

BINDURA UNIVERSITY OF SCIENCE EDUCATION
FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCES
DEPARTMENT OF ANIMAL SCIENCES



**A SOCIO-ECOLOGICAL READINESS ASSESSMENT FOR ARTIFICIAL
INSEMINATION ADOPTION IN MT DARWIN, ZIMBABWE.**

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***A research proposal submitted in partial fulfilment of the requirements of a Bachelor of
Science Honours in Animal Health and Production Extension Degree***

JUNE 2026

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DECLARATION

I hereby declare that the research project entitled “ A Socio-Ecological Readiness Assessment for Artificial Insemination Adoption in Mt Darwin, Zimbabwe” submitted in partial fulfillment of a Bachelor of Science Degree (Honours) in Animal Health and Production Extension submitted to Bindura University of Science Education, Department of Animal Science is a record of an original work done by me under the guidance and supervision of Dr Samakonde and this work is submitted in partial fulfilment of the requirements for the award of a Bachelor Science Degree (Honours)in Animal Health and Production Extension. The results embodied in this thesis have not been submitted to any University or Institute for the award of any degree or diploma.

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DEDICATION

“To my loving husband and children, your unwavering support and encouragement have been the driving force behind my academic journey. Your patience, understanding, and sacrifices have enabled me to pursue my degree while fulfilling my duties. I am forever grateful for your love and commitment. This achievement is not just mine, but ours, and I dedicate it to you all. Thank you for being my rock, my motivation, and my everything.”

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ABSTRACT

Livestock farming is key for food and income in rural communities in Zimbabwe, including Mt Darwin District. But smallholder farmers still get low production because of climate problems, animal diseases, and poor breeding methods. Artificial Insemination, AI, can improve cattle breeds and make herds more climate-resilient. However, AI use in communal areas is still very low, below 15%. This is because most AI programs focus only on technical and money issues, and ignore the social, environmental, and local rules that affect farming in these areas. In this study, a qualitative case study design was used to find out why AI adoption is low. Ostrom's Socio-Ecological Systems framework, Rogers' Innovation Diffusion Model, and the Economic Constraints idea was used. Data was collected through in-depth interviews with cattle farmers and key informants; focus group discussions and reviewed documents. All data was analyzed using Braun and Clarke's six-step thematic method in NVivo 14. Findings show that Mt Darwin has low to moderate readiness for AI. Socially, many farmers see AI as a threat to culture. Men make most decisions, so women's knowledge on heat detection is ignored. There is also wrong information that AI causes abortions or less milk. Environmentally, dry seasons mean little feed and water, many ticks and diseases, and heat stress. Open grazing makes heat detection and cow isolation hard. Institutionally, poor roads, unreliable liquid nitrogen supply, few local technicians, and no credit or subsidies make adoption hard. The study concluded that AI will not work if delivered alone without considering the local context, and recommend that the Department of Veterinary Field Services, AGRITEX, and partners combine AI with feed and water support in dry seasons, offer subsidized inputs, and use farmer groups to clear myths and empower women.

Keywords: Artificial Insemination, Socio-Ecological Systems, Technology Adoption, Smallholder Farmers, Mt Darwin

List of Acronyms and Abbreviations

ABBREVIATION	MEANING
AI	Artificial Insemination

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Livestock farming is a cornerstone of livelihoods for a significant majority of households in many communities across Zimbabwe, including the Mt Darwin District. This sector not only provides direct income through sales of animals and their products but also serves as a critical source of food security, social status, and a safety net against economic shocks (Munakandafa, 2022). However, farmers in this region face significant hurdles in maintaining optimal cattle health and, critically, reproductive efficiency. These challenges, which include pervasive animal diseases, nutritional deficiencies, and often suboptimal breeding practices, directly impact productivity, income, and overall household livelihoods (Mpofu, 2023).

Mt Darwin, like many parts of Zimbabwe, is highly vulnerable to its impacts of climate including increasingly frequent and severe droughts, unpredictable rainfall patterns, and rising temperatures (ZCFU, 2023). These climatic shifts lead to reduced availability of pasture and water, increased prevalence of climate-sensitive diseases, and exacerbated feed shortages, all of which critically undermine livestock health, productivity, and reproductive performance (Jamba, 2019). Farmers are struggling to adapt traditional practices to these new environmental realities, making the adoption of resilient and efficient livestock management strategies more imperative than ever.

In this challenging context, Artificial Insemination (AI) stands out as a key reproductive technology with substantial potential to overcome many of these limitations. AI offers numerous benefits, including the rapid dissemination of improved genetics from superior sires, enhanced disease control by reducing physical contact between animals, and overall improved herd

performance through selective breeding for traits like disease resistance, heat tolerance, and higher productivity (UNESCO, 2023). Despite its immense potential and increasing availability in certain regions, a noticeable gap often exists between the availability of AI technology and its widespread adoption by farmers in areas like Mt Darwin. This study aims to explore the factors influencing this adoption gap, considering the interwoven social, economic, and environmental contexts within which farmers operate.

1.2 Problem Statement

The socioecological readiness assessment for artificial insemination (AI) adoption in Mt Darwin, Zimbabwe, addresses a profound challenge. Despite AI's potential to revolutionize genetic improvement and climate resilience in communal livestock systems, adoption remains remarkably low, at less than 15 % (Zimbabwe Agricultural Extension Services, 2023). This uptake deficit stems from a disconnect between conventional AI delivery strategies and the unique socio-ecological context of communal farming, where communal tenure governance, gendered decision-making, indigenous knowledge, and climate vulnerabilities shape livestock management (FAO, 2022; Ncube and Tawodzera, 2019). Existing research focuses on technical or economic aspects of AI, neglecting an integrated socio-ecological framework specific to Zimbabwean communal settings. The study therefore seeks to fill this gap by diagnosing the interplay of social, ecological and institutional factors influencing AI adoption, developing a context-specific framework, collecting empirical data on farmers' willingness and capacity, and providing recommendations to align AI delivery with local socio-ecological realities, thereby

improving resource utilisation and reducing poverty among cattle-dependent households (Mudhumeni, 2022; Zimbabwe Climate Change Adaptation Report, 2024).

1.3 Research Aim

The aim of the study is to assess the Socio-ecological readiness for artificial insemination adoption by cattle farmers in Mt Darwin, Zimbabwe.

1.4 Objectives

This study seeks to:

- i. Identify key social factors influencing artificial insemination adoption among cattle farmers in Mt Darwin, Zimbabwe;
- ii. Examine ecological factors affecting artificial insemination adoption by cattle farmers in Mt Darwin, Zimbabwe
- iii. Investigate institutional factors impacting AI adoption by cattle farmers in Mt Darwin, Zimbabwe.
- iv. Analyze how these factors interact to influence AI adoption among cattle farmers in Mt Darwin.

1.5 Research Questions

- i. What are the key social factors that influence AI adoption among cattle farmers in Mt Darwin, Zimbabwe?
- ii. How do ecological conditions impact AI adoption among communal farmers in Mt Darwin, Zimbabwe?
- iii. How do institutional factors influence farmers' decisions to adopt AI technology?
- iv. How do social, ecological and institutional factors interact to influence farmers' decisions to adopt AI in Mt Darwin?

1.6 Justification of the Study

This study is justified on several critical fronts:

Addressing Low Livestock Productivity and Enhancing Livelihoods

Zimbabwe's livestock sector, particularly at the smallholder level, suffers from low genetic potential, leading to suboptimal yields in milk, meat, and draught power. By facilitating the strategic adoption of AI, this research directly contributes to efforts aimed at improving livestock productivity and resilience. This, in turn, promises enhanced household incomes, improved nutrition, and greater food security for communities in Mt. Darwin, aligning with national development goals for rural upliftment.

Bridging Knowledge Gaps in AI Adoption

While the technical aspects of AI are known, there's a significant gap in understanding the specific socioecological readiness of communities in regions like Mt. Darwin. Traditional studies

often generalize findings, but local nuances related to farmer perceptions, community trust, existing support systems, and environmental constraints are crucial for successful technology transfer. This research will provide granular insights into these factors, identifying not just if AI can be adopted, but how it can be adopted effectively and sustainably within this unique context.

Informing Context-Specific Intervention Strategies

A "one-size-fits-all" approach to agricultural development rarely succeeds. By conducting a detailed socioecological readiness assessment, this study will pinpoint the precise enablers and barriers to AI adoption in Mt. Darwin. The findings will directly inform the design of targeted, culturally sensitive, and environmentally appropriate intervention strategies.

Contributing to Sustainable Agricultural Development

Understanding the socioecological dimensions of AI adoption is vital for fostering sustainable agricultural development. The insights from this study can serve as a valuable case study for similar rural contexts in Zimbabwe and beyond, facing similar challenges in modernizing their livestock sectors.

In conclusion, by comprehensively assessing the socioecological landscape, this study will lay the groundwork for informed decision-making, effective policy formulation, and ultimately, a more productive and resilient livestock sector in the region.

1.7 Delimitations of the study

This study is limited to communal cattle farming areas in Mt Darwin, Zimbabwe excluding other districts or regions. The subject focus for the study is the socio-ecological factors affecting AI

adoption, not technical or veterinary aspects or AI itself. Methodologically, the research employs a socio-ecological readiness assessment, limiting the analysis to qualitative interviews excluding experimental or clinical trials. In terms of technology, the study examines readiness for AI adoption, excluding other livestock improvement technologies.

1.8 Definition of Terms

- **Socio-ecological readiness-** Refers to the interaction between human and environmental factors that influence behaviours, practices and systems in a community.
- **Readiness assessment-** Refers to a systematic evaluation of how prepared a community or system is to accept, implement, and sustain a new intervention.
- **Artificial Insemination (AI)-** A reproductive technology involving the deliberate introduction of sperm into a female's reproductive tract to achieve pregnancy.
- **Adoption-** Refers to the process of accepting and integrating a new technology or practice into existing social, economic, and environmental systems for regular use.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter reviews literature related to the study based on the study objectives. It conceptualises AI and discusses the social, ecological and institutional factors affecting AI adoption how they interact to influence farmers' decisions to adopt.

2.1 Conceptual analysis

This section analyses key conceptual issues for the study. These are technological adoption and artificial insemination

2.1.1 Technology adoption

Loevinsohn et al., 2013 define technology as the means and methods of producing goods and services, including methods of organization as well as physical technique. According to these authors new technology is new to a particular place or group of farmers, or represents a new use of technology that is already in use within a particular place or amongst a group of farmers. Technology is the knowledge/information that permits some tasks to be accomplished more easily, some service to be rendered or the manufacture of a product (Lavison 2013). Technology itself is aimed at improving a given situation or changing the status quo to a more desirable level. It assists the applicant to do work easier than he would have in the absence of the technology hence it helps save time and labor (Bonabana-Wabbi 2002). Adoption on the other hand is also defined in different ways by various authors. Loevinsohn et al., 2013 defines adoption as the integration of a new technology into existing practice and is usually preceded by a period of 'trying' and some degree of adaptation. Citing the work of Feder, Just and

Zilberman (1985), Bonabana-Wabbi defines adoption as a mental process an individual passes from first hearing about an innovation to final utilization of it. Adoption is in two categories; rate of adoption and intensity of adoption. The former is the relative speed with which farmers adopt an innovation, has as one of its pillars, the element of ‘time’. On the other hand, intensity of adoption refers to the level of use of a given technology in any time period (Bonabana-Wabbi 2002). This study adopts the two definitions.

2.1.2 Artificial Insemination (AI) in Livestock Production

Artificial insemination (AI) is a process by which sperm are collected from the male, processed, stored and artificially introduced into the female reproductive tract for the purpose of conception (Webb, 2003; Temesgen et al., 2017). The first commercial AI cooperative was established in 1936 by a Dane, Sorenson (Foote, 2002). Before the Second World War, most cows in Europe and North America were fertilized by means of natural service. However, since several cows on different farms were mated by the same bull, the spread of genital diseases with decreased fertility outcomes was a constant threat. Moreover, keeping herd bulls was expensive and represented potential danger for the herd manager (Vishwanath, 2003). Apart from these facts, the limited number of offspring produced per bull after natural mating made it impossible to set up effective progeny testing schemes and resulted in a very poor genetic gain. The introduction of AI in cattle was mainly forced by sanitary reasons, and especially by fertility problems caused by *Campylobacter foetus* subspecies *venerealis* (vibriosis) and *Trichomonas foetus*. However, also the control and prevention of non-sexually transmitted diseases such as tuberculosis, brucellosis and paratuberculosis at the farms benefited from the introduction of AI (Thibier and Guerin, 2000).

Artificial insemination has become one of the most important techniques ever devised for the genetic improvement of farm animals. It has been widely used for breeding dairy cattle as the most valuable management practice available to the cattle producer and has made bulls of high genetic merit available to all (Webb, 2003; Bearden et al., 2004; Temesgen et al., 2017). In livestock rearing, the producer makes efficient use of the generous supply of sperm available from an individual male in a manner that greatly increases genetic progress, as well as improving reproductive efficiency in many situations. By 2004, many bulls have been reported to produce sufficient semen to provide enough sperm for 40,000 breeding units in one year (Bearden et al., 2004).

Productive advantage of AI

The widespread application of AI in countries such as the USA has resulted in a steady improvement in the genetic quality of dairy animals and a doubling of milk yields during the past 30 years. In countries such as India, state governments were able to support crossbreeding programmes with the semen of exotic breeds like Holstein–Friesian, Brown Swiss and Jersey (Gordon, 2004). Selection for increased yield Improved animal production, largely as a result of genetic selection, was one of the greatest achievements of the last century (Broom, 2014). In many countries yield per cow has more than doubled in the last 40 years because of AI. The average energy corrected milk (ECM) yield for Swedish dairy cows increased from 4,200 to 9,000 kg between 1957 and 2003 (Oltenacu and Algers, 2005). Changes in dairy cows in Austria from 1988 to 2007 show that, the mean yield per lactation in Holsteins increased from 5,500 to 8,200 kg and in Simmentals from 4,500 to 6,600 kg (Knaus, 2009). Data from National Milk Records in the UK show an increase in average yields of dairy cows of about 200 kg per year

from 1996 to 2002 and 50% of the progress in milk yield is attributed to genetics (Pryce and Veerkamp, 2001).

Economic advantage of AI

Some economic advantage of AI over natural service Improved reproductive performance; A natural service bull's fertility, ability to detect cows in heat, and servicing capacity can vary greatly depending on the environment and season (Fricke, Paul, 1997). A.I. works to eliminate that variability and get cows pregnant, on average, 3-5% faster than natural service bulls, regardless of the environment or season. A 1% increase in pregnancy rate results in approximately \$35 per cow per year. With improved reproductive performance, A.I. can increase profit, on average, \$105-\$175 per cow per year for a dairy (Chatikobo, 2009).

Genetic advantage of AI

AI plays an important role in enhancing animal productivity, especially milk yields, in developing countries that have a well-defined breeding strategy and a sound technical base to absorb and adapt the technology to meet their needs (BBC, 2015). Daughters of AI sires produce significantly more milk than those of herd bulls' sires and the income from this extra milk may cover the extra costs resulting from extended calving intervals because of low heat detection. A study indicated that daughters of AI sires were producing almost 900 kg of extra milk per lactation than daughters of natural service bulls (Valergakis et al, 2007). Another report from USA showed a difference of more than 1000 kg of milk per lactation on farms using AI (Smith et al., 2005; Temesgen et al., 2017). This means that farming using AI can be more profitable apart from covering the extra costs even with calving interval of 13.5-14 months (Valergakis et al, 2007).

Another of the major advantages of artificial insemination is the elimination of the costs and dangers of maintaining a bull on the farm. The use of AI is the cumulative beneficial effects on dairy cows because of the opportunity of choosing sires that are proven to transmit superior genetic traits. The risk of spreading sexually transmitted diseases or genetic defects is also decreased when AI is practiced on a dairy farm. Natural mating allows transmission of venereally transmitting diseases like brucellosis, listeriosis, leptospirosis, trichomoniasis etc between males and females (IAEA, 2005). Some pathogens can be transmitted in semen through artificial insemination, but the collection process allows for the screening of disease agents. The progeny testing can be done at an early age. The semen of a desired sire can be used even after the death of that particular sire. The semen collected can be taken to the urban areas or rural areas for insemination. It makes possible the mating of animals with great differences in size without injury to either of the animal. It is helpful to inseminate the animals that are refusing to stand or accept the male at the time of estrus. It helps in maintaining the accurate breeding and calving records and increases the conception rate. It helps in better record keeping. Old, heavy and injured sires can be used (Johnson, 2011). Collected semen is also routinely checked for quality, which can help avoid problems associated with male infertility (Chatikobo, 2009).

2.3 Theoretical Framework

This study is premised on the Socio-Ecological Systems framework and the Agriculture Technology Adoption Theory.

2.3.1 Ostrom's Socio-Ecological Systems (SES) framework.

Ostrom's Socio-Ecological Systems (SES) framework is a comprehensive and interdisciplinary framework that explains the complex interaction and interdependency that exist between human

society and ecological systems (Motalleb et al 2016). According to the SES framework human society and the ecosystems (environment) form a single complex and adaptive system with feedback mechanisms or loops (Katengeza et al 2015). This means human society is constantly interacting with and responding to changes within their immediate environment. It has been noted through the SES theory that the system formed from human society and their environment is dynamic and constantly adapting to various changes from local to global scale Di Falco (2018). Thus, the SES theory has been widely used to examine the sustainability of human-ecosystem interactions in terms of its resilience and adaptive capacity. Choices made by humans within the social systems modify the outcomes from interaction with dynamic natural processes in the ecological system (Rapsomanikis, 2015).]. Thus, the social-ecological systems (SES) theory provides valuable insights into understanding human choices in the form of agricultural practices within broader contexts and in response to stress and changes within the ecological system.

According to Yletyinen et al. (2020), resilient agricultural practices are a product of the interaction between humans and the environment with a focus on balancing food production, management of natural and environmental resources, livelihoods, and uncertainties in SES. The extent and capacity to respond or adapt to changes in the ecological system will depend on factors internal to the SES such as individual demographics, ecological identity, acquired traditional/indigenous knowledge and access to scientific information and experts (Marenja and Barret 2007).

Ecological identity is different environmental thoughts, worldviews and how people see themselves in relation to nature (Thomashow 2018). Ecological identity is manifested in the attitude of a person towards nature-related issues and consequently is associated with behaviour and interaction between social system and element of ecological systems. Likewise, traditional

knowledge and access to scientific information create awareness, promote and aid the transition to behaviour and practices that promote ecological integrity and sustain balance in the socioecological system (Fisher et al 2015). Sociodemographic factors such as gender, age, education and landownership predisposed small holder farmers to varying adaptive behavior and response to ecological stress and climate change (Moser and Barret, 2006)

As Nagel & Partelow (2018) have observed, there have been no standards constructs and measures for the empirical application of the SES theory. While there is a uniform set of concepts within the SES framework, there is heterogeneity in the variables used. In this study, a pragmatic approach is adopted to specify the factors from the SES framework for the adoption of Artificial Insemination among small holder farmers in Mt Darwin.

2.3.2 Agricultural Technology Adoption

This study also adopts agricultural technology adoption theory, a multi-disciplinary field that combines elements of decision theory and diffusion of innovations theory in an attempt to explain why some farmers adopt new technologies and others do not. This literature falls into three paradigms: the innovation-diffusion paradigm; the economic constraints paradigm; and the adopter-perception paradigm (Adesina and Zinnah, 1993, Prager and Posthumus, 2010). Each paradigm emphasizes the role of different factors on adoption rates and patterns.

Innovation-diffusion paradigm

The innovation-diffusion paradigm assumes that information is the critical parameter that controls the spread of an innovation through a society. This paradigm follows from the pioneering work of Ryan and Gross (1943), then Rogers (2003). This field focuses on the characteristics of innovations, and how they impact rates of diffusion. Societies are assumed to

be composed of a range ‘adopter categories’, from innovators and early adopters to laggards, which differ on measurable socioeconomic, personality, and communication attributes (Rogers, 2003). Innovation-diffusion theory has been criticized for assuming that innovations will be appropriate (Adesina and Zinnah, 1993, Negatu and Parikh, 1999), which Rogers (2003) refers to as ‘pro-innovation bias’.

Economic constraints paradigm

The economic constraints paradigm postulates that farmers aim to maximize utility, and that uneven resource endowments lead to observed patterns of adoption (Adesina and Zinnah, 1993, Negatu and Parikh, 1999). In comparison to the innovation-diffusion paradigm, the economic constraints model emphasizes the role of economic factors at the individual level in determining adoption decisions. However, this model allows for only strictly rational and informed behaviour and fails to capture the effects of cultural and individual perceptions of an innovation.

The adopter-perception paradigm allows for a level of subjectivity by contending that it is the perceived need to innovate and the perceived attributes of innovations that determine adoption behaviour (Kivlin and Fliegel, 1967, Adesina and Zinnah, 1993). Characteristics of an innovation and its delivery combine with cultural, contextual, and individual factors to influence perception (Adesina and Zinnah, 1993, Prager and Posthumus, 2010).

Meijer, Catacutan, Ajayi, Sileshi, and Nieuwenhuis (2015) present an analytical model of decision making that includes the intrinsic factors of knowledge, perceptions, and attitudes, which are conditioned by extrinsic factors, such as characteristics of the farmer, the external environment, and the innovation. Within the adopter-perception paradigm, farmers may still be considered rational actors who maximize utility; however, in contrast to the economic

constraints' paradigm, the definition of utility is expanded beyond simple financial considerations.

The influence of many factors on adoption can be explained by any of the three paradigms. For example, the innovation-diffusion paradigm holds that earlier adopters tend to have larger farms than later adopters. However, this paradigm does not distinguish whether early adoption of innovations is the cause or result of increased wealth and resources (Rogers, 2003). The economic constraints paradigm might argue that larger farms are better able to exploit economies of scale required to make adoption of an innovation profitable. The adopter-perception paradigm would reason land size correlates with the perceived need to innovate, as well as with positive perception of the innovation. Many empirical adoption studies construct econometric models which combine variables derived from all three paradigms (Adesina and Zinnah, 1993, Negatu and Parikh, 1999, Ntshangase et al., 2018). In this study, adoption theories are used to interpret the factors that explain smallholder farmers adoption outcomes and readiness for AI.

2.4 Socio-Ecological Factors Influencing Technology Adoption in Agriculture

This section reviews literature on the socio-ecological factors influencing Technology Adoption in Agriculture. Factors presented in this section touch on agriculture in general and also specific subsectors of agriculture such as crops, dairy, fisheries and of course livestock and the different technologies in agriculture AI included.

2.4.1 Institutional factors

Studies found that belonging to a social group enhances social capital allowing trust, idea and information exchange (Mignouna et al., 2011). Farmers within a social group learn from each other the benefits and usage of a new technology. Uaiene et al. (2009) suggests that social network effects are important for individual decisions, and that, in the particular context of agricultural innovations, farmers share information and learn from each other. Studying the effect of community-based organization in adoption of corm-paired banana technology in Uganda, Katungi and Akankwasa (2010) found that farmers who participated more in community-based organizations were likely to engage in social learning about the technology hence raising their likelihood to adopt the technologies.

Although many researchers have reported a positive influence of social group on technology adoption, social groups may also have a negative impact on technology adoption especially where free-riding behavior exists. Foster and Rosenzweig (1995) when studying adoption of Green Revolution technologies in India found that learning externalities within social networks increased the profitability of adoption, but also farmers appeared to be free-riding on their neighbors' costly experimentation with the new technology. Bandiera and Rasul (2002) as cited by Hogset (2005) suggests that, learning externalities generate opposite effects, such that the more other people engage in experimentation with a new technology, the more beneficial it is to join in, but also the more beneficial it is to free-ride on the experimentation of others. As a result of these contradictory effects, Bandiera and Rasul (2002) propose an inverted U-shaped individual adoption curve, implying that network effects are positive at low rates of adoption, but negative at high rates of adoption.

Government policies and support

Government policies and support for cattle AI play an important role in enhancing livestock productivity, improving herd genetics, and ensuring the sustainability of the dairy and beef industries. Many breeding programmes have been implemented in developing countries but the majority of them have been unsuccessful. The failures are largely attributed by lack of government support for Research and Development (R&D) initiatives focused on improving AI technology, including advances in genetics and (Arslan, Belotti, and Lipper. 2017)

Regarding the infrastructure development, governments, investors or Non-Governmental Organizations (NGOs) should also invest in infrastructure such as AI centres, semen storage facilities, and diagnostic laboratories (Baumgart-Getz, Stalker, and Floress (2017). Infrastructure development should equally support for the logistics of transporting and storing semen, including refrigerated transport systems. In any efficient AI program, there ought to be some activities that will promote the benefits of AI to farmers and encourage adoption while improving possibilities for the export of high-quality semen and AI technology within and outside markets.

Acquisition of information

Acquisition of information about a new technology is another factor that determines adoption of technology. Access to information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time (Caswell et al., 2001; Bonabana- Wabbi 2002). However, access to information about a technology does not necessarily mean it will be adopted by all farmers. This simply implies that farmers may perceive the technology and subjectively evaluate it differently than scientists (Uaiene et al., 2009). Access to information may also result to dis-adoption of the technology. For instance, where experience within the general population about a specific technology is

limited, more information induces negative attitudes towards its adoption, probably because more information exposes an even bigger information vacuum hence increasing the risk associated with it (Bonabana- Wabbi 2002). It is therefore important to ensure the information is reliable, consistent and accurate. Farmers need to know the existence of technology, its beneficial, and its usage for them to adopt it.

Access to extension services

Access to extension services has also been found to be a key aspect in technology adoption. Farmers are usually informed about the existence as well as the effective use and benefit of new technology through extension agents. Extension agent acts as a link between the innovators (Researchers) of the technology and users of that technology. This helps to reduce transaction cost incurred when passing the information on the new technology to a large heterogeneous population of farmers (Genius et al., 2020). Extension agents usually target specific farmers who are recognized as peers (farmers with whom a particular farmer interacts) exerting a direct or indirect influence on the whole population of farmers in their respective areas (Genius et al., 2020).

Many authors have reported a positive relationship between extension services and technology adoption. A good example include; Adoption of Imazapyr-Resistant Maize Technologies (IRM) by Mignouna et al. (2011); Factors determining technology adoption among Nepalese Karki and Siegfried (2004); Uaiene et al., 2009; adoption of improved maize and land management in Uganda by Sserunkuuma (2005); adoption of modern agricultural technologies in Ghana Akudugu et al. (2012) just to mention a few. This is because exposing farmers to information based upon innovation-diffusion theory is expected to stimulate adoption (Uaiene et al., 2009).

The influence of extension agents can counter balance the negative effect of lack of years of formal education in the overall decision to adopt some technologies (Yaron, Dinar and Voet, (1992); Bonabana- Wabbi 2002).

Access to credit

Access to credit has been reported to stimulate technology adoption (Mohamed and Temu, 2018). It is believed that access to credit promotes the adoption of risky technologies through relaxation of the liquidity constraint as well as through the boosting of household's-risk bearing ability (Simtowe and Zeller, 2016). This is because with an option of borrowing, a household can do away with risk reducing but inefficient income diversification strategies and concentrate on more risky but efficient investments (Simtowe and Zeller, 2016). However, access to credit has been found to be gender biased in some countries where female-headed households are discriminated against by credit institutions, and as such they are unable to finance yield-raising technologies, leading to low adoption rates (Muzari et al., 2013). There is therefore need for policy makers to improve current smallholder credit systems to ensure that a wider spectrum of smallholders is able to have access to credit, more especially female-headed households (Mkandawire, 1993; Simtowe & Zeller, 2006). This may, in certain cases, necessitate designing credit packages that are tailored to meet the needs of specific target groups (Muzari et al., 2013). For instance, in Kenya, the government has started a program that offer free interest loans to youths and women (UWEZO fund). This will help empower women and enable them to adopt agricultural technologies hence enhancing economic growth.

2.4.2 Household-specific factors

Human capital

Human capital of the farmer is assumed to have a significant influence on farmers' decision to adopt new technologies. Most adoption studies have attempted to measure human capital through the farmer's Education, age, Gender, and household size (Fernandez-Cornejo & Daberkow, 2004; Fernandez-Cornejo et al., 2007; Mignouna et al, 2011; Keelan et al., 2018). Education of the farmer has been assumed to have a positive influence on farmers' decision to adopt new technology. Education level of a farmer increases his ability to obtain; process and use information relevant to adoption of a new technology (Namara et al., 2018). A study by Okunlola et al. (2021) on adoption of new technologies by fish farmers found that the level of education had a positive and significant influence on adoption of the technology. This is because higher education influences respondents' attitudes and thoughts making them more open, rational and able to analyse the benefits of the new technology (Waller et al., 2018). On the other hand, some authors have reported insignificant or negative effect of education on the rate of technology adoption (Samiee et al., 2019; Ishak and Afrizon, 2021). Studying the effect of education on technology adoption, Uematsu and Mishra (2010) reported a negative influence of formal education towards adopting genetically modified crops. Since the above empirical evidence have shown mixed results on the influence of education and adoption of new technology, more study needs to be done in order to come up with a more consistent result.

Age

Age is also assumed to be a determinant of adoption of new technology. Older farmers are assumed to have gained knowledge and experience over time and are better able to evaluate technology information than younger farmers (Mignouna et al, 2011; Kariyasa and Dewi 2021).

On contrary age has been found to have a negative relationship with adoption of technology. This relationship is explained by Mauceri et al. (2015) and Adesina and Zinnah (2013) that as farmers grow older, there is an increase in risk aversion and a decreased interest in long-term investment in the farm. Conversely younger farmers are typically less risk-averse and are more willing to try new technologies. For instance, Alexander and Van Mellor (2015) found that adoption of genetically modified maize increased with age for younger farmers as they gain experience and increase their stock of human capital but declines with age for those farmers closer to retirement.

Gender

Gender issues in agricultural technology adoption have been investigated for a long time and most studies have reported mixed evidence regarding the different roles men and women play in technology adoption (Bonabana- Wabbi 2022). In analysing the impact of gender on technology adoption, Morris and Doss (2019) had found no significant association between gender and probability to adopt improved maize in Ghana. They concluded that technology adoption decisions depend primarily on access to resources, rather than on gender and if adoption of improved maize depends on access to land, labour, or other resources, and if in a particular context men tend to have better access to these resources than women, then in that context the technologies will not benefit men and women equally. On the other hand gender may have a significant influence on some technologies. Gender affects technology adoption since the head of the household is the primary decision maker and men have more access to and control over vital production resources than women due to socio-cultural values and norms (Mesfin, 2005). According to Lavison (2018) male farmers are more likely to adopt organic fertilizer unlike their female counterparts.

Infrastructure and accessibility

Infrastructure and accessibility are major for the successful implementation of cattle artificial insemination since proper facilities and resources help ensure efficient AI procedures, maintain cattle health, and maximize the success rates of insemination. Tanzania, like many other developing countries in Africa, is constrained by having limited facilities and equipments needed for an efficient operationalization of Artificial Insemination (AI) (Ali et al 2018). In a study conducted by Mugwabani (2023) in South Africa, it was clearly indicated that low-income farmers were still struggling to access inputs and services to drive their animals' productivity. Since effective artificial insemination requires reliable transportation to move semen and equipment, in remote or rural areas with poor road networks, this can be a major hurdle leading to delays and reduced effectiveness of the AI process. In a recent study conducted to assess the quality of cryopreserved dairy bulls' semen in Tanzania, it was observed that among the contributing factors to low semen parameters was the leakage of storage and transportation containers and the delay of refilling of liquid nitrogen. Related to infrastructure is the power supply which is more often not reliable, making it difficult to maintain the necessary low temperature needed for quality of semen.

2.5 Summary

This chapter discussed literature related to this study. The next chapter presents the methodology.

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter describes the methodology employed in collecting and analyzing data. It explains the methodology, the study area, the sample and sampling procedure, data collection instruments and how data was analyzed.

3.1 Research Design

This study was a qualitative, descriptive case study design framed by the Socio-Ecological Model (SEM). This was done to understand the complex social norms, cultural beliefs, institutional practices, and ecological realities that require in-depth exploration of meaning, context, and lived experience that shape AI adoption.

3.2 Study Area

The research was conducted in Mt Darwin District, Mashonaland Central Province, Zimbabwe. Wards were purposively selected to reflect diversity in agro-ecological zones, cattle management systems, and prior exposure to AI programs. This ensures variation in social and ecological contexts relevant to AI readiness.

3.3 Study Participants & Sampling Strategy

Purposive and snowball sampling methods were employed to select information-rich participants. 25 farmers that had at least five years of experience in cattle production, and or had tried AI breeding were snowball and purposively sampled. Five key informants from the DVS and

AGRITEX were purposively sampled because of their expertise and experience. Sampling continued until data saturation was reached and no new themes emerge.

3.4 Data Collection Methods

This study employed various data collection methods: in-depth interviews, key informant interviews, focus group discussions, participant observation and document review.

3.4.1 In-Depth Interviews (IDIs)

Semi-structured guides explored individual experiences, perceived benefits/risks of AI, cultural taboos around animal reproduction, and gender roles in breeding decisions. Interviews with farmers were conducted at homesteads in Shona.

3.4.2 Key Informant Interviews (KIIs)

Key Informant Interviews were conducted with vet officers, extension staff, and policymakers. This focus for KIIs was institutional readiness, liquid nitrogen supply chains, training gaps, policy-enabling environment, and historical challenges with AI programs in Mt Darwin.

3.4.3 Focus Group Discussions (FGDs)

Separate male and female farmer groups created to capture gendered norms and allow free discussion of sensitive topics. Topics discussed included community attitudes toward AI calves, trust in technicians, influence of traditional leaders, ecological issues like heat stress and water.

3.4.4 Observation

The researcher attended dip tank days, farmer field schools, and AI service delivery. Field notes documented crush pen conditions, farmer-technician interactions, and informal discussions on breeding.

3.4.5 Document Review

District Veterinary Services reports, AGRITEX annual plans, NGO project documents, and Zimbabwe's Livestock Growth Plan were reviewed to understand the policy and organizational context.

3.5 Data Analysis

All IDIs, KIIs, and FGDs were audio-recorded with consent, transcribed verbatim, and translated to English where needed. Data were analyzed following Braun & Clarke's 6-step thematic analysis approach. Transcripts were coded in NVivo 14 and manually. Deductive coding mapped themes to the five SEM levels. Inductive coding allowed new themes to emerge from the data. Triangulation across IDIs, FGDs, observations, and documents was used to enhance credibility. Findings were organized using the Community Readiness Model's 9 stages to assign an overall readiness stage for Mt Darwin, supported by narrative evidence.

3.6 Trustworthiness

To ensure rigor, the study employed credibility involving prolonged engagement in Mt Darwin, member checking of transcripts with 2 participants per FGD. The study also ensured transferability through thick description of context so findings can be assessed for other rural districts. It further ensured dependability by audit trailing of decisions, codes, and theme

development. Trustworthiness was also ensured by confirmability where the researcher had university confirmation that she is positioned as a student from Bindura University of Science Education.

3.7 Ethical Considerations

Ethical approval was sought from Bindura University of Science Education. Permission from Mt Darwin Rural District Council and District Veterinary Services was obtained. Written/verbal informed consent was secured, with clear explanation that participation is voluntary. Anonymity was ensured using pseudonyms and codes. No animals were handled in this study. Findings will be shared with the community through a feedback meeting at ward level.

3.8 Limitations

This study may have the following limitations:

- Findings are context-specific to Mt Darwin and not statistically generalizable.
- Potential social desirability bias in FGDs, mitigated by separate gender groups and probing.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.0 Introduction

This chapter presents the findings of the key determinants shaping adoption of AI among cattle farmers in Mt Darwin, drawing from qualitative interviews, focus group discussions and key informant data to organize these factors into three interrelated domains- social, ecological and institutional factors. Upon examining these three domains together, this chapter provides an understanding of why AI adoption remains low in Mt Darwin setting the stage for exploring priority interventions and policy actions that address both immediate hurdles and underlying structural constraints.

4.1 Findings

4.1.1 Role of DVFS officials

The study found that the District Veterinary Field Officer plays a central role in building farmer preparedness for artificial insemination in communal areas. Through farmer training and awareness programs, DVFS officials transfer knowledge on breeding management, heat detection, and the advantages of AI over natural service, while field days and demonstrations provide practical exposure to AI procedures and outcomes. Officials also deliver AI services directly or coordinate with technicians, manage semen and liquid nitrogen supplies, and maintain records of inseminations and conception rates. Before AI is conducted, DVFS staff assess farmer and herd readiness by evaluating nutrition, disease control, and housing, and advise on management practices needed to improve breeding success. Beyond service delivery, they link

AI programs with disease control, parasite management, and overall herd health initiatives, while collecting data on uptake and challenges to inform program planning. By coordinating with AGRITEX, NGOs, and farmer groups, DVFS officials act as the frontline link between the national AI program and farmers, ensuring that knowledge transfer, service access, technical readiness, and feedback mechanisms align to support adoption.

4.1.2 Main breeding method used by farmers in Mt Darwin

This study found that natural mating using bulls is the dominant cattle breeding method among smallholder farmers in Mt Darwin District. This approach was preferred across most wards due to its low cost, accessibility and alignment with traditional farming practices. Limited adoption of artificial insemination (AI) was linked to infrastructure gaps, cost barriers, and knowledge constraints. As a result, herd genetics and calving rates remain largely dependent on locally available bulls and communal grazing systems.

‘We don’t use AI here because the technician is far and its expensive. Our cows just meet bulls around the village.’ Farmer, Ward 34.

4.2 Key social factors influencing artificial insemination adoption among cattle farmers in Mt Darwin, Zimbabwe

The study found that the adoption of artificial insemination among farmers in Mt Darwin is shaped significantly by the prevailing social context, which influences farmers’ perceptions, attitudes, and decision-making regarding the technology. Unlike technical constraints, social factors determine whether farmers consider, trust, and continue using AI once it is available.

4.2.1 Cultural beliefs and attitudes toward breeding

Farmer interviews, Key informant Interviews and FGDs showed that most farmers in Mt Darwin prefer natural mating to AI as it aligns with established traditional practices and the cultural value placed on the natural bull. Cattle are often regarded as symbols of wealth, status, and bride price, and some farmers perceive AI as an interference with ancestral practices. Some farmers raised concerns that AI may produce weaker offspring and AI interferes with natural processes thus contributing to low uptake.

‘AI or Bhuru mugaba is against our ancestral practices, we cannot allow it to take over the bull that mates naturally. Imagine a woman bearing a child without a man. We can’t let this happen.’
(said a traditional leader).

‘I am afraid the offspring comes out strong. I cannot risk it. better I use natural mating.’ Said a farmer.

4.2.2 Gender roles and household decision-making.

The study found that adoption is also influenced by gender roles and household decision making. Farmers and Key Informants agree that breeding decisions in Mt Darwin being a communal system are predominantly controlled by men, even where women undertake most of the daily herd management. Consequently, women’s practical knowledge of heat detection and animal condition is frequently excluded from breeding decisions. Extension meetings in Mt Darwin are male-dominated thus limiting the participation of women farmers who may be more receptive to AI.

'I am the man of the house and I decide on how my cattle breed. This Bhuru Mugaba (AI) thing is an attack on my manhood. I don't want it.' Male farmer 5.

'I have the knowledge on artificial insemination, but I cannot tell my husband to breed this way. He decides.' Female farmer 1.

'as you can see, majority of participants here are men. Women rarely participate in meeting or trainings that involve cattle.' Said a Key informant from AGRITEX.

4.2.3 Knowledge, awareness, and misinformation

Respondents to this study mentioned limited understanding of how AI functions, its benefits, and associated costs restricts adoption as another social factor limiting AI adoption in Mt Darwin. There are misconceptions in Mt Darwin with beliefs that AI causes abortion and reduces milk yield.

This has been confirmed in FGDs where a farmer stated that, 'word around is that AI causes abortion' with another saying 'cows mate by AI produce less milk than those naturally mated'. Conversely, farmers with prior exposure to AI through training or observation of successful cases among peers demonstrated higher willingness to adopt. *'I have completed a course on AI and have seen successful cases during my training. I am willing to try it.'* said a trained farmer.

4.2.4 Social networks and peer influence

Social networks and peer influence were found to play as mechanisms for diffusion or resistance to AI in Mt Darwin. Most farmers and key informants stated that adoption often spreads through farmer groups, dip tank committees, and neighborhood interactions. When respected farmers adopt AI and achieve positive outcomes, others are more likely to follow, yet a single negative

experience can undermine confidence across the group. Extension officers confirmed this with one stating that,

‘the over thirty AI cases that I know to have been done in my ward since 2018 failed causing my farmers to refuse willing to adopt.’

4.2.5 Collective action and group dynamics.

There was a general consensus among farmers and key informants that AI delivery in Mt Darwin is impractical due to limited collective and group dynamics. Participants admitted that grouping animals for a single technician visit reduces costs and improves efficiency, but Mt Darwin has weak organization within communal grazing systems thus limiting this approach. Communal farming in Mt Darwin uses the open grazing system which complicates heat detection and animal restraint, necessitating coordination among farmers.

‘I had my cow artificially inseminated but then there are bulls around our open grazing lands, I do not know if the offspring is from the AI or the natural bull.’ Said a farmer.

4.3 Key ecological factors influencing artificial insemination adoption among cattle farmers in Mt Darwin, Zimbabwe.

The study identified a number of ecological conditions that determine the biological feasibility of artificial insemination (AI) in Mt Darwin. In In Mt Darwin, agro-ecological variability across natural regions shapes pasture availability, animal condition, and disease pressure, which in turn influence whether farmers view AI as a practical and worthwhile intervention.

4.3.1 Rainfall and agro-ecological region

Participants in both higher rainfall regions reported zero conception after AI. This is despite the wide believe that higher rainfall regions can register better results than drier regions.

“In a good season cows come back fat and they can hold to the AI but for the cows that were inseminated in both high rainfall and low rainfall regions, we did not record any conception, leaving us worried about what went wrong. ‘AGRITEX officer 1’

“Here in Region V we only get rain for three months. The rest of the year the animals are thin, so AI does not work.” Farmer 4 ward 34.

4.3.2 Feed and pasture availability

Seasonal feed scarcity was repeatedly cited as a barrier in the Dande area, particularly during the dry season when body condition scores drop and oestrus expression becomes irregular.

“From July to November there is nothing in the veld. Even if the technician comes, the cow is too thin to conceive.” Farmer 6. FGD.

“We know AI needs a fat cow, but on communal grazing that only happens after the rains.” VET Official 3.

4.3.3 Water availability

Farmers in all areas and Key Informants presented limited water access as complicating both animal management and service delivery. This was mostly said in the Dande area.

“The borehole is far. To bring 10 cows for AI we need to walk 4 km, and they come tired and thirsty.” Farmer 8

“Technicians also need water to clean their equipment, but sometimes we don’t have enough for that.” Farmer 5

4.3.4 Disease and parasite pressure

Participants cited Mt Darwin as one the farming communities had hit the burdens of ticks and tick-borne diseases resulting in farmer priorities shifting away from breeding toward disease control. This even true to commercial farmers.

“When January disease is around, we focus on dipping and treatment. Breeding can wait.” Said a commercial farmer

“Ticks make the cows weak. Even if you inseminate, the cow aborts or does not hold.” Farmer 9, FGD.

4.3.5 Climate and temperature stress

The study also found that extreme heat estimated at 26 degrees celcius and 31 degrees dayne in Mt Darwin particularly in wards within the lowveld Dande areas reduced both heat expression and semen viability, narrowing the practical window for AI.

“When it is too hot the cows don’t show heat properly. You miss it.” AGRITEX official.

“I suppose the semen went bad for staying in the flask too long in the sun. that’s why we failed to get any conception.”

4.3.6 Land tenure and grazing management

Participants highlighted that open communal grazing systems limited farmers' ability to isolate cows in heat and prevent uncontrolled mating after insemination. This is common in communal areas and for commercial farmers grazing is controlled but straying is also common.

“We raise our cattle on the open veld where you cannot keep the bull away after AI. The cow gets served again.” Farmer 11.

“Without a paddock or kraal you cannot restrain the cow properly for insemination.” VET officer.

The ecological data indicate that AI is most feasible in areas where seasonal nutrition, water, and disease control align to maintain animals in breeding condition. In much of Mt Darwin's communal areas, these conditions are met only during the wet season. Consequently, farmers reported that AI adoption is constrained unless it is bundled with interventions to improve feeding, water access, and parasite control.

4.5 Institutional Factors Influencing Artificial Insemination Adoption

This study identified a number of institutional factors as having a toll on adoption of AI by farmers in Mt Darwin. The study refers institutional factors to as the policies, organizations, services, and infrastructure that determine whether artificial AI is available, affordable, and reliable for farmers in Mt Darwin. The study found that compounding the institutional factors even compound the adoption of AI in Mt Darwin.

4.5.1 Limited Availability and reliability of AI services

Participants highlighted inconsistent service delivery and frequent breakdowns in the liquid nitrogen supply chain as major deterrents.

“We do not have a specified AI technician in Mt Darwin. The three that are trained cannot do it alone. They depend on a specialist from Mazowe, who last visited in 2022.”
AGRITEX key informant.

‘We are not even aware if there is an AI specialist in Mt Darwin. If there is I doubt the person is skilled or have adequate resources.’ (Farmer 6. FGD)

The study also observed that private AI providers are unwilling to operate in communal areas since they favor commercial farming areas. This limits communal farmers’ access to AI services.

‘The only place we know to have AI providers is Mazowe and probably Bindura where there are commercial farmers. They can’t stay in Mt Darwin. We can’t afford it.’ Farmer 12. Interview.

This was corroborated by a VET official who stated that, *‘Mt Darwin is not commercially viable to have private AI service providers. No one will pay for that service.’*

4.5.2 Cost and input subsidies

While farmers recognized that AI is cheaper than maintaining a bull long-term, the upfront cost remained a barrier in the absence of subsidies or credit.

“We tried this when an NGO was paying part of the cost. 36 farmers tried AI. When we had to pay everything on our own, we could not afford it.” Farmer 4. Interview.

Compound this is unavailability of loan facilities for cattle livestock.

“We don’t have loans for cattle. If the AI fails, that money is gone. So, we can’t risk it.”
(Farmer FGD).

4.5.3 Extension and training support

High officer-to-farmer ratios and infrequent follow-up were reported to limit the effectiveness of training on heat detection and post-AI management.

“One officer covers many villages. He trains us once and then we don’t see him again.”

“The technician does the insemination but does not explain what to do after, so the cow loses condition and aborts” (Farmer 6 FGD).

4.5.4 Policy and regulatory environment

Disease control policies, particularly movement restrictions during foot-and-mouth outbreaks, interrupted scheduled AI campaigns. *“When there is FMD, they stop all cattle movements. The AI program stops too.”* Farmer 6.

Farmers noted the absence of a clear national breeding policy, which left districts without a unified direction for breed improvement.

4.5.5 Infrastructure and logistics

The condition of dip tanks and handling facilities was also cited as directly affecting the practicality of AI in Mt Darwin.

“Our dip tank has no crush pen. You cannot hold the cow properly for insemination.”

Farmer 8.

“The road is bad in the rainy season. The technician cannot reach us, and the semen gets spoiled.” Farmer 11.

4.5.6 Coordination between institutions

The study found that there is poor coordination among institutions supporting farmers in Mt Darwin. Participants revealed that parallel programs run by AGRITEX, DVFS, NGOs, and farmer unions often led to mixed messages and fragmented support.

“One organization says use this breed; another says use that one. We get confused.” Farmer 9
FGD. *“NGOs start the project, train us, and then leave. Government does not continue it.”*
Farmer 3

4.5.7 Land and resource governance

Land and resources governance was also cited as a critical factor for adoption of AI in Mt Darwin. According to famers and key informants, local leadership and communal grazing rules influenced whether farmers could group animals for efficient AI delivery.

“If the headman does not allow us to gather cows, we cannot do group insemination.”

*“Without ear tags and registration, you cannot keep track of which cow was inseminated.”*VET Officer

4.6 Summary

The findings from this study reveal that cattle farming in Mt Darwin is shaped by a complex interplay of social, ecological and institutional factors all of which directly influences farmers' preparedness for AI. Social and cultural beliefs that view natural bull service as more reliable, gender roles that exclude women from breeding decisions, low level of knowledge, weak networks for sharing AI experiences were found to reduce farmer willingness to adopt AI. Ecologically, erratic rains, pasture availability, limited water access, high disease and parasite pressure and climate stress and poor communal grazing management limit farmers capacity to adopt AI.

CHAPTER 5

DISCUSSION OF FINDINGS

5.1 Factors Affecting AI adoption in Mt Darwin

Figure 1 groups factors affecting AI adoption in Mt Darwin into social, ecological, and institutional factors, and these align closely with three complementary theoretical lenses: Ostrom's Socio-Ecological System framework, Rogers' Innovation Diffusion Model, and the Economic Constraints paradigm.

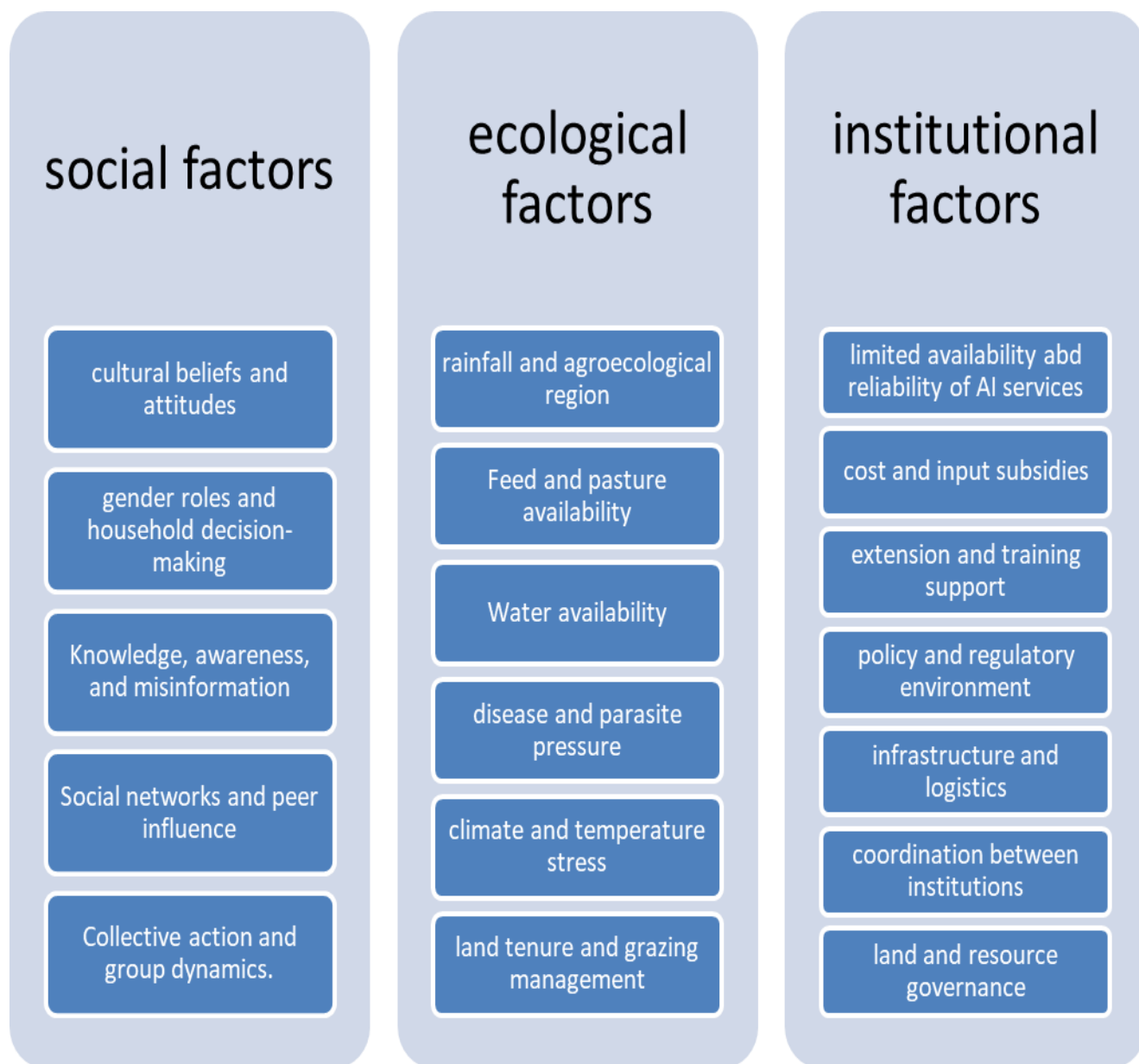


Figure 1: factors affecting adoption of AI in Mt Darwin

Using Ostrom's SES framework, adoption outcomes emerge from interactions between the resource system, governance system, and actors. The ecological factors identified- rainfall, agroecological region, water availability, feed, pasture, disease pressure, and land tenure correspond to Ostrom's resource system and ecosystem tiers. These conditions set the biophysical limits for AI success, since conception rates and calf survival depend on adequate

nutrition and heat management. The institutional factors such as policy, extension services, coordination, and infrastructure reflect the governance system, where weak institutional arrangements often lead to under-provision of collective goods like AI services in communal areas of Zimbabwe. Social factors including cultural beliefs, gender roles, knowledge, peer influence, and collective action represent the actor subsystem, shaping how farmers perceive, trust, and act on new technologies. As Ostrom (2009) argues, mismatches across these subsystems constrain collective action and sustainability, which explains why low AI adoption in Mt Darwin occurs where ecological constraints, weak institutions, and restrictive social norms overlap.

Rogers' Innovation Diffusion Model provides a second lens by framing adoption as a process shaped by the perceived attributes of the innovation, communication channels, social system, and time. Social factors identified in this study capture perceived attributes: knowledge and awareness affect relative advantage and complexity, while cultural beliefs and gender roles influence compatibility. Social networks and peer influence function as informal communication channels that accelerate diffusion when early adopters are visible, whereas limited extension and training support weaken formal channels. The limited availability and reliability of AI services also slow diffusion by reducing observability and trialability. This pattern matches findings across sub-Saharan Africa, where AI adoption among smallholders remains below 5% largely due to stalled diffusion at the knowledge and persuasion stages rather than at the decision stage (Feder, Just & Zilberman, 1985; FAO, 2018).

The Economic Constraints paradigm adds that adoption is primarily constrained by costs, risk, liquidity, and market access. Direct cost barriers arise from the price of semen, nitrogen, technicians, and transport, making subsidies essential for smallholders. Indirect constraints

emerge from poor feed, water shortages, and weak infrastructure, which raise the effective cost by reducing conception rates even when AI is free. High disease and climate stress further increase risk, making investment in AI economically irrational without risk mitigation. These dynamics are consistent with evidence from Zimbabwe's communal livestock systems, where economic and infrastructural constraints limit uptake of improved breeding technologies despite farmer interest (Mavedzenge et al., 2008).

Taken together, the three frameworks are complementary. Ostrom's SES explains the mismatch between ecological conditions, governance, and social norms; Rogers' model explains why diffusion stalls at early stages; and the Economic Constraints paradigm explains why farmers may not adopt even when aware. For Mt Darwin, this suggests interventions must be integrated: improve feed, water, and heat stress management ecologically; strengthen reliable AI service delivery, technician training, and subsidies institutionally; and use farmer groups and peer influencers socially to address misinformation and gender barriers.

5.2 AI Adoption readiness for Mt Darwin

To assess the feasibility of scaling artificial insemination (AI) in Mt Darwin, this study evaluated readiness across three core domains: social and economic, ecological, and institutional. Table 2 presents a consolidated scorecard that synthesizes the current status, adoption readiness rating, and priority gaps for each domain based on field findings and stakeholder input using Ostrom's Socio-ecological systems framework, Rogers Innovation Diffusion Model, and the Economic Constraints paradigm.

Table 2: AI Adoption readiness scorecard for Mt Darwin

<i>Domain</i>	<i>Current Status</i>	<i>Adoption Readiness Rate</i>	<i>Key Gaps to Address</i>
Social and economic readiness	Low awareness culture and gender barriers, and high costs reduce demand and perceived feasibility. Diffusion stalled at knowledge/persuasion stage	Low	Use farmer groups and peer influencers to shift norms, reduce misinformation, and lower cost-risk barriers through subsidies
Ecological readiness	Variable rainfall, limited feed and water, high disease and heat stress reduces conception success and calf survival	Low	Improve feed availability, water access, disease control before scaling up AI
Institutional readiness	Weak extension services, unreliable AI delivery, poor infrastructure, and limited subsidies restrict access to quality semen and technicians	Low to moderate	Strengthen reliable AI service delivery, technician training, and input subsidies

The results indicate that social-economic, ecological and institutional constraints are currently misaligned, limiting the district's capacity for widespread AI adoption under present conditions.

The scorecard reveals that readiness is uneven across domains. Social and economic readiness is rated low, constrained by limited awareness, gendered barriers, high costs, and stalled diffusion at the knowledge-persuasion stage. Ecological readiness is also low, with variable rainfall, feed

and water shortages, and high disease and heat stress undermining conception success and calf survival. Institutional readiness falls between low and moderate, reflecting weak extension services, unreliable AI delivery, poor infrastructure, and limited subsidies that restrict access to quality semen and technicians.

For each domain, the table identifies targeted gaps that must be addressed to enable adoption. These include shifting social norms through farmer groups and peer influencers, improving feed and water access before scaling up AI, and strengthening service delivery and technician capacity. Together, the scorecard provides a diagnostic framework for sequencing interventions and aligning policy, program, and community-level actions to build a viable pathway for AI adoption in Mt Darwin.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The findings indicate that Mt Darwin is not yet positioned for widespread AI adoption under current conditions. Social barriers such as cultural skepticism, gendered decision-making, and low awareness limit farmer demand and trust. Ecological constraints including feed shortages, water scarcity, and high disease pressure reduce the biological feasibility of AI success. Institutionally, unreliable AI service delivery, high input costs, weak extension support, and poor coordination further restrict access and consistency. The overlap of these constraints means that technical delivery of AI alone is insufficient without parallel improvements in the social and ecological context.

5.2 Recommendations

The following are recommendations based on the findings from this study.

- There is a need strengthen ecological support through improving feed and water access, disease control, and heat management practices to create conditions where AI can lead to viable conception and calf survival.
- Institutional delivery must be improved by ensuring reliable, affordable AI services through trained technicians, consistent input supply, targeted subsidies, and better coordination between government, NGOs, and local structures.

- Social barriers need to be addressed through the use of farmer groups, peer influencers, and targeted extension to correct misinformation, demonstrate success cases, and shift norms around gender roles and cultural beliefs.
- Adoption of an integrated approach where there is alignment of interventions across social, ecological, and institutional domains rather than treating them in isolation, so that improvements in one area are not undermined by weaknesses in another. This integrated approach would build the foundation for moving Mt Darwin from low readiness toward sustainable adoption and diffusion of AI among smallholder farmers.
- Future research should employ mixed-methods and systems approaches. Longitudinal studies that examine how changes in one domain, such as conception success, would generate stronger causal evidence to inform policy and programs.

APPENDIX 1

SEMI-STRUCTURED IN-DEPTH INTERVIEW GUIDE FOR FARMERS

Study Title: A Socio-Ecological Readiness Assessment for Artificial Insemination Adoption in Mt Darwin, Zimbabwe

Section A: Introduction & Background

1. Can you tell me a bit about your farming background?

-Probe: How many cattle do you keep? For how long have you been farming? Is cattle your main source of income?

2. What are the main breeding methods you currently use for your cattle?

- Probes: Natural mating, AI, other? Why do you use this method?

Section B: Social Factors Influencing AI Adoption*

Objective 1: Identify key social factors influencing AI adoption

3. What do people in your community think about using artificial insemination for cattle?

- Probes: Do neighbors, family, or traditional leaders support or discourage it? Why?

4. Have you discussed AI with other farmers? What was their experience or opinion?

5. What role do culture, religion, or traditional beliefs play in decisions about cattle breeding here?

6. How does gender influence who decides whether to use AI in your household or community?

Section C: Ecological Factors Affecting AI Adoption

Objective 2: Examine ecological factors affecting AI adoption

7. How does the environment in Mt Darwin affect cattle breeding and reproduction?

- Probes: Grazing, water availability, disease, climate/seasonal changes.

8. Do you think the local environment is suitable for AI to work well? Why or why not?

9. What environmental challenges make it difficult for you to adopt AI, if any?

- Probes: Distance to services, road access, storage for semen, cold chain.

Section D: Institutional Factors Impacting AI Adoption

Objective 3: Investigate institutional factors impacting AI adoption

10. What support do you receive from government, NGOs, or private providers regarding AI?

- Probes: Training, subsidies, access to technicians, equipment.

11. How easy or difficult is it to access AI services in Mt Darwin?

- Probes: Distance, cost, availability of trained personnel, semen quality.

12. What policies or programs have you heard about that support or hinder AI adoption?

13. What would make it easier for you to use AI services?

Section E: Interaction of Factors & Overall Readiness

Objective 4: Analyze how these factors interact to influence AI adoption

14. In your experience, how do social, environmental, and institutional factors affect each other when it comes to AI?

- Probes: E.g., does lack of trust in technicians make cost less important? Does poor road access make training useless?

15. What do you think needs to change for more farmers in Mt Darwin to adopt AI successfully?

16. If you had the chance to advise the Ministry of Agriculture on AI programs, what would you tell them?

Section F: Closing

17. Is there anything else about AI adoption in Mt Darwin that we haven't discussed but you think is important?

18. Thank you for your time. May I contact you if I need clarification later?

APPENDIX 2

KEY INFORMANT INTERVIEW GUIDE

A Socio-Ecological Readiness Assessment for Artificial Insemination Adoption in Mt Darwin, Zimbabwe

Participants: AGRITEX officers, Veterinary Services officers, NGO program managers, Traditional leaders, AI service providers

Interview time: 45-60 minutes

Section A: Introduction & Role

1. Can you describe your role and how long you've worked with cattle farmers in Mt Darwin?
2. In your work, how common is the use of artificial insemination compared to natural mating?

Section B: Social Factors

Objective 1: Identify key social factors influencing AI adoption

3. From your experience, what social or cultural factors most influence whether farmers in Mt Darwin adopt AI?

Probes: Community attitudes, gender roles, influence of traditional leaders, farmer associations.

4. How do farmers' perceptions and knowledge about AI affect uptake?
5. What misconceptions or resistance have you encountered, and where do they come from?

Section C: Ecological Factors

Objective 2: Examine ecological factors affecting AI adoption

6. What environmental and geographical factors in Mt Darwin affect the delivery and success of AI services?

Probes: Road access, distance, climate, water, pasture quality, disease burden.

7. How do seasonal changes influence demand and feasibility of AI in this area?
8. Are there ecological constraints that make AI less viable compared to natural mating here?

Section D: Institutional Factors

Objective 3: Investigate institutional factors impacting AI adoption

9. What institutions currently support AI service delivery in Mt Darwin?

Probes: Government, NGOs, private sector, training programs.

10. What are the main gaps in policy, funding, human resources, and equipment for AI services?

11. How do cost, availability of semen, and access to trained technicians affect adoption?

12. What policies or programs have worked well, and what has failed?

Section E: Interaction of Factors & Readiness Assessment

Objective 4: Analyze how these factors interact to influence AI adoption

13. In your view, how do social, ecological, and institutional factors interact to either enable or block AI adoption?

Probe: Give a concrete example from Mt Darwin.

14. Based on your assessment, how “ready” is Mt Darwin for scaling up AI? What’s missing?

15. What would need to change at community, district, and national level to improve readiness?

Section F: Recommendations & Closing

16. If you were designing an AI adoption program for Mt Darwin, what 3 priorities would you include?

17. Are there any documents, reports, or data you recommend I review for this study?

18. Is there anything else about AI adoption in Mt Darwin that I should know?

APPENDIX 3

FOCUS GROUP DISCUSSION GUIDE

A Socio-Ecological Readiness Assessment for Artificial Insemination Adoption in Mt Darwin, Zimbabwe

Participants: 6-10 cattle farmers per group, grouped by gender/age if needed for comfort

Duration: 60-90 minutes

a. Welcome and Ground Rules

- Welcome everyone and thank them for coming.
- Explain the study purpose: “We want to understand what helps or stops farmers in Mt Darwin from using artificial insemination for cattle.”
- Confidentiality: What’s said here stays here. No right or wrong answers.
- Get verbal consent and permission to record.
- Ground rules: One person speaks at a time, respect different views.

b. Warm-up and Background

1. Let’s go around - can each of you tell us how many cattle you keep and how you usually breed them?

Purpose: Break ice, get context, see current practice distribution.

c. Social Factors Influencing AI Adoption

Objective 1: Identify key social factors

2. When you talk about artificial insemination with other farmers here, what do people usually say?

Probes: Is it seen as good/bad? Why? Who supports it, who doesn’t?

3. Who in the community or family influences the decision to use AI?

Probes: Husbands, wives, sons, traditional leaders, AGRITEX officers, neighbors.

4. Are there any cultural beliefs, traditions, or community norms that affect whether you would use AI?

Probe: Examples, stories.

d. Ecological Factors Affecting AI Adoption

Objective 2: Examine ecological factors

5. Thinking about Mt Darwin's environment, what makes cattle breeding easy or difficult here?

Probes: Grazing, water, disease, seasons, distance to services.

6. How do these environmental conditions affect whether AI would work for you?

Probe: Discuss cold chain, timing, access to technicians.

e. Institutional Factors Impacting AI Adoption

Objective 3: Investigate institutional factors

7. What help or services have you received from government, NGOs, or private people regarding AI?

Probes: Training, cost, availability, quality of service.

8. What stops you from using AI services even if you wanted to?

Probes: Cost, distance, trust, lack of information.

f. Interaction of Factors & Group Views on Readiness

Objective 4: analyze how factors interact

9. If we put all these things together - what people think, the environment, and the services available - what makes it hardest for farmers here to use AI?

Probe: Get group to rank top 3 barriers.

10. What would need to change for more farmers in this group to try AI and keep using it?

Probe: Practical, realistic changes.

g. Closing

11. If you could tell the Ministry of Agriculture one thing to improve AI services in Mt Darwin, what would it be?

12. Is there anything we didn't talk about that you think is important for this topic?

Thank participants, explain next steps, offer refreshments.

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