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Factors Affecting Utilisation of Indigenous Knowledge to Control Gastrointestinal Nematodes in Goats

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Abstract: Adoption and utilisation of indigenous knowledge (IK) is declining. The objective of the current study was to determine differences in the extent of use of IK to control gastrointestinal nematodes (GIN) in goats between wet and dry environments. A structured questionnaire was used to collect data. Almost all households used IK in controlling parasites. There was a close association among environment, gender, and religion ($p < 0.05$) on IK use. Farmers who were less poor were 2.38 times more likely to use IK ($p > 0.05$) than farmers that were poor. Adults were 1.20 more likely to use IK ($p < 0.05$) than younger people. Unemployed farmers were 4.26 more likely to use IK compared to their employed counter parts ($p < 0.01$). Having a herbalist in the community was 3.6 times more likely to influence the use of IK ($p < 0.05$) compared to the environment in which there was no herbalist. Farmers that received informal education in the dry environment were 5.88 times more likely to use IK ($p < 0.05$) than those in the wet environment. Farmers who practised traditional Zulu culture were 2.05 times more likely to use IK compared to those following the Christian faith ($p < 0.05$). The considerable variation in the adoption of IK suggests that intervention strategies that advance IK use should consider the socio-demographic information of the community.

Keywords: anthelmintic plants; ethno-veterinary knowledge; helminthiasis; small ruminants

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1. Introduction

Goat production in sub-Saharan Africa (SSA) is increasing significantly [1]. Developing countries are characterised by marginal and degraded lands, water scarcity, and harsh environmental conditions, in which the survival of imported goats is low. Indigenous goats are, therefore, predominant [2]. Indigenous goats are a backbone of rural economies and useful for nutrition and poverty alleviation [3]. Goats are also kept for traditional ceremonies and help during times of crop failure [4]. Despite their contribution, goat rearing is often characterised by low levels of management, lack of good animal husbandry practices, and lack of veterinary care. Low productivity is also exacerbated by high infestation with infectious diseases and parasites. Gastrointestinal parasitic infestation is rife due to warm temperatures and inadequate control measures [5,6].

Control of GI (gastrointestinal) nematodes using conventional anthelmintic drugs is not sustainable due to inconsistent supply, high prices, reduced efficiency because of incorrect dosages, and use of expired drugs [7]. These challenges contribute to the development of resistance against anthelmintics by nematodes [8]. The presence of chemical residue in animal products also limits the use of anthelmintics. Development of sustainable, affordable, integrated, novel, and non-chemical approaches to treat GI nematodes are required. One such strategy is to promote the use of indigenous knowledge (IK). Utilisation of IK may depend on socio-economic and demographic status [9], cultural and religious beliefs, gender, age, ethnicity, and environmental conditions [10–13].

Urbanisation, accessibility to resources, and presence of extension services actively contribute to the loss of IK. Changes in vegetation structure due to climate change also

influence the species of plants available at any given community. The influence of these factors on IK utilisation needs to be considered when designing sustainable strategies that promote goat health under resource-limited environments. The objective of the study was to determine factors influencing IK use to control GI nematodes in goats. The hypothesis tested was that the factors influencing IK used are similar in both wet and dry environments.

2. Materials and Methods

2.1. Ethical Clearance

The respondents' rights, religions, culture, and dignity were respected. The respondents were assured that no confidential information would be disclosed, and they had a right to stop the interview whenever they did not feel comfortable. The experimental procedures were performed according to the ethical guidelines specified by the Certification of Authorization to Experiment on Living Humans provided by the Social Sciences—Humanities & Social Sciences Research Ethics Committee (Reference No: HSS/0852/017).

2.2. Description of Study Site

The study was conducted at Jozini Municipality (Figure 1) of Umkhanyakude district in the Northern part of KwaZulu-Natal Province lying at 27°24′06.9″ S; 32°11′48.6″ E [14]. Jozini experiences a subtropical climate, with an average annual rainfall of 600 mm. The average daily maximum and minimum temperatures are 20 °C and 10 °C. The altitude ranges from 80 m to 1900 m above sea level. The vegetation at Jozini consists of coastal sand-veld, bushveld, and foothill wooded grasslands [15]. One of the agricultural practices of people at Jozini is to raise livestock extensively. KwaZulu-Natal forms one of the leading provinces in South Africa with the largest number of goats in communal production systems [16]. The selection of the study site was based on high dependence on IK by farmers [17] and the high population of goats in the area. The most common parasites constraining goat productivity in the study site are helminths, ticks, and tapeworms. Ticks are more important in the wet environment than the dry environment.

The environment is categorised as wet and dry environments. The wet environment is characterised by high rainfall that favours growth of many medicinal plants used by farmers to treat their livestock. The dry environment is a rangeland that is dominated by poor rainfall patterns, with limited plant availability. The study was conducted in villages that had high goat populations. The villages were Nyawushane, Biva, Mkhonjeni, Madonela, Makhonyeni, Mamfene, Mkhayana, and Gedleza. The eight communities were randomly selected from communities active in goat production. Four communities were from the dry environment and four from the wet environment.

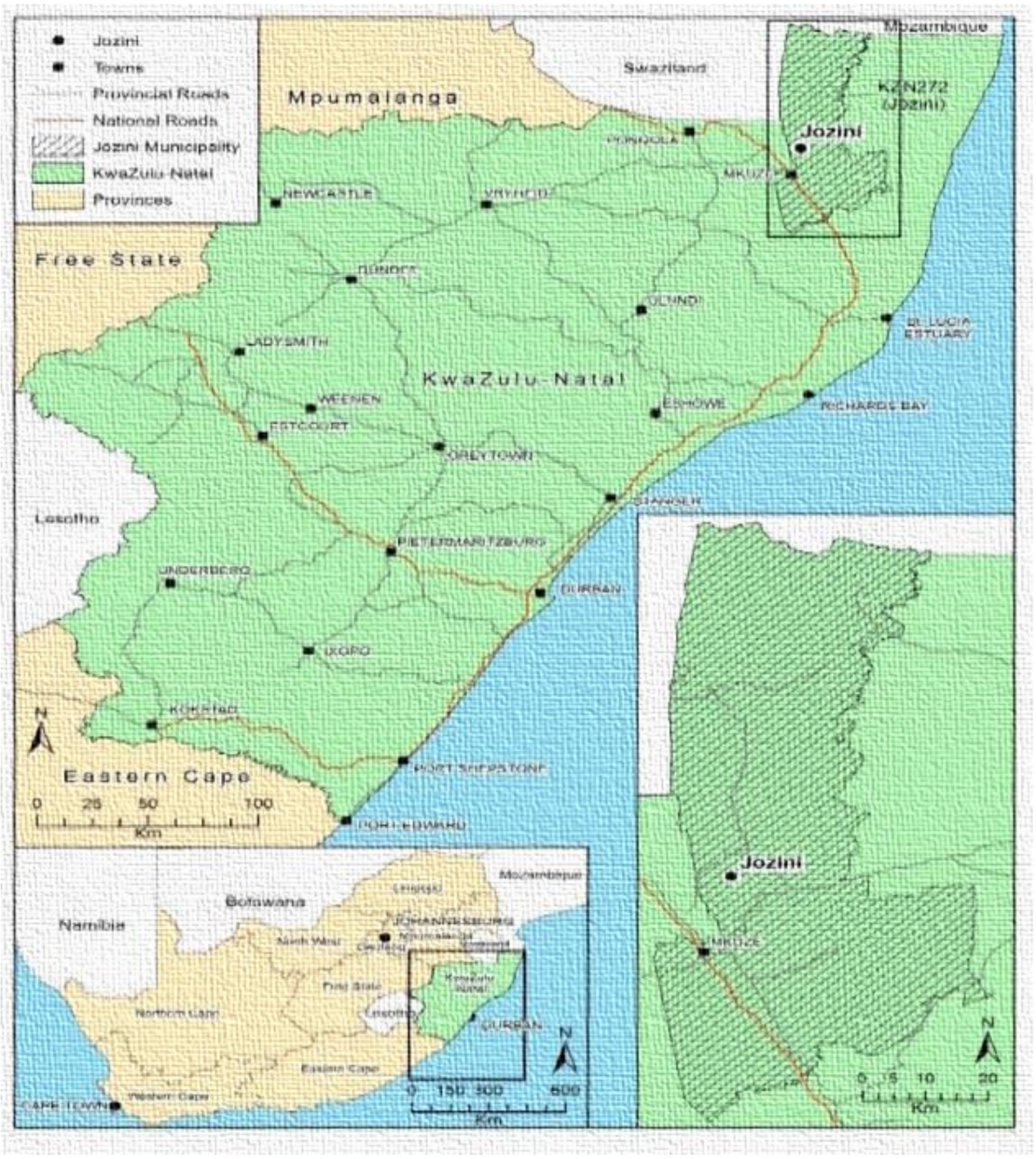

Figure 1. Location of the study site.

2.3. Data Collection

A total of 294 households were interviewed within their own homesteads. Data were acquired through interviews using a structured questionnaire. Questionnaires were administered in the IsiZulu vernacular by trained enumerators. Enumerators were obtained from local communities. Meetings with local authorities, such as chiefs and local headmen, were conducted to enable easy access to communities. Local livestock officers, veterinarians, farmers' associations, and extension officers from the Department of Agriculture were interviewed to help in identifying communities to generate a list of farmers that kept goats, and to give an overview of the challenges of controlling GI nematodes in livestock. Households were selected based on goat ownership and willingness to participate in the study.

Data were collected on household demographics and the socio-economic status of households. The questionnaire also captured the extent of use of IK to control GI nematodes reasons for using IK, measures used to control GI nematodes, and factors influencing the use of IK (Appendix A).

2.4. Statistical Analyses

All data were analysed using SAS (2013). An ordinal logistic regression (PROC LOGISTIC) was used to estimate the odds ratio of the factors influencing the use of indigenous knowledge to control GI nematodes. The gender of the household farmer, age, education status, residence, employment status, livestock training, member of farmer association, type of environment and presence of herbalists in the area were fitted in the logit model. The following logit model was used:

$$\text{In}\,[P/1-P] = \beta_0 + \beta_{1\times 1} + \beta_{2\times 2}\ldots + \beta_{t\times t} + \varepsilon$$

where: P = probability of the group using indigenous knowledge; $[P/1-P]$ = odds ratio of the group using indigenous knowledge; β_0 = intercept; $\beta_{1\times 1}$... $\beta_{t\times t}$ = regression coefficients of predictors; ε = random residual error.

3. Results

3.1. Household Demographic Information

Household demographic information of farmers who participated in the study is shown in Table 1. There was an association between environment and livestock training in the use of IK ($p < 0.01$). Farmers in the wet environment that had received livestock training (80%) used IK more than those in the dry environment. Farmers who attended tertiary education were less likely to use IK in both environments to control GI nematodes.

Table 1. Household demographic information of farmers participating in the study.

Characteristics	Wet Environment (158)	Dry Environment (136)	χ^2	Significance
Gender				
Male	49	59	2.988	*
Females	51	41		
Age				
18–30	6	4.2		
31–50	43	40	0.655	NS
>50	52	56		
Level of education				
No formal education	39	38.1		
Grade 1–7	35	34	0.377	NS
Grade 8–12	25	27		
Tertiary	0.70	1.36		
Source of income				
Livestock sales	31	26.3		
Crops	16	16.1		
Salary	13	17	3.331	NS
Government grants	36.7	40.2		
Other	3.13	0.73		
Religion				
Christianity	39	45	10.372	**
Traditional	61	55		
Livestock training	80	20	11.433	**

Other—represents other sources, such as money from working sons and daughters, ploughing for neighbours and taxi driving. * Significant association at $p < 0.05$, ** $p < 0.01$, NS not significant ($p > 0.05$). χ^2—represents a Chi-square value.

3.2. Reasons of Using Indigenous Knowledge

Figure 2 shows the ranking of major reasons for using IK. As expected, farmers ranked the purposes of using IK differently ($p < 0.05$) in both environments. Approximately 70% of farmers in the wet environment ranked effectiveness as their major reason for using IK compared to those in the dry environment (50%). Farmers ranked availability of medicinal plants second in the wet environment. The use of IK in the wet environment was influenced by affordability more than for their counterparts in the dry environment. Most farmers reported that IK produces similar results as conventional knowledge (CK).

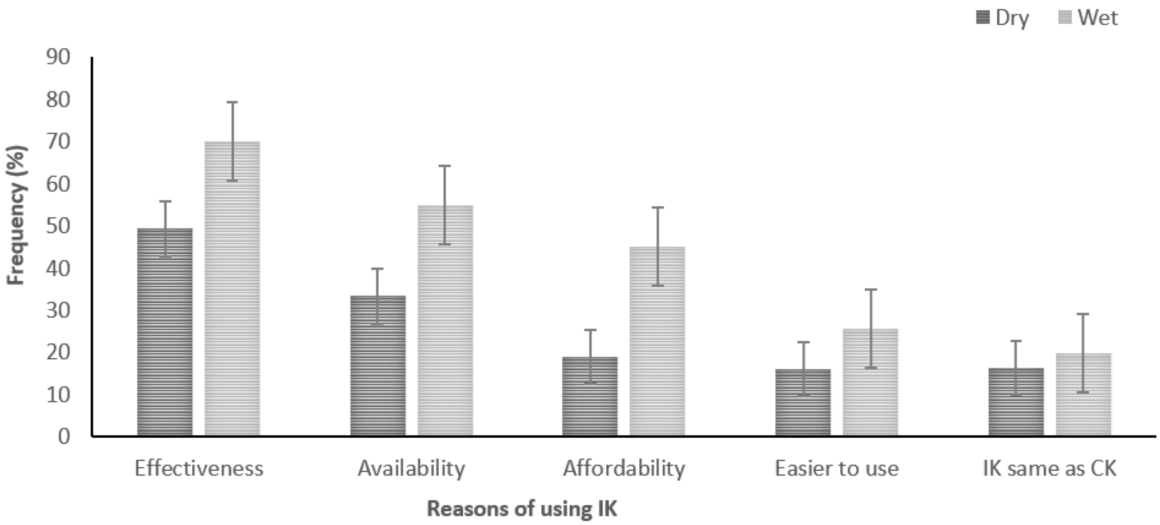

Figure 2. Reasons for using indigenous knowledge to control nematodes in goat. IK: Indigenous knowledge, CK: Conventional knowledge. Effectiveness: works as well as CK; Availability: easily accessible; Affordability: lower cost; Easier to use, does not require a manual for instructions.

3.3. Indigenous and Conventional Methods Used to Control Nematodes

Table 2 shows the indigenous and conventional methods used to control nematodes. Farmers used both IK and conventional knowledge to control GI nematodes. Most farmers in the dry environment used dewormers (54%) to control GI nematodes in goats ($p < 0.05$). There was no effect of vaccinating goats in both environments ($p > 0.05$).

Table 2. Measures used to control gastrointestinal nematodes.

	Methods Used	Environments		*p*-Value
		Wet Environment	Dry Environment	
Conventional Knowledge	Dewormers	45	54	*
	Injections	47.7	52.3	NS
	Vaccination	50.5	49.5	NS
Indigenous Knowledge	Use of plants	68	32	**
	Non-plant based material	40	60	**
	Occasional pasture burning	69	31	**

* $p < 0.05$, ** $p < 0.01$, NS: Not significant.

Of those using ethno-veterinary plants, a significant population (68%) was from the wet environment and only 32% was in the dry environment ($p < 0.01$). The majority of the farmers ($p < 0.01$) in the dry environment depended on non-plant-based materials (60%) to control GI nematodes. About (69%) and (31%) of farmers in the wet and dry environment ($p < 0.05$), respectively, practised occasional pasture burning.

3.4. Odds Ratio Estimates of the Factors Influencing IK Use to Control Nematodes in Goats

The odds ratio estimates for the factors influencing IK use is shown in Table 3 Male farmers in the wet environment were 1.69 times more likely to influence the extent of use of IK than their female counterparts ($p < 0.05$). Youths residing in the wet environment were 1.47 times more likely to influence the use of IK. Farmers who received informal education were 1.85 times more likely to influence IK use in the wet environment ($p > 0.05$).

Table 3. Odds ratio estimates, lower (LCI) and upper confidence interval (UCI) of the factors influencing the use of IK to control gastrointestinal nematodes in the wet and dry environment.

Predictor	Wet Environment			Significance	Dry Environment			Significance
	Odds	LCI	UCI		Odds	LCI	UCI	
Gender (male vs. female)	1.69	0.47	6.90	*	8.05	1.14	16.11	**
Age (adult versus youth)	0.68	0.17	2.63	*	1.20	0.068	6.04	*
Education (formal vs. informal)	0.54	0.13	2.23	NS	0.17	0.01	1.46	NS
Employment (unemployed vs. employed)	1.36	0.51	4.02	NS	4.26	0.03	1.92	**
Religion (tradition vs. Christianity)	1.11	0.42	2.93	*	2.05	0.42	7.93	*
Livestock training (yes vs. no)	0.54	0.14	1.26	NS	1.74	0.34	5.52	*
Socio-economic status (poor vs. less poor)	0.42	0.36	5.75	NS	1.67	0.36	5.75	NS
Herbalist (yes vs. no)	1.03	1.61	11.96	*	3.63	1.61	9.96	**

Higher odds ratio estimates indicate greater difference in occurrence between levels of predictors; * $p < 0.05$; ** $p < 0.01$; NS = Not different ($p > 0.05$), vs. indicates versus.

Farmers who believe in tradition ($p < 0.05$) were 1.11 times more likely to influence the use of IK to control GI nematodes than farmers who practice Christianity. The probability that farmers who did not receive livestock training influence the use of IK was 1.4 times higher ($p > 0.05$) than that of farmers that were trained. Farmers who are less poor are 2.38 times more likely to influence the use of IK ($p > 0.05$) than farmers that are poor. The probability of having a herbalist in the wet environment was 3.6 times more likely to influence the use of IK ($p < 0.05$). The probability of gender influencing the extent of use of IK was significant ($p < 0.01$). Farmers who are males were 8.05 times more likely to use IK to control nematodes in the dry environment. Adults in the dry environment were 1.20 times more likely to influence the use of IK. Farmers that received informal education in the dry environment were 5.88 times more likely to influence the use of IK ($p < 0.05$). Unemployed farmers were 4.26 times more likely to influence the use of IK in the dry environment compared to their employed counterparts ($p < 0.01$).

Farmers who practised traditional Zulu culture in the dry environment were 2.05 times more likely to influence the use of IK compared to those who are Christians ($p < 0.05$). The probability of receiving livestock training was 1.74 times more likely to influence the use of IK in the dry environment. The likelihood of having a herbalist in the dry environment was 3.63 times more likely to influence the extent of use of IK ($p < 0.01$).

4. Discussion

The significant association between environment and gender on IK use was expected. However, it was also expected that in both environments, men would use IK similarly because they normally make decisions about livestock, including goats. Male farmers attend livestock meetings, which then increases their knowledge of IK. Women seek education about how to raise goats because they depend on the goats for income generation and food security. The finding that the majority of females in the wet environment use IK could be influenced by the fact that the majority of households are now headed by women [18]. Farmers whose religious belief is traditional used IK more in both environments, which was expected. The finding that, in the wet environment, most livestock trained farmers used IK could be due to the influence of plant availability and accessibility compared to those in the dry environment.

Livestock information is usually shared through livestock organisations and dip tank committees [19], whose membership is generally limited to men who are the legal owners of livestock. The association of the high availability and accessibility of remedies in the wet environment with farmer support groups can also boost knowledge levels of IK because they witness other farmers sharing their ideas. The observation that farmers above 50 years of age in both environments used IK could presumably be due to the fact that older generations are sole bearers of IK, and they mostly own livestock, whereas younger generations are unlikely to own livestock due to career advancement and migration to urban areas [20]. Members of the younger generation neglect IK because they associate the knowledge with witchcraft and backwardness, hence making it difficult for the older generation to share knowledge with them [10].

Use of IK by farmers with no formal education in both environments is attributed to a high level of illiteracy, whereby they cannot read instructions written on conventional anthelmintics. Their low-income status also reduces the affordability of conventional drugs.

The perception that farmers used IK because of its effectiveness more in the wet than dry environment could be due to the fact that, because the vegetation grows well in this environment, there is a wide variation of plants with anthelmintic properties compared to the dry environment [10]. Culturally linked traditions and trust in IK influences its effectiveness more than CK, although some participants stipulated that the efficiency of these methods is the same. This could also explain the high use of IK due to availability in the wet environment compared to the dry environment. Mkwanazi et al. [10] agrees with this finding, however, Gumbochuma et al. [21] reported that people view the efficacy of indigenous practices to be low. Most farmers in both dry and wet environments were of the perception that IK produces similar results as CK, which could mean that farmers deem the efficacy of these two forms of knowledge to be the same, hence, the need for knowledge complementarity. The easier use of IK in both environments could be because practical training is provided by elders to younger generations.

The observation that farmers in the dry environment depend more on dewormers to control GI nematodes could be linked to scarcity of medicinal plants in the area because more plants have been lost due to climate change. This finding, however, disagrees with that of Masika et al. [22]. The finding that farmers in both dry and wet environments vaccinate their goats could be due to the influence of extension services, who usually offer veterinary precautions to farmers. The use of vaccination programmes could also be the factor limiting IK adoption by extension services. Extension services are trained using Western science, hence, it is hard for them to accept IK because it is not considered to be scientifically approved. Thus, lessons from veterinary structures and other veterinary institutions of higher training should be merged with the knowledge gained by people at the ground level.

The finding that IK was the most prominent method used to control GI nematodes agrees with Masika et al. [22], who reported that 75% of farmers in resource-limited areas use traditional medicine to treat livestock. Medicinal plants are locally available in natural vegetation, which makes them easily accessible and affordable [23]. The higher use in plant remedies in the wet environment could be influenced by the abundance of vegetation that possesses anthelmintic properties in the area. There is need to control and develop methods that farmers can use to grow plants to ensure IK remains sustainable in the future. Farmers in the dry environment depend on non-plant-based materials because, due to the absence of medicinal plants possessing anthelmintic properties and their limited diversity, farmers have to seek possible approaches to deal with GI nematodes. The observation that the majority of the farmers in the wet environment practice occasional pasture burning is difficult to explain. A possible explanation for this result, however, could be that farmers burn pastures to limit re-infection of pastures with parasites, even though this approach is not recommended because it reduces feed availability.

The finding that odds ratio estimates were in favour of males in both environments to influence the use of IK could be due to the fact that decision-making processes in resource-

limited households are widely influenced by men as household heads, irrespective of whether they own livestock, stemming from cultural ideologies that dictate the roles between men and women. Most males grow up herding livestock as the cultural norm, enabling them to gain knowledge in animal husbandry. Men are seen as having superior knowledge in terms of what should not be done [10]. Differences in knowledge and perception between men and women can also be partly explained by the consequence of sexual division in traditional societies because learning is culturally conditioned. For example, kraals are traditionally considered a sacred space and women are not allowed to enter under normal circumstances because they are seen to be contaminating it, which could lead to sickness and death of livestock. The issue of gender bias that favours men, where kraal access is patriarchal and of a strictly territorial nature, resonates with Mkwanazi et al. [10]. Such patriarchal setups need to be considered when designing sustainable goat management programmes due to increased dominance of women in goat production.

The observation that age influenced the use of IK was anticipated in both environments. It was, however, surprising that in the wet environment the odds were in favour of younger people. This finding could be influenced by the scarcity of job opportunities for young people, hence, farming becomes the gateway. The observation that in the dry environment adults influenced the use of IK could be because the older generation is usually the sole bearer and recognises the usefulness of IK more than youth. It is also logical that, with progressive age, people tend to have more time to accumulate knowledge and thus become more informed than the younger generation [9]. Other authors explain the lower level of knowledge in the younger population in terms of the ongoing socio-economic and cultural changes. Hence, there is need to close the barriers and age gaps to ensure that there is smooth transition of IK from elders to younger generations. The need for government institutions to revive IK could be useful in creating opportunities for young people. The observation that the level of education influenced the use of IK with the odds in favour of farmers who received informal education in both environments agrees with Mkwanazi et al. [10]. The probable explanation for this finding could be that Western schooling and institutions of training do not incorporate or recognise African histories, cultures, and ways of learning and traditional knowledge. As a result, farmers with informal education have not been taught to believe that CK is superior to IK, whereas the educated group of farmers believe IK is toxic and based on mythology.

The finding that employment status influenced the use of IK, with the odds in favour of unemployed farmers, is in agreement with the fact that resource-limited farmers in sub-Saharan Africa are characterized by poverty and high unemployment rates, and survive with less than 1 USD per day [24]. Consequently, they cannot afford to purchase expensive commercial anthelmintics because the few remittances they receive from government are used to support children's education and food purchases. The finding that religious belief influences the use of IK with the odds in favour of tradition was expected. Most Christians associate the use of IK with unclean spirits, hence, they do not rely on it. This observation represents a challenge to the continued use of IK because the number of Christians in developing countries is increasing.

In resource-limited areas, farmers usually have back-to-back training at which they share knowledge about livestock. Hence, the finding that receiving livestock training influenced IK use was expected, because in the absence of commercial anthelmintics, farmers teach each other indigenous ways of controlling parasites. It was anticipated that the availability of herbalists in the study areas would influence the use of IK. Findings from Mkwanazi et al. [10] agree that herbalists play a huge role in promoting IK, because they mostly share information with elders. It is of paramount importance that people such as herbalists are included in IK development policies. Policymakers should consult indigenous people to ensure effective and inclusive development policies of IK.

5. Conclusions

The perceptions of farmers regarding the factors that influence the use of IK vary based on the environment. Hence, understanding the factors that influence the use of IK is a critical step in the development of a robust alternative and an integrated system for sustainable goat intervention strategies. The extent of use of IK was influenced by gender, employment status, age, religion, and presence of a herbalist. These are important factors that should be considered when IK policies are implemented in the near future. Scientific knowledge should be integrated with IK methods for sustainable goat veterinary care. The government should be engaged to explore means of creating an enabling environment for the formal recognition, development, promotion, and integration of IK into veterinary extension services.

Author Contributions: S.Z.N., M.V.M. and M.C. designed the study; M.V.M., S.Z.N. collected the data; S.Z.N. interpreted results, and wrote the manuscript. S.Z.N., M.V.M. and M.C. critically reviewed the manuscript. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical consideration.

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Conflicts of Interest: Authors declare that there is no conflict of interest.

Appendix A

Objective: Farmer perceptions on the factors influencing of use of indigenous knowledge to control gastrointestinal nematodes in goats

Questionnaire Number……Village name…….Numerator name……..Ward Number……

SECTION A: Household demography
A1. Gender: 1. M □ 2. F □
A2. Marital status: 1. Married □ 2. Single □ 3. Divorced □ 4. Widowed □
A3. Age: 1. 18-30 □ 2. 31-50 □ 3. >50 □
A4. Is the head of the household residing on-farm? 1. Yes □ 2. No □
A5. Highest education level: 1. No formal education □ 2. Grade 1-7 □ 3. Grade 8-12 □ 4. Tertiary □
A6. Have you ever received any training on livestock production? 1. Yes □ 2. No □
A7. Are you employed? 1. Yes □ 2. No □
A8. What are major sources of income? 1. Crops □ 2. Livestock sales □ 3. Livestock products □ 4. Salary □ 5. Government grant □ 6. Other □, specify …….
A9. Wealth status: 1. Poor □ 2. Less poor □

SECTION B: Goat Health
B1. Do you use indigenous knowledge? 1. Yes □ 2. No □
B2. What is the reason of using indigenous knowledge?

	Effectiveness	**Availability**	Affordability	Quick solution	Similar to Conventional knowledge	Other (specify)
Rank						

B3. Which method do you use to control nematodes?
1. Dewormers □ 2. Vaccines □ 3. Ethnoveterinary plants □ 4. Non plant-based material □ 5. Occasional pasture burning □

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