=PD(0 1)

/MISSING=ANALYSIS
/VARIABLES=DAYSOPEN
/CRITERIA=CI(.95).

T-Test

Notes

Output Created		16-APR-2021 17:00:20
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=PD(0 1) /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00

[DataSet1]

Group Statistics

	PD	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	0	52	280.38	192.422	26.684
	1	65	236.63	168.904	20.950

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	1.250	.266	1.309	115
	Equal variances not assumed			1.290	102.282

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.193	43.754	33.436
	Equal variances not assumed	.200	43.754	33.926

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-22.477	109.984
	Equal variances not assumed	-23.535	111.043

```
T-TEST GROUPS=ZONE(2 1)
 /MISSING=ANALYSIS
 /VARIABLES=DAYSOPEN
 /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		16-APR-2021 17:02:37
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=ZONE(2 1) /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00

[DataSet1]

Group Statistics

	ZONE	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	2	30	282.27	180.884	33.025
	1	37	303.14	211.246	34.729

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	.188	.666	-.428	65
	Equal variances not assumed			-.435	64.784

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.670	-20.868	48.713
	Equal variances not assumed	.665	-20.868	47.924

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-118.155	76.418
	Equal variances not assumed	-116.586	74.849

```
T-TEST GROUPS=ZONE(3 1)
  /MISSING=ANALYSIS
  /VARIABLES=DAYSOPEN
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		16-APR-2021 17:03:23
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=ZONE(3 1) /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

[DataSet1]

Group Statistics

	ZONE	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	3	50	205.54	141.702	20.040
	1	37	303.14	211.246	34.729

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	4.062	.047	-2.578	85
	Equal variances not assumed			-2.434	59.147

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.012	-97.595	37.857
	Equal variances not assumed	.018	-97.595	40.096

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-172.865	-22.325
	Equal variances not assumed	-177.822	-17.368

```
T-TEST GROUPS=ZONE(3 2)
  /MISSING=ANALYSIS
  /VARIABLES=DAYSOPEN
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		16-APR-2021 17:04:18
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	117
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=ZONE(3 2) /MISSING=ANALYSIS /VARIABLES=DAYSOPEN /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.02

[DataSet1]

Group Statistics

	ZONE	N	Mean	Std. Deviation	Std. Error Mean
DAYS OPEN	3	50	205.54	141.702	20.040
	2	30	282.27	180.884	33.025

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
DAYS OPEN	Equal variances assumed	2.690	.105	-2.111	78
	Equal variances not assumed			-1.986	50.256

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
DAYS OPEN	Equal variances assumed	.038	-76.727	36.353
	Equal variances not assumed	.052	-76.727	38.629

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
DAYS OPEN	Equal variances assumed	-149.100	-4.354
	Equal variances not assumed	-154.306	.853

Appendix XIV: Similarity Report

DrillBit

The Report is Generated by DrillBit Plagiarism Detection Software

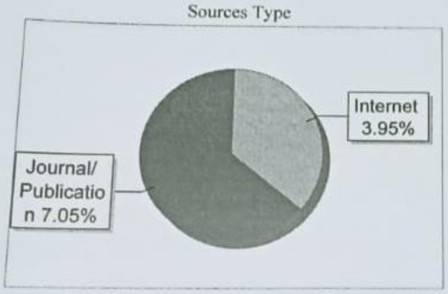
Submission Information

Author Name	Philip Kiplel Biamah
Title	FACTORS AFFECTING CONCEPTION RATES OF DAIRY CAT..
Paper/Submission ID	954042
Submission Date	2023-09-06 11:15:33
Total Pages	94
Document type	Thesis

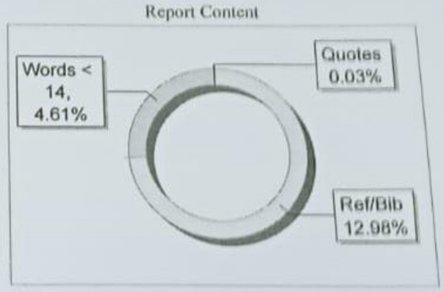
Result Information

Similarity **11 %**

Sources Type



Report Content



Exclude Information

Quotes	Excluded
References/Bibliography	Excluded
Sources: Less than 14 Words Similarity	Not Excluded
Excluded Source	**7 %**
Excluded Phrases	Not Excluded

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