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Bibliometric Analysis of Worldwide Research Studies on Goat Ticks: A Seven Decade Outlook

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Abstract

Background and Objective: Ticks are well-known parasites that cause significant adverse effects on goat husbandry. They negatively affect the health of the goat and impair the economic sustainability and productivity of the animal. The present study illustrated the findings on the global research trends of scholarly literature with respect to goat ticks. **Materials and Methods:** A search keyword was done as related to the subject matter of goat ticks. All articles from the year 2024 were removed from the initial sum of 2018 documents in order to allow for the reproducibility of the method. A sum of 2013 documents was retrieved from Scopus and Web of Science Databank for evaluation using bibliometric permutations in RStudio software. After data were obtained from WoS and Scopus, they were then cleaned up and filtered before they were validated for analysis. **Results:** Research articles on goat ticks had rising research outputs of an annual increase of 7.36%. China led in the rankings with the highest amount of research outputs (n = 183) and citations (n = 3751) globally. The result also revealed the co-authors per document (n = 6.35), single-authored documents (n = 133), average citations per document (n = 18.65) and percentage of international co-authorships (18.43 %), accordingly. South Africa, Ethiopia, Tunisia and Kenya were the only African countries that were ranked among the top-rated 20 nations on goat ticks. **Conclusion:** The annual increase in research investigations on goat ticks over the seven decades of bibliometric assessments indicates the economic significance of tick-borne disease in goat farming.

Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

From time immemorial, goats have played a vital role in the livestock industry when compared to other widely raised domesticated animals[1,2]. Goats are utilized in various ways to accomplish the demand for several food and related products (such as milk, cheese, milk, meat, skin and hides as well as by-products) for both local and international markets[2,3]. However, there are known external parasites (including ticks, lice and mites) that are generally common to goats and they cause significant constraints in goat farming. These parasites especially ticks cause several significant negative consequences ranging from weight loss, stunted growth, reduced production, skin damage from severe irritations, paralysis and economic loss as a result of reduced goat product quality and market value of hides and skin[4-6]. Conversely, ticks have significant adverse effects on goat husbandry which may impact negatively on the health of the animal as well as impair the economic sustainability and productivity of goats.

According to the United Nations Food and Agricultural Organization (FAO), it was reported that some years ago, the severe financial loss caused by Ixodidae tick (also found in goats) infestations was up to the tune of $7.0 billion[7]. Ticks transmit pathogenic organisms such as viruses, haemato-protozoan as well as bacteria between livestock to livestock and human beings during the process of blood-sucking of their host[7]. Tick infestation in goats causes anaemia and a reduction in production that has a severe economic impact on goat husbandry as well as local and global goat production in most nations, especially in developing countries[8]. It means causing anaemia to its host as a parasitic agent by sucking the blood of its host for a prolonged number of days (7-14 days), which may be extended with regards to tick species as well as the type of host they are attached to[9]. Ticks can suck up to 0.5-2.0 mL blood per day in some instances during their adult and growing larvae phase leading to morbidity as well as mortality[10].

The body temperature of most livestock favours the rapid growth and survival existence of ticks with temperature (26-37°C) as well as relative humidity (85%) of its host[1]. This body condition is always suitable for the growth and reproduction of ticks[11], after which they become parasitic to their host. The infestation of ticks has without a reservation been a dangerous threat to goat farmers in several countries globally with developing countries facing more of the threats. This is why several studies on goat ticks have been on and are still ongoing globally[12,13].

Despite several studies and investigations on goat ticks in the literature, to date, it seems that publications archiving the number of articles in this niche area are rare and hence, the present study becomes of essence. The method of utilizing bibliometrics for assessing research outputs is currently a unique tool for schematic representation as well as characterization of research investigation in a particular research niche and it combines statistical computations as well as mathematical metrics to disclose the scholarly knowledge pool that has the potential for the forecasting of research direction in a given research subject matter[2,14]. It thus simplifies roadmaps for scientists, academics, as well as policymakers to come up with stratagems, policies and proposals to advance important projects in line with innovative and impactful research happenings within that research niche[15]. Bibliometric analysis is an important area of study that helps to weigh the extent of growth of a particular research domain[16]. Due to the aforementioned reasons, the present study employed a bibliometric approach to report the trends and research articles for ticks in goats using data obtained from WoS (Web of Science) and Scopus archives from 1952-2023. Therefore, the study aims to pinpoint and present global research scope on goat ticks studies, for example, authors, keywords, distribution of nations, research outputs, the worldwide trends of citation and trending topics on the topic of consideration.

MATERIALS AND METHODS

Study area: The study was done between June and August, 2024 and the coverage was global using the WoS and Scopus for data collection and the RStudio software package for data analysis.

Data retrieval and analysis: The two data archives utilized for the present study (WoS and Scopus) were 2 bibliographic data archives commonly used because they allow for the building of a wide range of data capture and search questions for bibliometric studies[17-19]. These data archives were from Scopus as well as WoS. The WoS and Scopus are data archives that are known for reliable top-rated scholarly research articles[20]. For the present study, the title search was used to collect data from the Scopus archive while the topic search was used to obtain data from WoS for a wider collection of publications of the subject matter. After data were obtained from WoS and Scopus, they were then cleaned up and filtered before they were validated for analysis. The data that were cleaned up and filtered were achieved after an exhaustive literature search of the important subject matter keywords that are related to the
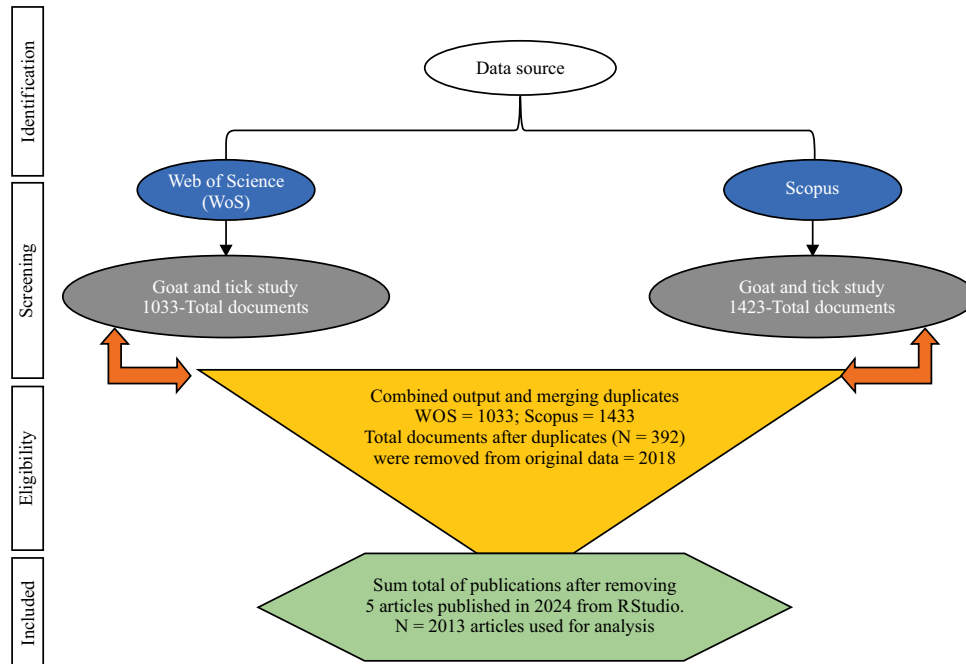
Fig. 1: Data inclusion and exclusion of documents for selection

topic in consideration. The method of data collection used in the present study has previously been used[21]. All the retrieved data that were collected from the data archives were further transferred into RStudio and a special mathematical command was used to remove duplicated articles that may occur from the combined data archives. A figure presentation of data collection, exclusion as well as evaluation was explained in Fig. 1.

Data processing: The processing of all the data from Scopus and WoS was first moved into the bibliometrix R-package software (RStudio v. 127.0.0.1: 5645) within the biblioshiny tab before they were evaluated for descriptive bibliometric analysis. The analysed data descriptions for the present study include global publication status per annum, outputs per year and citation by various countries, source of articles as well as their scholarly influence in the globe, allied networks globally and trend of vital topics and subject matter, amongst other features as given by the (RStudio v. 127.0.0.1: 5645) software[22]. Again, the RStudio was used to visualize, tabulate, as well as present other bibliometric details, including author's keywords; author contributions; article keywords plus; author impact; institutions, nations and authors' collaborations; frequency of citations; and co-citation networks among others. Authors' impact in a specific research niche area is evaluated using Lotka's law[23].

RESULTS AND DISCUSSION

Main scholarly research trend on goats and ticks: The trends on the subject matter of goats and ticks from 1952 to 2023 were given in this present study. From the result, the 2013 literature articles from Scopus and WoS Databank as presented (Table 1) were available from 500 data sources and 6643 authors. Single-authored articles written on the research topic of goats and ticks were written by 133 authors, while the co-authors per documents on the research topic of goats and ticks were written by a percentage of 6.35 authors, accordingly. All the scholarly research publications had a sum of 20194 references with a document average age of 14.4. The average number of citations per article was 18.65. In addition, the result from keyword plus (ID) and author's keywords (DE) was 5401 and 2498, respectively.

Annual growth of articles and citations on goat and ticks research: Bibliometric investigation is a study instrument that is utilized to define how research work grows in numbers for a particular niche area. A yearly decline in the number of research works in a niche area depicts a decreasing interest among authors in the niche area[24]. With respect to the yearly rise in the publications of articles on goat ticks, there was a slow growth (1980 to 1985), followed by sharp fluctuating trends in article publications between the years 1986 and
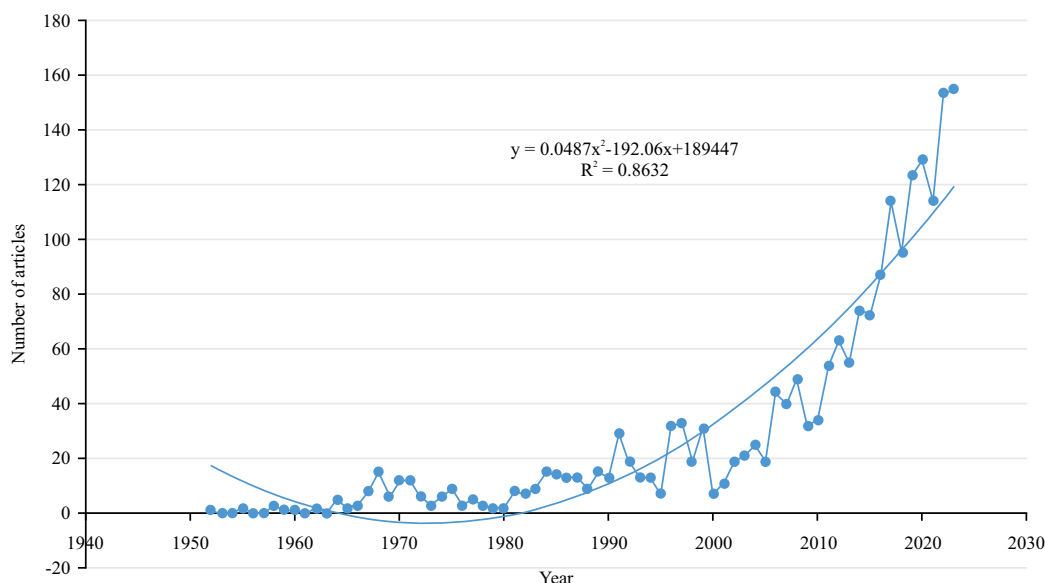
Fig. 2: Annual scientific article publications (from 1952 to 2023) on goat tick research studies with an annual growth rate of 7.36%

Table 1: Summary findings of retrieved published documents on goat tick from Scopus and WoS databases

Description	Results
Main information about data	
Timespan	1952:2023
Sources (Journals and Books etc.)	500
Documents	2013
Annual growth rate (%)	7.36
Document average age	14.4
Average citations per doc	18.65
References	20194
Document contents	
Keywords plus (ID)	5401
Author's Keywords (DE)	2498
Authors	
Authors	6643
Authors of single-authored docs	110
Authors collaboration	
Single-authored docs	133
Co-Authors per doc	6.35
International co-authorships (%)	18.43
Document types	
Article	1946
Article; article	13
Article; book chapter	4
Article; data paper	1
Article; early access	1
Article; proceedings paper	47
Article; publication with expression of concern	1

2018, however, a substantial increase was observed from 2019 to 2023 (Fig. 2). The highest number of publications of articles on goat tick research was in 2023, with about 155 articles (Fig. 2). Equally, research studies in this field recorded an annual growth of 7.36%. This result was lower when compared to those reported by other studies[25-27].

However, the gradual rise in research on goat ticks from the year 2019 gives credence to the fact that research work in this niche area is growing globally and gaining attention. This may have resulted from the recent surge in the investigations on goat tick research globally[28-30] and the potential impacts of infection on people and other livestock and the impacts on the surrounding as well as distance communities[31].

Global influential researchers in the field of goat ticks research niche: From the result of the current study, it was observed that 6643 authors were involved in the publication of 2013 research articles within the studied year. Likewise, the co-authors per article from the study was 6.35 and the international co-authorship percentage was 18.43, hence, showing the power of collaboration as well as partnership by different global authors in this research area. Table 2 shows the 20 most relevant researchers in this research niche, with an h-index of between 9 to 20 with citations ranging from 204 to 1332. The observed citation numbers in this study were expected, the reason being that there are high numbers of researchers who reported their findings on goat ticks as compared to other bibliometric findings who reported lower citation numbers of authors in different subject matters[32]. With respect to the h-index, it is commonly used to evaluate the worth of both the author's findings and the author's relevance in a particular research niche[33]. Furthermore, the h-index is used to appraise the impact (through the number of article citations) and prolific researchers within an institution or a country[34]. The global ratings of authors, countries, institutions and scholarly journals are often established from their h-index

Table 2: Top 20 relevant researchers on goat and tick research from 1952 to 2023

Author	h_index	g_index	m_index	TC	NP	PY_start
Yin H.	20	36	0.71428571	1332	40	1997
Aktas M.	15	26	0.75	741	26	2005
Liu Z.	15	25	0.78947368	646	27	2006
Luo J.	15	25	0.78947368	705	25	2006
Li Y.	13	24	0.72222222	581	28	2007
Guan G.	12	20	0.66666667	563	20	2007
Horak I.G.	12	18	0.35294118	376	18	1991
Jongejan F.	12	14	0.35294118	676	14	1991
Li J.	12	17	0.66666667	322	17	2007
Yang J.	12	14	0.92307692	315	14	2012
Ali A.	10	16	0.90909091	280	22	2014
Altay K.	10	10	0.5	442	10	2005
Dumanli N.	10	11	0.5	516	11	2005
Papa A.	10	12	0.55555556	220	12	2007
Ben Said M.	9	13	0.9	306	13	2015
Liu	9	10	0.5625	204	10	2009
Liu J.	9	16	0.5	368	16	2007
Ma M.	9	12	0.5	440	12	2007
Mahan S.M.	9	11	0.26470588	297	11	1991
Raoult D.	9	11	0.31034483	405	11	1996

PY-start: Publication year start, TC: Total citation and NP: Number of publications

score and this aligns with the number of intellectual articles arraigned based on the citation numbers by other authors in the field and this score is calculated using the logic that h articles were cited h number of times at the least[34]. Nonetheless, the logic of using the h-index as a means of comparison to assess the performance among authors should fall within certain research niche areas since it will not give an accurate justification for such a reason across different lines of expertise. Furthermore, the use of the h-index for article performance and measurement is a vital tool in this type of evaluation, as it gives accurate replicates of the level of scholarly performance to the pool of knowledge of individual authors[35].

From the present study, the impact of research organizations, the global relevance of authors, as well as various nations with respect to their impact on the pool of knowledge on goat tick research were evaluated. Meanwhile, the importance of any scholarly article most times is based on the number of times the article is cited by other scholars. Howbeit, the use of article citations is not always a perfect yardstick for the global performance of an article[36]. Some scholars argued that the sheer count does not mirror the exact impact of an author because each authored or co-authored paper acquires a score and grade for each literature article, while not taking into account the number of co-authors the said article has[37]. A more suitable yardstick proposed to score an author or co-authors is by using a fractionized metric whereby the score for an article is divided among the contributing co-authors for papers with more than one authors[37]. This kind of metric gives each author or co-author of a particular paper a score of 1 divided by the amount of contributing authors to the article.

This metric has been employed by several research institutions and journal outlets[38].

Table 2, showed the performance of the 20 influential publishers, from which the first, second and third authors including contributing 40 (1.98%), 26 (1.29%) and 27 (1.34%) articles from a total of 2013 documents retrieved from WoS and Scopus databank, respectively. Furthermore, these three authors had h-index of 20, 15 and 15, accordingly. Conversely, the author named Luo, J (h-index = 15) in the 5th position, had a higher citation (n = 705) when compared to the third-ranked researcher in the field with 646 citations, despite the author recording a lesser number of publications. This is a pointer that the utilization of article citations is not only influenced by the number of publications of an author as well as the rating of the h-index, but also by the publication year[24].

Topmost global institutions on goat ticks research: The information for the top twenty institutions with the highest number of research articles in this niche area was presented in Table 3. The Lanzhou Veterinary Research Institute from China published the highest number (n = 73) of articles on goat ticks globally, while the University of Pretoria from South Africa had the second highest number (n = 72) of articles, accordingly. Meanwhile, Henan Agricultural University from China was ranked the 20th institution on the list of the twenty topmost global organizations from Table 3. Furthermore, 20% (4 out of the 20) of the topmost global institutions are from the nation of Iran (Table 3). This finding is in contrast to previous bibliometric studies which have often reported institutions from the USA to produce research findings from a wide range of different bodies of knowledge globally[25,39].
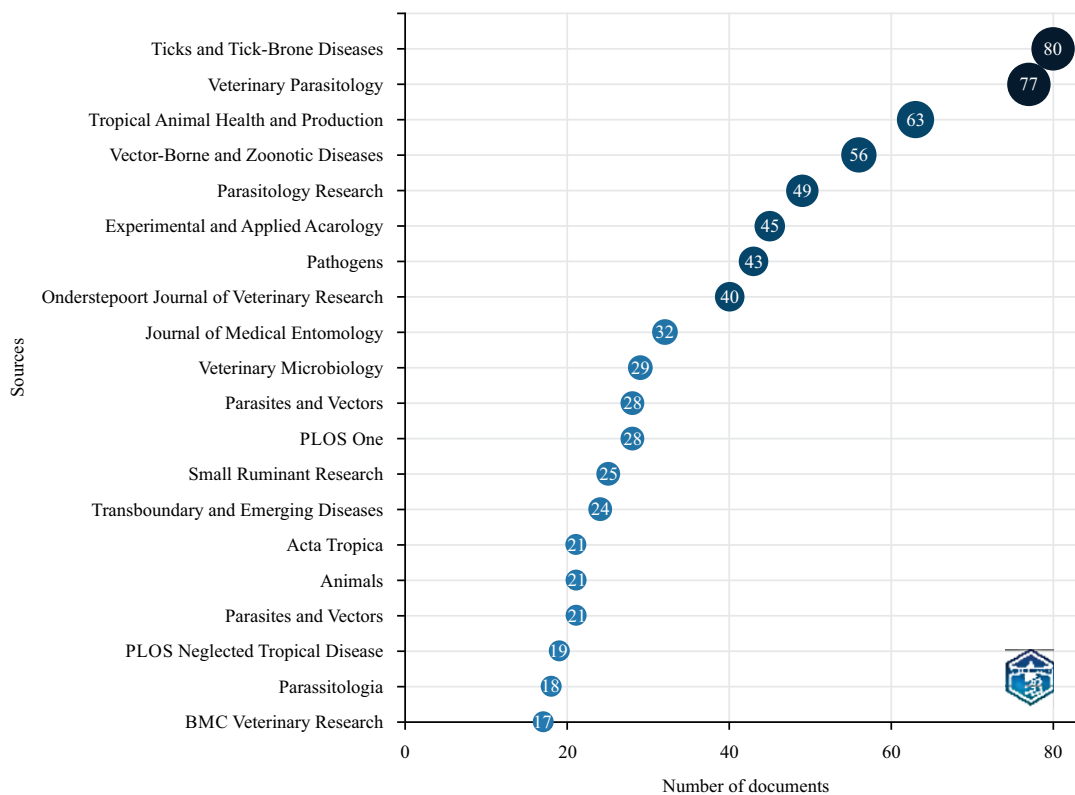
Fig. 3: Topmost 20 journals in the field of goat tick from 1952 to 2023

Most relevant journal document source on goat tick research: Different journal source generally showcase their area of specialty in various research and the number of specific research topics in a given journal is an important yardstick in bibliometric assessment for disseminating relevant scientific information[40]. From the present study, the most relevant document sources (journals) for articles on goat tick research were evaluated. The information obtained from the most relevant journal sources included article numbers published in different journals. The 20 topmost impactful journal sources in goat ticks research was explained in Fig. 3. The first five listed journals are ranked as Ticks and Tick-Borne Diseases (n = 80); Veterinary Parasitology (n = 77); Tropical and Animal Health Production (n = 63); Vector-Borne and Zoonotic Diseases (n = 56) and Parasitology Research (n = 49), respectively, which are articles published within the specified period of 1952 to 2023. These journal sources are well-known for disseminating intellectual information related to goat ticks research and other goat-related diseases in goat farming.

Top ranked globally cited articles in goat ticks research: The indices of citation for ranking any article point to the number of citations that the document receives on scholarly data banks for the period in which the said article was downloaded. Furthermore, the global citation of an article is dependent on the intellectual weight of the citing document rather than its popularity in the scientific space. For example, an article that is cited by an impactful paper pulls the attention of global researchers who are more relevant in the field, while the citation numbers of a publication attract its global influence, not caring about the worth of the manuscripts citing it.

The top ranked cited documents that were assessed judging from their total citations per year (TC/Year) and total citations (TCs) in goat ticks research from 1952-2023 was presented in Table 4. The authors with the five globally cited publications with each paper having above 200 citations were presented in Table 4[41-45]. These afore-mentioned articles were published in Veterinary Parasitology (TC: 452; TC/Year: 23.78), Advances in Parasitology (TC: 360; TC/Year: 9.00), Veterinary Research Communications (TC: 209; TC/Year: 11.61), Veterinary Microbiology (TC: 208; TC/Year: 11. 55) and Vector-Borne and Zoonotic Diseases (TC: 204; TC/Year: 8.86), respectively. The pressing subject matters covered in the afore-mentioned highly cited articles cover a range of tick-borne pathogens associated with causing diseases in goats and other ruminants and their economic relevance in livestock farming. For

Table 3: 20 topmost productive institutions on goat tick research with over 20 publications per institution

Affiliation	Articles	Nations
Lanzhou Veterinary Research Institute	73	China
Univ Pretoria	72	South Africa
University Veterinary and Animal Science	64	Pakistan
Abdul Wali Khan University Mardan	53	Pakistan
Friedrich Loeffler Institute	52	Germany
Firat University	49	Turkey
Aristotle University Thessaloniki	45	Greece
University Tehran Medical Science	42	Iran
Pasteur Institute Iran	41	Iran
Obihiro University Agriculture and Veterinary Medicine	37	Japan
Kyungpook National University	35	South Korea
University Florida	32	USA
University Malaya	32	Malaysia
Centers for Disease Control and Prevention	30	USA
University of Agriculture Faisalabad	29	Pakistan
University Tehran	28	Iran
University Edinburgh	27	Scotland
King Saud University	26	Saudi Arabia
Urmia University	26	Iran
Henan Agricultural University	22	China

Table 4: Top 20 most cited global articles on goat tick research from 1952 to 2023

First author, year and journal name	DOI	Total citations	TC per year	Normalized TC
Uilenberg G., 2006; Vet Parasitol	10.1016/j.vetpar.2006.01.035	452	23.7894737	10.5787234
Mehlhorn H., 1985; Adv Parasitol	10.1016/S0065-308X(08)60285-7	360	9	9.048473968
Stuen S., 2007; Vet Res Commun Med Trop	10.1007/s11259-007-0071-y	209	11.6111111	3.710608078
De La Fuente J., 2007; Vet Microbiol	10.1016/j.vetmic.2006.09.011	208	11.5555556	3.692853972
Mcquiston J.H., 2002; Vector Borne Zoonotic Dis	10.1089/15303660260613747	204	8.86956522	6.36453202
Stuen S., 2007; Vet Res Commun	10.1007/s11259-007-0071-y	202	11.2222222	3.586329339
Friedhoff K.T., 1997; Parassitologia		199	7.10714286	4.707526882
Nijhof A.M., 2007; Vector Borne Zoonotic Dis	10.1089/vbz.2007.0130	196	10.8888889	3.479804705
LI H., 2015; Lancet Infect Dis1	10.1016/S1473-3099(15)70051-4	194	19.4	7.904923599
LI H., 2015; Lancet Infect Dis	10.1016/S1473-3099(15)70051-4	176	17.6	7.17147708
Rodriguez L.L., 1997; Am J Trop Med Hyg	10.4269/ajtmh.1997.57.512	169	6.03571429	3.997849462
Schnittger L., 2004; Parasitol Res	10.1007/s00436-003-0980-9	152	7.23809524	4.97382199
De La Fuente J., 2007; Vet Microbiol1	10.1016/j.vetmic.2006.09.011	152	8.44444444	2.698624057
Liu Z., 2012; Appl Environ Microbiol	10.1128/aem.06848-11	148	11.3846154	4.597633136
Holzmann H., 2009; Emerg Infect Dis	10.3201/eid1510.090743	147	9.1875	5.113043478
Liu S., 2014; Rev Med Virol	10.1002/rmv.1776	146	13.2727273	5.290891283
Na Na, 2015; EFSA J	10.2903/j.efsa.2015.3940	141	14.1	5.74533107
Schnittger L., 2003; Parasitol Res1	10.1007/s00436-003-0979-2	141	6.40909091	4.714968153
Schnittger L., 2003; Parasitol Res	10.1007/s00436-003-0979-2	128	5.81818182	4.280254777
Mediannikov O., 2010; Plos Negl Trop Dis	10.1371/journal.pntd.0000821	128	8.53333333	3.209439528

instance, the paper by Stuen[43], highlighted the causal agent of *Anaplasma phagocytophilum* as the most widespread tick-borne infection in goats and other animals in the whole of Europe. Although, other related factors (e.g., climate, management, other infections, individual conditions, etc.) were also mentioned to be important that indirectly promotes tick-borne disease infection in animals.

It is important to note that due to the wide range of tick-borne pathogens infestation responsible for causing diseases in livestock in the universe, several researchers have now embarked on genetic studies to ascertain the exact tick species involved in farm-animal diseases. For instance, in the study by one of the top-cited articles, it was reported that the pathogenic species known as *Anaplasma ovis* causes infection in ruminants (including goats) in the Western United States of America[44]. The total citation (TC) and total citation per year (TC/Year) as presented in Table 4 ranged from 128 to 452 and from 5.81 to 23.78. The global influence and impact of a research paper in the intellectual space are mostly determined by citation numbers[46]. This impact also improves with the years as the citation number increases[47]. Meanwhile, an increase in citation numbers of a paper may increase negative criticism as a result of self-citations of an individual author[48]. For newly published articles within a certain research field, it has been observed that as the years go by, they accumulate more citations[49].

Table 5: Top 20 publications by nations on goat tick research from 1952 to 2023

Country	Articles	Articles (%)	SCP	MCP	MCP (%)
China	183	9.09090909	162	21	11.4754098
Pakistan	112	5.56383507	74	38	33.9285714
Iran	109	5.41480378	104	5	4.58715596
USA	91	4.520616	71	20	21.978022
South Africa	87	4.3219076	72	15	17.2413793
Turkey	79	3.92449081	74	5	6.32911392
Germany	77	3.82513661	48	29	37.6623377
India	60	2.98062593	56	4	6.66666667
France	54	2.68256334	41	13	24.0740741
Greece	39	1.93740686	30	9	23.0769231
Brazil	36	1.78837556	26	10	27.7777778
Japan	36	1.78837556	16	20	55.5555556
Korea	36	1.78837556	31	5	13.8888889
Italy	35	1.73869846	24	11	31.4285714
United Kingdom	34	1.68902136	19	15	44.1176471
Ethiopia	31	1.53999006	27	4	12.9032258
Tunisia	31	1.53999006	24	7	22.5806452
Spain	28	1.39095877	17	11	39.2857143
Kenya	17	0.84451068	8	9	52.9411765
Argentina	16	0.79483358	13	3	18.75

SCP: Single country publications and MCP: Multiple country publications

Table 6: Top 20 most cited countries in terms of average article citations (AAC) in research on goat ticks from 1952 to 2023

Country	TC	Average article citations
China	3751	20.5
USA	2511	27.6
Germany	2110	27.4
France	1974	36.6
Iran	1803	16.5
Turkey	1660	21
Pakistan	1361	12.2
South Africa	1270	14.6
Italy	837	23.9
Greece	731	18.7
Tunisia	697	22.5
Japan	679	18.9
Slovakia	608	40.5
Netherlands	591	36.9
United Kingdom	578	17
Norway	577	72.1
India	519	8.7
Spain	456	16.3
Switzerland	448	40.7
Brazil	437	12.1

Topmost influential countries with publications on goat ticks research: The top 20 influential countries with more article publications on goat ticks research by corresponding researchers was tabulated in Table 5. From the top 20 countries, seven countries are from Europe (Turkey, Germany, France, Greece, Italy, UK and Spain), six countries are from Asia (i.e., China, Pakistan, Iran, India, Japan and Korea), four countries from Africa (South Africa, Ethiopia, Tunisia and Kenya), two of the countries are from North America (i.e., USA and Argentina) and one country is from South America (Brazil), respectively. This result showed that European countries were more intentional in the research on goat ticks, although they had fewer amount of publications when compared to Asian countries (i.e., China, Pakistan, Iran and India etc.) that have a number of single country publications (SCPs) and multiple country publications (MCPs). The article's contributions from China depict the nation as a real influential nation in the research domain of the understudied niche area. In addition, intellectual contributions of articles from other nations on the subject matter were also presented in Table 5.

There were position switches in the rankings among the top 20 most influential nations that were placed as the most active countries in research done on goat ticks when research publications were assessed based on total citation (TC) per nation (Table 5-6). This obvious observation is akin to the result of other bibliometric studies as reported by Orimoloye and Ololade[26] and Idamokoro and Niba[39]. The likely implication for the position switch in the ratings (for nations) when using the total aggregate of citations to determine the author's research outputs may describe its unpredictability as a reliable tool to determine the productivity of authors. Fricke *et al.*[50] reported that the frequency of article citations of a specific country does not automatically depict the research publications of that author. This is because, the fewer the number of publications used for assessment in bibliometric analysis, the more significant a few regularly cited articles[50]. For instance, it has observed that some authors involve themselves in self-citations, while other authors give false citations when reporting their investigations and this situation results in giving pseudo-qualitative as well as quantitative metrics of citations of that particular author or country[51].
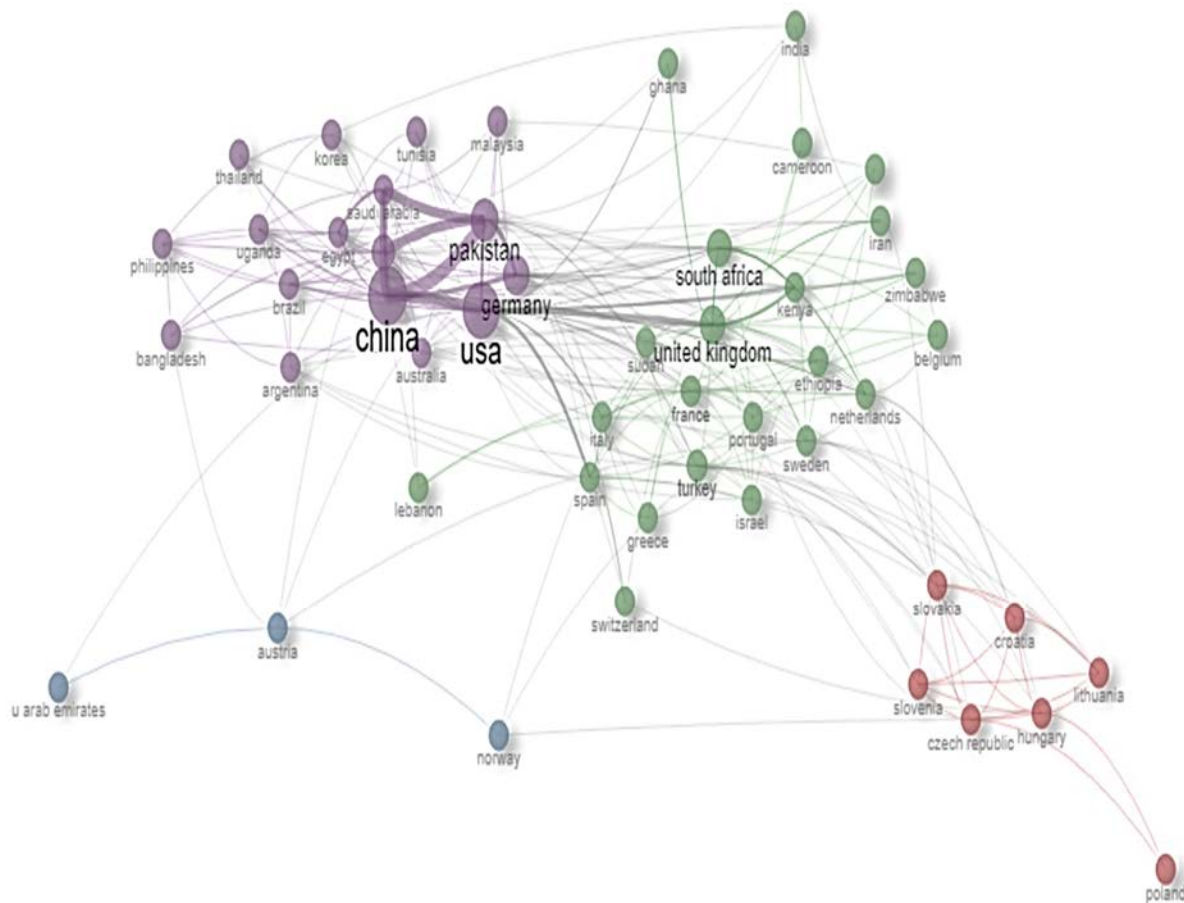
Fig. 4: Networking among countries from 1952 to 2023

Institutions, authors and countries scholarly networking on goat ticks research: Networking in research is an essential instrument employed to progress the significance of research findings and intensify publications, as it improves collaboration among authors in the same field of research locally as well as globally. Networking also permits multi-disciplinary exchange and knowledge sharing as well as helps to improve academic fellowship at different cadres among scientists who do research in related niche area[52]. Furthermore, global networking is currently observed to pull interest and support from financial institutions, policymakers as well as government bodies for research strengthening in various research globally. Scholarly partnerships also improve the quality of results of well thought-out research[53]. Some other thought-out benefits of scholarly networking among scientists, institutions as well and countries as linked to scholarly publications comprise human capacity development, financial possibilities, access to state-of-the-art equipment and more importantly team-work from collaborators in resolving difficult research mysteries resulting from networking with different expertise with years of research experience[54].

The result for the networking among countries was shown in Fig. 4 using four different colors to show their groups of networking. In all, four clusters were portrayed in the diagram. The node from the four clusters depicts each collaborating country and the lines that connect them have different sizes and thicknesses, which indicates how the significance of their connection and the strength of the partnership that occurs among the countries. It should be noted that the names of the countries shown in Fig. 4 should originally be written in the right lettering, but by default (RStudio software), they were presented in small alphabetical letters. Presenting nations' networking with small alphabetical lettering is a common phenomenon[55]. China, Pakistan, Germany and the USA were among the nations shown to be the most influential with large nodes and lines and with the highest numbers of networks from different nations globally. From Fig. 4, the most influential countries in the studied niche area show robust collaboration with each other and most of these countries are economically developed. This further shows the significance of the topic under consideration.
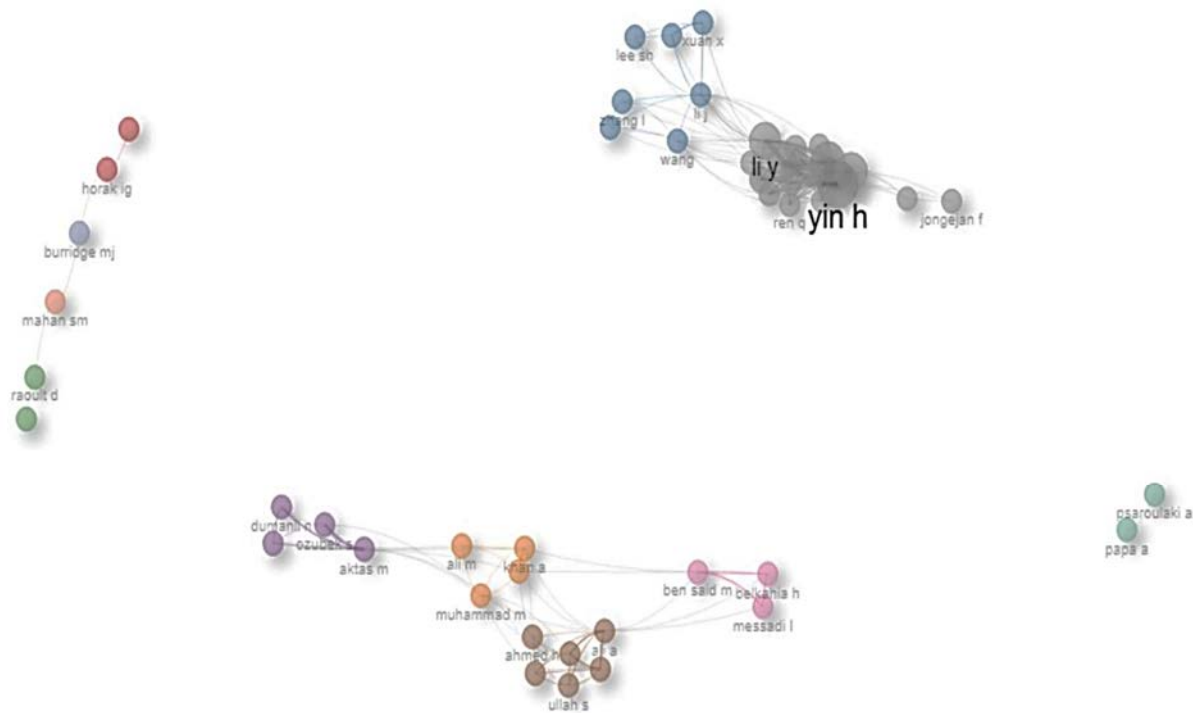
Fig. 5: Authors' network across several institutions and nations between 1952 and 2023

Likewise, the global networking among the leading authors in goat ticks research was presented in Fig. 5. The strength of collaborations among authors is shown by the level of thickness of the strokes and the size of the nodes linking the different countries together. There are varied groups in the diagram, as shown by the various colours representing each group of networks. Authors with similar colour are collaborators within the same cluster[56].

Article source growth assessment of goat ticks research: The assessment of article source growth of the 5 topmost impactful journals was shown in Fig. 6. From this observation, the result of top-ranked journals reporting research publications on goat ticks started in a slow trend in the early years (from 1990-2012). However, this trend took a rapid rise from the year 2012-2023, making them earn the accolades as most impactful journals. The journals "Parasitology Research", "Tick and Tick-Borne Disease", "Tropical Animal Health and Production" and "Vector Borne and Zoonotic Diseases" among other impactful journals have grown significantly over the years on the present studied subject matter. Important to note from our observation is that, between the years 1990 to 2001, there were very few or negligible numbers of publications on goat ticks research. However, there have been more numbers

of articles published in recent years on the subject matter which is a pointer (indicative) to the fact that the research niche area is attracting more attention by scholars and research institutions. The observation was similar to the findings of another author who also reported their findings on a bibliometric study on a particular research topic that expounded the significance of researching livestock improvement[27].

The current report on the rise in research publications on goat ticks and their related fields is not out of place. This is because the economic importance of tick infection in goats and other farm animals in general has its implication as a predisposing factor for other infections (e.g., zoonotic diseases). Meanwhile, other associated factors including climate, farm management, other pathogenic infections and surrounding individual animal conditions among others are essential and should be considered when reporting the outbreak of tick-borne diseases in livestock including goats[43]. More importantly, new investigations on goat ticks are also being carried out in more detail to ascertain to the species level (using gene sequencing techniques) the exact variant that causes tick-borne infections. This is necessary because different tick variants may behave differently and interact differently in their human (zoonosis) or animal host[43].
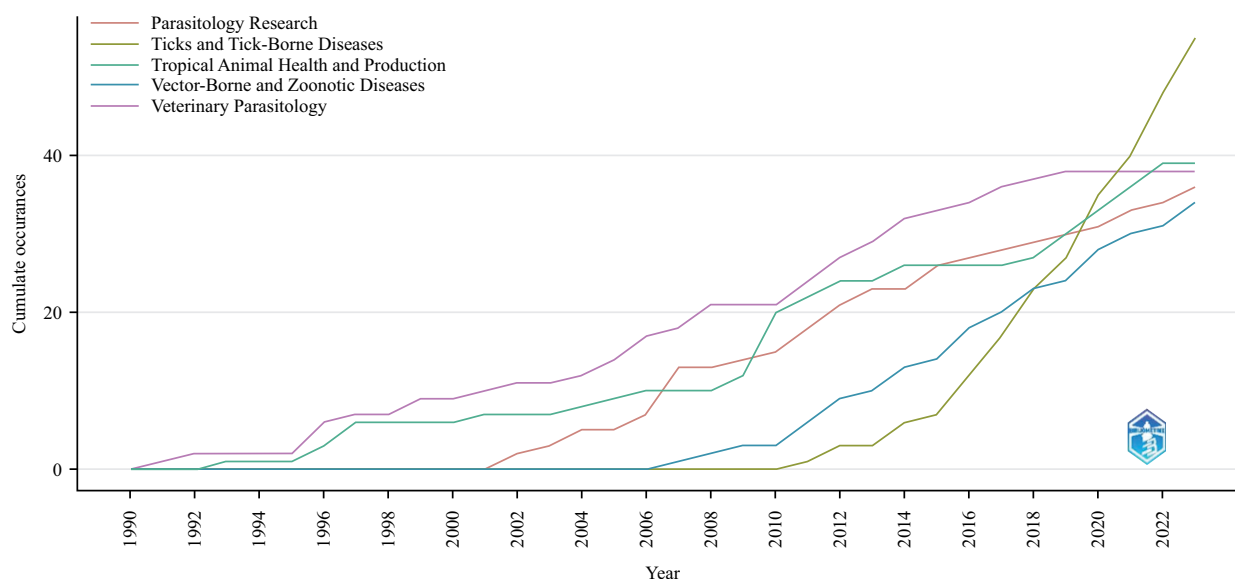
Fig. 6: Source growth of the incremental trend of the 5 topmost productive journals in goat ticks research from 1952 to 2023

Frequently used co-occurrence author's keywords and word cloud on goat tick research: Authors' keywords are used as indices for projecting research topics and hot spots in different research niche area[57]. Editors of scholarly journals regularly require authors (who are in the process of manuscript submission) to enumerate the keywords on the subject of their manuscript to ascertain whether their manuscript is suitable or not for a review process. However, the number of required keywords for different journals varies from one journal to the other. Author's keywords are essential to readers of a manuscript because they help them to understand the main areas captured by the study and it is often mandatory within the abstract section of a manuscript[24]. Furthermore, Figures 7 and 8 were used to capture the author's keywords for research in goat ticks from 1952 and 2023.

The most relevant keywords as revealed from this study by most of the author's goats (n = 160), prevalence (n = 152), small ruminants (n = 83), infection/s (n = 239), sheep (n = 230), cattle (n = 214), prevalence (n = 162), epidemiology (n = 57), seroprevalence (n = 47), identification (n = 144), transmission (n = 91), genetic diversity (n = 34), antibodies (n = 39), molecular detection (n = 50), acari (n = 57) and PCR (n = 46) among others. Conversely, it is essential to note that the aforementioned keywords from authors have occurrences above n>30 (Fig. 7).

Importantly, the varied keyword clusters and sizes in different colours as depicted in the word cloud and network diagram (Fig. 7-8) shows how strongly connected these keywords are as well as the number of their occurrences in

goat ticks research as relates to the present studied subject matter. Similar findings on the significance of the sizes and network connections of author keywords have also been previously reported by Altarturi et al.[37]. Essentially, keywords are utilized to cover the fields of important subjects of a niche area and these keywords also assist potential readers of a paper to focus as well as understand the important concepts of the niche area[58]. From the keywords portrayed in the present study, leading authors in the research on ticks have reported their findings with regard to infections, identifications, transmissions, types of diseases, zoonosis and methods of effective management of livestock against tick-borne diseases. For example, the study by McQuiston and Childs[45] whose paper ranked among the top rated documents in the field, reported outbreaks of tick-borne diseases via transmission of small ruminants to animals and humans-this tick-borne infection is also zoonotic.

Again, another leading author (Table 4) reported the emergence of "*A. capra*" which is a tick-borne infection from goats as a cause of human diseases in the Northern Region of China[31]. Conversely, the authors also suggested precautionary measures (e.g., avoidance of high-risk areas and reduced human-livestock exposure) that may help to reduce the risk of infection to the novel tick-borne pathogen[31]. The emergence, as well as re-emergence of zoonotic diseases linked with ticks, leading to recurrent epidemics, have risen in recent times, although the holistic preventive approach to tackle this menace is still missing in several nations of the world[59]. One of the ways researchers and experts in this fields have

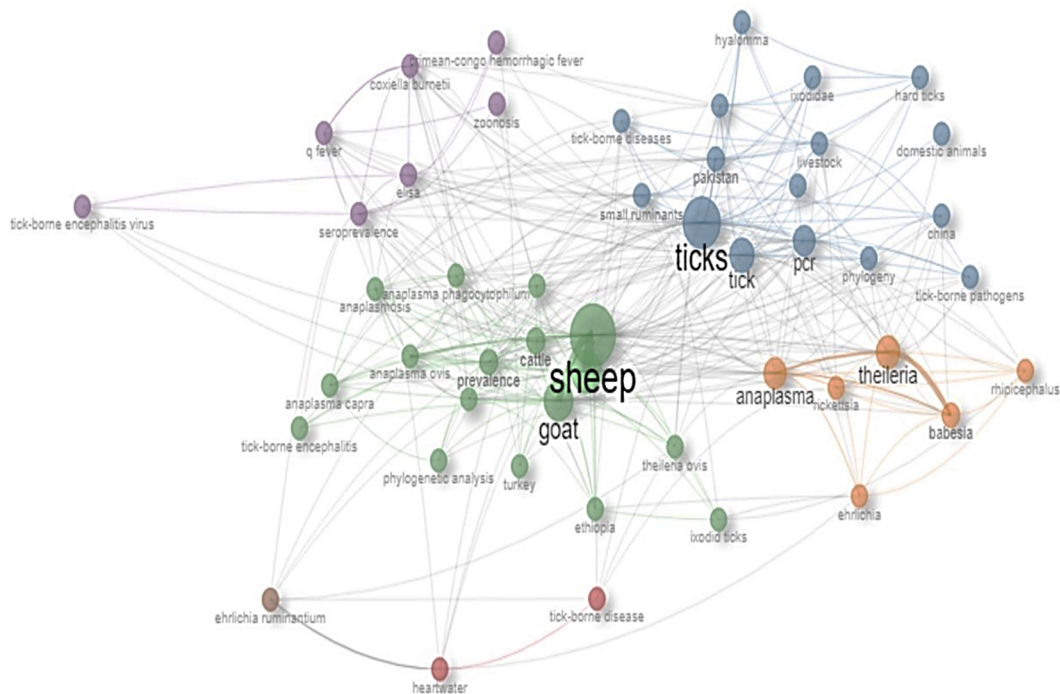Fig. 7: Word cloud on goat tick research studies from 1952 to 2023

Fig. 8: Top author's keywords of goat ticks research studies from 1952 to 2023

recommended the control of these ecto-parasites, especially in developing nations is by adopting a proper and effective tick control program[3,60]. Another way scientists are presently finding a solution to the menace of ticks associated with goats and related livestock is to identify the different types of tick species (morphologically by using taxonomic keys) and then confirm them through molecular characterization so that the right management strategy and medications can be administered for prevention and cure[30]. Howbeit the major constraint and challenge in tick control is their resistance to treatment chemicals utilized in treating them[3,61]. Furthermore, the inappropriate and misuse of medications with wrong concentration is another cause of the failure of tick control programs[1].

Irrespective of the numerous benefits of bibliometric assessment of the current study on goat tick research, it is of the essence to admit limitations that are associated with our current investigation. The published scholarly documents associated with goat tick research were determined using Scopus and WoS data banks, to allow several coverages of the targeted articles. Notwithstanding, it is not unlikely that there may be a few omissions of some articles published in other indexed journals that are not in Scopus and WoS data archives. Therefore, the results of the current study may not have covered holistically all the articles that should be accessible on the subject matter and incorporated into the study.

Due to the huge economic and production loss that could result from tick-borne pathogens on goats and related livestock, certain measures need to be put in place to curb this menace. For example, future investigations on goat ticks research should employ an all-inclusive as well as integrated strategy, combining practical innovations in science and technology as well as an on-the-ground solutions to the problem of ticks. Other future measures and recommendations can also be that scientists in the field of tick research can develop sustainable stratagems to alleviate the negative effects of tick infestations on goat health and productivity. Furthermore, networking among researchers, livestock farmers, policymakers, as well as international institutions will be important in achieving these goals and ensuring the well-being of goat populations globally.

CONCLUSION

The present study revealed a global assessment of goat ticks research with the majority of the studies done in high-income nations. Current findings also revealed limited authors and institutional networking among high-income and developing nations. Furthermore, there was a rise in research on goat ticks from the year 2019 to 2023 giving credence to the fact that research in this niche area is growing globally and it is gaining more attention. This may be because of the grave significant consequences of ticks as linked to goat farming and sustainability. Scientists from both economically stable nations and developing countries are encouraged to network and do more innovative research that will help combat the threat of goat ticks globally.

SIGNIFICANCE STATEMENT

Tick infestation in goats causes anaemia and a reduction in production that has a severe economic impact on goat husbandry in most nations of the world. Despite several investigations on goat ticks, to date, it seems that publications archiving the number of articles in this niche area are rare and hence, the present study becomes of essence. The method of utilizing bibliometrics for assessing research outputs is currently a unique tool for the schematic characterization of investigations in a particular research niche and it also discloses scholarly knowledge that forecasts future research direction. This study will help scientists in the field of tick research to develop sustainable stratagems to alleviate the negative effects of tick infestations on goat health and productivity.

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