

BINDURA UNIVERSITY OF SCIENCE EDUCATION
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**Research project AG420: Understanding Anthelmintic Use in livestock in Bindura. A
Knowledge, Attitudes and Practices Study among Farmers and Animal Health
Professionals**

By

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Bachelor of Science Honours in Animal Health Production and Extension*

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APPROVAL FORM

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DECLARATION

I, Theophilus Alistair Mutandadzi, registration number, B231225B, do hereby declare that this dissertation is my own original work and has not been submitted to any university before for marking.

DEDICATION

I dedicate this dissertation to all smallholder farmers who are into livestock farming.

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First and foremost, I want to thank my parents and siblings for their support in making this a dream come true. Gratitude also goes to all lecturers in the Animal science department at BUSE for their patience and ensuring that my write-up became a meaningful thing. Lastly, but not least I thank my friends and classmates for their support during the course of this project.

ABSTRACT

The objective of this study was to examine the knowledge, attitudes and practices of livestock farmers and animal health workers of the use of anthelmintics in Bindura District of Zimbabwe. The study was stimulated by the concerns to anticipate the improper use of anthelmintic drugs and the increasing problem of anthelmintic resistance in livestock production systems. A quantitative cross sectional research design was used and data gathered using structured questionnaires from the livestock farmers and animal healthcare providers. Farmers involved in cattle, goat, sheep and poultry farming and veterinary officers, animal health technicians and agricultural extension officers in Bindura District were the study population. 350 questionnaires were sent to livestock farmers, and 332 completed questionnaires were returned, yielding a 94.9% response rate. A total of 20 questionnaires were sent to animal health professionals and 18 were returned yielding a 90% return. Descriptive statistical techniques such as frequencies and percentages were used to analyse the information that was collected. Moreover, a goodness of fit test, using a chi-square distribution, was conducted to determine whether or not there was statistical significance at the 5% level. The findings revealed that the majority of the farmers had a general knowledge about anthelmintics and recognized the necessity of regular deworming in animal husbandry. Despite this overall knowledge, there were concerns regarding A number of factors that prevented correct use of the anthelmintics were found such as the high cost of veterinary medicines, inadequate veterinary service availability, lack of knowledge about the use of the medicines by the farmers and irregular availability.

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ACRONYMS

Acronym	Full Meaning
AGRITEX	Department of Agricultural Technical and Extension Services
DVS	Department of Veterinary Services
FAO	Food and Agriculture Organization
SPSS	Statistical Package for the Social Sciences
WHO	World Health Organization
KAP	Knowledge, Attitudes and Practices
ILO	International Labour Organization
OECD	Organisation for Economic Co-operation and Development
VMO	Veterinary Medical Officer
NGO	Non-Governmental Organization
LSD	Livestock Service Delivery
QA	Quality Assurance
IRB	Institutional Review Board
ANOVA	Analysis of Variance
PPR	Peste des Petits Ruminants
PPE	Personal Protective Equipment
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
SDGs	Sustainable Development Goals
DNA	Deoxyribonucleic Acid
GDP	Gross Domestic Product

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Anthelmintics are used widely in the livestock industry to control endoparasitic infection, which affects animals in many ways, namely on the animal's health status, growth performance and productivity. A good endoparasite control has been found to increase livestock production performance and improve reproductive performance and farm profit. Hence, anthelmintic administration has become one of the common practice in animal production industry around the world. However, an inappropriate use of the drugs, which is often found to be underdosing, repeated administration and administration against recommended guideline, reduces the drug's performance, risk of developing anthelmintic resistance, adverse environmental impact and increase in production costs. Livestock production is the source of food and economic security for the livelihoods of many rural households in Zimbabwe, and forms part of many national agricultures sectors. Cattle, goats, sheep and poultry livestock play a major role on households' economy, livelihood and also contributes to the nation's agriculture development. Despite of important of effective parasite control, limited knowledge of farmers concerning appropriate use of anthelmintics and management of resistance have been reported (Jafarey et al., 2020; Van Wyk & Bath, 2002). In addition to insufficient availability of veterinary services and information and farmer's perception on deworming procedure would likely have led to decision that have influence on parasites control, that leads to poor performance and may contribute to acceleration of development of resistance in parasites population in livestock, the fact which threatens the sustainability of livestock production.

This study is on the knowledge, attitude and practices of livestock owners towards the use of anthelmintics in the Bindura District, Zimbabwe. It, in turn examined knowledge of the selection, dosage, administration of anthelmintics and knowledge about the selection of a variety of antiparasitic drugs and farmers' views, knowledge and beliefs about the risk and benefits of using anthelmintics and the implementation strategies used by owners. In so doing, this study attempts to explore the drivers of anthelmintic use and help establish better management strategies for sustained production of livestock, controlling of parasites. This chapter offers a review of this study including the background of the research, the problem statement, justification of the study, research question, research hypothesis and placement of the study into a broad framework on animal health and livestock production management in Zimbabwe.

1.2 Background to the Study

The farmers knowledge, attitudes and practices of anthelmintic use serve as the independent variables and effective animal health management serves as the dependent variable. The term knowledge refers to the farmer's awareness about parasites biology, the different class of drugs, dose of drug, the time interval and also resistance management. The term attitude encompasses the perception, belief and apprehension of farmer toward the use of anthelmintics. Practice includes all that the farmers actually do, or are able to do regarding the administration of anthelmintics, including how they administer the dose, and how often and if they follow veterinary advices (Van Wyk & Bath, 2002; Jafarey et al., 2020).

In livestock production worldwide parasitic infection represents a significant obstacle. The Food and Agriculture Organization (FAO, 2019) stated that the economic losses to the production of the livestock as a result of gastrointestinal nematodes and other helminths are estimated at billions of dollars each year from loss of production, morbidity and mortality. The burden of the parasites is particularly great in developing countries with lack of adequate veterinary services, poor farmer education, and uncontrolled availability of drugs (Charlier et al., 2014).

The overuse of anthelmintics is common in Sub-Saharan Africa; in Kenya, Nigeria and South Africa, most studies conducted have showed that farmers over-rely on empirical knowledge, wrong dosage or purchase and use of over the counter medicines without the intervention of veterinarians and this had leads to the emerging of drug resistance and low level efficacy (Taylor et al., 2016; Mwendia et al., 2020). In Zimbabwe research had showed that in the rural areas, small holder farmers are having limited access to veterinary advices, finances and good understanding of parasite life cycle, which influences their knowledge attitude practices regarding anthelmintic use (Chikowore et al., 2018). However, there is a gap in empirical data that reflects the knowledge attitude and practice regarding the use of anthelmintics in farmers in Bindura. This study sought to capture this missing context specific information for the extension services, veterinary services and policy formulation in sustainable livestock health.

1.3 Statement of the Problem

Livestock productivity in Bindura is limited by parasitic diseases that negatively impact animal health and reduce the income of farmers. It has been reported that farmers can misuse anthelmintics (including under-dosing, over-dosing, or they may select inappropriate drugs), with the potential to speed up the development of parasite resistance (FAO, 2019; Charlier et al., 2014). Although veterinary guidelines exist, there is a lack of information regarding the knowledge, attitudes, and practices of farmers with respect to anthelmintic usage in Bindura. These are the issues that need to be addressed if we are to achieve better livestock health, avoid drug resistance and improve rural livelihoods.

1.4 Justification of the Study

The research has implications for a variety of actors. For farmers, the findings provide practical guidance on proper use of anthelmintics and will result in better health, productivity and higher income. Veterinary services and extension officers will be able to use the data for better planning of education campaigns, outreaches and monitoring interventions that will bridge gaps between farmers' knowledge and behavior.

Secondly, the research adds to the knowledge and scientific literature on the sustainable management of livestock. The application of the KAP framework gives data about the behavior in rural agriculture at Zimbabwe and will provide useful guidance for policy makers with respect to the usage and resistance to anthelmintics.

1.5 Research Objectives

1.5.1 Main Objective

To assess farmers' knowledge, attitudes, and practices regarding anthelmintic use in livestock in Bindura.

1.5.2 Specific Objectives

1. To determine farmers' level of knowledge regarding anthelmintic use in Bindura.
2. To examine farmers' attitudes towards anthelmintic use in Bindura.
3. To identify farmers' practices in administering anthelmintics to livestock in Bindura.
4. To analyse the relationship between farmers' knowledge, attitudes, practices, and effective livestock health management in Bindura.

1.6 Research Hypotheses (Null Hypotheses)

H₀₁: Farmers' knowledge of anthelmintic use is not significantly associated with good livestock health management along the value chains in Bindura.

H₀₂: Farmers' attitudes towards anthelmintic use are not significantly associated with good livestock health management in Bindura.

H₀₃: There is no significant relationship between farmers' practices and good livestock health management in Bindura.

1.7 Limitations of the Study

While the study was successfully implemented with all the intended content, some limitations were faced when conducting this study. Such limitations could have an impact on the results of analysis, however, that impact was minimized with the implementation of appropriate

action. Different study methods were used to increase the trustworthiness, dependability and confirmability of the data and findings of this study.

1.7.1 Research Design Limitation

The study used a Knowledge, Attitudes and Practices (KAP) design and largely used self-reported data from farmers on their use of anthelmintics. While a KAP survey is appropriate in studying perceptions, beliefs and behaviors it has drawbacks and is open to social desirability and individual reporting bias and some of the participants may over-report good practices and report good attitudes so that they provide acceptable responses. To counter this structured questionnaires were used for all respondents to obtain consistent data and anonymity assured. Consistency and coherence of answers were also checked.

1.7.2 Sampling and Generalisability Limitation

Purposive sampling method was used to select the livestock farmers who were in livestock production in Bindura District. Through this method, only those farmers with a relevant background in livestock production and anthelmintic usage participated in the study. Since purposive sampling method is a non-probability method, statistical generalization from the sample to all the livestock farmers in Zimbabwe is not possible.

However, because of the relatively small sample size, the variety of information obtained might have been affected. In spite of the limitation, efforts were made to ensure the validity of the finding by having the respondents from various backgrounds in terms of socio-economic, scale of production and type of farming so as to have in-depth context and validity of finding.

1.7.3 Secondary Data Limitation

The analysis drew to some extent on veterinary histories, farming literature and government statistics as secondary data, to descriptively contextualise the management of livestock health and patterns of anthelmintic use. But there may have been a few inconsistencies with these reports not been accurate on up-to-date trends and practices.

In order to reduce this limitation, the review was limited to the following authoritative and trustworthy sources: documents from the Ministry of Agriculture, FAO, and peer reviewed-journal articles. In addition, secondary data were validated with primary data collected from farmers to ensure reliability and consistency.

Alternatively, if the research utilises primary data collection as its main source of information, the engagement with secondary data may be limited to positioning the study

within the relevant background material, in so doing reducing the need to rely on what may be outmoded records.

1.7.4 Contextual Limitation

In the case of Bindura District, context the socio-economic, cultural and agro-ecological conditions prevailing in this district are not the same as those that exist in other parts of Zimbabwe. However, the selection of farmers from different wards and farming systems added to the strength of the contextual generalisability of the findings of the study.

1.8 Delimitations of the Study

The study was restricted to farmers from Bindura District who are keeping livestock and administer the anthelmintics themselves. Farmers from rural set-ups as well as those on the urban set-ups, farms located outside the district and those who do not keep livestock have been left out in order to narrow the study to the knowledge, attitudes and practices of the small holder rural farmer only. Veterinarians, politicians and agro-dealers opinions were not covered in the study although sometimes used to complement the findings.

1.9 Definition of Key Terms

Anthelmintics

Anthelmintics is the use of drugs to control parasitic worm disease in animal (Taylor et al, 2016). They are all the chemicals and veterinary drugs used by the farmers in the control of GI and systemic parasites in cattle, goats and sheep.

Knowledge

According to Van Wyk and Bath (2002) Knowledge, refers to the farmer's awareness regarding the biology of parasite and categories, doses and modes of drug administration and resistance. It entails both explicit knowledge and application

Attitudes

Attitudes refer to farmers' perception, belief and feeling on the use of anthelmintics (such as Farmer's confidence on veterinarian advice, belief on need for treatment, perceived effectiveness and safety of treatment) (Charlier et al., 2014).

Practices

Practice refers to the type of actual techniques or routines related to treatment with

anthelmintics and it could involve choice of drug, administration, drug dose, interval of treatment or strictness of treatment (Jafarey et al., 2020).

Effective Livestock Health Management

It includes the provision of proper nutrition, disease prevention and control among the livestock and parasites, such as using the anthelmintics properly. It is indicated by the productivity of the animals, low parasite burden and minimal development of resistance to drugs.

1.10 Chapter Summary

The chapter formulated the problem under review by defining the background, statement of the problem, rationale of the study, objectives of the study, research hypotheses, the constraints and delimitations of the study and the main terms used in the study. The chapter made evident the importance of the knowledge, attitude and practices (KAP) farmers have towards the use of anthelmintics in Bindura and placed the study in the rural agricultural background of Bindura and Zimbabwe. It laid down the premise of further analysis and the subsequent chapter will examine relevant literature on the use of anthelmintics, parasite control and rural farming practices.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The chapter provides a critical and context-specific review of the literature pertaining to anthelmintics usage in livestock with specific attention paid to the KAP of farmers. This review of literature was performed to place the current research: Understanding Anthelmintics Usage in Livestock in Bindura: A KAP Study among Farmers, in context and in the established academic discourse and to define conceptual, empirical and context-specific gaps where current research is necessary. The review examines empirical studies of anthelmintics usage, resistance and farmer decision making and veterinary service utilization at global, regional (Africa) and national level (Zimbabwe) in the smallholder/communal agricultural systems

This review is based on the idea that efficient anthelmintic use is not simply a technical or veterinary problem, but rather is a human behavior and knowledge-based practice influenced by farmer perceptions, socioeconomic factors, access to information and institutional factors. Evidence already confirms that improper anthelmintic use (under-dosing, over-dosing, mis-dosing, inappropriate timing, poor drug choice) has been the primary driver for rapid development of anthelmintic resistance thereby putting at risk the livestock productivity and the livelihood of rural people (Miller et al., 2019; Kaplan & Vidyashankar, 2021). While a significant body of literature focuses on the problem of anthelmintic resistance from a biomedical and parasitological point of view, only few of the studies focused systematically on the aspects of human behavior like the knowledge, attitudes and practices of farmers in the given local circumstances.

Additionally, most of the literature is focused on either high income countries or regional aggregations without considering the district in Zimbabwe, where the importance of the livestock sector to household food security, income and socio-culture is under-emphasized. Consequently this chapter covers closely related areas of inquiry such as farmer health-seeking behaviour in animal health, veterinary extension, drug regulation and informal livestock health management systems. In so doing, it exposes contradictions, consensus, and contestations within the literature, and draws out a clear empirical void around context-specific KAP from Bindura District. The chapter ends by outlining how the current research seeks to fill this void through a focused, theory-led investigation.

2.2 Theoretical Context

Knowledge on theoretical background helps to explain as why and how information is converted into knowledge, attitudes, into actions with regard to a particular way of farmers' use of anthelmintics. This work is based on two conceptually reinforcing behavioural and decision making theories which are often cited as tools in research involving the areas of health, agricultural as well as veterinary issues; namely; Knowledge Attitude Practice (KAP) model and Theory of Planned Behaviour (TPB).

2.2.1 Knowledge Attitude Practice (KAP) Model

The KAP (Knowledge, Attitude, Practice) Model has been widely used in the fields of public health, agricultural extension and veterinary epidemiology to examine how a person's knowledge about a particular topic may affect their attitude, and subsequently behaviour. In the applied study, the KAP model in animal health literature revealed that knowledge acquisition is a prerequisite to the behavior change and not a sufficient condition. This is because attitudes toward practices and constraints have a mediator role in transforming knowledge to practices (Abubakar et al., 2018; Alarcon et al., 2020).

Internationally, KAP-based studies conducted on the use of anthelmintics also showed that knowledge deficits exist among livestock farmers regarding the life cycles of parasites, appropriate dosage and long-term effects of anthelmintic misuse. For example, in a cross-sectional survey carried out among sheep producers in Australia, Bellet et al. (2018) reported that while majority of farmers acknowledged anthelmintic resistance as an issue, only few have know-how about how to prevent this phenomenon such as by practicing selective targeted treatment.

Similarly, an investigation in Spain by Martinez-Valladares et al. (2020) showed that the knowledge that farmers had about drug efficacy sometimes superseded veterinary recommendations leading them to continue to use readily failing anthelmintics. The KAP studies conducted in an African context consistently highlighted that farmers' knowledge on various aspects of worm control is influenced by the availability of veterinary extension services, level of literacy, sources of information used. In Ethiopia, Sori et al. (2019) showed that smallholder farmers depended on the advice of neighbours and agro-vet shops for anthelmintics resulting in inappropriate use and dosage. Similar observations were made in Kenya by Kanyari et al. (2021) who showed that farmers having positive attitudes to deworm regularly were practicing poorly due to low technical knowledge and lack of cash flow.

In Zimbabwe, there is scant and fragmented literature on the application of KAP to animal health. Certain studies such as by Moyo and Masika (2019) and Chimonyo et al. (2020) indicate that communal farmers have experiential knowledge on livestock diseases but are not necessarily formally trained on use of pharmaceuticals. However, these studies are general in the sense that the focus is on animal health management as a whole rather than specific knowledge, attitudes, and practices linked to anthelmintic use. Thus, although the KAP model has been successful in uncovering behavioural gaps, there is a conspicuous absence of district-specific anthelmintic oriented KAP investigations, more so in Bindura which is a mixed crop, livestock area and high parasite burden area.

Application of the KAP model to this study The KAP model is useful in the context of this study to provide a structured approach to determine if the observed anthelmintic use practices under investigation in Bindura were driven by lack of knowledge (KN), negative attitudes (AT), or unsuitable practices (PR), to be used to derive interventional measures.

2.2.2 Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour gives a more detailed description of behavioural prediction by stating that the behaviour of a person is directly determined by the person's intention to perform the behaviour, which is in turn determined by the person's attitude towards performing the behaviour, subjective norms and perceived behavioural control (Ajzen, 1991). In the fields of animal husbandry and farming, TPB is increasingly used to describe why farmers continue to use hazardous and/or suboptimal practices, despite knowing these have damaging consequences.

Recent studies have shown the relevance of TPB to explain decisions about anthelmintic use. In the United Kingdom, a survey by Vande Velde et al. (2018) revealed that intentions of farmers to move towards sustainable parasite control were more dependent on prevailing social norms on the farms and perceived financial risks than simply on technical information. In a similar vein, Eastwood et al. (2020) presented that whereas some New Zealand farmers held favourable attitudes to resistance mitigation, low perceived behavioural control led to adherence to traditional practices, especially in situations where veterinary services were expensive or difficult to obtain.

The application of TPB in Africa and for livestock health showed that structural and social determinants of behavior must be addressed in livestock health behaviors. Kabirizi et al. (2019) in Uganda discovered that although veterinary extension information on anthelmintics was provided; community acceptance and belief about veterinarians, community behavior

and trust on private drug sellers were highly predictive of their livestock health practice on use of anthelmintics. Ndlovu et al. (2021) found that perceived control, based on drug affordability and drug availability significantly predicted inappropriate drug dosage by communal cattle owners in South Africa.

However, there are very limited application of the TPB framework in livestock drug use in Zimbabwe. Animal health literature for animals generally seems to focus more on infrastructural determinants of livestock health behaviors than behavioral aspects like intentions, behavior based norms, and perceived control mechanisms by farmers. This is evident in the current study in Bindura where farmers are functioning under a multi faceted socio-economic context characterized by instability of income and lack of adequate veterinary service providers, and strongly influenced by peers.

TPB integration allows the present study to go beyond describing the KAP patterns in Bindura and explore how and why farmers adopt specific anthelmintic-use behaviours despite those behaviours contradicting the welfare of livestock in the long run. TPB, thus, aids to fill in the explanatory vacuum left by the KAP model.

2.3 Empirical Literature on Anthelmintic Use in Livestock

Empirical research on the usage of anthelmintics in livestock production systems has grown considerably in the past two decades. This is largely in response to the global anthelmintic resistance problem and its repercussions on animal health, food security and rural livelihoods. However the comprehensiveness and nature of research varies widely in different geographical contexts. Whilst research in high-income countries is increasingly focusing on behavioural aspects like the role of farmers' decisions, perception of risk, and their adherence to advice from veterinarian, research in low- and middle- income countries are mostly piecemeal, emphasizing parasitological results over farmers' behaviour. Since this research is predominantly concerned with farmers' knowledge, attitude and practice, the empirical literature is thus reviewed with respect to these aims.

2.3.1 Farmers' Knowledge of Anthelmintic Use

In surveys undertaken in Europe, North America and in several Asian countries, a variable and often inadequate technical knowledge among farmers concerning the correct use of anthelmintics is generally reported and is a challenge to parasite control. Surveys in UK and Ireland show most livestock farmers acknowledge the significance of gastrointestinal nematodes as production problems, but knowledge about parasite epidemiology, mechanism

of resistance and drug pharmacokinetics are lacking (Morgan et al., 2019). As indicated by a French longitudinal survey, farmers often have misunderstanding concerning dosage calculation especially live weight estimates visually, results were systemically under-dosing in livestock (Chartier et al., 2020).

In Australia and New Zealand where anthelmintic resistance is reaching epidemic stage, there are studies investigating knowledge dissemination via extension services. Besier et al. (2018) showed a high level of knowledge about resistance was generally present, but the detailed knowledge concerning resistance-preventing strategies, like refuge management and strategic selective treatment, was generally limited to the subset of commercially oriented producers.

In Denmark, similar results were also observed where farmer had theoretical knowledge on resistance but lack of practical understanding on how to apply integrated parasite management under field condition (Hoglund et al., 2021).

Empirical evidence across Asian continent and especially from India and China revealed that, the knowledge of farmers are driven by indigenous and informal knowledge systems. Farmers were depending much on agro-veterinary shopkeepers for information on anthelmintics, leading to partial or incomplete knowledge about the drugs, especially by small holders (Singh et al., 2020). The findings indicated that, even in resourceful context, farmer's knowledge is still an important factor that influences use pattern, proving the necessity of empirically investigating what the farmers know, rather than what they are expected to know due to availability of information.

In African region, empirical results are found to show more significant knowledge gaps, primarily due to the weak veterinary extension system and low formality of training among small holder farmers. Ethiopian, Kenyan and Ugandan studies, uniformly confirmed the insufficient farmer knowledge about correct dosing, drug rotation and withdrawal periods (Sori et al., 2019; Kanyari et al., 2021). While most of them possessed experimental knowledge on the presence and clinical signs of parasites, scientific explanation of the life cycle of parasites and development of resistance to drugs was incomplete.

The results from a multi-country study across East and Southern Africa showed that less than 30% of the farmers interviewed had the knowledge about classes of anthelmintics or why drug rotation is essential (Onyango et al. 2020). In Tanzania, Mtengeti et al. (2019) noted that most of the farmers considered regular deworming to be good husbandry; their knowledge about

parasite control was largely based on results and not processes of treatment. Similar results have been observed in West Africa. In Nigeria, Adedipe et al. (2021) recorded that knowledge among livestock owners was partial and was transmitted through peer learning and tradition and often was not in concordance with veterinary prescription. Overall it seems that this problem of having poor knowledge about parasite control is continental, and it is primarily informal, partial, and disconnected from strategies of managing resistance. Data that focus on farmers' knowledge of anthelmintic use from empirical studies in Zimbabwe appear to be limited and have concentrated mostly on prevalence and resistance studies rather than on farmer knowledge Zvinorova et al., (2016) observed significant presence of GIPs within communal cattle but failed to assess farmers' knowledge on anthelmintics).

Latest studies suggest still existing knowledge gaps. Dube et al. (2021) described a growing resistance against the most commonly used anthelmintics in cattle but ascribed this mainly to misuse without investigating farmers sense empirically. Moyo and Masika (2019) observed a heavy dependency on indigenous knowledge system among communal farmers for the management of livestock health with minimal incorporation of scientific knowledge of drug-use.

2.3.2 Farmers' Attitudes Toward Anthelmintic Use

Empirical studies carried out in Europe and North America more and more recognize the attitude of farmers as important factor influencing anthelmintic use behavior. Indeed, in Netherlands and Germany the beliefs of farmers regarding the efficacy of drug determine continuation to use the non effective anthelmintics (Vande Velde et al., 2018). It was also revealed that many farmers had optimistic bias and believed resistance is an issue for others rather than for themselves.

In USA, the research carried out by Woodgate et al. (2020) indicated that negative attitude toward veterinarian surveillance drove some farmers to self-administer anthelmintics without any vet consultation. It was also shown that in Sweden farmers believed resistance management practices were economically risky and as a consequence they had an unfavorable attitude toward this type of action, despite being aware about negative consequences in a long term (Hansson et al., 2019).

Results obtained from Asia, indicate that attitudes are affected by the production demands. In Pakistan, Khan et al. (2021) reported that farmers were focused on immediate production and thus had positive attitudes to repeated deworming practices independently from the scientific recommendation.

Research across sub-Saharan Africa has indicated that farmers' attitudes towards anthelmintics are mostly influenced by their own experiences, social pressures and economic vulnerability. Kanyari et al. (2021) reported that Kenyan farmers have been very much influenced by their own experience and “belief that observed weight gain after administration of drugs justified high frequency treatment of the drugs”, Similarly Kabirizi et al. (2019) demonstrated that community pressure played a major role in influencing individual farmers behavior towards deworming practices in Uganda.

In Southern Africa, research conducted in Zambia and Botswana has revealed that farmers view anthelmintics as the 'quick fix' "thus they have become very dependent on the drugs" (Phiri et al. 2020), this consequently leads to resistance towards non chemical measures for controlling the problem. The social acceptance of a broad spectrum preventive treatment is influenced by access to diagnostics, or lack of it.

The Zimbabwean literature presents an indirect account of influential attitudes towards anthelmintics, without direct investigation. Livestock health seeking behaviour studies have also indicated high confidence placed in farmers' own experiences, and information from neighbours, agro-dealers that exceeds their trust in veterinary officials (Chimonyo et al., 2020), which suggests a perception in favor of ease of access and prior familiarity over accuracy of the product. Economic instability has also played a role in developing farmer attitudes toward drug usage: preference for instant and visual results. These attitude-variables are however largely under-researched particularly in Bindura. These attitude-related studies were not available.

2.3.3 Farmers' Practices of Anthelmintic Use

On a global scale, there is a consistent empirical demonstration of inappropriate anthelmintic use. Studies from Europe, Asia and Latin America reveal the presence of widespread blanket treatments, underdosing, and lack of rotation of drug classes (Kaplan & Vidyashankar, 2021). More than half of surveyed sheep farmers in Spain according to Martinez-Valladares et al. (2020) in four different regions were reported to give anthelmintics without hazardologic test preceding.

In Brazil and Argentina, two studies found that farmers would repeatedly treat old prescriptions, and that they would share and move drugs across herds, further accelerating resistance development (Fiel et al., 2019). And they were nearly always justified as saving money.

Africa, the few quantitative studies on private providers illustrate how smallholder systems

are especially prone to poor practice given the minimal regulation and scant veterinary supervision. Onyango et al. (2020) stated that 70% or more of the farmers applied anthelmintics without any professional advice. Informal drug markets in Tanzania and Zambia accounted for a majority of the drugs, raising the risk of fake or subparamount products (Mtengeti et al., 2019).

Similarly, in a study conducted in South Africa, communal farmers often under-dose their livestock because they are concerned with costs and they are poor at estimating the correct weight of their animals (Ndlovu et al., 2021). These results have been shown to have direct implications on increased resistance. There is little or no recent empirical data in Zimbabwe concerning anthelmintic practices. Zvinorova et al., (2016) observed high parasite prevalence in the country but no actual investigation on treatment practices was conducted, while Dube et al., (2021) also identified similar patterns of resistance but no farmer-level investigation on actual anthelmintic usage was conducted and instead relied more on the diagnostics. In the absence of proper veterinary support the study concludes with evidence showing prevalent cases of self-medication of animals with medication from the black market, sporadic treatment regimes and a glaring absence of any empirical studies on anthelmintic practices of farmers in Bindura District.

2.4 Research Gaps

It is evident from this review that the literature contains a number of important trends. The most significant of these include: wide agreement among all sources on the importance of inappropriate anthelmintic use as a factor contributing to the current levels of resistance in the world in general and in Africa in particular; the good documentation of the technical and less emphasis on behavioral aspects including the farmers' knowledge, attitudes and the role of the society especially in most developing areas; a lack of district-level analyses of farmers' behavior in most of the documented studies conducted in Zimbabwe that would enable policy implementation and farmer practices to correspond. There is an immediate need for context-specific KAP data for anthelmintic usage in Bindura, which would effectively lead to the development of interventions that may ameliorate this problem. This, in turn necessitates applying the theoretical framework like TPB, which has been little utilized in studies relating to livestock management in Zimbabwe.

2.5 Role of the Current Study

The current study aims to fill these gaps and provide theoretical and empirical informed understanding on farmer knowledge, attitudes and practices (KAP) towards anthelmintic use in Bindura. This study, by combining the KAP model and the Theory of Planned Behaviour, give descriptive and explanatory results and thus advances scientific knowledge, provides meaningful information for veterinary extension service and sustainable livestock health management in Zimbabwe.

2.6 Chapter Summary

The review of the literature on the use of anthelmintics in livestock production systems primarily with a focus on KAP was addressed in this chapter. KAP model and theory of planned behavior have been identified as the theoretical framework of the research, while knowledge, perceptions, influences, intentions are the mechanisms influencing farmers' decisions to use or not use anthelmintics. Moreover, the literature on studies that have been done worldwide, in Africa and in Zimbabwe were presented. They identified common issues concerning inappropriate dosing, over use of anthelmintics, lack of awareness on proper parasite control, growing anthelmintic resistance and their causes (limited access to veterinary services, financial constraints, traditional practices). The review identified that there has been a substantial research on anthelmintic resistance and parasite control but largely with an emphasis on technical/biomedical factors and less emphasis on the behavioral aspects related to farmer's practice of use of anthelmintics. It is noticeable that in Zimbabwe, the livestock health research has been primarily focusing on the prevalence of parasite and anthelmintic resistance with very limited emphasis on farmers' knowledge, attitudes and practices especially at district level. Thus a large theoretical, empirical and contextual gap exist in relation to livestock farmers' use of anthelmintics in Bindura District.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Description of the Study Area

The research will take place in Bindura District, in the province of Mashonaland Central, the Republic of Zimbabwe, 88 km North-East from the capital City of Harare. Bindura is located at 17°18'-17°33' S latitude and 31°15'-31°30' E longitude at an elevation of about 1,100-1,200 metres above sea level. Living in rural and peri-urban setting and reliant on agriculture for their livelihoods, most of the over 156000 people that make up the population of Bindura District according to Zimbabwe National statistics agency (ZIMSTAT, 2022) are farmers. The Natural Region is where the majority of the district lies; this is where the land is suitable for mixed crop-cattle farming.

Bindura has a subtropical highland climate with a rainy summer season (from November to March) and a dry winter season (from April to October). The average precipitation lies between 750 and 1,000 mm yr⁻¹ and the average temperature varies from 12 to 15 °C during winter to 25 to 30 °C during summer. It is intersected by several rivers and streams, many of which are tributaries of the Mazowe River, which are a seasonal water source for livestock. Miombo woodland forms the dominant vegetation cover but it is punctuated by grazing lands that support concentration of cattle, goats, sheep and small ruminant. Livestock farming in Bindura is predominantly smallholder and communal, confined by land pressure with animal husbandry largely dependent on natural grazing with some supplementary feeding and regular use of veterinary drugs such as anthelmintics an obligated use which requires farmers to often self-administer the drugs to their stock

3.2 Study Design

This study used a quantitative cross-sectional case study design where livestock producers in Bindura District were surveyed. This design was suitable in this case as it helped the researcher gather information about livestock farmers knowledge, attitude and practices on anthelmintics usage at a specific point in time. A cross-sectional approach was ideal for the researcher to determine patterns of anthelmintics usage, awareness and behaviors of livestock farmers without manipulating variables or adding an experimental component to the study (Creswell, 2018).

Quantitative data was obtained using a structured questionnaire administered to livestock producers. The design was suitable as it provided quantitative data that can be analyzed to statistically determine association between socio-demographic characteristics of livestock producers and their knowledge, attitudes and practices towards use of anthelmintics.

3.4 Target Population and Sampling Frame

Population of interest consisted of livestock owners that own or manage cattle, goats, sheep or mixed herd livestock and had used anthelmintics from January 2025 to 31 December 2025 in Bindura District.

The sampling frame was derived from records available at the Department of Veterinary Services (DVS), Bindura Office and farmer lists kept by the local extension officers (AGRITEX).

3.5 Sampling Strategy and Sample Size Determination

At the first stage, the wards in Bindura District were purposively selected on the basis of livestock density and accessibility. At the second stage, villages in selected wards were sampled at random. At the last stage, the livestock owning households were selected by simple random technique using list of households available from village heads and agriculture extension officers.

The sample size for the study was calculated by Cochran's (1977) formula for cross-sectional studies:

$$n = d^2 / Z^2 p (1 - p)$$

Where:

(n) = the required sample size

(Z) = The value of the standard normal deviates/score corresponding to the desired confidence level of 95% which is 1.96

(p) = The anticipated proportion of the farmers that uses anthelmintics (p=0.5 was assumed due to no prior data)

(d) = Error of the estimation (0.05)

There were 384 farmers to minimum calculated sample size. However, a total of 350 livestock farmers were interviewed due to logistic and financial constraint, which was considered sufficient for statistical analysis and representation of the study population.

3.6 Data Collection Tools

3.6.1 Structured Questionnaire

Livestock farmers were interviewed using a pretested structured questionnaire to collect quantitative data. The questionnaire was divided into four parts:

Section A: Sociodemographic data of respondents

B: Knowledge of anthelmintic use (Type of drugs, dosing and resistance to drugs)

C: Attitudes to anthelmintic use and parasite control

D: An examination of the practice of anthelmintic administration and livestock rearing

Questions from the questionnaire were modified based on certain previously validated KAP tools from studies on the health of livestock (Bellet et al., 2018; Kanyari et al., 2021). The questionnaire contained multiple choice questions, closed ended questions and Likert scale questions. The tool was administered in English and translated into Shona where necessary to improve understanding by the respondents.

3.7 Data Collection Procedures

The data were collected from March 2006 to May 2006. Before the collection of the data, the researcher was guided on questionnaire administering and research ethics by academic supervisor. Questionnaires were administered using personal interview approach so that each question would be clearly understood and to reduce non-response rate. For every household chosen, consent was taken from household member before questionnaire was administered. Responses were documented manually on a paper questionnaire and then transcribed onto the database for analysis.

3.8 Methods Used for Each Research Objective

Objective 1: To assess farmers' knowledge of anthelmintic use

The data were collected using the knowledge section of the questionnaire. Variables were; the awareness of anthelmintic categories, the correct dosage administration, rotation of the drugs and the knowledge of resistance. The answers were ranked and classified into low, moderate and high knowledge levels.

Objective 2: To examine farmers' attitudes toward anthelmintic use

Data was obtained via the knowledge section of the questionnaire. The variables were knowledge of the types of anthelmintics available, correct dosing, rotation and resistance. The data obtained was then scored and grouped into low, medium and high knowledge

Objective 3: To evaluate farmers' practices related to anthelmintic use

Practice data were Practice data included frequency of deworming, sources of drugs, methods of dosing, and use of records. The answers were analysed to determine correct and incorrect practices of anthelmintic use in the livestock owners.

3.9 Quality Control Procedures

In order to improve validity and reliability, different steps were taken. A pilot study of 20 livestock farmers was conducted outside the target community and the questionnaire was adjusted on the basis of the information gathered and further changes were done prior to conducting main survey. Cronbach alpha values were obtained to confirm internal consistency of the items in the Likert scale. An extra effort to check data entry was done by double data entry.

3.10 Data Analysis

The data were analyzed using the SPSS version 26. The descriptive statistics; frequencies, percentages, means and standard deviations were applied to summarize sociodemographics and KAP variables. The inferential statistics were chi-square test used to determine associations between sociodemographics and KAP, logistic regression analysis to identify predictors for appropriate anthelmintic practice of livestock farmers. All analysis were tested for significance of ($p < 0.05$)

3.11 Ethical Considerations

The Department of Veterinary Services, Bindura District, gave permission to carry out the investigation. The study was voluntary, informed consent was taken from the participants, and anonymity of the information of the participants was maintained.

3.12 Chapter Summary

The materials and methods used in the study in order to determine livestock farmers' knowledge, attitudes and practices towards the use of anthelmintics in Bindura District, Zimbabwe were presented in this chapter. The study site was described and characterized on the basis of location, climate and production systems. The design of the study, which was quantitative cross sectional case study was also presented and its use for the purposes of collecting data at one point in time justified.

The target population, sampling frame, sampling method, sample size determination were all presented and discussed, how the respondents were selected. The instrument used for the study, which was a structured questionnaire, and the procedure for its administration during

the collection of the data was explained.

The methods used for achieving each objective of the study were discussed and how farmers' knowledge, attitudes and practices towards anthelmintics use were determined explained. Also the methods used in controlling quality so as to enhance the validity and reliability of data was stated. Furthermore, the statistical methods that were used to analyse the data and its interpretation through descriptive and inferential statistics were described and finally, the ethical considerations that were taken throughout the research were stated so as to safeguard the rights and confidentiality of respondents.

CHAPTER FOUR

DATA PRESENTATION, INTERPRETATION AND ANALYSIS

4.0 Introduction

This chapter discusses the results from the study titled Understanding Anthelmintic Use in Livestock in Bindura: A Knowledge, Attitudes and Practices Study among Farmers and Animal Health Professionals. It aimed at assessing knowledge, attitudes and practices of livestock farmers toward anthelmintic use in livestock production in Bindura District. Livestock farmers and animal health professionals working in Bindura District were included in the target population. A total of 350 structured questionnaires were given to livestock farmers and 20 questionnaires were given to animal health professionals. A total of 332 farmer questionnaires and 18 animal health questionnaires were correctly filled and returned which is equivalent to an overall return rate of 94.9% and 90% for farmers and animal health professionals, respectively. These results are enough for statistical analysis and reliable in drawing conclusions from the findings. Data was collected using structured questionnaires which included the socio-demographic characteristics, anthelmintic use knowledge, attitude towards anthelmintic application and livestock production methods towards parasite control. Results were presented in tables and figures, and they were interpreted using descriptive statistics such as frequency and percentage. For inference statistics, Chi-square goodness-of-fit test was used to compare results from samples at 5% significant level.

4.1 Demographic Characteristics of Farmer Respondents

4.1.1 Gender Distribution of Farmer Respondents

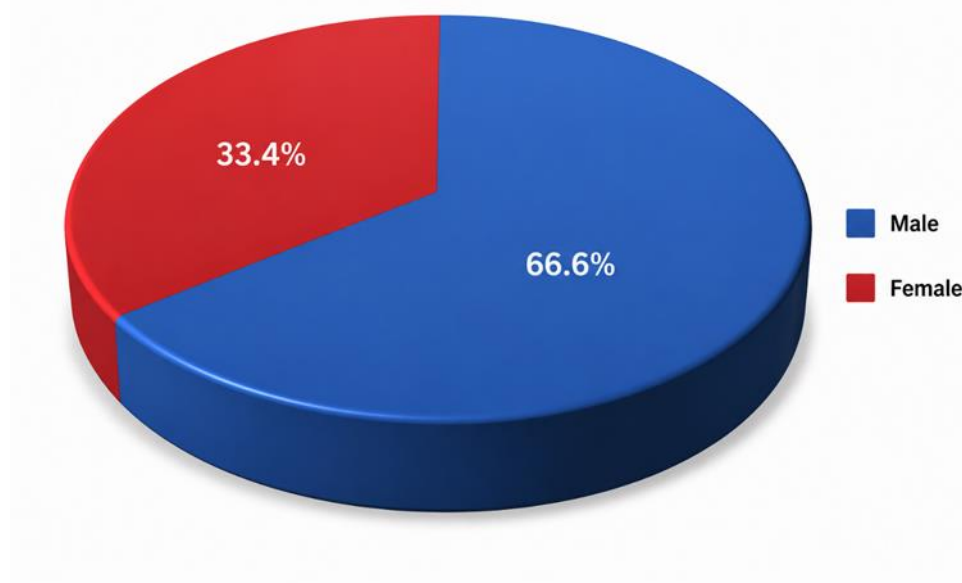


Figure 4.1: Gender Distribution of Farmer Respondents (n = 332)

Figure 4.1 Gender distribution of the farmer respondents. The analysis reveals that 221 (66.6%) of the respondents were male while 111 (33.4%) of the respondents were female. This suggests that most of the livestock activities in Bindura district are dominated by male farmers though women participation is not less.

4.1.2 Age Distribution of Farmer Respondents

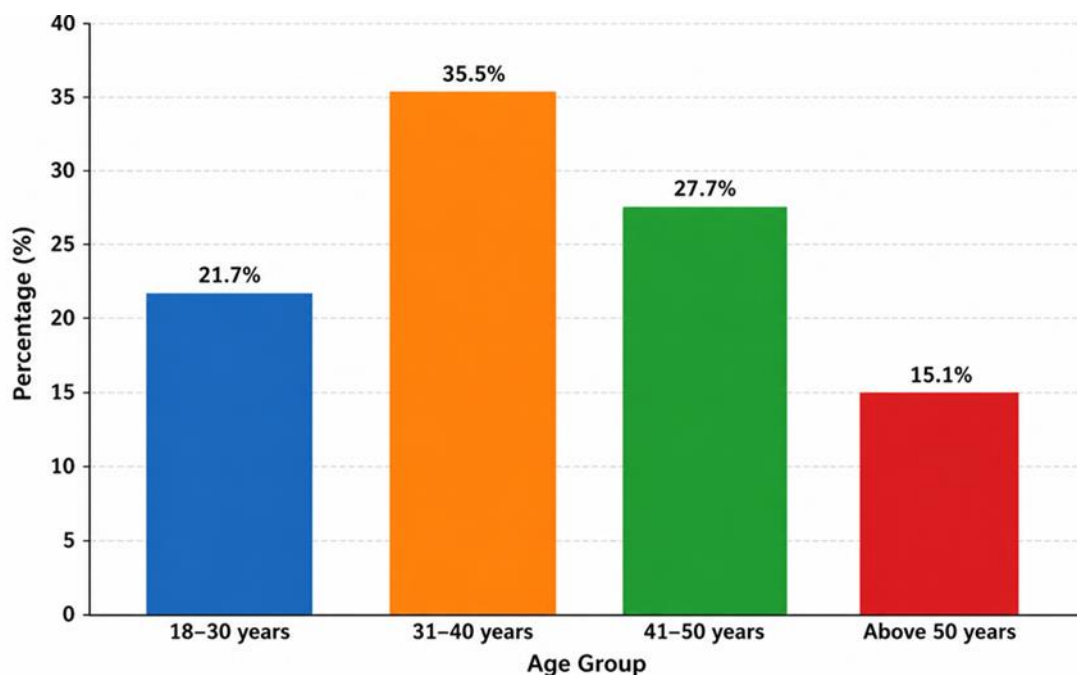


Figure 4.2: Age Distribution of Farmer Respondents (n = 332)

Figure 4.2 below shows the ages of the respondents. From the data below, majority of the respondents was found to be between the ages of 31-40 years where, 118 respondents accounted to 35.5%. The second highest group of age range were the respondents between 41-50 years and 92 respondents account for 27.7% and the group between 18-30 were 72 respondents accounting for 21.7%. Those that were 51 and above was 50 respondents, which represents 15.1%. Among all the groups, the age 31-50 represents 210 respondents of 63.2%.

4.1.3 Educational Qualifications of Farmer Respondents

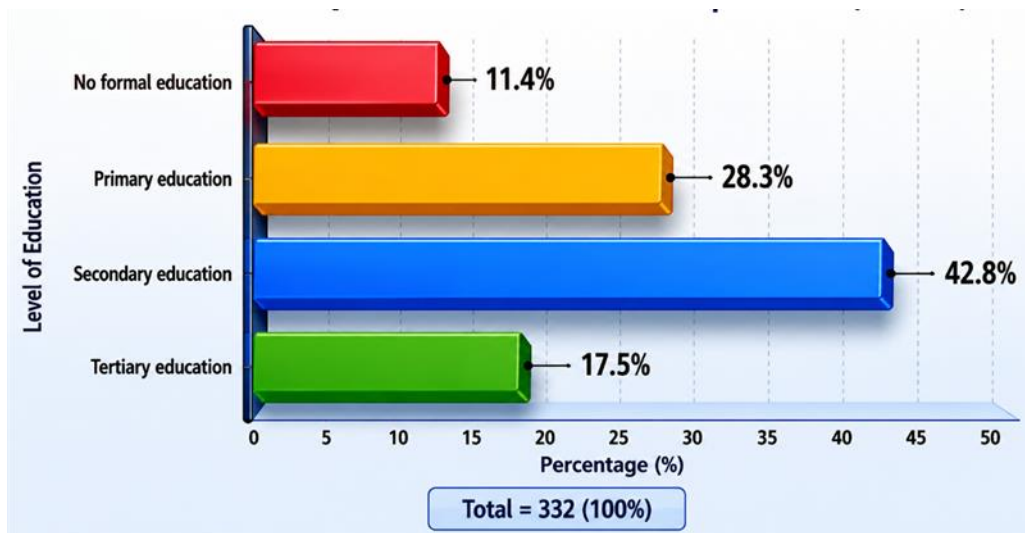


Figure 4.3: Educational Qualifications of Farmer Respondents (n = 332)

Figure 4.3 presents the education of respondents. Most respondents had secondary level of education and represented 142 respondents (42.8%). The primary education holders represented 94 respondents (28.3%). Respondents with tertiary level of education were 58 (17.5%) and the without any education had 38 respondents (11.4%). These indicate that most respondents had primary formal education at a minimum, this implies that respondents might be able to comprehend animal health information and instruction on how to use anthelmintic drug.

4.1.4 Farming Experience of Respondents

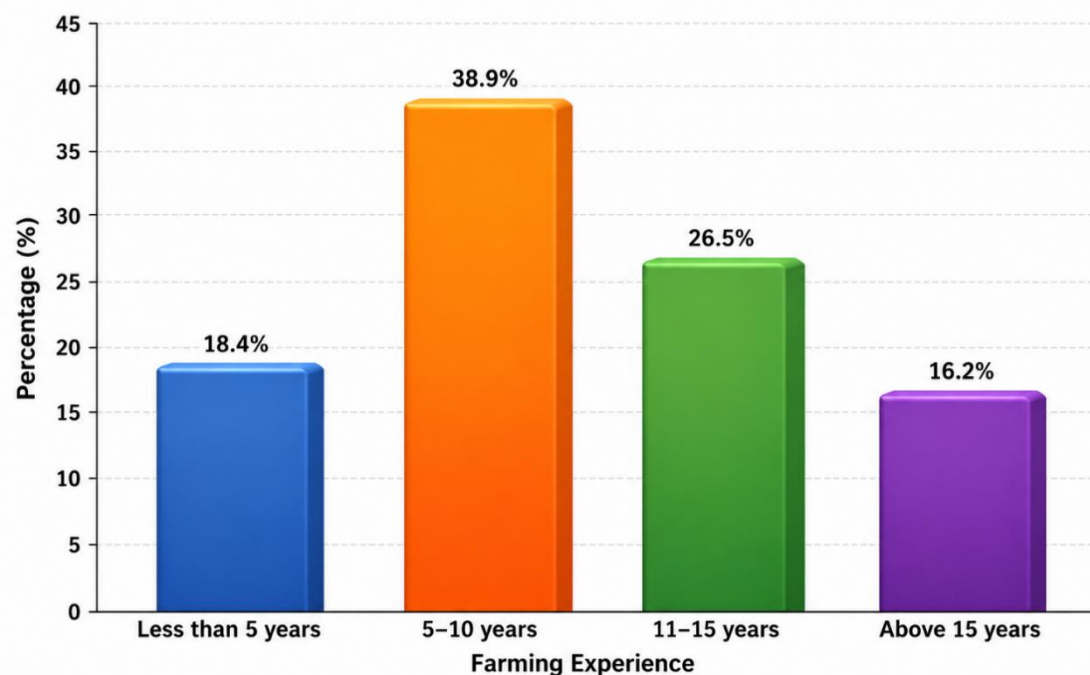


Figure 4.4: Farming Experience of Respondents (n = 332)

The farming experience of the respondents is illustrated in Figure 4.4 below. The largest percentage of respondents (38.9%) had an experience between 5-10 years and these respondents were 129 in number. This was followed by the respondents (26.5%) whose farming experience were between 11-15 years and these respondents were 88 in number. From this, it could be observed that 271 (81.6%) respondents had an experience between 6 years to 20 years in livestock production.

4.1.5 Type of Livestock Owned

Table 4.1: Type of Livestock Owned by Respondents (n = 332)

Livestock Type	Frequency	Percentage (%)
Cattle	256	77.1
Goats	218	65.7
Sheep	104	31.3
Poultry	182	54.8
Other livestock	27	8.1

Table 4.1. presents the types of livestock owned by the respondents . The findings show that the cattle enterprise was the largest livestock enterprise with 256 respondents (77.1%). Goat farming was also very common with 218 respondents (65.7%) and poultry production had 182 respondents (54.8%). The result reveals that most of the farmers in Bindura District practice mixed livestock farming.

4.2 Farmers' Knowledge of Anthelmintic Use

4.2.1 Knowledge of Anthelmintics

Table 4.2: Awareness of Anthelmintics Among Farmers (n = 332)

Response	Frequency	Percentage (%)
Yes	286	86.1
No	46	13.9
Total	332	100

Table 4.2 Awareness of anthelmintics among the respondents is presented in Table 2. The result suggests that 86.1% of the respondents (286) were aware of what anthelmintic is while 13.9% (46) of the respondents were not aware. The result also shows among livestock farmers a relatively high level of knowledge on anthelmintic drugs.

4.2.2 Knowledge of the Purpose of Anthelmintics

Table 4.3: Knowledge of the Use of Anthelmintics (n = 332)

Purpose Identified	Frequency	Percentage (%)
Worm infections	251	75.6
Bacterial diseases	28	8.4
Viral diseases	16	4.8
Do not know	37	11.2
Total	332	100

The farmers knowledge of why anthelmintics are used is depicted in Table 4.3. Most of the farmers (251 respondents or 75.6%) knew that anthelmintics are used for worm infections. A small percentage did incorrectly identify bacterial or viral diseases when they were supposed to say the other medication that farmers might use for bacterial and viral diseases indicating that a percentage of the respondents have the wrong conception of livestock medications.

4.2.3 Knowledge of Correct Deworming Frequency

Table 4.4: Knowledge of Recommended Deworming Frequency (n = 332)

Response	Frequency	Percentage (%)
Monthly	44	13.3
Every 3 months	201	60.5
Once a year	39	11.7
Do not know	48	14.5
Total	332	100

The response to the questions are reflected in Table 4.4 above, which indicated that 201 respondents (60.5%) answered every three months, which are what the study thinks is recommended. Some of the farmers also responded with the deworming intervals as monthly, and every year, and there are also other farmers who stated that they did not know.

4.2.4 Awareness of Anthelmintic Resistance

Table 4.5: Awareness of Anthelmintic Resistance (n = 332)

Response	Frequency	Percentage (%)
Yes	183	55.1
No	149	44.9
Total	332	100

Awareness on anthelmintic resistance among respondents is presented in Table 4.5. Results show that 183 (55.1%) respondents are aware of anthelmintic resistance while 149 (44.9%) respondents do not know about the term. Since the results reveal that livestock keepers have at best moderate awareness of anthelmintic resistance, it seems realistic that the corraling effort will have to continue.

Table 4.6: Inferential Statistics for Farmers' Knowledge Variables

Knowledge Variable	Test Used	Chi-square (χ^2)	df	p-value
Awareness of anthelmintics	Chi-square goodness-of-fit	24.18	1	0.001
Purpose of anthelmintics	Chi-square goodness-of-fit	31.74	3	0.000
Deworming frequency	Chi-square goodness-of-fit	27.52	3	0.002
Awareness of resistance	Chi-square goodness-of-fit	18.43	1	0.004

Results 4.6 show that at the 5% significance level ($p < 0.05$) there are significant differences between farmer responses for all knowledge related variables. The findings indicate non-random response patterns for farmers' knowledge of anthelmintic use.

4.3 Farmers' Attitudes Toward Anthelmintic Use

4.3.1 Attitudes Toward Regular Deworming

Table 4.7: Attitudes Toward Regular Deworming (n = 332)

Response	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Deworming improves productivity	45.8	34.0	9.3	6.0	4.9
Veterinary advice is important	48.2	31.6	8.7	6.6	4.9
Drug resistance is serious	40.7	30.1	13.6	9.0	6.6

Table 4.7 presents the respondents attitudes to the use of anthelmintics. In general most of the responses were centered on the agreeing response level, for all the attitudinal statements. The highest degree of agreeing response was found in relation to the use importance of veterinarian advice, and then on de-worming routinely enhances productivity. Overall positive attitudes of respondents on the correct usage of anthelmintics and deworming are found.

4.3.2 Trust in Veterinary Advice Versus Personal Experience

Table 4.8: Trust in Veterinary Advice and Personal Experience

Statement	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
I trust my own experience more than veterinary officers	29.8	25.3	14.8	18.1	12.0
Buying drugs without prescription is acceptable	24.7	28.0	16.3	18.7	12.3

Table. 4.8 reports the opinions of the farmers about the access to the veterinary advice and the level of drug purchase autonomy. The results show that a considerable fraction of

respondents is administered anthelmintics based more on experience than on consultation with a vet. Likewise, more than 50% of the participants considered that buying drugs without prescription was right, suggesting that there are different views concerning the regulated drug use practices.

Table 4.9: Inferential Statistics for Farmers' Attitudes

Attitudinal Variable		Test Used		Chi-square (χ^2)	df	p-value
Deworming improves productivity		Chi-square of-fit	goodness-	28.66	4	0.001
Importance of veterinary advice		Chi-square of-fit	goodness-	30.42	4	0.000
Drug resistance seriousness		Chi-square of-fit	goodness-	25.18	4	0.003
Trust in own experience		Chi-square of-fit	goodness-	19.56	4	0.007

Based on Table 4.9 the data for all attitudinal variables show a statistically significant difference in response, at a 5% significance level ($p < 0.05$). Most of the attitudinal variables were mostly agreement response, which shows that responses were consistent.

4.4 Farmers' Practices Related to Anthelmintic Use

4.4.1 Frequency of Deworming Livestock

Table 4.10: Deworming Frequency Among Farmers (n = 332)

Deworming Frequency	Frequency	Percentage (%)
Monthly	61	18.4
Quarterly	174	52.4
Twice a year	54	16.3
Only when animals are sick	43	12.9
Total	332	100

The Table 4.10 below reflects the frequency of deworming of livestock by the farmers. As from Table 4.10 below it was found out that Quarterly was the method commonly used by

most of the respondents, that is 174 respondents (52.4%) were found to deworm their livestock quarterly. But it was observed that there were few farmers who only dewormed their livestock when they got sick.

4.4.2 Sources of Anthelmintics

Table 4.11: Sources of Anthelmintics (n = 332)

Source	Frequency	Percentage (%)
Veterinary services	116	34.9
Agro-vet shops	157	47.3
Informal markets	42	12.7
Other sources	17	5.1
Total	332	100

Table 4.11: Major sources of anthelmintics for respondents. The most reported source was Agro-vet shops (157 respondents, 47.3%) followed by veterinary services (116 respondents, 34.9%). The result suggest that majority of the farmers obtain medicines for their livestock from private agro-veterinary outlets.

4.4.3 Dosage Practices Among Farmers

Table 4.12: Compliance With Dosage Instructions (n = 332)

Response	Frequency	Percentage (%)
Always	118	35.5
Sometimes	142	42.8
Rarely	47	14.2
Never	25	7.5
Total	332	100

According to Table 4.12, 142 (42.8%) of the respondents always sometime obey with the instructions on doses whereas 118 (35.5%) said always. Livestock farmers had diverse levels on the adherence of the given instructions on dosing procedures.

4.4.4 Rotation of Anthelmintic Drugs

Table 4.13: Rotation of Anthelmintic Drugs (n = 332)

Response	Frequency	Percentage (%)
Yes	132	39.8
No	148	44.6
Not sure	52	15.6
Total	332	100

Chapter responses about anthelmintic drug rotation are given in Table 4.13. Results show that 148 respondents (44.6%) did not rotate anthelmintics, while 132 respondents (39.8%) said they did. The results imply that there is some mixing of adherence to recommended practices in managing resistance among the livestock keepers.

Table 4.14: Inferential Statistics for Farmers' Practices

Practice Variable	Test Used	Chi-square (χ^2)	df	p-value
Deworming frequency	Chi-square goodness-of-fit	29.87	3	0.001
Source of drugs	Chi-square goodness-of-fit	24.55	3	0.003
Dosage compliance	Chi-square goodness-of-fit	26.13	3	0.002
Drug rotation	Chi-square goodness-of-fit	21.47	2	0.005

The output from Table 4.14 has demonstrated all practice relevant variables were found to be significantly responded to at 5% level ($p < 0.05$) of significance. The results indicate that there is substantial variation in the livestock management and anthelmintic treatment routines of the farmers.

4.5 Challenges Faced by Farmers in Correct Anthelmintic Use

Table 4.15: Challenges Affecting Correct Anthelmintic Use (n = 332)

Challenge	Frequency	Percentage (%)
High cost of drugs	226	68.1

Lack of knowledge	183	55.1
Lack of veterinary access	174	52.4
Drug unavailability	121	36.4
Other challenges	28	8.4

Table 4.15 Major obstacles to proper use of anthelmintics in livestock farmers: It could be seen in Table 4.15 that among all the constraints reported to be influencing the farmers use of anthelmintics, the drug costs was the biggest constraint, reported by 226 respondents (68.1% of respondents followed by the lack of knowledge and inadequate vet care. It thus shows that economics and knowledge constraints were significant issues to the farmers regarding proper use of anthelmintics.

Table 4.6 Responses from Animal Health Professionals

4.6.1 Professional Background of Respondents

Table 4.16: Professional Positions of Animal Health Professionals (n = 18)

Position	Frequency	Percentage (%)
Veterinary officers	6	33.3
Animal health technicians	7	38.9
Extension officers	5	27.8
Total	18	100

Table 4.16 outlines the professional make-up of the animal health respondents. The professional make-up of animal health respondents Animal health technicians or allied veterinary staff accounted for the majority with 7 respondents 38.9% followed by veterinary officers who were the 6 respondent 33.3%.

4.6.2 Professional Assessment of Farmers' Knowledge

Table 4.17: Assessment of Farmers' Knowledge Levels (n = 18)

Knowledge Rating	Frequency	Percentage (%)
Poor	4	22.2
Fair	8	44.4
Good	5	27.8
Very good	1	5.6

Total	18	100
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Based on the results presented in table 4.17 above, majority of the professionals felt that farmer knowledge was average (44.4% of responses).

4.6.3 Improper Practices Observed by Professionals

Table 4.18: Improper Anthelmintic Practices Observed (n = 18)

Improper Practice	Frequency	Percentage (%)
Under-dosing	13	72.2
Overuse of drugs	11	61.1
No drug rotation	14	77.8
Self-medication	12	66.7

The results showed that the most common type of malpractice reported by farmers was that drugs not being rotated.

4.7 Chapter Summary

Chapter presents findings for knowledge, attitude and practices of anthelmintic usage among the livestock farmers and animal health professionals in Bindura District. It presents the demographic characteristics of the respondents, farmer knowledge about the use of anthelmintics, their attitudes about parasite control, the animal management practices used by the respondents, the problems affecting their proper use of anthelmintics. Data were presented using figures and tables with descriptive statistics namely, frequencies and percentages, and the inferential statistics of Chi-square goodness-of-fit was used to compare distributions, all at a 5% significance level. In conclusion, it shows that there are variable degrees of farmer knowledge about the usage of anthelmintics and heterogeneous attitudes toward veterinarians advice and the way livestock farmers apply anthelmintics varied among the different farming systems in Bindura District.

CHAPTER FIVE: DISCUSSION

5.0 Introduction

In this chapter, I provide an in-depth analysis of the results obtained from the study titled Understanding Anthelmintic Use in Livestock in Bindura: A Knowledge, Attitudes and Practices Study among Farmers and Animal Health Professionals. The discussion is presented in accordance with each specific research aim in the same order as in Chapter Four. The objectives of this chapter are not to restate the already presented results but provide an interpretation and explanation of the empiric findings through relating to the used theories, the empiric literature and the practice of managing livestock health. Discussion –This chapter concentrates on the main themes of the quantitative results which include demographic characteristics of the respondents, knowledge of anthelmintics among farmers, attitudes towards anthelmintic use, livestock management, and the constraints to good use of anthelmintics. The results are critically discussed against previous work in Zimbabwe and other developing countries that have comparable livestock production systems. This chapter also discusses the potential implications of the results for animal health management, parasitic control and anthelmintic resistance management in communal and small-scale livestock farming systems. Analysis of findings is underpinned by the Knowledge, Attitudes and Practices (KAP) model, which posits knowledge as an influence on attitudes and attitudes as an influence on behavioural practice.

5.1 Demographic Characteristics of Respondents

The result of the study showed that most of the livestock farmers in Bindura District were males. This indicates that livestock rearing in the study area is still predominantly a male affair in though women involvement in agriculture sector is on the upsurge. These results agree with those of the Food and Agriculture Organization (FAO, 2021), which states that while livestock ownership and decision-making are usually male-dominated in most rural African communities due to cultural, economic and land tenure systems.

The preponderance of male respondents may also have implications on the decisions on livestock health management and use of veterinary drugs including anthelmintics. Men in communal farming systems are more likely to make decisions about the sale of animals and on disease control and veterinary costs (Chitura & Dube 2020). Nevertheless, the high female participation from this research suggests an increase in women participation in livestock production activities in rural Zimbabwe. The study further established that the majority of respondents were within the economically active age group of 31-50 years.

This study has revealed that livestock production in Bindura is dominated by a mature and economically viable person, having relevant farming experience. Similar to the findings, Mapiye et al., (2019) reported that most farmers in the livestock production system were middle-aged, attributed to farmers acquiring experience in farming, owning productive assets and engaging in the market transactions in farming activities.

From the result, majority of respondents had secondary education with a smaller percentage having tertiary education. These findings are significant as they directly relate to how a farmer can understand instructions from a veterinarian, knowledge of disease preventive measure and correct drug usage. It has been found that farmer's ability to comprehend livestock health information and adhere to veterinary advice increase with literacy level and education exposure (Mwale et al., 2021). Farmers with formal education have been noted to be in a position to implement scientific recommended practices better than those with less education.

The results also revealed that majority of the respondents had more than five years experience in livestock farming. This indicated that most of the respondents had practical knowledge and extended experience in livestock management activities. This was confirmed by Ncube et al. (2020) who reported that the farming experience plays a significant role in the recognition of animal disease, treatment choice and in introducing parasite control measures among communal livestock farmers. The predominant level of cattle ownership found in the results is indicative of the relevance of cattle production in the livelihoods in Zimbabwe. Cattle are highly appreciated in the country as a source of livelihood, cultural roles, family income and a source of food security. According to FAO (2021), cattle continue to play one of the highest economic roles in the communal farming systems in Southern Africa. Additionally, the presence of livestock ownership such as Goats and Poults further suggests the presence of mixed farming system in Bindura District.

5.2 Farmers' Knowledge of Anthelmintic Use

The results indicated that Livestock farmers have relatively high knowledge of anthelmintic drugs. The majority of the respondents knew what anthelmintics were and had identified worm infections as being the condition that is treated most commonly with them. The results indicated that the basic awareness of livestock farmers in Bindura on parasite control and livestock treatment practices is there. Rationalisation of the observed awareness levels might be linked to greater interaction between the farmers and the agro-veterinary retailers, veterinary extension services and livestock development programs within the rural farming communities.

Kanyari et al. (2021) reported similar results for livestock farmers across the East and Southern Africa region where they reported that many of the farmers are generally knowledgeable about deworming drugs because of the frequent interactions with livestock extension campaigns and veterinary services.

The results of this study also showed that there was a misconception amongst the respondents, especially about the use of anthelmintics as relatively high awareness was found, however. Some farmers believed that anthelmintics were for treating bacterial and viral diseases. The results indicated that some livestock farmers lack a full knowledge of veterinary medicines. This misconception is in line with Bellet et al. (2018) who found that many smallholder livestock farmers are likely to mix up the different types of veterinary drugs because they receive limited technical training and have poor access to professional veterinary advice. A similar study was conducted by Moyo and Masika (2020) which noted that the informal knowledge system is often used by communal farmers in choosing livestock products, leading to incorrect use of drugs.

The study also confirmed that the majority of those surveyed believed that the recommended deworming interval is quarterly. This is an indication of moderate awareness of recommended parasite control programmes among farmers. De-worming is crucial in livestock nutrition for the maintenance of productivity, reduction in parasite infestations and prevention of outbreaks of disease.

According to Kaplan and Vidyashankar (2018) correctly spaced deworming periods are crucial to control parasitic infections and development of resistance. However some respondents claimed monthly deworming, some year-round single-purpose deworming, while some other reported they deworm livestock only if the animals are obviously sick. The results have shown different perceptions on correct parasite control period between farmers. Both over-deworming and under-deworming would increase development rate of anthelmintic resistance and parasite infestation as well as reduce livestock productivity respectively. This is also reported by Van Wyk et al. (2019), who stated that wrong timing of deworming is still a driving factor in the development of anthelmintic resistance in livestock. Knowledge on anthelmintic resistance was found to be moderate, with just over a half of the respondents being familiar with it.

The research indicated that though some farmers are familiar with the problem of resistance, there are still major knowledge gaps with respect to how and why resistance develops and their implication. The findings are in line with The Theory of Planned Behavior as formulated by

Ajzen (1991), which indicated that an individual's behaviors are determined by knowledge, perceptions and beliefs. A farmer that does not have adequate knowledge on resistance issues would probably not practice correct drench rotation, correct dosage and rational control of parasites. The findings are also supported by Sutherland and Leathwick (2019) that small holder farmers in developing countries generally have a poor level of knowledge on the presence and consequences of anthelmintic resistance because of poor farmer education and poor veterinary extension services. There is a serious risk of a rapid spread of resistance to more products, and reduced efficacy of the drugs remaining available.

5.3 Farmers' Attitudes Toward Anthelmintic Use

The study has shown that livestock farmers have largely positive perceptions toward a good poultry deworming and veterinary attendant. Most of the respondents were of the opinion that regular deworming enhance productivity of livestock and that veterinary advice is needed while administering anthelmintics. These results indicate that farmers may understand the role of parasite management in enhancing the health of the animal and production outcomes. The positive attitudes observed in this study are in line with the KAP model which purports that positive attitudes related to health care interventions lead to better practice of behaviours. Similar results were also reported by Mthethwa et al. (2021) who revealed that positive attitudes among livestock farmers towards veterinary services favour the uptake of the recommended disease prevention strategies.

The opinion of deworming benefits productivity is backed by science as worm control leads to better growth rate, milk production, reproductive efficiency and health status of animals. According to Zajac and Conboy (2020), the losses on livestock productivity by the effect of internal parasites may be due to poor utilization of food, reduced weight gains and poor performance, greater susceptibility to diseases. Farmers who are aware about these gains of production, more likely will be the support of deworming process.

Furthermore, the majority of respondents found that consultation with the veterinary professionals was essential for correct use of dewormers. This may reflect the confidence of the livestock farmers to veterinary science. According to FAO (2021), veterinary extension services are important in farmer's education on drug usage, diseases diagnosis and control of parasites.

Although general acceptance of veterinary recommendations was recorded, findings also indicated that an equally high percentage of farmers trusted their knowledge and experience better than veterinary officers. Traditional knowledge and experience at the farmer level thus still plays a significant role in livestock management practices. These observations are in support of Chagunda et al. (2020), who identified farmer experience, peer consultation and indigenous knowledge as key determining factors that many community animal farmers use when dealing with livestock disease control. It is common in the region for farmers to view veterinary services as expensive and unavailable, or inaccessible, hence resort to self-treatment. In the same way, the majority of respondents approved the purchase of deworming agents without a prescription; this indicates poor regulation in access of vet drugs in livestock markets.

Similar results to the ones from Caudell et al. (2020) showed that uncontrolled access to veterinary medicines by agro-vet shops leads to the misuse of medicines by livestock farmers in developing countries.

A legitimisation of the informal selling of medicines could be associated to potential risks of under-dosing, inadequate choice of medicines, and misuse of anthelmintics. The unregulated access to veterinary medicines is mentioned as one of the main causes of the development of anthelmintic and antimicrobial resistance world-wide (WOAH, 2022).

Interestingly, most farmers seemed to consider drug resistance as a significant problem in their communities. This implies that farmers may become aware of the decreasing effectiveness of drugs and parasite treatment. These conclusions agree with the results of Kaplan (2020) who proposed that farmers are more likely to consider treatment failure as a sign of emergent resistance.

5.4 Farmers' Practices Related to Anthelmintic Use

The results of the survey indicated that there was a lot of variation in livestock management and anthelmintic usage patterns in Bindura District. Respondents' periodicity of deworming their animals was quarterly in the majority and that is the indication of compliance to some extent with parasite control regimen. This is in line with veterinary advice that recommends deworming at specified intervals to effectively control parasites.

Nevertheless, it was also shown that a proportion of farmers (18 %) would only deworm if the animals showed clinical signs of disease. Such behavior would be a strong indication of livestock health management geared towards reaction rather than prevention. As noted by Sissay et al. (2018) "it is the principle of waiting for clinical signs to show before intervening,

which increases the risk of heavy parasite infection, reduced production and increased potential for disease spread”.

The results also showed that agro-vet shops were the primary source of anthelmintics for the farmers. This shows that the private veterinary drug sellers have the largest share in livestock health care provision in Bindura District. Similar results were observed by Higham et al., (2021), who observed that agro-veterinary outlets are influential drug suppliers in the majority of rural livestock production systems because they are the most easily accessible and affordable.

Agro-vet shops have enhanced access to veterinary drugs but reliance on retail drug outlets in the absence of professional supervision may result in misuse of drugs. Many farmers acquire livestock drugs with little or no advice about dosing, withdrawal periods, or how to avoid resistance (Caudell et al.).

The results also indicated a non-uniform adherence to the dosage information among the respondents. Several farmers said that they only occasionally observe dosage instructions, some rarely or by no means listen to dosage advice. These results indicate that dosing discrepancies are common in the treatment of livestock.

Dosing errors are a major factor contributing to anthelmintic resistance. Parasites are also exposed to sub-therapeutic concentrations of the drug when under-dosing, which may result in the survival and reproduction of resistant parasites. Besier et al. (2019) also reported similar results with incorrect dosing being one of the biggest drivers for resistance in livestock systems.

It also indicated that a significant proportion of respondents did not use anthelmintic drugs rotation. Not rotating drugs leads to multiple generations of parasites being exposed to the same drugs, promoting resistance development. Strategic anthelmintic class rotation is a key component in delaying the development of resistant parasite populations (Leathwick and Besier, 2018).

These findings suggested that, while farmers may have a rudimentary level of knowledge with respect to anthelmintics, practice-based resistance management is not universally adopted.

5.5 Challenges Affecting Correct Anthelmintic Use

Several challenges facing correct anthelmintic use in farmers were observed; these include high cost of drugs, availability of veterinary services and drugs and farmer's knowledge. The

problem that featured high in responses was high cost of drugs. This is due to the fact that smallholder livestock production systems in Zimbabwe are largely facing challenges of finance and, as supported by Zimbabwe Livestock Recovery Reports (2022) the rising costs of veterinary drugs is eroding farmers' capacity to use the approved livestock treatments on a regular basis. Farmers are likely to be faced with reducing treatment intervals, buying less effective drugs, sharing treatments among animals or using inappropriate dosages in an attempt to cut costs. These are similar to what was found by Moyo et al. (2021), who noted that finance constraints affect treatment decisions among communal livestock owners.

Lack of access to the veterinary sector was also identified as a significant factor which had influenced on correct use of anthelmintics. It was reported that there is a problem with number of vet-officers for farmers living in the rural areas, also distance to the vet-facilities is big and extension services are week. FAO (2021) pointed weak veterinary delivery services as major obstacle on the way of control of livestock diseases in many developing countries. Farmer's knowledge about disease control practices, about the drugs and methods of treatment (or prevention), is the main problem influencing appropriate application of anthelmintics. A high gap in farmers' knowledge about parasite treatment and, most important, about resistance development, correct application, dosage, rotating of drugs, and about general concepts of resistance was identified in results of this survey. The problem of insufficient farmer's education was supported also by Sutherland and Scott (2020) who stressed education to be main pillar to the sustainable control strategies of parasitic infections.

Unavailability of drugs was also reported to be a problem influencing good practice in parasite control. Supply interruptions in drugs might also promote farmers to apply improper substitute drugs or to postpone the treatment schemes. Unreliable veterinary drug supply chains have detrimental impact on management of livestock diseases in many low-income countries (WOAH, 2022).

Together the economic, educational, and institutional barriers seen in this study highlight the difficulty in changing the practices of anthelmintic use in communal livestock production systems.

5.6 Perspectives of Animal Health Professionals

The results from the veterinarians showed that many veterinarians considered the knowledge of farmers on anthelmintics as fair, not good or very good. These results are broadly in line with the results of the farmers survey, which indicated a moderate level of awareness,

notwithstanding some important misconceptions about use of drugs and resistance.

Veterinarians also reported that under-dosing, overuse of drugs, self-medication, and not rotating the drugs were the most common wrong practices committed by farmers. These findings concur and support the earlier farmer based findings and thus substantiates the study by way of triangulation of responses/groups.

Perry and Randolph (2020) also reported that livestock professionals in developing countries are often witness to farmers practice irrational drug usage on communal land farmers as a consequence of poor regulation and inadequate extension support. The professional participants also emphasized the issue of farmers' limited financial resources, the unregulated sale of veterinary drugs, and farmers' lack of education as significant barriers to good parasite control. These results indicate that advancing anthelmintic use strategy is an educational matter for farmers as well as an issue for veterinarians support system, regulatory enforcement, and professional livestock health services availability.

5.7 Chapter Summary

This chapter has discussed the results of the study in light of the theories and empirical literature related to livestock health management and underdosing of anthelmintics. The discussion concluded that livestock farmers of Bindura District have average knowledge on anthelmintic application, however, critical misunderstandings and knowledge deficits exist on resistance management and dosing under unlike an increasingly does of anthelmintic an option. The results also showed that in general farmers have a positive attitude to deworming and veterinary advice, even though many still place their trust in personal experience and informal drug supply channels. Livestock rearing treatment The research also found that when it comes to treatment administration and drug rotation for livestock rearing, a number of growers are inconsistent. A number of issues hindering correct anthelmintic use were specified such as high drug prices, inadequate veterinary service, lack of farmer education, and veterinary drug shortages.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This research looked at the knowledge, attitudes, and practices among livestock owners and veterinary professionals concerning anthelmintic use in Bindura district of Zimbabwe. The results indicated that anthelmintics still hold a considerable significance in livestock health practices in small holder and commercial livestock owners. The work also indicated that the level of awareness regarding deworming and parasitic control in the livestock owners is moderate and that there are notable lack of knowledge among owners about proper dosage and drug rotation, resistance to drugs and importance of Veterinary recommended dosage as many livestock owners are using many drugs at the wrong dosages. The work also found out that the majority of the farmers view deworming and veterinary use as very important for improving the productivity of livestock and animal health. But majority of the farmers depend on their experiences, informal advise from vets and availability of readily available agro veterinary drugs in administration of deworming treatment.

This type of practice can lead to drug misuse and adds to anthelmintic resistance as an emerging problem. The results also showed that farmers have some issues that are hampering the appropriate use of anthelmintics including high cost of drugs, scarcity of veterinary services, low farmers' education, and intermittent supply of veterinary drugs. The animal health practitioners also noted under-dosing, self-medicating, overusing drugs and not rotating anthelmintics as prevalent problems impacting on livestock parasite control in the study area.

6.2 Summary of Findings

Discussion of findings in relation to the objectives The major findings of the study findings are discussed based on the objectives of the study. The relevance, contributions and limitations of the study are also illuminated at the end of the section.

Objective 1: To assess farmers' knowledge of anthelmintic use

It was concluded from the study that most livestock owners in Bindura District generally know about anthelmintics and worm treatment in livestock. Most livestock owners correctly identified worm infestation as the key disease treated using anthelmintics while majority of livestock owners knew the recommended frequency of deworming and the significance of parasite control in animal production.

However the study noted some gaps in knowledge among the farmers. Some livestock owners

knew that anthelmintics can treat viral and bacterial diseases while the same had poor knowledge of what is anthelmintic resistance and how to determine the correct drug dosage, rotation, frequency. In terms of awareness it was observed that awareness about anthelmintic resistance was at the average level and not high as it was expected.

These results suggest that while livestock farmers have some general knowledge about deworming, their knowledge about practical sustainable parasite control management is very limited. The results also potentially indicate that misinformation could have been a factor in contributing to illogical drug use habits and a higher risk of resistance development in animal production systems.

The study adds to current knowledge by establishing empiric evidence on the level of farmers' knowledge in the communal systems of livestock farming in Zimbabwe, a context hitherto under-explored. These results could therefore be used to guide veterinary services, livestock extension workers and policy makers in the development of focused farmer educative interventions to promote improved parasite management and drug use.

However, the study was limited to a single geographic district and the results may not be generalizable to the rest of the livestock production systems in Zimbabwe. Also, because data was collected using self-administered questionnaires, this could as well have led to response bias as some respondents might have given socially acceptable answers. Future research could also be extended to several districts and observational studies conducted in order to cross validate farmers responses.

Objective 2: To examine farmers' attitudes toward anthelmintic use

It was found that most farmers had positive attitude toward routine deworming, veterinary consultation and deworming practices. Most farmers also agreed that the production of livestock is enhanced by routine deworming, while many also appreciated veterinary advise on administering of anthelmintics. Quite many of the farmers had positive attitude toward the threat posed by the emerging problem of anthelmintic resistance in their areas. This means that the farmers are well aware of the role of parasite control in enhancing productivity, improving animal health and minimizing losses associated with animal diseases. It also implies that livestock owners are likely to embrace best practices regarding animal health when services are readily available.

Despite these encouraging observations however, it also observed that many farmers used their past experiences and intuition in making their treatment decisions. Large proportion of the respondents accepted to purchase vet drugs without vet prescription. These observation suggest persistence of the role of informal animal husbandry and unregulated veterinary drug dispensing system in rural livestock-producing households. The observations therefore suggests that farmer attitudes do not necessarily always correlate with correct management practices. The economic pressures, constraints on the accessibility and the existing long-term animal husbandry may still prevail in spite of the knowledge and practices in vet procedures recommended by vet professionals. This study's strengths can be seen in the fact that the researchers tested farmers' attitudes in a context specific environment of collective livestock production system in Bindura District. In this respect the study focused on testing the knowledge, attitudes, towards the use and resistance of anthelmintics which provides a critical background information regarding the behavior of the farmers' animal husbandry practices in Zimbabwe. However, cross sectional approach used in this study can only measure the knowledge and attitude of farmers at a particular point in time. Future study would thus need to consider adopting longitudinal approach which would track how farmer attitude change after they attended the vet educational intervention and aware on the existence of the resistance issue.

Objective 3: To evaluate farmers' practices related to anthelmintic use

The study indicated a variability in livestock management practices, anthelmintic administration among livestock farmers in Bindura District. Quarterly deworming was the most reported practice, indicating only a partial adherence to the recommended deworming intervals. However, other farmers deworm only when they observe clinical signs, while others use erratic deworming intervals. The findings also indicated that farmers acquire anthelmintics mostly from the agro-veterinary shops, and then from the veterinary services. Most of the farmers confirmed they only sometime follow the recommended dosage regimes while large numbers fail to rotate their anthelmintic drugs. These finding indicate a generally poor implementation of recommended parasite control and resistance management strategies. The study also confirmed that under-dosing, self-medication, irregular treatment intervals and failure to rotate deworming drugs are widespread. The Animal Health Practitioners also confirmed that poor farmer training and lax regulations of veterinary drugs distribution networks contribute greatly to the above problem.

These results suggested that, while farmers may have some knowledge of deworming, their management of correctly administering anthelmintics in the various livestock systems has not been reached optimal levels. Over usage, incorrect dosage or inappropriate administration of anthelmintics may result in a lower efficiency of treatment, low performance of the livestock and may promote resistance of the parasite population. These results further emphasize the role that agro-veterinary retailers are playing in disease management. The retail systems enhance access to the farmers to veterinary drugs, however sale of drugs without appropriate veterinary counseling may foster the irrational drug usage in the farmer level. The research added more knowledge that farmer awareness and their respective practices have a gap and knowledge only does not ensure adoption of sustainable parasite control methods. The data were collected through self response which could not represent actual observed practice, future study can combine field work, on-site examination, laboratory analysis along with questionnaire to reflect actual farmer practices regarding parasite control and estimation of resistances level in parasite population.

Objective 4: To identify challenges affecting correct anthelmintic use among livestock farmers

There were a number of the key factors, which affected the proper usage of anthelmintics, identified in the survey amongst livestock producers in Bindura district. These include the high cost of veterinary medicines (most reported by farmers), restricted access to veterinary services, poor farmer knowledge and intermittent availability of the anthelmintics.

The results have implied that the economic factors have greatly affected the decision-making with regards to the treatment of livestock among the communal farmers. This is because at high costs of medicines, a farmer may be forced to delay the treatment, decrease dosage, share the medicines between different animals or acquire substandard veterinary medicines from an unofficial source, all these will have an impact on the failure to control the parasites and possibly increase resistance development.

Restricted access to the veterinary services has been another crucial factor influencing proper use of anthelmintics. Many communal farmers found problems in access to veterinary officers as they have long distance traveling to veterinary clinics and services are too short from vet-physicians due to limited number of the veterinary officers and extension services in some areas. This situation may turn livestock farmers depend more on self-judgment, opinions of peers or information given by the sellers of the products to make decisions on treating livestock.

These results also indicated that poor farmer education is still a significant barrier to sustainable parasite control. There is a simple knowledge deficit among farmers when it comes to deworming, but many are misinformed about if, how, when, and why they should be preventing resistance, rotating drugs, doing dose calculations, and applying larval control on pasture.

This study adds a new perspective to the literature by elucidating the combinations of economic, institutional and knowledge related factors that shape use of veterinary drugs in communal livestock systems in Zimbabwe. Hence the findings indicate that promoting sustainable anthelmintic use in anthelmintic delivery systems requires intervention beyond the level of farmer education.

Yet, the study did not investigate laboratory confirmed resistance pattern among livestock herds/populations which is considered as a limitation as it was not possible to directly associate farmers practices to actual resistance patterns. Future research could therefore add parasitological testing and resistance surveillance to build stronger epidemiological evidence on the impact of prevailing livestock management practices.

6.3 Recommendations

Based on the findings of the study, the following recommendations are proposed:

Strengthening farmer education and awareness programs

Farmer education programs through which farmers are aware of the accurate use of anthelmintics, its resistance, calculating the dosage, strategic deworming should be improved by the Department of Veterinary Services and AGRITEX. Awareness campaigns should be performed on community basis, in farmer field schools, in the villages. Health training programs on animal health practices should be held periodically in livestock communities in the rural areas.

Improvement of veterinary extension services

To increase access of veterinary extension services at rural level, Government and livestock development actors should increase veterinary personnel, improve mobile outreach service and farmer access to professional advices on livestock health care.

Regulation of veterinary drug distribution systems

Relevant regulatory bodies need to enhance surveillance and control on the sales of veterinary drugs in the agro-veterinary shops. Action should be taken to ensure that the livestock producers are adequately advised on dose rates, withdrawal periods and resistance management at the point of sale of anthelmintics.

Promotion of sustainable parasite management practices

The Veterinary authorities should advocate integrated approach to parasite management where strategic deworming, adequate drug rotation, correct drug dosing and monitoring of parasite burden are implemented. Furthermore the farmers should be encouraged to adopt a preventative animal health management system rather than a curative one.

Improvement of access to affordable veterinary drugs

Government and livestock development agencies need to consider ways of enhancing accessibility and affordability of quality veterinary drugs in the rural farming communities. Subsidized veterinary drugs schemes and livestock health cooperatives can help poor farmers to access recommended treatments.

Strengthening resistance surveillance systems

Regular monitoring systems need to be set up by the Department of Veterinary Services for the surveillance and recording of anthelmintic resistance patterns in livestock populations. Evidence-based parasite control strategies and judicious use of the currently available anthelmintic products would benefit from these resistance surveillance programs.

6.4 Areas for Further Studies

Future research efforts can extend these inquiries regarding the use of anthelmintics and livestock parasites in order to yield an extensive view of livestock health systems in Zimbabwe. Certain areas could be explored:

- Further studies examining resistance prevalence to anthelmintics among livestock by laboratory parasitology testing methods.
- Comparative analysis on anthelmintic usage by livestock producers in various districts, provinces, and animal husbandry systems in Zimbabwe.
- Analysis of the impact of veterinary extension services and farmer education on livestock parasite control practices.
- Further evaluation on the link between knowledge level of livestock farmers and the actual development of livestock parasite resistance.
- Economic impact of livestock parasites and their resistance on livestock productivity and household economy.

- Longitudinal research to understand dynamics of farmer knowledge, attitudes and practices before and after exposure to resistance knowledge and veterinary education programs.
- Research to analyze behavior of agro-veterinary retailers as predictors of farmers' animal treatment practices and animal drug usage.
- Studies examining the effect of alternative and integrative parasite control methods in order to minimize the dependence of intensive livestock production systems on chemicals such as anthelmintics.

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QUESTIONNAIRE 1: FARMERS

SECTION A: Socio-Demographic Information

1. Age: ____ years
2. Sex:
Male ☐
Female ☐
3. Level of education:
No formal education ☐
Primary ☐
Secondary ☐
Tertiary ☐
4. Farming experience: ____ years
5. Type of livestock owned (tick all that apply):
Cattle ☐
Goats ☐
Sheep ☐
Poultry ☐
Other: _____ ☐
6. Herd size:
Small (1–10) ☐
Medium (11–30) ☐
Large (31+) ☐
7. Main source of income:
Farming ☐
Formal employment ☐
Informal trading ☐
Other: _____ ☐

SECTION B: KNOWLEDGE OF ANTHELMINTIC USE

8. Do you know what anthelmintics are?
- Yes ☐
- No ☐
9. Anthelmintics are used to treat:
- Bacterial diseases ☐
- Worm infections ☐
- Viral diseases ☐
- I don't know ☐
10. How often should livestock be dewormed?
- Monthly ☐
- Every 3 months ☐
- Once a year ☐
- Don't know ☐
11. Do you know that incorrect dosing can cause drug resistance?
- Yes ☐
- No ☐
12. How do you determine dosage?
- Visual estimation ☐
- Weighing livestock ☐
- Veterinary instruction ☐
- Guesswork ☐
13. Have you heard of anthelmintic resistance?
- Yes ☐
- No ☐
14. If yes, what causes it? (tick all that apply)
- Under-dosing ☐
- Overuse of drugs ☐
- Wrong drug selection ☐
- I don't know ☐

SECTION C: ATTITUDES TOWARD ANTHELMINTIC USE

15. Deworming livestock regularly improves productivity.

Strongly Disagree ☐

Disagree ☐

Neutral ☐

Agree ☐

Strongly Agree ☐

16. Veterinary advice is important when using anthelmintics.

Strongly Disagree ☐

Disagree ☐

Neutral ☐

Agree ☐

Strongly Agree ☐

17. I trust my own experience more than veterinary officers.

Strongly Disagree ☐

Disagree ☐

Neutral ☐

Agree ☐

Strongly Agree ☐

18. Anthelmintics should be used only when animals show symptoms.

Strongly Disagree ☐

Disagree ☐

Neutral ☐

Agree ☐

Strongly Agree ☐

19. Drug resistance is a serious problem in my area.

Strongly Disagree ☐

Disagree ☐

Neutral ☐

Agree ☐

Strongly Agree ☐

20. Buying drugs from agro-vet shops without prescription is acceptable.

Strongly Disagree ☐

Disagree ☐

Neutral ☐

Agree ☐

Strongly Agree ☐

SECTION D: PRACTICES OF ANTHELMINTIC USE

21. How often do you deworm your livestock?

Monthly ☐

Quarterly ☐

Twice a year ☐

Only when sick ☐

22. Where do you obtain anthelmintics?

Veterinary services ☐

Agro-vet shops ☐

Informal markets ☐

Other: _____ ☐

23. Do you follow dosage instructions?

Always ☐

Sometimes ☐

Rarely ☐

Never ☐

24. Do you rotate anthelmintic drugs?

Yes ☐

No ☐

Not sure ☐

25. Do you keep treatment records?

Yes ☐

No ☐

26. What challenges do you face in using anthelmintics correctly? (tick all that apply)

High cost ☐

Lack of knowledge ☐

Lack of veterinary access ☐

Drug unavailability ☐

Other: _____ ☐

QUESTIONNAIRE 2: ANIMAL HEALTH PROFESSIONALS

SECTION A: Professional Background

1. **Age:** ____ years

2. **Sex:**

Male ☐

Female ☐

3. **Qualification:**

Diploma ☐

Degree ☐

Masters ☐

Other: _____

4. **Position:**

Veterinary officer ☐

Animal health technician ☐

Extension officer ☐

Other: _____

5. Years of experience: ____ years

SECTION B: KNOWLEDGE OBSERVED AMONG FARMERS

6. How would you rate farmers' knowledge of anthelmintics?

Poor ☐

Fair ☐

Good ☐

Very good ☐

7. Common farmer misconceptions include (tick all that apply):

Overdosing is more effective ☐

Deworming only when animals are sick ☐

Herbal remedies are enough ☐

I don't know ☐

8. Do farmers understand anthelmintic resistance? Yes ☐ No ☐ Partially ☐

SECTION C: ATTITUDES OBSERVED

9. Farmers trust veterinary advice in your area. Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree ☐

10. Farmers prefer agro-vet shops over veterinary services. Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree ☐

11. Economic constraints influence farmers' drug choices. Strongly Disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly Agree ☐

SECTION D: PRACTICES OBSERVED

12. Common improper practices observed (tick all that apply):

Under-dosing ☐

Overuse of drugs ☐

No rotation of drugs ☐

Self-medication without guidance ☐

13. Frequency of veterinary consultation by farmers:

Often ☐

Sometimes ☐

Rarely ☐

Never ☐

14. Major challenges affecting correct anthelmintic use:

Drug availability ☐

Cost of services ☐

Poor farmer education ☐

Weak enforcement of regulations ☐

SECTION E: OPEN-ENDED QUESTIONS

15. What strategies can improve correct anthelmintic use in Bindura?

16. Any additional comments on livestock parasite control?
