Van Veterinary Journal

https://dergipark.org.tr/tr/pub/vanvetj

Cite this article as: **Çetin N (2025).** Global Research Trends and Future Perspectives on the Repeat Breeder Syndrome. *Van Vet J*, 36 (2), 85-90. DOI: https://doi.org/10.36483/vanvetj.1642610

ISSN: 2149-3359 **Original Article** e-ISSN: 2149-8644

Global Research Trends and Future Perspectives on the Repeat Breeder Syndrome

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Received: 18.02.2025 Accepted: 06.04.2025

ABSTRACT In cattle farming enterprises, reproductive efficiency is one of the most important factors that determine the income level of enterprises by directly affecting milk production and the number of calves born. One of the reasons for low productivity in dairy farming is repeat breeder cows. In this study, worldwide trends in repeat breeder were analyzed bibliometrically. The aim of the research is to analyze the trends and groups by examining the publications in this field. In the searches made with the keyword "repeat breeder" in the Web of Science (WOS) database between 1980-2025, 1746 studies were examined, inappropriate studies were eliminated and 1713 articles were analyzed. Data collection was based on information including the title, author names, year of publication, journal name, and citation count. VOSviewer software was used for the analysis, with accuracy ensured by applying text mining and visualization techniques (e.g., bubble maps). The results show that there are 1713 articles in the field of repeat breeder with 37419 citations and an average of 22 citations per article. The number of published articles and corresponding citations has grown since 2002. Most articles (72%) were published in the fields of agriculture and veterinary medicine, with the USA, India, and China accounting for the highest number of publications (45%). The majority of the studies (92%) are indexed in the SCI-Expanded category. This study highlights global trends and important studies in the field of repeat breeders and provides guidance on future research directions in this field.

Keywords: *Cow, Fertility, Infertility, Pregnancy.*

ÖZ

Repeat Breeder Sendromu Üzerine Küresel Araştırma Eğilimleri ve Gelecek Perspektifleri

Sığır yetiştiriciliği işletmelerinde üreme etkinliği, süt üretimini ve doğan buzağı sayısını doğrudan etkileyerek işletmelerin gelir düzeyini belirleyen en önemli faktörlerden biridir. Süt sığırcılığında verim düşüklüğünün nedenlerinden biri de döl tutmayan (repeat breeder) ineklerdir. Bu çalışmada, repeat breeder ile ilgili dünya çapındaki eğilimler bibliyometrik olarak analiz edilmiştir. Araştırmanın amacı, bu alandaki yayınları inceleyerek eğilimleri ve grupları analiz etmektir. Web of Science (WOS) veri tabanında 1980-2025 yılları arasında "repeat breeder" anahtar kelimesiyle yapılan aramalarda 1746 çalışma incelenmiş, uygun olmayan çalışmalar elenerek 1713 makale analiz edilmiştir. Veri toplama için başlık, yazar isimleri, yayın yılı, dergi adı ve atıf sayısını içeren bilgilere dayanmaktadır. Analiz için VOSviewer yazılımı kullanılmış olup, doğruluk metin madenciliği ve görselleştirme teknikleri (örneğin, kabarcık haritaları) uygulanarak sağlanmıştır. Sonuçlar, repeat breeder konusunda 37419 atıf ve makale başına ortalama 22 atıf ile 1713 makale olduğunu göstermektedir. Yayımlanan makale sayısı ve buna karşılık gelen atıflar 2002'den bu yana artmıştır. Makalelerin çoğu (%72) tarım ve veterinerlik alanlarında yayınlanmış olup, en yüksek yayın sayısı ABD, Hindistan ve Çin'e aittir (%45). Çalışmaların çoğu (%92) SCI-Expanded kategorisinde indekslenmektedir. Bu çalışma, repeat breeder konusundaki küresel eğilimleri ve önemli çalışmaları vurgulamakta ve bu alandaki gelecekteki araştırma yönleri konusunda rehberlik sağlamaktadır.

Anahtar Kelimeler: *Gebelik, Fertilite, İnek, İnfertilite.*

INTRODUCTION

Reproductive efficiency in cattle farming enterprises is one of the most important factors that determine the income level of enterprises by directly affecting milk production and the number of calves born (Lee and Kim 2007). Pregnancy loss can significantly affect the economic success of a cattle operation, leading to serious financial disruptions and potentially severe consequences (Bartlett et al. 1986). Today, although there has been an increase in milk yields of cows compared to the last 50 years, there has been a decrease in reproductive performance. While the pregnancy rate in inseminations was 55% in the

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1950s, this rate has decreased to 35-45% today (Cetin 2021).

One of the most significant factors contributing to low productivity in dairy farming is the presence of repeat breeder cows. Research has shown that these cows lead to considerable economic losses in dairy farming enterprises (Lafi and Kaneene 1992; Gustafsson and Emanuelson 2002; Zbylut et al. 2012; Tanimura et al. 2022). Repeat breeder cows are defined as cows under 10 years of age that have calved at least once, exhibit regular estrus cycles, show no pathological issues, yet fail to conceive despite undergoing three or more inseminations (Çakıcı and Aköz 2017; Cetin 2022). In cows with repeat breeder, the organs related to the reproductive system are usually clinically normal and no obvious pathological findings are observed. However, the reason for reproduction failure may be due to a single factor or it may occur as a result of more than one factor coming together. This makes it difficult to detect and solve the problem. The reasons for reproduction failure include: care, nutrition, management and environmental conditions, disorders seen in the endocrine system, early embryonic deaths, failure to form fertilization, genetic, anatomical or congenital defects, immunological factors, age and body condition of the cow, failure to determine the estrus period and incorrect insemination time, stress factors (heat stress, etc.), application errors in artificial insemination procedures, infections causing inflammation in the reproductive system (Çakıcı and Aköz 2017; Bogado Pascottini et al. 2018; Ak and Acar 2022). Some of these factors can be controlled by measures that livestock producers can take (Taşal et al. 2021). Continuity of profitability in dairy farms is ensured by milk and fertility (Lee and Kim 2007). Good fertility leads to consistent milk production and an increase in the average daily milk yield (Yüksel et al. 2000). For this purpose, enterprises aim to obtain a calf every 12-13 months (Kaya et al. 1998; Cetin and Koca 2024).

Repeat breeder cows, which fail to conceive despite three or more inseminations, increase the insemination cost per pregnancy, extend the calving interval, and raise culling rates, leading to significant economic losses in dairy farms (Bartlett et al. 1986; Gustafsson and Emanuelson 2002). From past to present, various methods such as ration adjustments, estrus synchronization, hormonal applications and intrauterine treatments have been tried in different countries in order to increase pregnancy rates in repeat breeder animals and different results have been obtained (Daniels et al. 1976; Santos et al. 2009; Warriach et al. 2009; Gümen ve ark. 2012; Talukdar et al. 2016; Reshma et al. 2020). Many studies have explored various strategies to improve pregnancy rates in repeat breeder cows. However, large-scale studies that comprehensively review international literature and highlight research intensities, trends, and methodological differences through bibliometric analysis are limited. This study aims to enrich the existing knowledge from a different perspective, contributing to the literature and offering new insights. In this context, it seeks to bibliometrically analyze global trends and the impact of repeat breeder studies. Using bibliometric analysis, the study will highlight publications on the future and effects of repeat breeder research conducted by researchers from various disciplines on a global scale, evaluate the significance of publications in this field, and analyze relevant trends and clusters.

MATERIAL AND METHODS

To achieve the reliability of our study and the accuracy of the results, a systematic data collection approach, a well-defined search technique, and network analysis software were utilized. These procedures facilitated the collection and analysis of the most recent and all-encompassing data available in previous research. Furthermore, analyzing these data provides insights into the current trends and perspectives of the research community regarding the future and impact of repeat breeder studies. Worldwide publication trends on repeat breeders were established through the evaluation of factors such as the foremost researchers, countries, and the most frequently used keywords.

Methods of Data Collection and Search Strategy

In this bibliometric analysis, investigations on the future of repeat breeder studies conducted between 1980 and 2025 (last accessed on February 1, 2025) and the analysis of global trends in their effects were examined using the "Web of Science Core Collection (Web of Science, Clarivate Analytics, Philadelphia, PA, USA)" database. A search using the keyword "repeat breeder" in the database resulted in 1.746 studies. After excluding irrelevant studies, those published before 1980, and non-article publications, 1.713 articles remained for analysis. These articles were examined using details such as article title, authors' names, year of issue, journal name, and citation count. The materials were reached through the online library and digital sources of Van Yuzuncu Yil University in Türkiye. The investigation was conducted in English.

In this study, publications on global trends in repeat breeder research were examined using bibliometric methods with the Web of Science database. Web of Science is an extensive database that includes scholarly articles across various specializations and subjects, making it an essential resource for interdisciplinary research. Publications in the Web of Science database were collected using specific search terms and subjected to bibliometric analysis. Data was gathered through the online interface of Web of Science and analyzed based on various parameters. This included publication growth, the most active countries and institutions, and keyword trends. All articles were carefully reviewed during the analysis.

Network analysis

In this bibliometric study, the "VOSviewer (version 1.6.20, Leiden University, Netherlands)" software was utilized to identify global trends in repeat breeder research and key topics within this field. VOSviewer served as an effective tool for data visualization, enabling detailed analysis of collaboration networks, research trends, and potential future research areas. This platform efficiently displays bibliometric data, including publication volume, article count, citation numbers, and keyword analysis.

Bubble Maps

In the bibliometric analyses conducted with VOSviewer, "Bubble maps" are used to visualize the grouping of articles in a specific research area based on their frequency. Each keyword or group is represented by a "bubble," and the size of the bubble reflects the frequency of the keyword or group. The bubbles are color-coded, with each color representing a different group or topic, ensuring that related keywords or topics are positioned close to one another.

RESULTS

A total of 1.713 published articles were retrieved from the Web of Science database, which were cited 37.419 times in total (34.459 citations excluding self-citations). The average number of citations per article was 22, and the H index was 80. Notably, since 2002, both the number of citations and the number of articles have shown an increasing trend. The distribution of publications and citations is presented in Figure 1.

The highest number of articles was found in Agriculture (45.4%), followed by Veterinary Science (26.8%), Plant Science (19.8%), and other fields. The distribution of publications by research field is presented in Table 1.

The USA ranked first in the number of published articles (n=392; 22.9%), followed by India (n=233; 13.6%), China (n=150; 8.8%), and Japan (n=88; 5.1%). In total, 106 countries worldwide published articles, with Turkey ranking 12th. The top 15 countries with the most publications are listed in Table 2 (Table 2 and Figures 3-4).

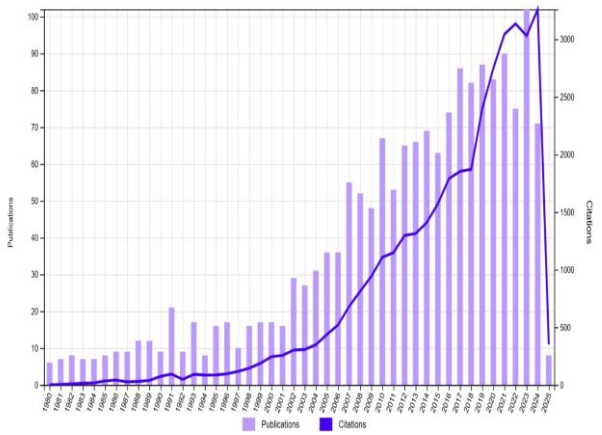

Figure 1: Frequency of publications and citations by year (last access: 01.02.2025).

When examined based on the selected keywords, it is evident that the broadest and most interconnected subject areas include terms such as "repeat breeder," "genetic diversity," "SSR," "germplasm," "pregnancy," and "dairy cow" (Figure 2).

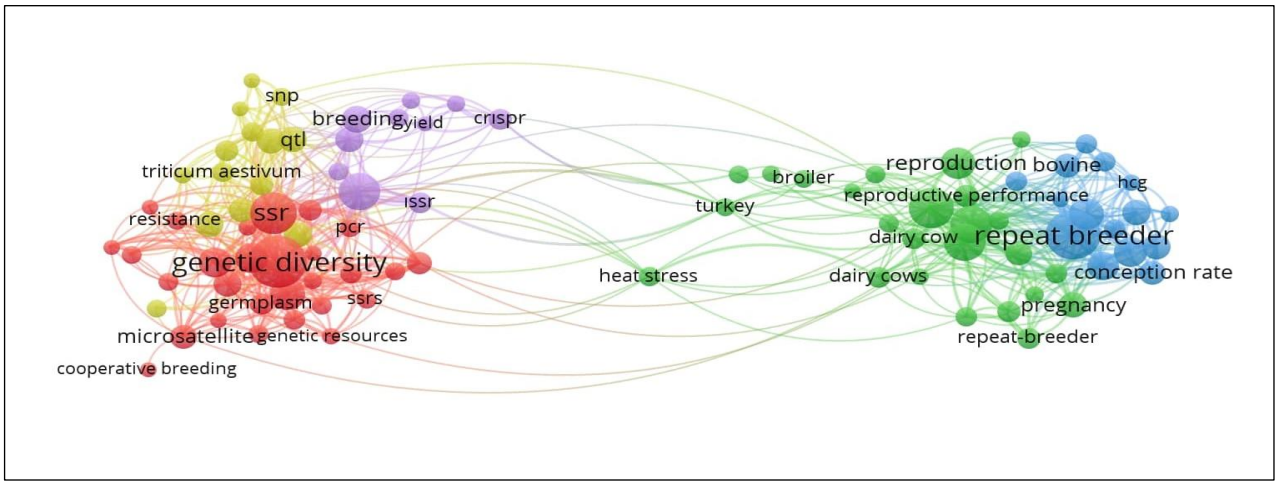

Figure 2: Keyword analysis reveals the association of the topic with specific keywords and the frequency of their usage.

Table 1: Categories of Publications.

Research Areas	Record Count	% of 1713
Agriculture	778	45.417
Veterinary Sciences	459	26.795
Plant Sciences	339	19.790
Genetics Heredity	207	12.084
Reproductive Biology	171	9.982
Zoology	104	6.071
Biotechnology Applied Microbiology	79	4.612
Biochemistry Molecular Biology	65	3.795
Environmental Sciences Ecology	63	3.678
Science Technology Other Topics	45	2.627
Food Science Technology	33	1.926
Behavioral Sciences	32	1.868
Life Sciences Biomedicine Other Topics	22	1.284
Chemistry	21	1.226
Forestry	19	1.109
Showing 15 out of 71 entries		

Table 2: Countries with at least 20 publications.

Countries/Regions	Record Count	% of 1713
USA	392	22.884
Indıa	233	13.602
Chına	150	8.757
Japan	88	5.137
France	80	4.670
Germany	80	4.670
Canada	76	4.437
Australıa	68	3.970
Brazıl	61	3.561
Italy	61	3.561
Spaın	56	3.269
Türkiye	56	3.269
Iran	52	3.036
England	50	2.919
Pakıstan	48	2.802
Showing 15 out of 106 entries		

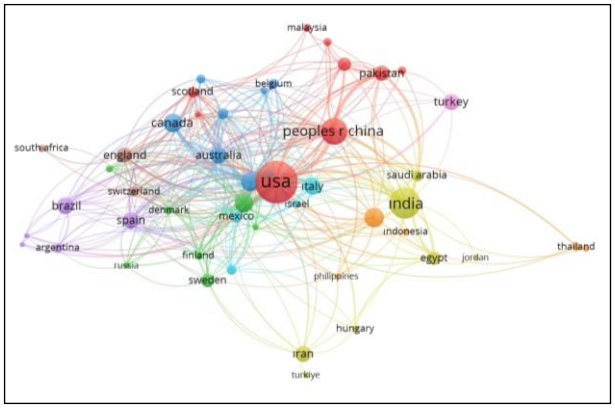

Figure 3: International collaboration network map illustrates collaboration between countries through lines, where the thickness denotes the strength of collaboration, and the size of circles/text reflects the level of international collaboration.

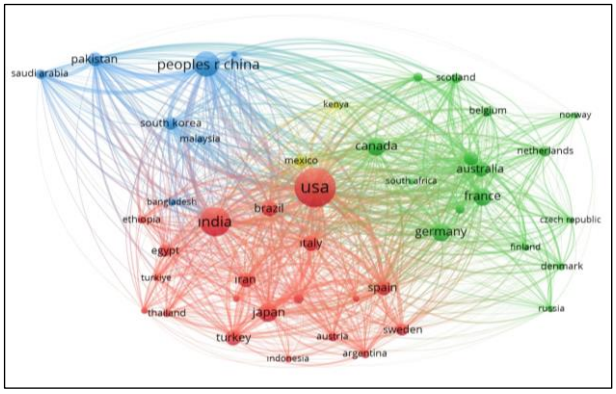

Figure 4: Bibliographic coupling analysis was performed for countries (the correlation between items was established by evaluating the number of references they share).

In this research area, the leading organizations were the US Department of Agriculture (USDA) (7.3%), the Indian Council of Agricultural Research (ICAR) (3.7%), and CGIAR (2.9%). As a result, the majority of the leading connections were based in the United States. In this context, 15 out of 2,051 records are displayed in Table 3.

Table 3: Top Affiliations Ranking.

Affiliations	Record Count	% of 1713
US Department of Agriculture USDA	125	7.297
Indian Council of Agricultural RES ICAR	63	3.678
CGIAR	49	2.860
INRAE	38	2.218
Swedish University of Agricultural Sci	37	2.160
Egyptian Knowledge Bank EKB	35	2.043
University of California System	31	1.810
Chinese Academy of Agricultural Sci	26	1.518
University System of Georgia	25	1.459
University of California Davis	24	1.401
State University System of Florida	23	1.343
Ministry of Agriculture Rural Affairs	20	1.168
University of Florida	20	1.168
University of Georgia	20	1.168
National Agriculture Food Res Org Japan	19	1.109
Showing 15 out of 2051 entries		

When examining the Web of Science indexes, it was found that the majority of the articles were in the "Science Citation Index Expanded (SCI-Expanded)" category (91.5%), followed by the "Conference Proceedings Citation Index- (CPCI-S)" (5.3%) and "Emerging Sources Citation Index (ESCI)" (4.9%) categories (Table 4).

Table 4: Web of Science Categories Index.

Web of Science Index	Record Count	% of 1713
Science Citation Index Expanded (SCI-Expanded)	1568	91.535
Conference Proceedings Citation Index - (CPCI-S)	91	5.312
Emerging Sources Citation Index (ESCI)	83	4.845
Book Citation Index - Science (BKCI-S)	16	0.934
Social Sciences Citation Index (SSCI)	11	0.642

DISCUSSION AND CONCLUSION

This study demonstrates that scientific publications and research on repeat breeders in cows are increasing globally. The study aimed to identify global trends and clusters in repeat breeder research, highlight specific focus areas within the field, and pinpoint the countries where these studies are most prevalent. VOSviewer was utilized as a powerful data visualization tool to conduct a detailed analysis of collaboration networks, research trends, and potential future research topics (Van Eck and Waltman, 2022). This method enhances the accuracy and reliability of the research, while also facilitating a clearer interpretation of the obtained data. The analyses offer a comprehensive view of the repeat breeder issue in veterinary medicine, with diagrams and maps highlighting key aspects of the research, the research process, and the publication dynamics over time.

Repeat breeder syndrome is a significant productivity issue in dairy and meat farming. It is defined as the inability of animals to conceive after three or more inseminations despite having a normal estrus cycle, and it is a widely discussed topic in the literature. The prevalence of this syndrome ranges from 5% to 62% in different regions of the world, with these variations influenced by factors such as management practices, production systems, and milk yield per animal (Pérez-Marín and Quintela, 2023; Yusuf et al. 2010). This situation highlights the importance of managing repeat breeder syndrome to ensure sustainable productivity (Pérez-Marín ve Quintela, 2023).

The etiology of repeat breeder syndrome remains unclear and is considered multifactorial (Pérez-Marín et al., 2012). Among the causes, hormonal dysfunction (Bage et al., 2002), uterine infections and reproductive system abnormalities (Villarroel et al., 2004), semen quality and insemination methods (Hallap et al., 2006), and inadequate diet and health management (Purohit, 2008) are particularly notable. Treatment approaches for repeat breeder syndrome are generally based on the identified etiological factors. Therefore, to minimize the negative economic impact of repeat breeder syndrome on farm profitability, an effective treatment plan should be established following a proper diagnosis (Pérez-Marín et al., 2012).

The primary goal of reproductive management is to ensure that cows become pregnant again within the optimal interval after calving (Walsh et al., 2011). However, a progressive decline in cow fertility has been observed globally in recent years, and this decline, likely driven by production-oriented genetic selection, has made reproductive issues even more critical (Norman et al., 2009). Specifically, complex reproductive disorders such

as repeat breeder syndrome are receiving increasing attention. To reduce and manage the impact of this issue, it is essential to develop advanced diagnostic and treatment methods, create innovative approaches to minimize the negative effects of the syndrome, and conduct comprehensive research to enhance reproductive efficiency. Future studies will help develop more effective methods for treating repeat breeder syndrome, significantly contributing to both improved animal health and reduced economic losses.

This study demonstrates that scientific publications on repeat breeders are increasing globally. It aims to identify global trends and clusters in repeat breeder research, highlighting key focus areas and the countries where this research is most prominent. Additionally, the study identifies important journals, authors, and studies in the field, while also predicting which areas of repeat breeder research will see greater focus in the future and which researchers are likely to lead in these areas.

This study provides a bibliometric analysis of global trends and publication patterns in repeat breeder research. The article is based on the analysis of 1,713 articles gathered through an extensive literature review. The analysis identifies the most influential countries, institutions, authors, journals, and keywords related to repeat breeder research. The findings can serve as a guide for future research in this field and offer a roadmap for further studies on repeat breeder syndrome.

The results of this study offer a global perspective on repeat breeder research, highlighting its significance and prevalence. This study can serve as a valuable resource for veterinary researchers, policymakers, and representatives from the agricultural production sector.

Bibliometric analysis is a method used to identify trends and tendencies in the literature, but it does not assess the accuracy or quality of the original data. Therefore, more comprehensive studies should be conducted on the research topic, and similar analyses should be performed using different databases. Additionally, bibliometric analysis does not aim to evaluate the applicability of the findings, as its primary purpose is to analyze the existing literature and provide a general overview of specific topics.

In conclusion, this bibliometric analysis highlights global trends and key studies in the repeat breeder field, offering valuable insights into the future directions of research in this area.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

AUTHOR CONTRIBUTIONS

Idea / Concept: NC
Supervision / Consultancy: NC
Data Collection and / or Processing: NC
Analysis and / or Interpretation: NC
Writing the Article: NC
Critical Review: NC

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