Plant domestication and cultivation in Latin America: archaeobotanical and ethnobotanical perspectives on Mato Grosso and the Pantanal

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Research

Abstract

Background: Plant domestication in Latin America is investigated through archaeobotanical, paleoecological, ethnobotanical, and historical-ecological approaches integrating cultivation, plant use, human occupation, and landscape transformation. This study aimed to map indexed literature on plant domestication and cultivation and their associations with archaeobotanical evidence and long-term human occupation in Latin America, while examining Mato Grosso and the Pantanal within broader debates on long-term human-plant interactions.

Methods: A bibliometric analysis was conducted using the Web of Science Core Collection. The search retrieved 440 records. After excluding 29 records published in the incomplete year of 2026, 411 records from 2001-2025 were screened by title, abstract, and keywords according to predefined eligibility criteria. The final corpus comprised 138 articles. Analyses were performed in R using Bibliometrix and Biblioshiny and complemented by a targeted qualitative review of regional literature.

Results: Scientific production increased markedly from the late 2010s onward. The thematic structure was organized mainly around domestication, maize, phytoliths, cultivation, vegetation, agriculture, archaeobotany, and starch grains. Six thematic clusters were identified, with domestication, phytoliths, and maize forming the largest cores. The regional review showed relevant archaeological, paleoethnobotanical, and anthracological evidence in Mato Grosso, whereas direct archaeobotanical evidence remains more limited in the Pantanal.

Conclusion: The results reinforce the integration of domestication, cultivation, historical ecology, and landscape transformation in Latin American archaeobotanical research. Mato Grosso is examined as a focal regional context and a strategic comparative setting for investigating long-term human-plant interactions across Cerrado, Amazonian, Pantanal, and transitional environments.

Keywords: Archaeobotany; Ethnobotany; Plant domestication; Phytoliths; Historical ecology; Mato Grosso; Pantanal.

Background

Plant domestication in Latin America cannot be understood solely as the outcome of intensive agriculture or as a linear transition from gathering to food production. Practices such as selecting, protecting, transporting, propagating, and favoring useful plants may precede the morphological or genetic changes associated with full domestication, while cultivation and management may occur without complete domestication of plant populations (Clement 1999; Clement *et al.* 2010). This distinction is particularly important in Neotropics, where different forms of species and landscape management coexisted with mobility, gathering, horticulture, and agriculture over long periods (Clement *et al.* 2010; Clement *et al.* 2021).

The development of archaeobotany has substantially expanded the capacity to investigate these relationships. Plant macroremains, phytoliths, starch grains, pollen, charcoal, and other proxies make it possible to identify plant use, foodways, cultivation, fire, and vegetation change in contexts where direct evidence of domesticated plants may be scarce or poorly preserved (Piperno & Pearsall 1998; Pearsall *et al.* 2004; Perry *et al.* 2007; Piperno 2011). Integrating these lines of evidence with archaeological and paleoenvironmental data has helped move interpretation beyond models centered exclusively on agriculture toward broader understandings of relationships among human populations, plants, and landscapes (Piperno 2011; Iriarte *et al.* 2020).

This conceptual expansion has also contributed to the development of the concept of landscape domestication. Human populations may alter the abundance and distribution of useful species, modify fire regimes, transform soils, and favor vegetation formations without necessarily producing intensive agricultural landscapes. In Amazonia, research on forest management, anthropogenic dark earths, enrichment of useful species, and vegetation transformation has shown that present-day landscapes may retain legacies of pre-Columbian occupation and cumulative management practices (Clement *et al.* 2010; Levis *et al.* 2018; Iriarte *et al.* 2020; Clement *et al.* 2021).

The archaeobotanical literature on Latin America has particularly well-established traditions in Amazonian, Andean, and Mesoamerican contexts where studies of domestication, crop origins and dispersal, plant microremains, paleoecology, and long-term human occupation have provided important frameworks for interpreting landscape transformation (Piperno & Pearsall 1998; Pearsall *et al.* 2004; Perry *et al.* 2007; Piperno 2011; Iriarte *et al.* 2020). However, the spatial representation of this knowledge in the indexed scientific literature remains uneven, with some regions exhibiting greater bibliographic visibility than others.

Mato Grosso represents a particularly relevant case in this context. The state encompasses Cerrado, Pantanal, Amazonian environments, and transitional zones, providing contrasting ecological conditions for investigating human occupation, plant use, fire management, and landscape transformation. Research at Santa Elina demonstrates that the region contains archaeological, paleoethnobotanical, and anthracological records capable of contributing to discussions of paleovegetation, plant-resource use, and long-term human occupation (Ceccantini & Gussella 2001; Bachelet & Scheel-Ybert 2017; Scheel-Ybert & Bachelet 2020). Its limited integration into broader archaeobotanical debates should therefore not be confused with an absence of empirical evidence.

The Pantanal broadens this regional problem by introducing a seasonally flooded landscape with a long history of Indigenous occupation and archaeological diversity in Central Brazil (Oliveira & Viana 1999-2000; Bespalez 2015). Its hydrological dynamics influence settlement possibilities, mobility, resource exploitation, and the organization of human occupation, creating archaeological conditions distinct from those of both Amazonian forests and Cerrado landscapes. Despite this archaeological record, studies directly investigating plant domestication, cultivation, and management through archaeobotanical proxies in this region remain relatively limited. Cerrado, Pantanal, Amazonian environments, and transitional zones should therefore not be treated as ecological equivalents, since differences in hydrology, vegetation, fire regimes, and mobility may generate distinct archaeological signatures of plant management and landscape domestication (Oliveira & Viana 1999-2000; Bespalez 2015; Levis *et al.* 2018; Iriarte *et al.* 2020).

Within this framework, bibliometric approaches can reveal how themes, authors, cited references, and archaeobotanical proxies structure the scientific debate, whereas a complementary regional qualitative review can examine evidence that does not necessarily achieve equivalent visibility in international databases. Combining these approaches is useful for distinguishing bibliographic presence in the indexed corpus from the archaeological relevance evidenced by the regional literature and for identifying comparative possibilities between well-established research traditions and regions that remain less integrated into the broader debate **(**Župič & Čater 2015; Donthu *et al.* 2021; Marzi *et al.* 2025).

Against this background, this study aimed to bibliometrically map indexed scientific literature on plant domestication and cultivation and their associations with archaeobotanical evidence, plant use, and long-term human occupation in Latin America. A complementary qualitative review was used to examine Mato Grosso as a focal regional context, including its Pantanal region and transitional environments, within broader debates on long-term human-plant interactions. By articulating these two analytical components, the study seeks to distinguish patterns identified within the bibliometric corpus from regional archaeological, archaeobotanical, paleoethnobotanical, and ethnobotanical evidence relevant to plant management and landscape transformation.

Materials and Methods

The study combined bibliometric analysis with a complementary qualitative narrative review. The bibliometric stage characterized indexed scientific production on plant domestication, cultivation, and use in Latin America, focusing on archaeological, archaeobotanical, paleoethnobotanical, pre-Columbian, and long-term human occupation contexts. The qualitative review was used to interpret the identified patterns and incorporate regional studies related to Mato Grosso, encompassing Cerrado, Amazonian, Pantanal, and transitional environments, particularly when these studies were not represented in the final bibliometric corpus. The two stages were treated as complementary procedures with distinct analytical functions, combining quantitative mapping with contextual interpretation (Župič & Čater 2015; Marzi *et al.* 2025). The qualitative review was not intended to provide an exhaustive or systematic inventory of regional literature.

Bibliometric Survey

Bibliometric analysis was employed to characterize the structure and development of scientific literature concerning plant domestication, cultivation, and use in archaeological and long-term human occupation contexts in Latin America. Bibliometric approaches allow the examination of publication patterns, recurrent authors and references, descriptor frequencies, and thematic organization within a documentary corpus, providing an appropriate framework for quantitative science mapping (Aria & Cuccurullo 2017; Donthu *et al.* 2021).

The bibliographic search was conducted in the Web of Science Core Collection without manually restricting the search to specific citation indexes. No language restriction was applied. The search strategy was organized into four thematic blocks applied to the Topic field (TS), which retrieves terms occurring in titles, abstracts, author keywords, and Keywords Plus. The blocks comprised: (1) domestication and cultivation; (2) archaeological, ethnographic, or pre-Columbian contexts; (3) plants and vegetation; and (4) a Latin American geographic framework. This combination was designed to increase retrieval sensitivity without restricting the principal concepts exclusively to article titles. The final search string was:

TS=(domestica OR cultiv*)*
AND TS=(archaeo OR ethno* OR "pre-columbian")*
AND TS=(plant OR flora OR botan* OR vegetat*)*
AND TS=("Latin America" OR "South America" OR "Central America" OR Mesoamerica OR Caribbean OR Mexico OR Guatemala OR Belize OR Honduras OR "El Salvador" OR Nicaragua OR "Costa Rica" OR Panama OR Colombia OR Venezuela OR Guyana OR Suriname OR Ecuador OR Peru OR Bolivia OR Brazil OR Paraguay OR Uruguay OR Argentina OR Chile)*The search was conducted on 15 September 2026 and initially retrieved 440 records. Because 2026 represented an incomplete publication year, 29 records from that year were excluded, resulting in 411 records published between 2001 and 2025. No lower publication-year limit was imposed; 2001 corresponded to the earliest publication year retrieved by the search strategy. These 411 records were screened on the basis of titles, abstracts, and keywords according to the predefined eligibility criteria. Screening was conducted by the first author, with records of uncertain eligibility reassessed against the predefined criteria before the final inclusion decision.

Of the 411 records screened, 273 were excluded because they did not meet the predefined eligibility criteria, resulting in a final corpus of 138 articles. No document-type filter was applied during data retrieval; however, all records retained after thematic screening were classified by Web of Science as Articles. The final corpus therefore resulted from a broad bibliographic retrieval followed by thematic screening based on explicit eligibility criteria. This procedure is particularly relevant in bibliometric research because sensitive search strategies may retrieve records only peripherally related to the research question, requiring eligibility assessment before quantitative analysis (Donthu *et al.* 2021).

Records whose relevance to archaeological, archaeobotanical, paleoethnobotanical, historical-ecological, or long-term human-plant contexts were not immediately clear were reassessed before the final inclusion decision.

Studies were included when they addressed plant domestication, cultivation, management, or use in relation to archaeological, archaeobotanical, paleoethnobotanical, pre-Columbian, long-term human occupation, or historical-ecological contexts. Studies based on phytoliths, starch grains, plant macroremains, charcoal and anthracology, pollen, and other botanical proxies capable of documenting relationships among human populations, plants, and environmental transformation were also retained. Studies of landscape domestication and historical ecology were included when they showed a substantive relationship with plant management, human occupation, or long-term environmental modification.
Studies were excluded when they focused exclusively on contemporary ethnobotany without an archaeological or long-term historical-ecological connection; pharmacological, phytochemical, or biomedical applications without a substantive archaeobotanical component; experimental agronomy; contemporary genetic conservation without a substantive relationship to historical domestication or long-term human occupation; studies conducted outside Latin America; or studies of human occupation without a relevant plant component.

Data processing and bibliometric analysis

Records included in the final corpus were exported from the Web of Science Core Collection in BibTeX format using the *Full Record and Cited References* option. Data processing and bibliometric analysis were performed in R version 4.6.1 (R Core Team 2026), using the Bibliometrix package (version 5.3.0) and the Biblioshiny interface (Aria & Cuccurullo 2017). The analyses included descriptive indicators of the corpus, annual scientific production, author frequency, recurrence of cited references, keyword frequency, and thematic structure. Term co-occurrence analysis was used to examine associations among descriptors and identify thematic groupings within the documentary set, allowing the recognition of conceptual cores related to domestication, archaeobotany, phytoliths, cultivation, and long-term human occupation (Donthu *et al.* 2021; Klarin 2024).

The thematic map was generated in Biblioshiny using the *All-Keywords* field, with a maximum of 250 words and a minimum cluster frequency of five (Aria & Cuccurullo 2017). The Louvain algorithm was used for community detection, with an alpha parameter of 0.5 and community repulsion of 0.5. No custom stop-word list or synonym list was applied. The thematic map was interpreted using the centrality and density measures calculated by Bibliometrix. Centrality expresses the degree of connection of a thematic cluster with the broader thematic network, whereas density represents its level of internal development. The combination of these measures positions clusters within the motor, basic, niche, and emerging or declining thematic quadrants.

Complementary qualitative literature review

The bibliometric analysis was complemented by a targeted qualitative narrative review used to deepen regional and conceptual aspects that could not be sufficiently assessed through bibliometric frequencies alone. Combining quantitative mapping with qualitative reading makes it possible to interpret thematic structures within broader historical, regional, and conceptual contexts, avoiding the treatment of bibliometric patterns as direct equivalents of the empirical complexity of a research field (Moresi *et al.* 2021; Marzi *et al.* 2025).

This stage did not constitute a second quantitative corpus and was not used to recalculate frequencies, networks, or bibliometric indicators. Its purpose was to contextualize archaeological, archaeobotanical, paleoethnobotanical, paleoenvironmental, and ethnobotanical evidence related to Mato Grosso, the Pantanal, and transitional areas of Central Brazil.

The complementary literature selection prioritized studies directly related to long-term human occupation, plant use and management, domestication, historical ecology, landscape transformation, phytoliths, starch grains, plant macroremains, charcoal and anthracology, pollen, anthrosols, fire, and agrobiodiversity. Historical ecology was considered particularly relevant because it allows landscapes to be examined as products of cumulative interactions among human populations, plants, and environments over time, including processes of management and landscape domestication (Clement *et al.* 2010; Levis *et al.* 2018).

Studies of contemporary Indigenous knowledge and management were also considered when they contributed to interpreting continuities, transformations, or comparative possibilities between present practices and archaeological records, without treating them as direct equivalents of pre-Columbian contexts.

Regional studies were identified through targeted searches by topic, locality, and authorship, complemented by references already established in the specialized literature. Scientific articles, book chapters, dissertations, theses, institutional

repositories, and regional publications directly relevant to the research problem were considered. Reading was organized around three analytical axes: (1) long-term human occupation and landscape transformation; (2) archaeobotanical and paleoenvironmental evidence in Mato Grosso, the Pantanal, and transitional areas; and (3) plant management, historical ecology, and agrobiodiversity.

The distinction between the two analytical stages was maintained throughout interpretation. Quantitative patterns presented in the Results derive exclusively from the 138 articles included in the bibliometric corpus, whereas the complementary literature was used to deepen regional interpretation, discuss limits of bibliographic visibility, and compare different trajectories of interaction among human populations, plants, and landscape

Data integration

Bibliometrics was used to identify patterns of scientific production, recurrence of authors, references, and descriptors, as well as the thematic organization of the corpus. The qualitative review was used to contextualize these patterns through archaeological, archaeobotanical, paleoenvironmental, and historical-ecological evidence related to Mato Grosso, encompassing Cerrado, Amazonian, Pantanal, and transitional environments. The combination of quantitative mapping and qualitative interpretation has been recommended as an approach capable of expanding the understanding of bibliographic structures and their meanings within specific contexts (Moresi *et al.* 2021; Marzi *et al.* 2025).

This integration made it possible to distinguish patterns directly measured within the 138 articles from regional interpretations derived from complementary literature. Bibliometric results were treated as evidence of the documentary structure of the corpus, whereas the qualitative literature was used to deepen the interpretation of processes such as domestication, cultivation, plant use, fire management, anthrosol formation, agrobiodiversity, landscape domestication, and long-term human occupation.

This distinction was particularly important for Mato Grosso, where archaeological and archaeobotanical relevance should not be inferred solely from the frequency of authors, references, or descriptors in the bibliometric corpus. The integration of the two stages allowed models developed in Amazonian, Andean, and Mesoamerican contexts to be compared with regional evidence from the Cerrado, Pantanal, Amazonian, and transitional environments of Mato Grosso, while maintaining a clear distinction between bibliographic visibility and regional empirical evidence.

Results

Annual scientific production

The final bibliometric corpus comprised 138 articles published between 2001 and 2025. The temporal distribution shows uneven growth throughout the series, with relatively low publication output during the earliest years and a more sustained increase from the 2010s onward. Between 2001 and 2006, only four articles were recorded, whereas publication output between 2007 and 2013 remained irregular, ranging from one to four articles per year.

From 2014 onward, scientific production became more continuous. Eight articles were published in 2014, followed by six in 2015 and three in 2016. Publication output increased to eight articles in 2017 and reached 11 in both 2018 and 2019. After seven articles in 2020 and nine in 2021, 11 articles were recorded annually in 2022 and 2023. The highest annual outputs occurred in 2024 and 2025, with 16 and 15 articles, respectively. Overall, 91 of the 138 articles (65.9%) were published between 2018 and 2025, indicating that nearly two-thirds of the corpus was concentrated in this period.

General indicators of the corpus reinforce this expansion. The 138 documents were distributed across 56 sources and involved 659 authors, with an annual growth rate of 11.94% as calculated by Bibliometrix. The corpus presented an average of 34.89 citations per document and included 8,395 cited references. Scientific production was predominantly collaborative, with an average of 5.76 co-authors per document and 47.1% international co-authorship. The temporal distribution of publications across the analyzed period is shown in Figure 1.

Thematic structure of the corpus

The thematic structure of the corpus reveals an organization strongly associated with plant domestication, archaeobotany, and the reconstruction of long-term relationships among human populations, vegetation, and landscapes. The most frequent descriptors include *domestication* (48 occurrences), *maize* (38), *cultivation* (23), *phytoliths* (20), *vegetation* (20), *agriculture* (19), *archaeobotany* (17), and *starch grains* (17). Other recurrent terms include *patterns* (16), *diversity* (15), *history* (15), *pollen* (14), and *charcoal* (11).

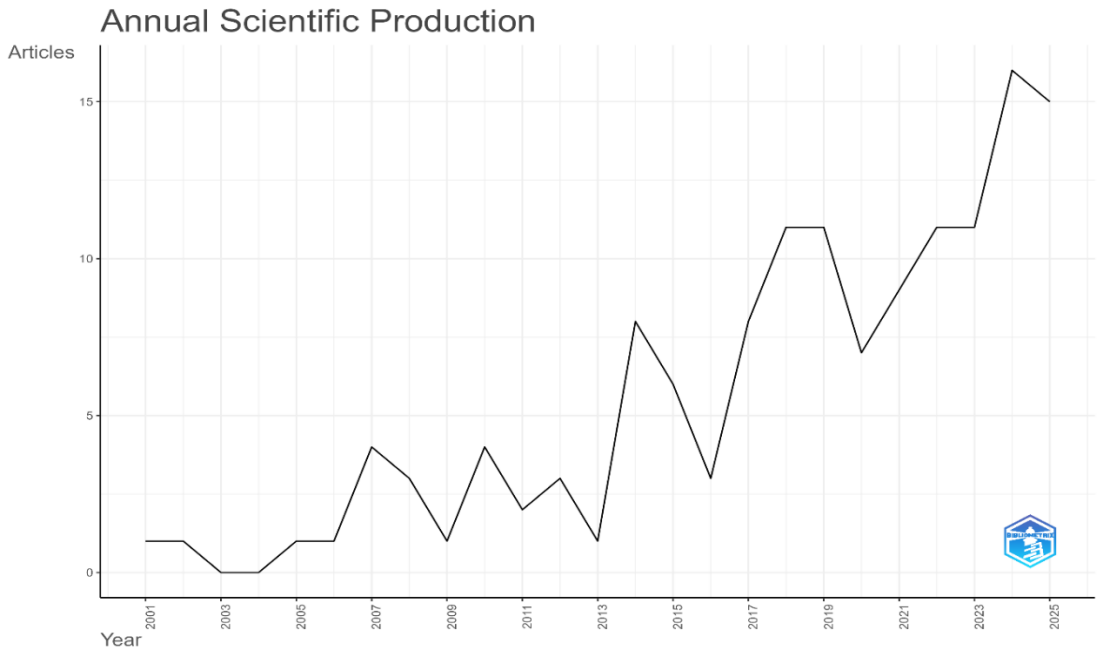


Figure 1. Annual scientific production in the analyzed bibliometric corpus, 2001-2025. Source: Authors' dataset based on Web of Science Core Collection records processed in Bibliometrix

The co-occurrence of phytoliths, starch grains, pollen, and charcoal indicates that the thematic structure of the corpus encompasses not only domestication as a conceptual problem, but also multiple archaeobotanical and paleoenvironmental proxies associated with the reconstruction of plant use, diet, cultivation, fire, and vegetation change. Descriptors such as *pre-Columbian*, *Amazonia*, *archaeology*, *landscape*, *subsistence*, and *Late Holocene* further indicate connections between research on domestication and long-term archaeological and paleoenvironmental contexts.

The thematic map identified six main clusters: domestication, maize, phytoliths, basin, late holocene, and Peru. The *domestication* cluster presented the highest cumulative term frequency (366) and included descriptors such as *cultivation*, *agriculture*, *diversity*, *management*, *historical ecology*, *ancient DNA*, *plant domestication*, *paleoethnobotany*, and *niche construction*. This composition indicates that domestication is associated both with the biological and evolutionary dimensions of plants and with management, historical ecology, and long-term relationships between human populations and landscapes.

The *phytoliths* cluster presented a cumulative frequency of 321 and included *vegetation*, *pollen*, *charcoal*, *pre-Columbian*, *Amazonia*, *landscape*, *fire*, *land-use*, *human occupation*, and *palaeoecology*. This cluster represents a research axis strongly associated with the reconstruction of environments and anthropogenic landscapes through archaeobotanical and paleoecological proxies. Regarding their position in the thematic map, the *phytoliths* and *maize* clusters were located in the upper-right quadrant, corresponding to motor themes characterized by relatively high centrality and density. The *domestication* cluster occupied the lower-right quadrant, corresponding to a basic theme characterized by high centrality but comparatively lower density. The *Late Holocene* cluster was positioned in the upper-left quadrant as a niche theme, whereas the *basin* and *Peru* clusters occurred in the lower-left quadrant, corresponding to emerging or declining themes.

The co-occurrence of fire, human occupation, vegetation change, and land use highlights the importance of approaches concerned with the historical transformation of landscapes. The *maize* cluster, with a cumulative frequency of 304, included terms such as *archaeobotany*, *starch grains*, *diet*, *archaeology*, *subsistence*, *dental calculus*, *stone tools*, *foodways*, and *microfossils*. This thematic core connects maize with archaeobotanical investigations of food, processing, consumption, and subsistence, particularly through plant microremains, residues on artifacts, and bioarchaeological evidence.

The three smaller clusters represent more specific thematic configurations. *Late Holocene* links mobility, settlement, food, cultivation, and transitions between foraging and farming.

The *Peru* cluster includes descriptors related to quinoa, *Chenopodium*, maize, and human populations, forming a regional thematic configuration associated with Andean contexts. The *basin* cluster includes descriptors such as hunter-gatherers, earthworks, and maize cultivation, indicating associations among human occupation, plant use, and landscape transformation.

Taken together, the clusters indicate that the thematic structure of the corpus encompasses three interconnected dimensions: domestication and cultivation; archaeobotanical evidence related to plant use and consumption; and paleoenvironmental and historical-ecological approaches to long-term human occupation and landscape transformation. The distribution of these themes according to centrality and density is presented in Figure 2.

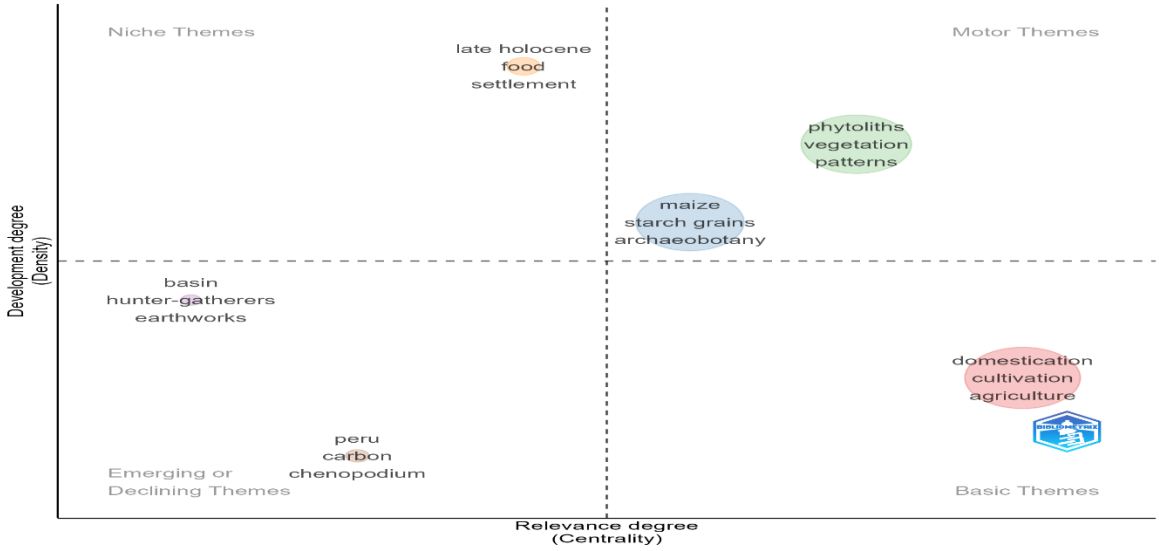


Figure 2. Thematic map of the bibliometric corpus based on term co-occurrence and the centrality and density measures calculated in Bibliometrix. Source: Authors' dataset based on Web of Science Core Collection records processed in Bibliometrix.

Most recurrent cited references, authors, and descriptors

Table 1 summarizes the most recurrent cited references, authors, and keywords in the analyzed corpus. The cited-reference analysis shows the recurrence of publications addressing agricultural origins, plant domestication, phytoliths, archaeobotany, and landscape transformation. Piperno and Pearsall (1998) were the most recurrent cited reference, with 34 occurrences, followed by Piperno (2011), with 25. Clement *et al.* (2015) and Levis *et al.* (2017) each occurred 23 times. Henry *et al.* (2009) and Piperno *et al.* (2000) occurred 17 times each, followed by Pearsall *et al.* (2004) with 16, Lombardo *et al.* (2020) with 15, and Perry *et al.* (2007) with 14. Collectively, these recurrent references are associated with research on plant domestication, crop origins and dispersal, archaeobotanical methods, microbotanical evidence, and long-term human-landscape interactions.

Among the authors represented in the 138 articles, José Iriarte occurred in nine publications, followed by Crystal N. H. McMichael and Dolores R. Piperno, with seven each. Mark B. Bush and A. Tavarone occurred in six articles, whereas M. de los Milagros Colobig, Corinne L. Hofman, Logan Kistler, Mark Robinson, and Jennifer Watling occurred in five each. These authors are associated with research spanning archaeobotany, paleoecology, plant domestication, bioarchaeology, and environmental history.

Keywords reinforce this configuration. *Domestication* is the most recurrent descriptor, followed by *maize*, *cultivation*, *phytoliths*, *vegetation*, *agriculture*, *archaeobotany*, and *starch grains*. The simultaneous recurrence of descriptors associated with domesticated plants, plant microremains, vegetation, climate, diet, and landscape indicates that the analyzed literature operates across multiple scales of evidence, ranging from evolutionary processes of domestication to cultivation practices, consumption, mobility, and environmental transformation.

The bibliometric corpus therefore presents a thematic structure strongly associated with archaeobotany and domestication research, while also encompassing paleoecology, historical ecology, and landscape-use studies. Overall, the thematic

patterns indicate recurrent associations among archaeobotanical proxies, long-term human occupation, plant management, and landscape transformation, highlighting the interdisciplinary character of the literature represented in the corpus.

Table 1. Most recurrent cited references, authors, and keywords in the analyzed corpus.

Cited references	Cited-reference frequency	Authors	Articles	Keywords	Occurrences
Piperno DR, Pearsall DM. 1998. *The Origins of Agriculture in the Lowland Neotropics*	34	Iriarte J	9	domestication	48
Piperno DR. 2011. *Current Anthropology*	25	McMichael CNH	7	maize	38
Clement CR *et al.* 2015. *Proceedings of the Royal Society B*	23	Piperno DR	7	cultivation	23
Levis C *et al.* 2017. *Science*	23	Bush MB	6	phytoliths	20
Henry AG *et al.* 2009. *Journal of Archaeological Science*	17	Tavarone A	6	vegetation	20
Piperno DR *et al.* 2000. *Nature*	17	Colobig MM	5	agriculture	19
Pearsall DM *et al.* 2004. *Journal of Archaeological Science*	16	Hofman CL	5	archaeobotany	17
Lombardo U *et al.* 2020. *Nature*	15	Kistler L	5	starch grains	17
Perry L *et al.* 2007. *Science*	14	Robinson M	5	patterns	16
Iriarte J *et al.* 2020. *Quaternary Science Reviews*	13	Watling J	5	diversity	15

Note: cited-reference frequencies represent the number of occurrences of each reference within the analyzed bibliographic corpus; author frequencies refer to the number of articles in which each author appears; keyword frequencies represent occurrences within the bibliographic dataset. These measures are not directly comparable because they represent different bibliometric units.

The bibliometric results indicate a marked concentration of publications in the more recent portion of the period analyzed, particularly from the second half of the 2010s onward. The thematic structure is organized primarily around domestication, maize, phytoliths, cultivation, vegetation, agriculture, archaeobotany, and starch grains. The recurrence of cited references, authors, and keywords further indicates connections among research on plant domestication, archaeobotany, paleoecology, historical ecology, foodways, and long-term human occupation. Together, these patterns characterize the thematic and intellectual structure of the 138 articles included in the bibliometric corpus.

Taken together, the results indicate that the analyzed literature is structured around interconnected research on plant domestication, cultivation, archaeobotanical evidence, and landscape transformation. The recurrence and co-occurrence of descriptors related to phytoliths, starch grains, pollen, charcoal, maize, and archaeobotany indicate sustained attention to multiple proxies and approaches relevant to plant use, food processing, cultivation, fire, vegetation change, and long-term human occupation. Historical ecology and landscape management also contribute to this thematic structure, providing a broader comparative framework for examining long-term human-plant interactions across Latin America and for contextualizing evidence from Mato Grosso, including its Cerrado, Amazonian, Pantanal, and transitional environments.

Discussion

Recent expansion of the literature and consolidation of an archaeobotanical debate

The concentration of publications between 2018 and 2025 indicates a recent expansion of the literature represented in the analyzed corpus. This increase is accompanied by a thematic structure in which domestication, cultivation, archaeobotany, maize, phytoliths, starch grains, vegetation, pollen, and charcoal occur as recurrent elements. Rather than representing independent research topics, these descriptors reflect a broader integration of biological, archaeological, and paleoenvironmental approaches to long-term human-plant relationships, a development also recognized in Neotropical archaeobotanical research (Piperno & Pearsall 1998; Pearsall *et al.* 2004; Piperno 2011; Iriarte *et al.* 2020).

The development of Neotropical archaeobotany has been fundamental to this analytical expansion. Phytolith analysis broadened the possibility of identifying plant use and vegetation change in contexts where plant macroremains are poorly preserved (Piperno & Pearsall 1998). Archaeobotanical approaches strengthened reconstructions of subsistence, cultivation, and plant exploitation through different classes of botanical evidence (Pearsall *et al.* 2004), while starch-grain analysis enabled the identification of plant processing and consumption from residues preserved on archaeological artifacts (Perry *et al.* 2007). Together, these approaches allowed the history of plant use to be investigated through multiple lines of evidence

rather than inferred solely from domesticated macroremains (Piperno 2011). In Brazil, earlier archaeobotanical research had already demonstrated the potential of plant remains for investigating cultivation and food-production histories, including evidence of ancient maize from archaeological cave contexts in Minas Gerais (Bird *et al.* 1991).

This trajectory is also visible in the citation profile of the present corpus. Works by Piperno and Pearsall, Clement, Perry, Levis, Lombardo, and Iriarte recur among the cited references, linking research on plant domestication, crop dispersal, phytoliths, microbotanical remains, human occupation, and landscape transformation. The prominence of maize within the thematic structure is connected to broader archaeobotanical questions concerning processing, consumption, subsistence, mobility, and the dispersal of cultivated plants across Latin America (Perry *et al.* 2007; Piperno 2011; Lombardo *et al.* 2020; Iriarte *et al.* 2020).

At the same time, the corpus reflects a broader understanding of domestication itself. Domestication cannot be reduced to morphological or genetic modification of individual species, since cultivation and management may occur without complete domestication and may precede the establishment of intensive agricultural systems (Clement 1999). In Neotropical contexts, practices such as selection, protection, propagation, transportation, vegetation enrichment, fire management, and soil modification may form part of long-term processes of interaction between human populations and plants (Clement *et al.* 2010; Clement *et al.* 2021). This perspective is particularly relevant for archaeological interpretation because it allows management to be investigated even where direct evidence of fully domesticated crops is limited.

The incorporation of paleoecological and landscape-scale evidence reinforces this analytical framework. Studies of anthropogenic vegetation, useful-species enrichment, fire regimes, and human occupation have demonstrated that pre-Columbian transformations may persist in present-day vegetation structure and species distributions (Levis *et al.* 2018). Archaeobotanical and paleoenvironmental records converge in the investigation of how human populations modified vegetation over long periods, including contexts in which cultivation coexisted with mobility, forest management, diversified subsistence strategies, and landscape transformation (Levis *et al.* 2018; Iriarte *et al.* 2020; Clement *et al.* 2021).

This thematic configuration provides a broader framework for contextualizing and comparing archaeological and archaeobotanical research developed in Amazonian, Andean, and Mesoamerican contexts with regional evidence from Mato Grosso, encompassing Cerrado, Amazonian, Pantanal, and transitional environments (Piperno 2011; Levis *et al.* 2018; Iriarte *et al.* 2020).

Archaeobotanical evidence, human occupation, and landscape transformation

The thematic structure of the corpus shows a strong articulation between archaeobotanical evidence and the reconstruction of long-term human occupation. The cluster centered on *phytoliths* brings together vegetation, pollen, charcoal, fire, land use, human occupation, and paleoecology, indicating that archaeobotanical research operates at the intersection of plant-use studies and broader reconstructions of anthropogenic landscapes. Human presence is therefore expressed not only through artifacts and settlement structures, but also through cumulative changes in vegetation composition, fire regimes, soils, and the distribution of useful plants (Piperno 2011; Levis *et al.* 2018; Iriarte *et al.* 2020).

Phytoliths, starch grains, charcoal, pollen, and plant macroremains provide complementary evidence for identifying cultivation, food processing, vegetation change, and environmental management. Their combined use is particularly valuable in tropical contexts, where preservation conditions can limit the survival of some classes of botanical remains (Pearsall *et al.* 2004; Perry *et al.* 2007; Piperno 2011). Archaeobotanical interpretation therefore depends less on a single diagnostic proxy than on the convergence of multiple indicators associated with human activity.

This multiproxy perspective has been especially productive in Amazonia, where archaeological and paleoenvironmental research has documented long-term relationships among human occupation, fire, vegetation change, soil modification, plant use, and the management of useful species (Clement *et al.* 2010; Furquim 2018; Levis *et al.* 2018; Watling *et al.* 2018; Iriarte *et al.* 2020). In southwestern Amazonia, research in the upper Madeira has further emphasized the antiquity and diversity of human occupation and provided an important comparative context for interpreting changes in plant use and cultivation (Almeida & Mongeló 2020; Watling *et al.* 2020). Such evidence has contributed to the recognition that contemporary vegetation and landscapes may retain historical signatures of human activity, including useful-species enrichment, anthropogenic soils, altered fire regimes, and persistent landscape modifications (Levis *et al.* 2018; Iriarte *et al.* 2020).

These findings are directly relevant to landscape domestication because human groups may transform environments without producing uniform or intensive agricultural signatures, particularly where mobility, diversified subsistence, forest management, and small-scale cultivation coexist. Archaeological evidence of plant management may consequently be spatially heterogeneous and dependent on local ecology, preservation, and sampling strategy (Clement *et al.* 2010; Piperno 2011; Levis *et al.* 2018).

This issue is particularly important for Central Brazil. Mato Grosso encompasses Cerrado, Pantanal, Amazonian, and transitional environments characterized by contrasting hydrological regimes, fire dynamics, vegetation structures, and resource availability. These ecological differences may influence the archaeological signatures through which plant management and long-term human-plant interactions are identified across the region. Evidence documented in humid Amazonian forests should therefore not be expected to occur in identical form in savanna, seasonally flooded, or transitional landscapes (Ceccantini & Gussella 2001; Bachelet & Scheel-Ybert 2017; Scheel-Ybert & Bachelet 2020).

Complementary regional studies support this comparative perspective. Investigations at Santa Elina and other archaeological contexts in Mato Grosso have provided paleoethnobotanical and anthracological evidence relevant to plant use, paleovegetation, fuelwood selection, long-term human occupation, and vegetation change (Ceccantini & Gussella 2001; Bachelet 2014; Bachelet & Scheel-Ybert 2017; Scheel-Ybert & Bachelet 2020). These studies demonstrate the potential for investigating plant use, fire, vegetation history, and landscape transformation beyond the better-documented Amazonian contexts and provide an empirical basis for expanding comparative archaeobotanical research in Central Brazil.

From plant domestication to landscape domestication

The thematic structure of the corpus reinforces the need to distinguish among plant domestication, cultivation, management, and agriculture. Domestication involves long-term biological and cultural processes through which plant populations are modified under human selection, whereas cultivation and management may occur without fully domesticated forms and may precede or coexist with more intensive agricultural systems (Clement 1999; Clement *et al.* 2010). This distinction shifts attention from domesticated species alone to the practices through which human populations selected, protected, propagated, transported, concentrated, and favored useful plants. Such practices may alter the abundance and spatial distribution of plant resources even in the absence of clear morphological markers of domestication, supporting the interpretation of human-plant interactions as a continuum encompassing species-level domestication, cultivation, in situ management, and broader ecological modification (Clement 1999; Clement *et al.* 2010; Clement *et al.* 2021).

The concept of landscape domestication extends this reasoning to the scale of ecosystems. Landscapes may retain long-term signatures of human activity through changes in floristic composition, enrichment of useful species, soil modification, altered fire regimes, and persistent anthropogenic environments. Evidence from Amazonia has shown that present-day vegetation patterns may partly reflect cumulative histories of pre-Columbian management rather than exclusively natural ecological processes (Levis *et al.* 2018; Iriarte *et al.* 2020).

Archaeobotanical evidence is central to identifying these processes because landscape domestication rarely produces a single diagnostic signature. Instead, it may be expressed through combinations of phytoliths, starch grains, charcoal, pollen, plant macroremains, anthrosols, and changes in vegetation composition. Interpretation of these proxies therefore depends on their archaeological context and their association with settlement, mobility, subsistence, fire, and land-use practices (Piperno 2011; Levis *et al.* 2018; Iriarte *et al.* 2020).

This perspective is particularly relevant for comparisons between Amazonia and Central Brazil. Models of landscape domestication developed in humid tropical forests emphasize useful-species enrichment, forest management, anthropogenic soils, and long-term vegetation modification. Cerrado, Pantanal, and transitional environments differ substantially in hydrology, fire dynamics, vegetation structure, and resource distribution, potentially generating distinct archaeological signatures of plant management (Clement *et al.* 2010; Levis *et al.* 2018; Scheel-Ybert & Bachelet 2020). These ecological contrasts therefore caution against the direct transfer of models developed for humid Amazonian forests to other environmental settings.

Mato Grosso therefore provides a strategic comparative setting for examining whether and how processes associated with plant management and landscape domestication developed under heterogeneous ecological conditions. Archaeological and paleoethnobotanical evidence documents long-term human occupation across environmentally diverse settings and

provides a basis for investigating the potential roles of cultivation, fire use, selective management of vegetation, soil modification, and combinations of these processes (Ceccantini & Gussella 2001; Bachelet & Scheel-Ybert 2017; Scheel-Ybert & Bachelet 2020). The analytical value of Mato Grosso lies not simply in extending Amazonian models southward, but in evaluating how relationships among plants, people, and landscapes may have varied across its Cerrado, Amazonian, Pantanal, and transitional environments.

The Pantanal further broadens this comparison because seasonal flooding and long-term human occupation created particular conditions for settlement, mobility, subsistence, and resource exploitation (Oliveira & Viana 1999-2000; Bespalez 2015). These conditions distinguish the Pantanal from both humid Amazonian forests and Cerrado landscapes and may have generated different archaeological signatures of human-plant interaction. In this context, limited direct evidence for intensive cultivation should not be equated with an absence of plant management. A landscape-domestication framework instead directs attention to potentially less visible interventions, including selective vegetation use, fire, resource concentration, and localized modification of soils and habitats (Clement *et al.* 2010; Levis *et al.* 2018; Iriarte *et al.* 2020).

From this perspective, Mato Grosso provides a comparative setting for examining the diverse pathways through which human populations transformed plants and landscapes across its Cerrado, Pantanal, Amazonian, and transitional environments. Domestication can thus be examined as part of a broader historical process involving agrobiodiversity, mobility, fire, soils, vegetation, and long-term ecological change rather than as a linear transition toward intensive agriculture (Clement *et al.* 2010; Levis *et al.* 2018; Iriarte *et al.* 2020).

Mato Grosso and the Pantanal: regional evidence and bibliographic visibility

Mato Grosso constitutes a focal regional context for the comparative problem examined in this study. Its territory encompasses Cerrado, Amazonian, and Pantanal environments, as well as broad transitional zones, creating a heterogeneous setting for investigating long-term human-plant interactions. This ecological diversity is particularly relevant to archaeobotanical research because models of plant domestication and landscape transformation developed primarily in Amazonian, Andean, and Mesoamerican contexts cannot be assumed to operate identically under the contrasting vegetation, soils, hydrological regimes, and fire dynamics of Central Brazil (Clement *et al.* 2010; Levis *et al.* 2018; Iriarte *et al.* 2020).

Limited integration into broader archaeobotanical debates, however, should not be interpreted as an absence of archaeological or archaeobotanical evidence. At Santa Elina, research has documented long-term human occupation together with paleoethnobotanical and anthracological evidence relevant to vegetation history, plant use, and environmental change (Ceccantini & Gussella 2001; Bachelet 2014; Bachelet & Scheel-Ybert 2017; Scheel-Ybert & Bachelet 2020). More recent regional research has broadened this perspective by examining human-plant relationships across the environmental diversity of Mato Grosso, including highland and lowland settings (Souza 2025). These studies provide an empirical basis for investigating plant use and landscape history, even though regional evidence remains less integrated into broader Latin American archaeobotanical debates.

This heterogeneity also has methodological implications. Archaeological signatures of plant management identified in humid tropical forests may differ from those preserved in savanna, transitional, or seasonally flooded environments because vegetation structure, hydrology, soils, resource distribution, and fire regimes affect both management practices and their archaeological visibility. Comparative research in Mato Grosso therefore requires a multiproxy approach integrating phytoliths, starch grains, charcoal, pollen, plant macroremains, anthrosols, and archaeological context rather than the direct transposition of models developed for other Neotropical settings (Clement *et al.* 2010; Piperno 2011; Levis *et al.* 2018; Iriarte *et al.* 2020).

Ethnobotanical evidence adds a complementary dimension to this framework. Research in Mato Grosso documents traditional plant knowledge and the maintenance of agrobiodiversity, illustrating practices through which local communities interact with cultivated plants, useful species, and managed landscapes (Miranda 2021). Contemporary practices of plant selection, cultivation, circulation, protection, tolerance, and in situ management should not be projected directly onto the pre-Columbian past; rather, they provide a hypothesis-generating framework for recognizing the diversity of processes through which human-plant relationships can produce culturally modified landscapes. This distinction is important because Neotropical domestication cannot be reduced to the emergence of intensive agriculture but encompasses broader histories of plant management, agrobiodiversity, and recurrent transformation of vegetation and soils (Clement *et al.* 2010; Piperno 2011; Levis *et al.* 2018).

Within this regional framework, the Pantanal environment of Mato Grosso provides a particularly important comparative setting. Its pronounced hydrological seasonality, recurrent flooding, and ecological heterogeneity create conditions that differ from those of the Cerrado and Amazonian environments also present within the state. These contrasts make the Pantanal especially relevant for examining how long-term human occupation, plant management, fire, mobility, and resource use may have interacted with seasonal landscape dynamics. Direct archaeobotanical evidence, however, remains comparatively limited, reinforcing the importance of multiproxy approaches integrating phytoliths, starch grains, charcoal, pollen, plant macroremains, anthrosols, and archaeological context.

The analytical value of Mato Grosso therefore extends beyond its bibliographic visibility. Its Cerrado, Amazonian, Pantanal, and transitional environments provide contrasting ecological settings for evaluating whether processes documented elsewhere—such as useful-species enrichment, fire management, cultivation, soil modification, and landscape domestication—produced similar or distinct archaeological signatures under different environmental conditions (Clement *et al.* 2010; Levis *et al.* 2018; Iriarte *et al.* 2020). Systematic multiproxy research combining phytoliths, starch grains, charcoal, pollen, plant macroremains, anthrosols, archaeological context, and regional knowledge of agrobiodiversity could clarify these trajectories and allow Central Brazil to contribute not simply additional case studies, but empirical tests of broader models of long-term human-plant interaction (Pearsall *et al.* 2004; Piperno 2011; Levis *et al.* 2018; Iriarte *et al.* 2020).

This study has several limitations that should be considered when interpreting its results. First, the bibliometric corpus was restricted to records indexed in the Web of Science Core Collection and therefore does not represent the entirety of the literature on human-plant interactions in Latin America. Second, because the search strategy required terms related to domestication or cultivation, studies addressing plant management, agrobiodiversity, historical ecology, or landscape transformation without using these descriptors may not have been retrieved. Third, the thematic structure depends on the bibliographic metadata and keyword indexing available in the retrieved records and on the parameters adopted for analysis in Bibliometrix. No custom synonym harmonization was applied, so lexical variants may have been treated as distinct terms. In addition, the bibliometric corpus was not systematically coded by geographic study area; consequently, regional differences in bibliographic representation should be interpreted qualitatively rather than as direct quantitative comparisons among Amazonia, Mato Grosso, the Pantanal, or other regions. Finally, the complementary regional review was targeted rather than exhaustive and was used to contextualize the bibliometric patterns, rather than to constitute a second systematic corpus.

Conclusion

The bibliometric analysis of 138 articles published between 2001 and 2025 revealed a recent expansion of the literature and a thematic structure organized around domestication, cultivation, maize, phytoliths, archaeobotany, starch grains, vegetation, and long-term human occupation. These patterns show that research on plant domestication in Latin America increasingly integrates multiple lines of archaeobotanical and paleoenvironmental evidence to investigate historical relationships among human populations, plants, and landscapes.

The results also reinforce the importance of distinguishing domestication from cultivation, management, and agriculture. In Neotropical contexts, these processes may coexist and develop through non-linear trajectories involving plant selection, cultivation, fire management, soil modification, vegetation enrichment, and the maintenance of agrobiodiversity. Their archaeological expression may therefore extend beyond evidence of fully domesticated crops and include broader signatures of long-term landscape transformation.

Within this framework, Mato Grosso constitutes a focal regional context for comparative research because its territory encompasses Cerrado, Amazonian, Pantanal, and transitional environments with contrasting vegetation, hydrology, soils, and fire regimes. Archaeological, paleoethnobotanical, anthracological, and complementary ethnobotanical evidence provides an empirical basis for investigating how plants use, management, cultivation, mobility, and landscape transformation may have varied across these ecological settings. The Pantanal environment of Mato Grosso is particularly relevant in this comparison because its pronounced hydrological seasonality and recurrent flooding may have generated archaeological signatures of human-plant interaction distinct from those documented in Cerrado and Amazonian settings, while direct archaeobotanical evidence remains comparatively limited.

These contrasts reinforce the need for systematic multiproxy research integrating phytoliths, starch grains, charcoal, pollen, plant macroremains, anthrosols, archaeological context, and evidence of agrobiodiversity. Such approaches can help evaluate whether processes documented elsewhere in Neotropics such as useful-species enrichment, fire management,

cultivation, soil modification, and landscape domestication—produced comparable or distinct signatures under the heterogeneous ecological conditions of Mato Grosso.

By integrating bibliometric analysis with a targeted regional qualitative review, this study distinguishes the documentary structure of the indexed literature from the empirical relevance of regional evidence. Rather than treating bibliographic visibility as a direct measure of archaeological importance, the study positions Mato Grosso as a strategic comparative context for testing and refining broader models of plant domestication, historical ecology, and landscape domestication across ecologically contrasting environments in Latin America.

Declarations

List of abbreviations: MT - Mato Grosso State; WoS - Web of Science; PPGFCA - Graduate Program in Forest and Environmental Sciences

Ethics approval and consent to participate: Not applicable. This study is based on bibliometric analysis of published literature and qualitative review of secondary sources, with no involvement of human participants or traditional knowledge holders.

Consent for publication: Not applicable.

Availability of data and materials: The datasets analyzed during the current study were derived from the Web of Science Core Collection. The final bibliometric corpus comprised 138 articles published between 2001 and 2025 and was processed in R version 4.6.1 using the Bibliometrix package and the Biblioshiny interface. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Author contributions: Caio César Martins de Souza designed the study, performed the bibliometric analysis, conducted the literature review, and wrote the manuscript. Maria Corette Pasa contributed to the theoretical framework, supervised data analysis, and revised and approved the final version of the manuscript.

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