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The commercialisation of NTFPs and conservation of forest: a systematic review for forestry policy

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Abstract

Purpose – This current review examines the scientific literature report on non-timber forest products (NTFPs) commercialisation and forest conservation in different jurisdictions.

Design/methodology/approach – A systematic review using Scopus-indexed articles on NTFP commercialisation and forest conservation was done using the PRISMA framework.

Findings – The review categorised the factors influencing the commercialisation of NTFPs and forest conservation into five broad factors and sub-factors: socioeconomic, market-based, ecosystem, cultural and institutional factors. The scholarly publications on NTFP commercialisation and forest conservation have been undulating, with two years recording no publication on the subject matter under review. Besides, China and India in Asia are leading in the number of publications on NTFPs' commercialisation. The review revealed ambivalence and symbiotic relationship among the factors influencing the commercialisation of NTFPs and forest conservation. Specifically, tenure arrangement, strict regulations to forest entry, market information asymmetry, bureaucracy in certification acquisition, seasonality and distance were identified as barriers to NTFPs' commercialisation. While market demands for NTFPs increased, NTFPs' prices and unsustainable harvesting activities were threats to forest conservation. Policymakers should focus on safeguarding customary property rights and indigenous knowledge in forest conservation, designing workable capacity-building schemes for NTFP entrepreneurs and reducing the cost and processes in certification acquisition.

Originality/value – There are reviews on NTFPs' commercialisation and livelihoods, but a synergy between NTFPs' commercialisation and forest conservation for forest policy direction is yet to be done in the literature. Also, while earlier studies systematically reviewed literature on NTFPs' commercialisation, they did not relate the studies to forest conservation.

Keywords NTFPs' commercialisation and marketing, Income, Forest conservation, Systematic review

Paper type Literature review

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1. Introduction

The contribution of non-timber forest products (NTFPs) to the local economies has historical antecedence dating back to the spice trade between Europe and Asia during the industrial revolution (Sills *et al.*, 2011). However, the relevance of NTFPs began to ebb out post-World War II following the industrial production of synthetic products to replace forest products (Sills *et al.*, 2011). It was not until three decades ago that the Brundtland Report of 1987, which called for concerted efforts to harmonise economic development and conservation of nature, received the attention of policymakers. Pursuant to the Brundtland Report of 1987, the Earth Summit in Rio de Janeiro in 1992 re-echoed the prominence of NTFPs in enhancing and achieving sustainable development (de Mello *et al.*, 2020).

Consequently, there has been a surge in the number of scientific papers published in the past two decades on NTFPs' commercialisation and sustainability in the global space (Shackleton *et al.*, 2015; Mugido and Shackleton, 2018; de Mello *et al.*, 2020; Talukdar *et al.*, 2021). Scholars have written extensively on the notable role of NTFPs in providing for rural livelihoods and reducing rural poverty (Anokye and Adu, 2014; Adongo *et al.*, 2019; Walle and Nayak, 2021). Aside from the commercial value, NTFPs also function as a habitat for flora and fauna and forest soil conservation (Sarmah, 2012). The issue of sustainability is never lacking in the literature on NTFPs' commercialisation or marketing. The exposition is that a positive sum game between poverty alleviation and forest conservation could be the outcome of sustainable harvesting and trade of NTFPs (David *et al.*, 2019). Unfortunately, the sustainability of NTFPs resources is under attack by degradation, over-exploitation and deforestation despite their distinguished contribution to rural livelihoods (Derkyi *et al.*, 2014).

In most rural communities the commercialisation of NTFPs, though arguably has become the only viable and reliable alternative income-generating activity, has resulted in the intense exploitation of NTFPs (Khosravi *et al.*, 2017; Le and Nguyen, 2020). The over-exploitation of NTFPs can be placed at the doorsteps of poverty and forest policy lag (Adongo *et al.*, 2019; Jalonen *et al.*, 2022). For instance, Steele *et al.* (2015) revealed instances where the commercialisation of NTFPs adversely impacts the socio-ecological makeup attributable to a lack of clear policy guidelines, poor management practices and minimal financial returns. Another school of thought makes the counter-argument that the commercialisation and utilisation of NTFPs pose minimal and fewer threats to the forest than timber forest products (Shackleton *et al.*, 2015; Somuah *et al.*, 2021). Whether increased commercialisation of NTFPs would positively or negatively affect forest conservation, regulations on the harvesting and trading in NTFPs should not be overlooked. For instance, the 2012 Forest and Wildlife Policy of Ghana allows access to the forest reserves by forest-fringed community members to harvest NTFPs for household consumption only (Somuah *et al.*, 2021), in that commercial harvesting of NTFPs may pose threats to forest conservation. Albeit, such regulations should consider the socioeconomic costs and benefits of such regulations and the ability of the regulatory agency to enforce and ensure compliance by the necessary actors (David *et al.*, 2019).

In this regard, the concerted policy attempts by successive governments of developing nations (like Ghana) to conserve and preserve forest resources are still challenged by a high rate of forest resource depletion (Acheampong *et al.*, 2019; Somuah *et al.*, 2021). The World Bank (2019) reported that between 2010 and 2017, the forest of Ghana had depleted about 98% cumulatively, while the FAO reported a 0.05% yearly degradation rate (FAO, 2020a, b). Whatever the statistics may suggest, forest reserves are highly threatened by degradation (Acheampong *et al.*, 2019; Adom *et al.*, 2019). This trajectory leaves the achievement of SDG 7 in limbo.

The recognition of the economic value of NTFPs to rural dwellers in developing countries is gaining limelight in forest conservation and development debates (Heubach *et al.*, 2013; Meinhold *et al.*, 2022). The benefits of the forest to the forest-fringe communities are

multifaceted, including both pecuniary and non-pecuniary (Mugido and Shackleton, 2018), yet rural communities' participation in conservation practices is low. The conservationists' school of thought underscores the benefits of forest conservation in safeguarding biodiversity, mitigating climate change (Edwards *et al.*, 2019) and reducing society's exposure to zoonotic diseases (FAO, 2020a, b). Lack of proper consultation, inadequate sensitisation and exclusion of the local communities from forest management/conservation practices account for the lackadaisical attitude of NTFP harvesters' active participation in forest conservation (Duguma *et al.*, 2019). Localised knowledge is crucial in the forest conservation drive to make headway, and it should be incorporated into the forest governance framework (Somuah *et al.*, 2021).

In the view of FAO (2010), NTFPs' commercialisation is a potent forest conservation mechanism based on the axiom that the increased commercial value of NTFPs is a catalyst for the harvesters of NTFPs to engage in sustainable management and conservation of the forest. Given this, Ghosal (2014) and Worku *et al.* (2014) proffered a potent argument for quantitative studies on the contribution of forest resources to the rural economy to inform policy on the sustainable use and conservation of forest resources.

Against this backdrop, this current review examines what the scientific literature reports on the factors influencing NTFPs' commercialisation and forest conservation in different jurisdictions by systematically reviewing Scopus-indexed articles on NTFPs' commercialisation and forest conservation and offering suggestions for forestry policy.

There are reviews on NTFPs' commercialisation and livelihoods (Sardeshpande and Shackleton, 2019; de Mello *et al.*, 2020), but a synergy between NTFPs' commercialisation and forest conservation, though necessary for forest policy direction, is yet to be done in the literature. Also, while Sardeshpande and Shackleton (2019) systematically reviewed literature on the proposed topic, they did not relate their studies to forest conservation. To this end, this review set out to find answers to the following questions.

(1) What is the trend of publication on the commercialisation and conservation of NTFPs?

(2) Are there any determinants of NTFPs' commercialisation and forest conservation practices?

Box 1. Definition of NTFPs

The confusion in the definition of NTFPs still wages on as its definition is subject to the interest of the author (Delgado *et al.*, 2016). The Center for International Forestry Research (CIFOR) in 2011 defined NTFPs as "[..] any product or service other than timber that is produced in the forests. They include fruits and nuts, vegetables, fish and game, medicinal plants, resins, essences and a range of barks and fibres such as bamboo, rattans, and a host of other palms and grasses". They also include "[..] wood products, such as those used for woodcarving or fuel". The definition by CIFOR excluded cultivated forest products.

NTFP is defined in this paper to encompass all wood and non-wood materials, excluding the traditional timber of forest origin either in the wild form or cultivated by humans. This definition extends the definitions by De Beer and McDermott (1989) and CIFOR (2011) by encapsulating NTFPs collected either directly from the forest or domesticated.

This review therefore seeks to examine the factors influencing the commercialisation and conservation of NTFPs, and to adduce suggestions for forest policy guidelines on NTFP commercialisation and forest conservation.

Box 2. The concept of NTFPs' commercialisation

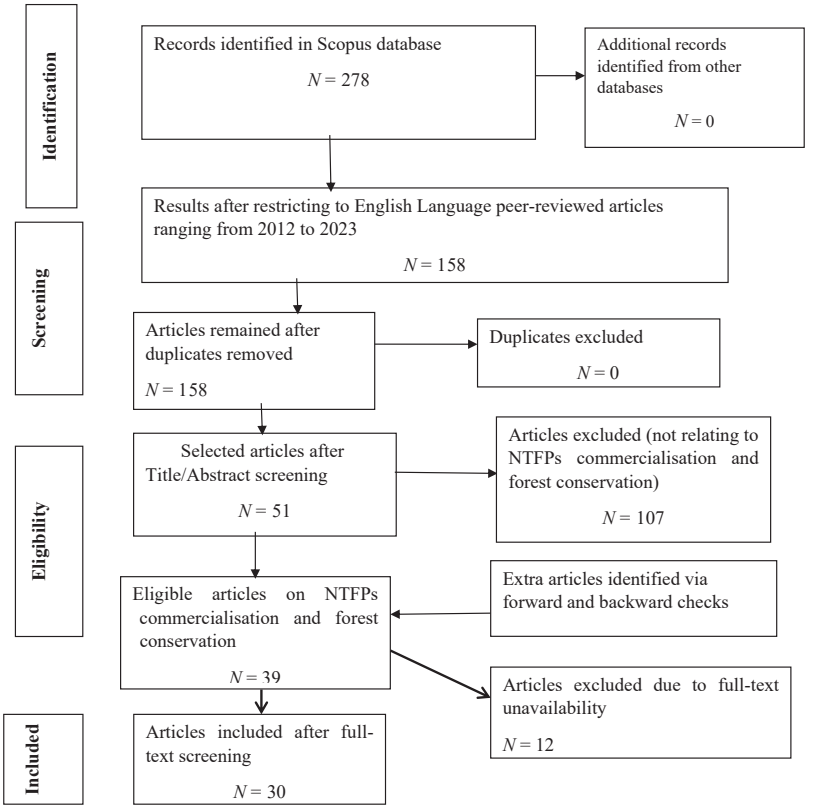
Households engage in the collection or harvesting of NTFPs for household consumption and for income generation. This implies that not all NTFPs harvested are consumed. Technically, NTFPs' commercialisation measures the portion of the total output or total quantity of NTFPs harvested that is sold. This can be estimated using the commercialisation index expressed as the ratio of the total output of NTFPs sold to the total output produced (Melkamu and Bannor, 2015).

However, in this review, we use NTFPs' commercialisation and marketisation interchangeably to reflect situations where households generate incomes from the sale of NTFPs for livelihood support irrespective of the percentage of total output offered for sale.

Source(s): Authors' own work.

2. Methods

This review article piggybacks on the famous PRISMA framework to identify and review scientific articles on NTFPs' commercialisation and forest conservation to contribute to forestry policy. Articles in the Scopus database are peer-reviewed, guaranteeing high-quality articles from reputable publishers (Oppong and Bannor, 2022). The data collation and article selection followed these protocols: (1) identification, (2) screening, (3) eligibility and (4) inclusion criteria, which are illustrated in the flow chart in Figure 1.



Source(s): Authors' own work

Figure 1.
PRISMA framework for article inclusion

The quality of the systematic review is a function of the literature retrieved for review (Xiao and Watson, 2019), hence, this systematic review relied on peer-reviewed articles published in the Scopus database. Scopus database has the largest repository of journals compared to the Web of Science database; as a result, articles indexed in Web of Science are highly likely to be covered by Scopus (Singh *et al.*, 2021). Also, using the database prevents the probability of having predatory journals and papers as part of the review. Again, following the argument of Xiao and Watson (2019) that scholars regard conference papers and Book chapters as having relatively less rigour of peer review compared to peer-reviewed articles, documents from these categories were excluded from this review (See Table 1 for the inclusion and exclusion criteria of articles).

The search string combined the keywords using the Boolean operators "AND" and "OR" keyed into the Scopus basic search fields. Scientific papers were retrieved using the Scopus search engine: Scientific papers were retrieved using the Scopus search engine: "non-timber AND forest AND products" OR "non-wood AND forest AND products" AND "commercialisation OR marketing OR trade" AND "forest AND conservation" OR "forest AND management". At this initial stage, there was no limitation to the articles' year of publication. It is worth noting that the final search of the articles in the Scopus database was on the 5th of December 2023. The query pulled out 278 documents. We then restricted the query to only peer-reviewed articles published in English Language from 2012 to 2023. The authors were interested in scholarly articles published from the past ten years so that our review synthesis and findings reflect recent publications. This restriction reduced the number of articles to 158. These articles were then checked manually to eliminate any possible duplication.

The authors proceeded to read through the titles and abstracts of these articles to exclude articles not specific to NTFPs' commercialisation and/or forest conservation/management. This exercise disqualified 107 articles. However, the forward and backward checks on the remaining articles' reference lists identified three articles relevant to the topic under review (Xiao and Watson, 2019; Oppong and Bannor, 2022). Furthermore, 12 articles were also excluded from the review because full texts were unavailable. Finally, the full-text screening included 30 articles, downloaded and coded in Microsoft Excel to extract data relevant to answering the review questions. To extract data for synthesis, the full texts of the included articles were thoroughly reviewed, and quantitative and qualitative data were extracted where applicable. Particular interest was placed on data on the location/context of the study, year of publication, number of citations, the sample size used, publication journal, source of funding, key variables studied, key findings and recommendations. Based on previous studies (Datta and Sarkar, 2012; Baiyegunhi and Oppong, 2016; Schunko *et al.*, 2019;

Table 1.
Articles inclusion and exclusion criteria

Inclusion criteria
• Peer-reviewed articles with full-text accessible
• Articles published in English Language from 2012 to 2023
• Articles relating to NTFPs' commercialisation and forest conservation
Exclusion criteria
• Articles published in any other language apart from English Language
• Book chapters, conference proceedings, reports, student dissertations, editorials and government publications
• Articles that do not discuss in detail NTFPs' commercialisation, forest conservation or sustainable harvesting of NTFPs
• Unavailable full-text articles on NTFPs' commercialisation and forest conservation/sustainable harvesting of NTFPs

Source(s): Authors' own work

Dinda *et al.*, 2020), this review categorised the variables influencing the commercialisation of NTFPs into socioeconomic variables, market variables, ecosystem variables, cultural variables and institutional factors.

3. Results

From the 278 related articles retrieved from the Scopus database, 30 relevant articles were selected for this review based on the inclusion criteria explicitly set out in Table 1. This number of articles included represented 10.8% of the total articles pulled from the database.

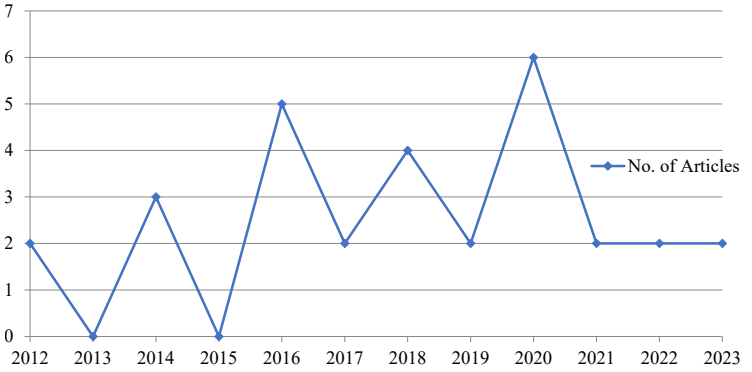
This section captures the descriptive statistical analysis of the 30 selected articles focussing on the yearly trends of publications, the most cited articles, funded articles, prolific authors and countries and continents with the most published articles on NTFPs' commercialisation.

3.1 Yearly distribution of publications

The year-on-year publication of articles on NTFPs' commercialisation and forest conservation is a pointer to the pattern of scholars' interest as well as the consistency and potential future studies (Oppong and Bannor, 2022). Figure 2 shows that the pattern of publications on NTFPs' commercialisation since 2012 has been undulating, though most of the years (eight years) recorded at least more than one publication, whilst two years (2013 and 2015) witnessed publication blackout, and a stagnation in publication between 2021 and 2023. Again, 2020 witnessed an exodus of publications (six articles), followed by 2016 (five articles) with an average yearly publication of two articles. The nose-dive in scholars' interest in NTFPs' commercialisation, especially from the year 2020, is a cause for worry given the incessant critical roles NTFPS play in respect of livelihoods, employment and poverty alleviation (Datta and Sarkar, 2012; Adongo *et al.*, 2019; Dinda *et al.*, 2020; Talukdar *et al.*, 2021; Harada and Munthe, 2022).

3.2 Top 10 most cited publications on NTFPs' commercialisation and forest conservation

The frequency of citation of a particular publication indicates the relevance or impact of the said publication in the field of study. Citation analysis compares the popularity of articles published in the same year and within the same research domain (Oppong and Bannor, 2022). Table 2 and Figure 3 present the top 10 most cited publications in NTFPs' commercialisation and forest conservation. The article authored by Dawson *et al.* (2014) received the highest



Source(s): Authors' own work

Figure 2.
Yearly distributions of publications on NTFPs' commercialisation from 2012 to 2023

Rank	Title of publication	Year	Journal	Research approach	No. of citation	Reference
1	The Management of Tree Genetic Resources and the Livelihood of Rural Communities in the Tropics: Non-timber Forest Resources, Smallholder Agroforestry Practices and Tree Commodity Crops	2014	*Forest Ecology and Management*	Quantitative	145	Dawson *et al.* (2014)
2	Traditional use and management of NTFPs in Kangchenjunga Landscape: implication for conservation and livelihoods	2016	*Journal of Ethnobiology and Ethno-medicine*	Mixed method	126	Uprety *et al.* (2016)
3	Wild Edible Fruits: A Systematic Review of an Under-Researched Multifunctional NTFP (Nontimber Forest Product)	2019	*Forest*	Quantitative	75	Sardeshpande and Shackleton (2019)
4	Importance of Nontimber Forest Products (NTFPs) in rural livelihood: A study in Patharia Hills Reserve Forest, northeast India	2020	*Trees, Forests and People*	Mixed method	53	Talukdar *et al.* (2021)
5	African Forest Honey: an Overlooked NTFP with Potential to Support Livelihoods and Forests	2018	*Environmental Management*	Mixed method	46	Lowore *et al.* (2018)
6	Wild Medicinal Species Traded in the Balsas Basin, Mexico: Risk Analysis and Recommendations for Their Conservation	2017	*Journal of Ethnobiology*	Quantitative	43	Beltrán-Rodríguez *et al.* (2017)
7	The Effects of Processing Nontimber Forest Products and Trade Partnerships on People's Well-Being and Forest Conservation in Amazonian Societies	2012	*PLOS ONE*	Quantitative	42	Morsello *et al.* (2012)
8	The Role of Non-Timber Forest Products in Creating Incentives for Forest Conservation: A Case Study of Phnom Prich Wildlife Sanctuary, Cambodia	2018	*Resources*	Quantitative	37	Chou (2018)

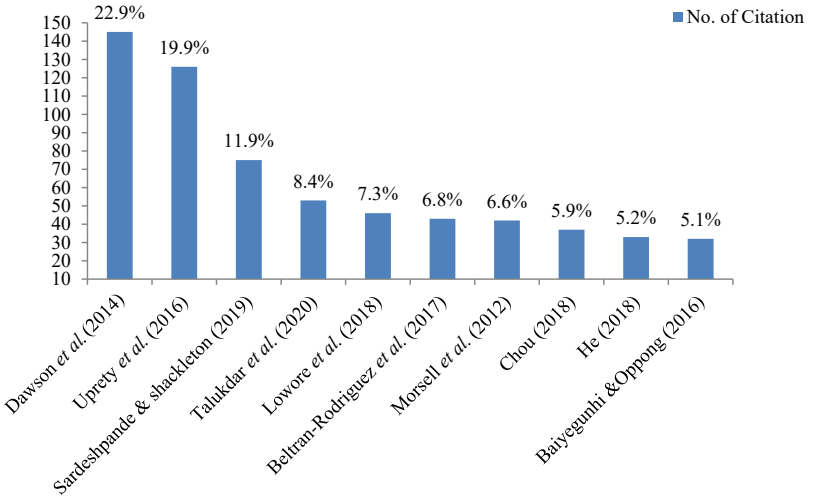
Table 2.
Top 10 most cited articles on NTFPs' commercialisation from 2012 to 2023

(*continued*)

Rank	Title of publication	Year	Journal	Research approach	No. of citation	Reference
9	Harvest and trade of caterpillar mushroom (*Ophiocordyceps sinensis*) and the implications for sustainable use in the Tibet Region of Southwest China	2018	*Journal of Ethno-pharmacology*	Mixed method	33	He (2018)
10	Commercialisation of mopane worm (Imbrasia belina) in rural households in Limpopo Province, South Africa	2016	*Forest Policy and Economics*	Quantitative	32	Baiyegunhi and Oppong (2016)

Source(s): Authors' own work

Table 2.



Source(s): Authors' own work

Figure 3.
Top ten most cited articles from 2012 to 2023

number of citations (145, representing 22.9% of the total number of citations of the top ten articles), followed by Uprety *et al.* (2016) with 126 citations representing 19.9%, with Baiyegunhi and Oppong (2016) at the bottom 10 with 32 citations representing just 5.1%.

Notably, out of the top 10 most popular articles, only two authors had two publications each to their credit, whilst the remaining eight had one publication each. In furtherance, the 30 articles included in the review were authored by 110 authors, with only 2 (1.8%) (He, 2018; Chou, 2018) going solo publication. The remaining 108 (98.2%) authors co-authored the remnant 28 articles.

3.3 Location/contextual analysis of publications on NTFPs' commercialisation and forest conservation

NTFPs' contribution to economies has gained relevance in both developed and developing countries and has been reflected in the focus of researchers. The location analysis of the articles selected for this review showed that the studies were conducted in 14 countries across four continents. Specifically, 25 (about 83.3%) of the articles were conducted in a specific country; two studies (Morsello *et al.*, 2012; Meaton *et al.*, 2020) were jointly carried out in two countries, whilst three studies (Dawson *et al.*, 2014; Uprety *et al.*, 2016; Sardeshpande and Shackleton, 2019) were inter-continentally carried out – specifically, Asia, Africa and Latin America.

From Table 3, India and China occupied the top two positions with the highest number of publications (i.e. seven and five publications, respectively) on NTFPs' commercialisation, with the publications from India gaining more recognition (109 citations combined) than the publications from China (74 citations). The bottom three countries – Indonesia, Italy and Ghana – had a single publication each, with publications from Italy more frequently cited (28) than Indonesia and Ghana (ten and eight citations, respectively).

The articles included in this review were mainly conducted in four continents (Africa, Asia, Latin America and Europe), with the Asian continent leading with 17 publications over and above the African continent (eight publications) as the second runner-up, whilst Europe had only one publication. This phenomenon is expected because the significance of NTFPs is much felt in developing countries with high rural populations and poverty rates (Lowore

Rank	Country	No. of publications	% of publications	Citations	Average citations	% of citations
1	India	7	23.3	109	16	19.4
2	China	5	16.7	74	15	13.2
3	South Africa	4	13.3	52	13	9.3
4	Ethiopia	2	6.7	49	25	8.7
5	Mexico	2	6.7	71	36	12.6
6	Brazil	2	6.7	66	33	11.7
7	Myanmar	2	6.7	1	1	0.2
8	Cambodia	1	3.3	37	37	6.6
9	Himalaya	1	3.3	26	26	4.6
10	Cameroon	1	3.3	12	12	2.1
11	Vietnam	1	3.3	19	19	3.4
12	Italy	1	3.3	28	28	5
13	Indonesia	1	3.3	10	10	1.8
14	Ghana	1	3.3	8	8	1.4

Rank	Continent	No. of publications	% of publications	Citations	Average citations	% of citations
1	Asia	17	53.1	603	35	45.4
2	Africa	8	25	341	43	25.7
3	Latin America	6	18.8	357	60	26.9
4	Europe	1	3.1	28	28	2.1

Note(s): Articles with location across continents are not counted as part of specific country publications
Source(s): Authors' own work

Table 3. Location/contextual analysis of publications on NTFPs commercialisation and forest conservation

et al., 2018). Using the citations as a measure of the recognition or popularity of the publications, the articles from Asia are more popular (603 citations), followed by Latin America (357 citations), Africa (341) and Europe with the least citation of 28.

3.4 Sources of funding of publications on NTFPs' commercialisation and forest conservation

Out of the 30 articles included in this review, 18 (60%) research publications on NTFPs' commercialisation and forest conservation received funding from 20 institutions. From Table 5, The Environmental Research and Technology Development Fund (JPMEERF 20191003), the National Council of Science and Technology (CONACYT), the European Union and the South African National Research Foundation were the leading funders of the research publications on the topic under review, funding two publications each.

In relation to the funding countries of the research articles, Mexican institutions funded four articles followed by Japan and South Africa (three articles each) and then Germany, the EU and India in the third position with two articles each. Eight countries – the UK, Netherland, Norway, China, France, the USA, Cameroon and Australia – funded a single publication each on NTFPs' commercialisation and conservation of forest.

3.5 Research approaches used in NTFPs' commercialisation and forest conservation publications

It is instructive to note that we did not set out to present a detailed review of the methodological approaches adopted by the selected articles. Nonetheless, we present a descriptive statistic of the research methods/approaches deployed in the included articles in this review. The articles included in this review deployed different research approaches in studying NTFPs' commercialisation and the conservation of forest. Of the 30 publications (see Figure 4), 11 (36%) publications exclusively employed a quantitative approach, five (11%) publications exclusively adopted the qualitative approach, while majority of the publications (14, representing 47%) adopted the mixed-method approach. This is an indication of increasing collaboration among researchers in the field since the approach requires a team with expertise in each approach. The majority of the publications using the mixed-method approach implies strong findings in these research works through triangulation of methods. This helps to smooth out the weaknesses in the standalone research approaches (quantitative or qualitative) while ensuring complementarity of the results (Fischer *et al.*, 2017).

3.6 Determinants of NTFPs' commercialisation and forest conservation

The articles' findings on NTFPs' commercialisation present a wide spectrum of factors influencing the commercialisation of NTFPs and forest conservation. However, for clarity and explicit syntheses of these determinants, this review categorised the factors into five broad themes: socioeconomic, market, ecosystem, cultural and institutional factors (see Table 4).

3.6.1 Socioeconomic factors. The literature reported that age (Morsello *et al.*, 2012; Krishnakumar *et al.*, 2015; Robinson, 2016; Baiyegunhi and Oppong, 2016; Adongo *et al.*, 2019), sex/gender (Morsello *et al.*, 2012; Baiyegunhi and Oppong, 2016; Adongo *et al.*, 2019; He, 2018; Talukdar *et al.*, 2021; Meaton *et al.*, 2020), level of education (Morsello *et al.*, 2012; Baiyegunhi and Oppong, 2016; Adongo *et al.*, 2019), income from NTFPs (Krishnakumar *et al.*, 2015; Adongo *et al.*, 2019; Lowore *et al.*, 2018; Chou, 2018), farm income (Krishnakumar *et al.*, 2015; Baiyegunhi and Oppong, 2016; Adongo *et al.*, 2019; Schunko *et al.*, 2019; Nguyen *et al.*, 2020) and household size (Datta and Sarkar, 2012; Morsello *et al.*, 2012; Baiyegunhi and

Variable	Indicator	Impact	Reference
Socioeconomic	Age	+	Morsello *et al.* (2012)
		–	Baiyegunhi and Oppong (2016), Adongo *et al.* (2019)
		NS	Robinson (2016), Krishnakumar *et al.* (2015), Nguyen *et al.* (2020)
	Education	+	Robinson (2016), Morsello *et al.* (2012)
		–	Krishnakumar *et al.* (2015), Baiyegunhi and Oppong (2016), Adongo *et al.* (2019)
		NS	Nguyen *et al.* (2020)
	Farm income	+	Krishnakumar *et al.* (2015)
		–	Baiyegunhi and Oppong (2016), Nguyen *et al.* (2020)
		NS	Chou (2018), Dinda *et al.* (2020)
	Income from NTFPs	+	Krishnakumar *et al.* (2015), Adongo *et al.* (2019), Lowore *et al.* (2018), Chou (2018)
		NS	Dinda *et al.* (2020)
	Gender	+	Baiyegunhi and Oppong (2016), Adongo *et al.* (2019)
		NS	Robinson (2016), Meaton *et al.* (2020), Nguyen *et al.* (2020)
	Household size	+	Adongo *et al.* (2019), Nguyen *et al.* (2020)
		NS	Baiyegunhi and Oppong (2016), Chou (2018)
Market factors	Price	+	Baiyegunhi and Oppong (2016), Lowore *et al.* (2018), Dinda *et al.* (2020)
		–	Steele *et al.* (2015), De Mello *et al.* (2020), Vallejo *et al.* (2016), Mon *et al.* (2023)
	Distance	+	Dinda *et al.* (2020)
		–	Baiyegunhi and Oppong (2016), Robinson (2016), Chou (2018), Epanda *et al.* (2020), Nguyen *et al.* (2020)
		NS	Baiyegunhi and Oppong (2016)
	Quantity harvested	+	Baiyegunhi and Oppong (2016)
		–	Uprety *et al.* (2016)
		NS	Krishnakumar *et al.* (2015)
	Transportation	–	Baiyegunhi and Oppong (2016), Chew *et al.* (2023)
		NS	Meaton *et al.* (2020)
	Market information	+	Baiyegunhi and Oppong (2016)
		–	Uprety *et al.* (2016), Schunko *et al.* (2019), Sekonya *et al.* (2020)
	Value addition	+	Chou (2018), Dinda *et al.* (2020)
		–	Morsello *et al.* (2012), He (2018)
	Certification	+	He *et al.* (2014)
		–	Schunko *et al.* (2019)
Ecosystem factors	Seasonality and availability	+	He *et al.* (2014), Lowore *et al.* (2018), Dinda *et al.* (2020)
		–	Talukdar *et al.* (2021)
		NS	Datta and Sarkar (2012), Krishnakumar *et al.* (2015)
	NTFPS diversity	+	Datta and Sarkar (2012), He *et al.* (2014)
		–	Mon *et al.* (2023)
	Harvesting practices/ management	+	He (2018), Epanda *et al.* (2020)
		–	Robinson (2016), Uprety *et al.* (2016), Sekonya *et al.* (2020), Zhang *et al.* (2021)
		NS	Schunko *et al.* (2019)

Table 4.
Determinants of NTFPs' commercialisation and forest conservation

(*continued*)

Variable	Indicator	Impact	Reference
Cultural factors	Land tenure	+	Lowore *et al.* (2018), Harada and Munthe (2022)
		–	He *et al.* (2014), He (2018)
	Gender	–	Meaton *et al.* (2020)
	Traditional Knowledge and uses	+	Morsello *et al.* (2012), Schunko *et al.* (2019), Harada and Munthe (2022)
		–	Beltrán-Rodríguez *et al.* (2017)
Institutional regulations	Regulations on forest access	–	Delgado *et al.* (2016), Ball and Brancalion (2016), Yadav *et al.* (2018), Sekonya *et al.* (2020)
		NS	Baiyegunhi and Oppong (2016)

Note(s): NS means not statistically significant; Gender as a socioeconomic factor espouses the likelihood of the male sex or the female sex to participate in NTFPs' commercialisation and forest conservation. However, gender as a cultural construct relates to the cultural arrangements in terms of resource accessibility, ownership, land tenure arrangements and how culturally defined gender roles (functionality) inhibit and/or facilitate NTFPs' commercialisation and forest conservation.
Source(s): Authors' own work

Table 4.

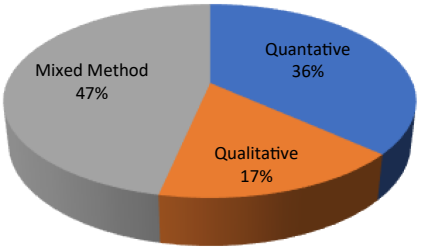
S/N	Source of funding	Country	No. of articles	Reference
1	Environmental Research and Technology Development Fund (JPMEERF 20191003)	Japan	2	Chew *et al.* (2023), Mon *et al.* (2023)
2	Australian Development Agency (*ADA*)	Australia	1	Uprety *et al.* (2016)
3	German Agency for International Cooperation (GIZ)	German	1	Uprety *et al.* (2016)
4	MISEREOR Grant	German	1	He *et al.* (2014)
5	Consortium of International Agricultural Research Centers (CGAIR)	France	1	He *et al.* (2014)
6	The National Council of Science and Technology (CONACYT)	Mexico	2	Delgado *et al.* (2016), Beltrán-Rodríguez *et al.* (2017)
7	University of the States of Morelos	Mexico	1	Beltrán-Rodríguez *et al.* (2017)
8	The National Social Science Foundation	China	1	Nguyen *et al.* (2020)
9	MINRESI French Debt Relief Program	Cameroon	1	Epanda *et al.* (2020)
10	The Ministry of Public Education (SEP-México)	Mexico	1	Beltrán-Rodríguez *et al.* (2017)
11	University of Yale	USA	1	Ball and Brancalion (2016)
12	The European Union	EU	2	Lowore *et al.* (2018), Meaton *et al.* (2020)
13	The Royal Norwegian Embassy	Norway	1	Lowore *et al.* (2018)
14	The Royal Netherland Embassy	Netherland	1	Lowore *et al.* (2018)
15	University of KwaZulu Natal	South Africa	1	Baiyegunhi and Oppong (2016)
16	The South African National Research Foundation	South Africa	2	Steele *et al.* (2015), Sardesphande and Shackleton (2019)
17	Indian Council for Cultural Relations	India	1	Steele *et al.* (2015)
18	Rufford Small Grant Foundation	UK	1	Yadav *et al.* (2018)
19	Government of India (University Grant Commission)	India	1	Dinda *et al.* (2020)
20	Japan Society for the Promotion of Science (JSPS)	Japan	1	Harada and Munthe (2022)

Source(s): Authors' own work

Table 5. Institutions that funded NTFPs' commercialisation and forest conservation research

Oppong, 2016; Adongo *et al.*, 2019; Nguyen *et al.*, 2020) play a crucial role in the decision on whether to participate in the commercialisation of NTFPs or otherwise. It was observed that though some of the articles failed to establish the clear vector of the influence of these socioeconomic variables (Robinson, 2016; He, 2018), other authors (Baiyegunhi and Oppong, 2016; Adongo *et al.*, 2019; Talukdar *et al.*, 2021; Nguyen *et al.*, 2020) did establish the direction of the influence of some of the socioeconomic variables. This is plausible because of the qualitative approach some of the authors adopted. For instance, in the work of Baiyegunhi and Oppong (2016) and Adongo *et al.* (2019), increase in the level of education, the age of NTFPs' harvesters and access to alternative sources of income reduce the likelihood of participation in the commercialisation of NTFPs (mopane worms) contrary to the finding of Talukdar *et al.* (2021). On the level of education, an individual must possess a university degree or undergo a rigorous training before engaging in wild plant commercialisation in South Tyrol (Schunko *et al.*, 2019), while female-headed households, large household sizes (Adongo *et al.*, 2019; Nguyen *et al.*, 2020) and alternative income sources positively influence the likelihood of participation in the commercialisation of NTFPs in South Africa. Interestingly, Baiyegunhi and Oppong (2016) established seemingly controversial results that Mopane worm harvesters with exogenous incomes (i.e. remittances, pension and wages) are more likely to engage in commercialisation by harvesting large quantities of mopane worms, and affording transport cost, labour cost and even cost of processing contrary to the earlier assertion that households with alternative sources of income are less likely to engage in NTFPs' commercialisation.

3.6.2 Market factors. The commercialisation or marketisation of any product, NTFPs inclusive, will only flourish if the product's price or market value is attractive and high enough to cover the cost. Therefore, price is both an incentive and a disincentive for the commercialisation of NTFPs. Several studies in this review have indicated price as a determinant of the commercialisation of NTFPs (Dawson *et al.*, 2014; Krishnakumar *et al.*, 2015; Baiyegunhi and Oppong, 2016; Adongo *et al.*, 2019; Lowore *et al.*, 2018; He, 2018; Talukdar *et al.*, 2021). Lowore *et al.* (2018) argued that an increase in the price or market value of NTFPs (forest honey) is a success factor for enhanced commercialisation, for it signals high profit (Baiyegunhi and Oppong, 2016), but on the flip side, a threat to forest conservation (Steele *et al.*, 2015) because increased price culminates into over-exploitation with its adverse impact on the forest ecology. However, other studies (such as De Mello *et al.*, 2020) adduced the contrary view that instead, the low price or market value of NTFPs pushes harvesters of NTFPs to extract large quantities for sale to earn meaningful income. For Krishnakumar *et al.* (2015), the mercantile of NTFPs is price responsive and results in over-extraction if regulatory mechanisms are not instituted. A similar exposition was adduced by Vallejo *et al.* (2016) that low prices exacerbated by high demand resulted in over-exploitation of *Euterpe oleracea* palm heart in Colombia. An article published by Baiyegunhi and Oppong (2016) on commercialising mopane worms in



Source(s): Authors' own work

Figure 4.
Research methods adopted in the publications

South Africa found a significant positive relationship between price and the intensity of mopane worms' commercialisation. Price, therefore, is a significant catalyst in NTFPs' commercialisation even though the prices of NTFPs vary from species to species and the availability of the species (Talukdar *et al.*, 2021; Harada and Munthe, 2022).

Distance to the market as well as to the harvest sites have been widely reported by the literature to significantly influence the participation in NTFPs' commercialisation in different contexts (Baiyegunhi and Oppong, 2016; Robinson, 2016; He, 2018; Chou, 2018; Nguyen *et al.*, 2020; Epanda *et al.*, 2020; Dinda *et al.*, 2020). Using the factor analysis technique and multiple regression models, Dinda *et al.* (2020) reported a positive correlation between the distance to the market and harvest site and the price received by NTFPs collectors. Baiyegunhi and Oppong (2016) found a decreasing quantity of mopane worms sold in the market attributable to the farther distance of the households harvesting mopane worms from the market. This consolidates the work of Steele *et al.* (2015), who hypothesised that the proximity of a village to a market positively influenced the decision to participate in the market, enhancing the commercialisation of NTFPs.

Holding other factors constant, the quantity of NTFPs harvested significantly influences the level of commercialisation of NTFPs. In this review, the literature has been unanimous on the quantity of NTFPs harvested as one of the major influencers of the degree of commercialisation of NTFPs (Krishnakumar *et al.*, 2015; Baiyegunhi and Oppong, 2016). Households or individuals who harvest large quantities of NTFPs are more likely to engage in commercialisation than those that harvest small quantities. For instance, using the double-hurdle regression model, Baiyegunhi and Oppong (2016) established a significant positive relationship between the quantity of mopane worms harvested and the decision to participate in commercialising mopane worms in South Africa. In tandem with the quantities of NTFPs harvested is the issue of transportation. Surprisingly, only four articles (Baiyegunhi and Oppong, 2016; Robinson, 2016; Meaton *et al.*, 2020; Chew *et al.*, 2023) reported transportation as a variable influencing the commercialisation of NTFPs. Baiyegunhi and Oppong (2016) documented that ownership of means of transport enabled NTFPs harvesters to participate in commercialisation, elucidating further that it offers them the opportunity to harvest from distant open forests, convey large quantities of NTFPs at minimal cost and to access far distant urban markets. However, Robinson (2016) indicated that less privileged and more vulnerable individuals tend to depend more on a far distant open forest to harvest wild NTFPs.

Access to market information and market demand were reported to exert on the commercialisation drive of NTFPs (Uprety *et al.*, 2016; Baiyegunhi and Oppong, 2016; Schunko *et al.*, 2019; Sekonya *et al.*, 2020). Uprety *et al.* (2016) aver that the excess market demand for NTFPs over the low quantities collected adversely impacted the commercialisation prospects of NTFPs. Sekonya *et al.* (2020) saw that increasing pressure from demand for mopane caterpillars in the urban markets increased the harvesting and marketisation of mopane caterpillars in South Africa. Urbanisation drives increased market demand for NTFPs as the collection of NTFPs drifts. The authors further documented that the inaccessibility to market information, especially prices, militate against the engagement of the local people in the marketisation of NTFPs in Kangchenjunga. Dinda *et al.* (2020) linked how lack of access to the market and value addition compelled tribal dwellers to receive low prices by selling NTFPs to local agents. Conversely, Phumee and Pagdee (2021) attempted to dilate how increased market demands for NFTPs increase the outflow, incentivising people to increase the harvesting of NTFPs, thus resulting in harvesters having to travel far distance for NTFPs. For Baiyegunhi and Oppong (2016), social capital and information access significantly and positively influence the probability of market participation and the intensity of participation; also, majority (97%) of the mopane worms collectors own telecommunication assets and, as a result, have access to market information. He *et al.* (2014)

underscored the essence of reliable information flow in strengthening the bargaining power and harvesting practice of mushroom harvesters. The competitiveness of most NTFP markets thrives on the availability of reliable and up-to-date information.

The proceeds from NTFPs' trade from both domestic and export markets are making meagre contributions to national economies (Uprety *et al.*, 2016) due to lack of value-addition activities like packaging, grading, labelling and processing along the chain (He *et al.*, 2014). NTFPs that undergo value addition attract higher prices than those sold in raw form. For instance, He (2018) reported that lack of grading and the trade in premature caterpillar mushrooms led to lower prices, as evidenced by the complaints made by 69% of the traders in mushrooms since low prices were received due to no value addition. Dinda *et al.*'s (2020) study shows a positive relationship between the price of NTFPs and value addition or processing. Thus, NTFPs processed before sales were expected to command higher prices than unprocessed NTFPs. In contrast, Morsello *et al.* (2012) found that processing alone did not improve the economic well-being (income) of the people and forest conservation, but trade partnerships without processing improved the economic well-being of the people. This could plausibly be due to the low price of NTFPs, which could not compensate for the increased cost arising from processing.

With the growing demand and supply of NTFPs in the international market, concerns about the certification of these products have assumed the front burner position as a mechanism to guarantee the safety and health of consumers, as both ecologically friendly and economically beneficial (He *et al.*, 2014; Krishnakumar *et al.*, 2015; Delgado *et al.*, 2016; Schunko *et al.*, 2019; Meaton *et al.*, 2020). The acquisition of certifications is expected to strategically position the traders of NTFPs to become competitive in the global market. However, bureaucracy, inadequate finance and poor institutional architecture inhibit mushroom farmers in China and India from engaging in certification schemes (He *et al.*, 2014; Krishnakumar *et al.*, 2015). Furthermore, Delgado *et al.* (2016) pinpointed land tenure arrangement and the size of a farm managed as impediments to participation in certification schemes by NTFP producers in Mexico, citing the minimum 20–250 ha farm size sin qua non; meanwhile, the mean tenure size of most Mexicans is less than 5 ha. Against this backdrop, Krishnakumar *et al.* (2015) proffered the revamping of the deficient institutional arrangements for certification and effective market information dissemination, especially on the benefits of certification in the global market, as a way of whipping up the interest of NTFPs traders for certification schemes. He *et al.* (2014) advocate for government support in decentralising the certification process, capacity building and compliance. Certification of NTFPs is considered a facilitating factor for commercialisation, but wild plant gathering by organic herb farmers in South Tyrol (Italy) views organic certification as a limiting factor to wild plant commercialisation (Schunko *et al.*, 2019). This is premised on consumers' belief that wild plants are uncontaminated and natural. Despite the potential of certification to propel NTFPs' commercialisation in the global space, the literature on NTFP certification is still scanty, especially in the African context (Sardeshpande and Shackleton, 2019).

3.6.3 Ecosystem factors. A great number (about 74% of the articles included in the review) reported on how ecosystem factors play to influence the level of commercialisation of NTFPs and forest conservation. Regarding the ecosystem factors captured in the review to potentially influence marketisation of NTFPs, 27% reported seasonality and availability of NTFPs (Datta and Sarkar, 2012; Krishnakumar *et al.*, 2015; Lowore *et al.*, 2018; Dinda *et al.*, 2020; Talukdar *et al.*, 2021), 5% recorded NTFPs diversity (Datta and Sarkar, 2012; Mon *et al.*, 2023), while a high percentage of the articles (41%) reported harvesting practices/management techniques (Ball and Brancalion, 2016; He *et al.*, 2014; Robinson, 2016; Uprety *et al.*, 2016; He, 2018; Sardeshpande and Shackleton, 2019; Schunko *et al.*, 2019; Sekonya *et al.*, 2020; Epanda *et al.*, 2020; Zhang *et al.*, 2021).

In the Paschim Medinipur district of India, Dinda *et al.* (2020) discovered the availability factor (classified as the time spent for collection in days and hours, and time spent on their sale) to show a positive influence. The authors related availability to the seasonality of NTFPs and concluded that the abundance of NTFPs signals a high commercial or economic value, hence an incentive to harvest NTFPS for commercial purposes. On the contrary, Talukdar *et al.* (2021) attributed the lower market value and, by extension, commercialisation of edible fruit plants such as *Diplazium esculentum and Homalomena aromatica* to their abundance in the Reserve Forest of northern India.

For Lowore *et al.* (2018), the successful commercialisation of NTFPs (forest bee honey) positively correlated with the availability of forest honey bees. He *et al.* (2014) and Datta and Sarkar (2012) looked at the diversity of NTFPs harvested by the diverse strata of forest-fringed dwellers in China and India, respectively. They agreed that the probability of commercialising NTFPs increases with the availability of an increased variety of NTFPs. Indisputably, the gathering of NTFPs is seasonal sensitive, but this factor is not a limiting factor to commercialisation (Datta and Sarkar, 2012; Lowore *et al.*, 2018) in that the seasonality of NTFPs can be surmounted via domestication of the wild NTFP, thus debilitating the possible pressure on wild NTFPs, increasing yield and ensuring all-time round harvesting (He *et al.*, 2014; Dinda *et al.*, 2020). In rebuttal to the advocators of domestication, Delgado *et al.* (2016) and Schunko *et al.* (2019) argue that domestication of NTFPs threatens forest conservation because more forest lands will be cleared for the plantation of NTFPs. Besides, some NTFPs in their wild state possess unique natural qualities and tastes which could be compromised through domestication; also, some species are cumbersome to domesticate.

As previously averred, the commercialisation of NTFPs is a function of the availability of the species for collection, which in turn depends on the harvesting or management practices adopted. An assessment of the articles included in the review revealed that about 50% of the articles mentioned harvesting practices or management as a variable influencing NTFPs' commercialisation and forest conservation efforts (He *et al.*, 2014; Ball and Brancalion, 2016; Robinson, 2016; Uprety *et al.*, 2016; He, 2018; Sardeshpande and Shackleton, 2019; Schunko *et al.*, 2019; Sekonya *et al.*, 2020; Epanda *et al.*, 2020; Zhang *et al.*, 2021). From a panoptic point, harvesting practice regimes should factor in the species' regenerative, reproductive and responsive capacity to disturbance (Sardeshpande and Shackleton, 2019; Zhang *et al.*, 2021). Sekonya *et al.* (2020) studied mopane caterpillars' commercialisation and environmental change in South Africa and noted that mopane harvesters engaged in premature harvesting activities and clearing of trees which threaten the reproductive and regenerative capacities of mopane caterpillars. Sardeshpande and Shackleton (2019) reviewed wild edible fruits in Asia, Africa and America and found that various wild edible fruit species respond differently to different extraction activities and disturbances. For instance, Zhang *et al.* (2021) looked at the harvesting intensity of two wild NTFPs and concluded that the effect of harvest intensity on the growth of *A. elata* is not so significant relative to the growth of *A. senticosus*, whilst Schunko *et al.* (2019) found no threat of harvesting activities on the availability of wild plants for collection in Italy, espousing that it served the well-being of the farmers to harvest sustainably for the continuous survival of their businesses. Robinson (2016) revealed that harvesting activities enhanced mushroom farmers' well-being but had an adverse impact on other ecosystem services that are sensitive to human disturbance. In He *et al.*'s (2014) view, the unsustainable harvesting activities of NTFPs, such as mushrooms, are the outcome of market failure resulting in uneven benefit sharing. In summary, unsustainable harvesting activities threaten forest conservation. For instance, burning of lands with anticipation that the regrowth of bamboo will occur, as well as slashing trees to collect shoots of wild vegetables, result in biodiversity losses, hence threating forest conservation (Uprety *et al.*, 2016; Phumee and Pagdee, 2021). He (2018), on the other hand, identified ambiguity in the

tenure system in Southwest China as the cause of unsustainable harvesting practices. Clarity on the tenure system would eschew any form of rivalry competition and the consequence of premature harvesting of mopane caterpillars.

3.6.4 Cultural factors. Culture and tradition play vital roles in managing forest and forest products, in that cultural and traditional value and norms shape people's behaviours towards the forest and its products. Acknowledging the cultural values and enhancing the transmission of some NTFPs' lore stimulate their commercialisation and conservation of the forests that habit these NTFPs (Schunko *et al.*, 2019). A recent study by Harada and Munthe (2022) showed how the cultural demands of rural Indonesians motivated them to conserve the forest aside from conservation for the commercialisation of NTFPs. The cultural construct of a society determines the tenure system and access to natural resources. The forest tenure system determines who has access to the forest to harvest NTFPs (He *et al.*, 2014; Lowore *et al.*, 2018; Sardeshpande and Shackleton, 2019). He *et al.* (2014) found that the de facto tenure arrangement in China forests gives open access to the forest for people to harvest any quantity of mushrooms at any time, thus resulting in overharvesting and forest depletion. In contrast, the tenure system in North Sumatra in Indonesia is hereditary (Harada and Munthe, 2022), while in Southwest Ethiopia, the *Kobo* system is the inherited customary tenure arrangement for honey harvesters (Lowore *et al.*, 2018). This has given the people the responsibility to conserve the forest for future generations by engaging in the commercialisation of NTFPs by conservation.

The traditional knowledge and the cultural uses of some NTFPs species were also reported to influence commercialisation and forest conservation (Morsello *et al.*, 2012; Uprety *et al.*, 2016; Schunko *et al.*, 2019). Uprety *et al.* (2016) examined the implication of the traditional uses and management of some 701 NTFPs species on forest conservation and livelihood in Asia. They concluded that the knowledge of the traditional uses and cultural values of NTFPs promotes forest conservation. For instance, herbal species like *Heracleun nepalense* is only harvested on the first Tuesday after the celebration of the *Teej* festival (Uprety *et al.*, 2016). In Mexico, Beltrán-Rodríguez *et al.* (2017) found that tropical forests are at a high risk of vulnerability to degradation because they supply close to 40% of the herbal plant species commercialised in the study area. Even with the growing modernisation and urbanisation of societies, the cultural uses of NTFPs are still a critical driver of the marketisation of some NTFPs (Morsello *et al.*, 2012).

Culture defines gender participation in forest resource use and commercialisation. However, only three (13.6%) articles tackled the issue of gender as a cultural construct to influence NTFP commercialisation (Morsello *et al.*, 2012; Delgado *et al.*, 2016; Meaton *et al.*, 2020). In Brazil and Bolivia, Morsello *et al.* (2012) found that partnership or cooperative trading in NTFPs reduces income disparity between men and women. In contrast, Meaton *et al.* (2020) found that female honey producers earn less profit in Zambia than their male counterparts. The reason could be that female honey producers incur more labour cost than men to produce honey. Also, the amount of time available to men is more than what is available to women, given their required domestic roles. Delgado *et al.* (2016) looked at how cultural arrangements limit women's access to forest resources and participation in decision making regarding NTFPs' commercialisation and forest conservation.

3.6.5 Institutional factors. The level and intensity of commercialisation of NTFPs and forest conservation is largely dependent on the governance structure and policy directives in place. In this review, we look at policy from the broader lens of access to harvest sites (forest), regulations on harvesting and ownership and distribution of benefits.

Firstly, the collection or harvesting of NTFPs from public and private forests requires a permit, while conservation policies proscribe entry to protected areas for the commercial harvesting of NTFPs in Italy (Schunko *et al.*, 2019). On regulation of access, Delgado *et al.* (2016) observed that stringent restrictive policy arrangements complicate the local-based

governance system of NTFPs, thereby making compliance to such regulations not only tricky but a surge in illegalities in extraction of NTFPs in Mexico. This has the potential to undermine forest conservation efforts. Ball and Brancalion (2016) studied the governance challenges concerning the commercial exploitation of NTFPs in Sao Paulo-Brazil and noted how policy restrictions limit the prospects of commercialisation of Jucara pulp. In light of the submissions of Delgado *et al.* (2016) and Ball and Brancalion (2016), a policy deregulation wills a positive impact on NTFPs' commercialisation and forest conservation.

In South Africa, a study on the governance and access to edible mopane caterpillars by Sekonya *et al.* (2020) found weak policy or regulation execution in communal forests relative to the private and state forest lands. The reasons adduced were that oral permission from the chief sufficed for anyone to access the communal forest land to harvest. However, for the private land, an access fee is charged per head per season, while only a few selected harvesters are granted access to state-owned forest lands.

There appear to be conflicting positions regarding policies seeking to harness the commercial value and the economic contribution of NTFPs' commercialisation to economies and the dangers of not regulating forest accessibility.

4. Discussions

Scientific studies on NTFPs' commercialisation and forest conservation have witnessed unstable patterns from 2012 to the present. Two years within this range go without a publication on commercialisation of NTFPs. This unstable interest in the subject matter may be due to a lack of or inadequate government support in terms of funding despite the eminent role of the trade in NTFPs in the development of economies (Adongo *et al.*, 2019; Dinda *et al.*, 2020). This is however at variance with the revelations of this review in that there is significant interest in the funding of research relative to this research domain by funding institutions and organisations. Though funding of research publications on NTFPs' commercialisation and conservation of forest is enormous, such fundings are skewed against the African continent as only three out of the 18 sponsored articles were carried out in Africa.

The analysis of the popularity of published papers measured by the number of citations showed a total of 110 authors, with Dawson *et al.* (2014) being the most popular research article. The popularity of their work debatably may be attributable to the intercontinental context of their study. This conclusion is evidenced by the revelation that the first three most cited articles were intercontinentally conducted (Dawson *et al.*, 2014; Uprety *et al.*, 2016; Sardeshpande and Shackleton, 2019). Collaboration in scientific research is critical for the consolidation of expertise and knowledge among researchers (Oppong and Bannor, 2022). This review revealed a high level of collaboration among researchers in the domain of NTFPs' commercialisation and conservation of forest as evidenced by about 98% of the included articles being co-authored.

It is worthy to note that India and China are among the top 10 countries with the most extensive forest cover globally. Therefore, it is not amazing that this review identified India and China as having the highest number of publications on NTFPs' commercialisation and forest conservation. The African continent recorded an appreciable number of publications with about 26.9% of the publications carried out on the continent. This trend in publications is expected in the sense that the significance of NTFPs is much felt in developing countries with high rural populations and poverty rates (Lowore *et al.*, 2018; Adongo *et al.*, 2019).

4.1 NTFPs' commercialisation and forest conservation

The result of this review underscored the influential role of socioeconomic variables such as age, gender, level of education and household income on commercialisation and

conservation. It is instructive to note that the nature and type of NTFP commercialised is gender sensitive. For instance, the review showed that the female gender dominated the marketisation of NTFPs like mopane worms and bensin resin, while the male gender dominated the commercialisation of NTFPs requiring physical energy such as honey harvesting. This observation resonates with the finding of Atinga and Bannor (2022) that the male gender dominated the commercial harvesting of fuelwood in the Bono Region of Ghana. Thus, the gender dynamic in NTFPs' commercialisation depends on the nature and type of NTFP under consideration. Interestingly, researchers in NTFPs' commercialisation and forest conservation presented contrasting positions on the link between the level of education and the decision to participate in the marketing of NTFPs (Baiyegunhi and Oppong, 2016; Adongo *et al.*, 2019; Schunko *et al.*, 2019; Talukdar *et al.*, 2021). The plausible explanation for this conflicting conclusion could be based on the commercialisation scale. As such, people with a high level of education may engage in the trade of NTFPs in the global market, while people who trade in NTFPs in rural markets to earn income just to meet their daily family expenses may desert the activity as their level of education increases since increased education opens opportunities for more formal employment. This assertion is congruent with Krishnakumar *et al.* (2015) that as the level of education increases, households' income from NTFPs trade diminishes. This also lends credence to increased education broadening the market knowledge about NTFPs' commercialisation (Amusa *et al.*, 2017). Besides, in some jurisdictions, the forest entry permit acquisition requires the individual to possess a high-level certificate to engage in commercial harvesting of NTFPs (Schunko *et al.*, 2019).

As revealed in this review, the factors influencing commercialisation and forest conservation are intertwined and coiled. As evidenced in this review, some factors can be seen simultaneously as facilitating factors for NTFPs' commercialisation and as constraining factors for forest conservation or function to enhance both commercialisation and forest conservation. For instance, the literature presented mix-bag arguments as to whether the increased market value (price) of NTFPs facilitates their marketisation (Baiyegunhi and Oppong, 2016; Lowore *et al.*, 2018) or whether it poses threats to forest conservation in the wake of over-exploitation of NTFPs for profits (Steele *et al.*, 2015). There is hesitance toward forest conservation emanating from the low market value of most NTFPs (Dinda *et al.*, 2020). Nonetheless, people will conserve the forest if they see value.

Furthermore, in the commercialisation of NTFPs, the distance covered either to the forest for harvesting or to the market centre is directly linked to the profit earned as well as the quantity that can be harvested for marketisation. This observation is in sync with Baiyegunhi and Oppong (2016) who established a significant positive relationship between the quantity of mopane worms harvested and the decision to participate in commercialising mopane worms in South Africa. The cost of transportation forms a principal component of the cost buildup of traders in NTFPs, which also relates to the distance travelled. The quantitative studies in this review showed that the market factors – such as distance, transport cost, price or market value of NTFPs and ownership of means of transport – reported a positive influence on the decision to participate in the commercialisation of NTFPs and, as such, are drivers of commercialisation of NTFPs.

The demand for and the supply of some NTFPs connive to both facilitate commercialisation and endanger forest conservation. The literature showed how increased demand for NTFPs in the urban centres caused by urbanisation motivates harvesters to scale up harvesting to meet the increased demand. This phenomenon threatens forest conservation, especially where the harvesting is from the open-access forest without recourse to sustainable and regulated harvesting. This could likely result in the tragedy of the commons attitude among harvesters.

The development of the market hinges on the availability and accessibility of information. Therefore, asymmetric market information, especially on price and consumer demands, is

reported to be a hindrance to the effective commercialisation of NTFPs. The lack of or weak bargaining power of most NTFPs traders, as described in the literature, stifle the commercialisation drives (Pandey *et al.*, 2016).

Furthermore, certification schemes such as organic certification and fair trade, though hitherto alien to the NTFPs' markets, have now been widely required in the international markets for NTFPs. Clearly, value addition to NTFPs also involves the adoption and compliance to certification and eco labelling, which are reported in the literature as enabling factors for commercialisation and producing positive forest conservation outcomes (Krishnakumar *et al.*, 2015). However, the bottlenecks (as identified in this review) to NTFPs harvesters' participation in certification schemes include the limited accessibility to gathering sites suitable for organic certification, legal restrictions and lack of consumer awareness about the additional value from organic certification (Schunko *et al.*, 2019). This is rightly so because certification's overarching goals are to ensure environmentally friendly production while guaranteeing remunerative returns to the producer. Unfortunately, NTFPs harvesters' adoption and compliance with certifications are bridled by factors such as bureaucracy, cost of certification, poor institutional arrangements, land tenure arrangement and fragmented farm size (Delgado *et al.*, 2016; He *et al.*, 2014; Krishnakumar *et al.*, 2015; Schunko *et al.*, 2020). Even though NTFPs' certification is gaining ground in other jurisdictions (China, India and Mexico), Africa is lagging behind in adopting NTFPs' certification schemes. Eliminating the bottlenecks to certifications would step up adoption and compliance with certification schemes, especially in Africa. This call is consistent with the suggestion by He *et al.* (2014) and Krishnakumar *et al.* (2015) that decentralisation of the process, cost-effectiveness of the schemes, institutional capacity building and advocacy could trigger adoption and compliance. The articles reviewed carried out a qualitative assessment of the certification schemes as enablers and barriers to the commercialisation of NTFPs, which is enormous. However, for actionable findings on NTFPs certification, the impact in quantitative terms of such certification schemes on the well-being of the NTFPs' producers who adopted and complied to the schemes is worth talking. The argument is that the adoption of certification schemes often results in the increased price of certified products but not the well-being or living standards of the adopters of such schemes (Oya *et al.*, 2017).

Regarding ecosystem factors, the flow of the commercialisation of NTFPs hinges on the continuous availability of the products. The harvesting activities or management systems also influence the quantity of the NTFPs available for commercialisation. With most NTFPs, the availability of the products for commercialisation is directly linked to seasonal variations. However, this review unearthed contrasting positions. In the affirmative, Datta and Sarkar (2012) and Lowore *et al.* (2018) opined that NTFPs availability and seasonality are facilitators of commercialisation rather than limiting factors. The domestication of commercial NTFPs can compensate for any lag in the availability of the NTFPs for marketing emanating from seasonal variation. It must, however, be noted that not all NTFPs can be domesticated to mitigate the availability and seasonality challenge. For example, while some NTFPs, such as honey and mushrooms, are easily domesticated to reduce uncertainty and unpredictability, others, especially tree NTFPs, may not be fruitful.

More than half of the articles reviewed mentioned the impact of harvesting or management practices on NTFP commercialisation and forest conservation. The result of the review showed that the nature of harvesting practices adopted by the NTFPs' harvester directly influences the quantity of NTFPs available for commercialisation. The outcome of a good harvesting practice is a continuous availability of NTFP species for marketisation, while poor harvesting activities would produce adverse outcomes and threaten forest conservation, ceteris paribus. It is instructive to note that different NTFP species react differently to different harvesting practices/management practices (Sardeshpande and Shackleton, 2019; Schunko *et al.*, 2019; Zhang *et al.*, 2021). Therefore, this review identified

that, to accommodate for the differences in response to different harvesting practices, the regenerative, reproductive and tolerance capacity to anthropogenic disturbances must be considered. Also, the causal factor of unsustainable harvesting activities that threaten forest conservation, as revealed from this review, is a market failure which results in unequal benefit sharing and over-exploitation.

The cultural factors mentioned in this review not only support commercial gathering of some NTFPs such as medicinal plants, but also non-commercial gathering and forest conservation. The land ownership system, especially the private and communal lands which are culturally defined, determines who has access to the forest and at what season to harvest NTFPs for both commercial and non-commercial purposes. The sustainable harvesting and conservation of some NTFPs may not exclusively be a consequence of their commercial value but cultural value. Thus, some NTFPs may command low market value and yet are still harvested sustainably or conserved by the people because of their cultural knowledge and use value of the NTFPs. This assertion was supported by Harada and Munthe (2022) who revealed that the tribal people of Indonesia conserve forests with NTFPs to maintain their customs and culture. It is therefore appropriate to question the accuracy of the commercialisation by conservation proponents given the cultural significance of NTFPs in the forest conservation drive of forest-fringe communities as revealed in this review.

In furtherance, the property regime also influences accessibility to forest products for commercialisation. From the review, regulatory policies on forest conservation may sometimes unintentionally thwart the commercialisation of some NTFPs by restricting access to the forest for harvesting. Also, the permit issuance procedure and cost (Sekonya *et al.*, 2020) limit the successful commercialisation of NTFPs. The result showed that stringent forest conservation policies negatively impact NTFP commercialisation. On the other hand, deregulatory forest policies produce positive commercialisation outcomes but negatively impact forest conservation. These observations are in consonance with Ball and Brancalion (2016) and Baiyegunhi and Oppong (2016). As mentioned earlier, the commercial harvesting of NTFPs may negatively impact forestry conservation or management, leading to overharvesting and even species extinction. It becomes necessary to improve the spirit of understanding of existing forest policy goals and the market gaps to enhance sustainable NTFP commercialisation and forest conservation. It is pertinent to reach an equilibrium position regarding clear policy objectives on forest conservation and commercialisation of NTFPs. It will also be prudent to factor in forest policies in the planting and production of NTFPs on off-reserves to supplement the ones harvested from the forest (Bannor *et al.*, 2021).

5. Conclusion

This paper reviewed scientific articles indexed in Scopus on NTFPs' commercialisation and forest conservation. This review sought to achieve these objectives: to establish the trend of research publications on NTFPs' commercialisation on forest conservation, to examine the influential factors (supporting and limiting factors) of NTFPs' commercialisation and forest conservation, and to make recommendations for forestry policy.

The scholarly publications on NTFP commercialisation and forest conservation have been undulating, with the past two years recording no publication on the subject matter under review. The scientific studies conducted across continents are more popular and recognisable relative to those articles carried in specific single locations. There is a high degree of collaboration among researchers in the area of NTFPs' commercialisation and forest conservation which enhances sharing and triangulation of skills, expertise and knowledge, translating into impactful research works.

It was observed from the review that some of the factors influencing commercialisation and forest conservation are intertwined and coiled. There is a symbiotic relationship between

the factors influencing NTFP commercialisation and forest conservation. As evidenced in this review, some factors can be seen simultaneously as facilitating factors for NTFPs' commercialisation and as failure factors or hindrances to forest conservation or function to enhance both commercialisation and forest conservation.

The review categorised the factors influencing the commercialisation of NTFPs and forest conservation into five broad factors and sub-factors as: socioeconomic factors (age, gender, level of education, household size and income from NTFPs), market factors (price/market value of NTFPs, distance travelled, quantity of NTFPs harvested, ownership of means of transport, market information, market demand, value addition and NTFPs certification), ecosystem factors (seasonality and availability of NTFPs, NTFPs diversity and harvesting practices/management), cultural factors (traditional knowledge and cultural values, gender dynamics, land tenure system and cultural beliefs) and institutional factors (policy and regulation mechanisms).

5.1 Recommendation for practice

Pro-producer-based cooperatives and organisations could be formed to consolidate the market power or bargaining power of NTFPs' harvesters. This would stimulate networking, market information sharing and better forest management and sustainable harvesting practices.

The state agencies and NGOs operating in the forestry subsector should intensify and roll out more comprehensive training programmes on sustainable forest management practices to forest-fringed communities engaging in the commercial collection of NTFPs. It is imperative to note that such training programmes should be participatory to tap into the wealth of indigenous content knowledge of rural communities on forest conservation strategies. This approach can potentially ensure that the marginal economic benefits from NTFPs' commercialisation equal the marginal social, environmental and cultural costs. Besides, forest-fringed communities will be willing to meaningfully contribute financially and labour to forest conservation if they are carried along in policy and programme designs.

Furthermore, the domestication of NTFPs is the bridge between the commercialisation of NTFPs and forest conservation. Therefore, financial and technical support to NTFPs collectors for the domestication of NTFPs would ensure a continuous supply of NTFPs with minimal adverse impact on the forest ecosystem.

5.2 Recommendation for forestry policy

One of the factors that stood out to influence NTFPs' commercialisation and forest conservation in the literature is the tenure system or arrangement. Therefore, forestry policy should encompass and acknowledge the cultural and customary property rights of the tribal people. In furtherance, policies should be geared towards achieving positive sum game outcomes from NTFPs' commercialisation and forest conservation. In this regard, softening the stringent forest access regulations, decentralising the certification process, encouraging domestication and intensifying monitoring and surveillance of harvesting activities in the forest could yield the desired goals of poverty reduction and biodiversity conservation.

There should be a paradigm shift in forestry policy on conservation funding, that is, a shy away from the use of market instruments only (compensation measures) to focussing on outcome target rewards such as safeguarding property rights and active participation in decision making.

Additionally, forestry policy frameworks should focus on the development and promotion of domestication of potential commercial NTFPs as a conduit to simultaneously conserve the forest by lessening pressure on the forest and ensuring continuous availability of NTFPs for commercial harvesting for income generation. Such

policies should also clearly spell out funding, incentive mechanisms and capacity building of NTFPs entrepreneurs. Such policies should be grounded on scientific research findings on NTFP commercialisation and their concomitant impact on forest conservation strategies.

5.3 Implications for future research

There is a subtle difference between commercialisation and market participation (Oppong-Kyeremeh *et al.*, 2019). Therefore, using market participation as synonymous with commercialisation may not be apt. It was observed from the review that none of the articles attempted to measure the level of NTFPs' commercialisation in econometric terms. Households harvest NTFPs for both domestic consumption and income generation. Therefore, to make a meaningful assessment of the linkage between NTFPs' commercialisation and forest conservation and determining or estimating how much (quantity) of the NTFPs harvested by households is sold (commercialisation index) are necessary.

More often than not, certification schemes result in increased prices of certified products but not the well-being or living standards of the adopters (Oya *et al.*, 2017). The qualitative assessment of the certification schemes as enablers and barriers to the commercialisation of NTFPs is enormous, but for actionable findings on NTFPs certification, the impact in quantitative terms of such certification schemes on the well-being of the NTFPs producers who adopted and complied to the schemes is worth taking, especially in Africa.

From the literature reviewed, there is no gainsaying that, aside from the other factors identified (socioeconomic, market, ecosystem and institutional), cultural factors substantially influenced the commercialisation of NTFPs and the attitudes towards forest conservation. It is intriguing that none of the articles adopted socio-psychological theories or behavioural theories to present comprehensive and backstopping quantitative and qualitative results explanations. Future research works employing the theory of planned behaviour (TPB) and other behavioural and psychological theories to study the attitudes and behaviours of NTFP commercialists towards forest conservation would be revealing. The TPB argues that the decision to engage in NTFPs' commercialisation and forest conservation is a derivative of three factors, i.e. attitude, subjective norms and perceived behaviour control (Ajzen, 1991; Bannor *et al.*, 2022), this, together with intention as the moderating factor, will be interesting to study.

5.4 Limitations

This review, just like any other review, is not without limitations. Firstly, the strict execution of the article inclusion criteria limited this review, just like any other review. There is a high possibility of omission of relevant evidence articles published in non-English Language and other credible research database such as Web of Science other than the Scopus database. Nonetheless, language barriers and resource constraints could not permit such wide-ranging inclusion criteria. Besides Scopus database has the largest repository of scientific literature, and Scopus indexed articles are peer-reviewed and are widely relied upon by many researchers for review works in a spectrum of disciplines.

Again, most articles included in this review adopted the qualitative approach. The authors could have performed a critical appraisal of the likely risk of bias in these articles to increase the dependability and objectivity of their results and the conclusions thereof. However, the inclusion of both qualitative and quantitative articles in the review helped smooth out the inherent flaws, improving the findings of this review.

The multifarious nature of NTFPs and the different parts harvested makes the general conclusion of this review problematic. The review included swathes of articles on different NTFP species that have unique distinct characteristics and respond differently to different interventions.

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