Non-timber Forest Products Value Chain Toward Sustainable Livelihood: Exploring Linkages and Trends Using Visual Optimization Network Analysis

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ABSTRACT

Non-timber forest products (NTFPs) contribute significantly to the livelihood, food, and nutrition security of rural communities and forest dwellers. Earlier studies on NTFPs emphasized the economic importance, sustainability aspects, and commercialization of NTFPs, and highlighted the importance of strong value chains if NTFPs were to fulfill their economic potential for communities and people who rely on them. Formulation of proper policy and commercialization of NTFPs through their value chain will require a thorough review of existing research to identify the policy loopholes. A review of literature sought to determine whether research on NTFPs links to sustainable livelihood, policy, and value chains using clustering and visual network visualization. The results of the study reveal four domain clusters indicating a mix of traditional and evolved approaches toward strengthening of the NTFP value chain. Policy issues on NTFP have also evolved as one of the important clusters of research. The study recommends the mapping of value chains in the NTFP research to guide the pursuit of holistic and sustainable livelihood security.

Keywords: non-timber forest products, NTFP, development, trends, network visualization, policy, value chain, livelihood security

JEL Classification: Q100, Q22

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INTRODUCTION

More than one-fourth of the world's population rely on the forest for food and livelihood, 60 percent of whom are indigenous and tribal communities (FAO 2015). They rely specifically on non-timber forest products (NTFPs), defined as "forest products consisting of goods of biological origin other than wood, derived from the forest, other woodland, and trees outside forests" (FAO 2014). These include products from plants and trees (e.g., medicinal plants, herbs, resins, fruits, nuts, etc.), as well as animals (e.g., honey, fish). As one of the major sources of livelihood for tribal communities in many of the developing countries, NTFPs act as community safety nets where agriculture is unable to provide a sustainable income. Strengthening NTFPs in these countries will help in aligning with various sustainable development goals (SDGs), mainly SDG 1 (no poverty), SDG 2 (zero hunger), and SDG 10 (reduced inequality).

Previous studies have focused on various kinds of NTFPs (Gunatilake, Senaratne, and Abeygunawardena 1993; Ticktin 2004); plant parts and animal and insect products used (Ogunbanjo and Aina 2013; FAO 2014; FAO 2015); their economic importance and diverse uses (Shackleton and Shackleton 2004; Gopalakrishnan et al. 2005). These studies highlighted, as well, the non-commercial NTFPs, i.e., not sold but used for the household, which contribute significantly to the food security of rural households (Delang 2006) and are valued differently between communities and even between genders (Vodouhê et al. 2009).

Against this backdrop, the commercialization of NTFPs is recognized by conservation and development organizations as a potential source of income and livelihood security for rural poor. NTFPs generate income and help the poor in achieving livelihood security (Vedeld et al. 2007). Belcher (2005) concluded that for NTFP to contribute toward the goal of poverty eradication, there must be increased and more efficient commercial production and trade of these products.

This study sought to determine whether research on NTFP adequately links to sustainable livelihood, policy, and value chains. Specifically, it attempted to map the existing literature on NTFP value chain studies and analyze the research trends in different aspects of NTFP. This article thus describes the results of this literature review, which is based on meta-analysis and visual network optimization, including density visualization and network analysis. With this visualization and meta-analyses, the linkages and associations in different domains across NTFP research will facilitate a deeper understanding of NTFP research and the association between NTFP and sustainable livelihoods and pinpoint the gaps in its various domains.

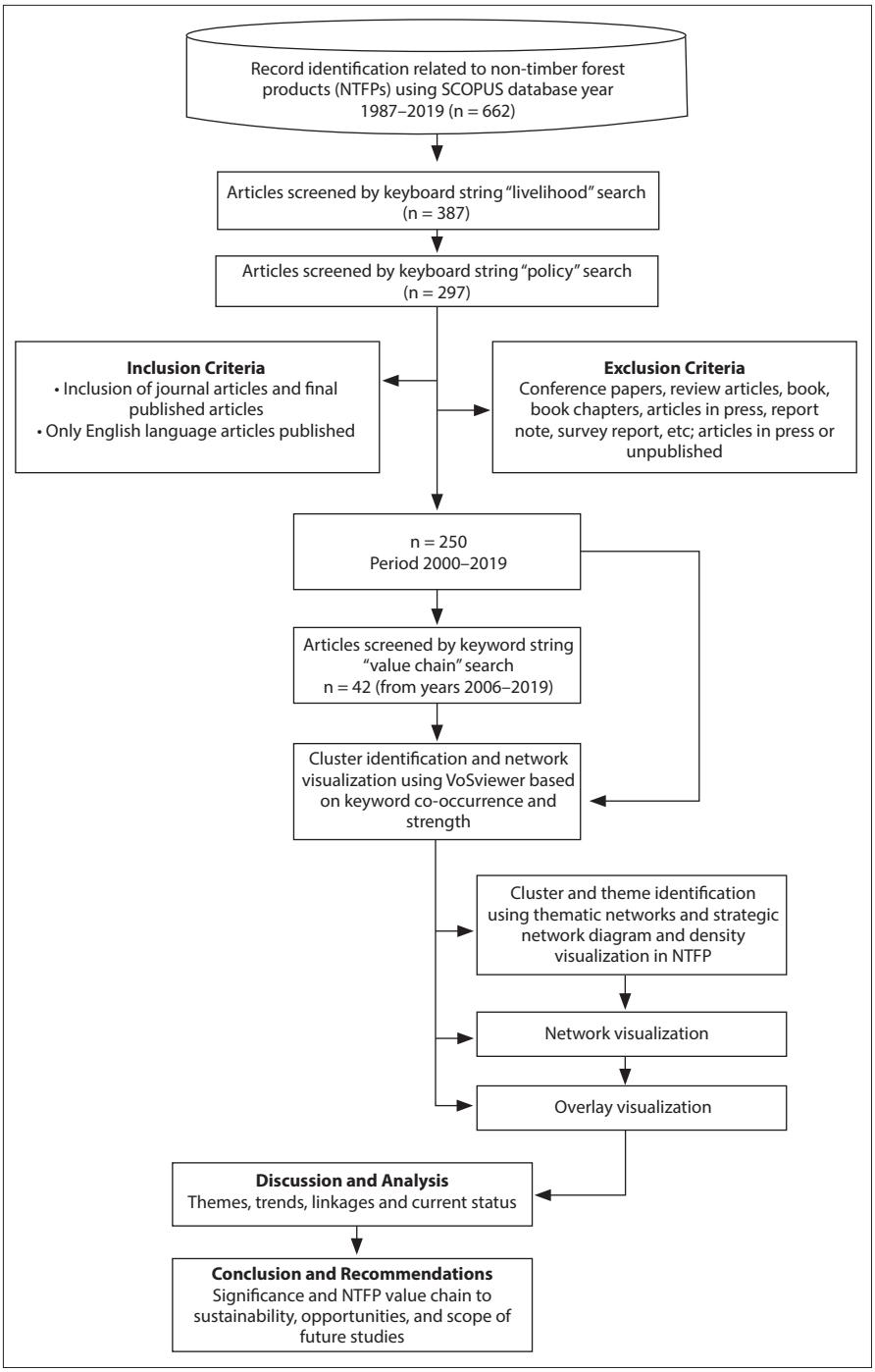
METHODOLOGY

We explored the trends and linkages of major aspects in the domain of NTFPs and livelihood research globally, using Elsevier's Scopus online database as the source of structured data articles (Figure 1). The Scopus database was preferred over others because of its advanced export functionalities for retrieved structural data (Vezyridis and Timmons 2016). To explore the linkages between NTFP value chains and livelihood, we searched for the "NTFP", "livelihood", "policy" and "value chain" in titles, keywords, and abstracts with a string search. We evaluated the structured data based on the information from the abstract and title and on the relevance of the articles. The results were further limited only to the articles.

For this analysis, we excluded review articles, conference papers, short surveys, books, book chapters, and similar publication. Furthermore, the data cleansing and mining were done to remove duplicate articles. The bibliometric information (e.g., author, citation) was likewise excluded.

Without considering the inclusion and exclusion criteria, there were 662 articles related to NTFP research from 2006 to 2019. Considering the linkage of NTFP to livelihood and policy, this number decreased to n = 250, and then to n = 42

Figure 1. Schema for extraction and analysis of structured data on NTFP livelihood and value chain research



based on the linkages of NTFP, livelihood, and policy research toward the value chain.

These 42 articles were analyzed to present the visual optimization network analysis using VoSviewer (version 1.6.11) software for determining the association and trends in NTFP-livelihood research using keyword evolution and relevance strength (Van Eck and Waltman 2014). The software was used effectively to visualize agricultural engineering hot spots, ecosystem resilience, tourism, and sustainability of dairy and fruit supply chains (Shi and Yang 2016; Yuan and Bai 2020; Garrigos-Simon, Narangajavana-Kaosiri, and Lengua-Lengua 2018; Boboc and Diaconeasa 2019).

Based on co-occurrence of pairs of keywords, the built-in VoSviewer algorithm extracts the topics of keyword history and launches the links between these topics and keywords directly from the content of texts and content of the manuscripts as defined during the search (Van den Besselaar and Heimeriks 2006; Sinkovics 2016). The relations occurring among these keywords are established and the relationship distance along with the distance strength is determined. The larger the number of co-occurrence, the smaller the distance between the two keywords. VOSviewer constructs the final map where the similarity matrix is calculated using the association strength of keywords based (Van Eck, and Waltman 2007; Sinkovics 2016).

The maps were explored based on the identification of themes as recorded by the clusters formed in the visualization forms. The clustering enables defining the themes based on clusters and studying the linkages between them. This facilitates identification of gaps and exploring opportunities and trends in this field, which would help in deriving recommendations and policy-related implications, and future directions for research.

However, this approach produces more of a pictorial presentation than a quantitative presentation. To address this gap, further analyses were done using R-package.[1] The blend of this R-package in meta-analyses results in a more confident interpretation of thematic structure and structural mapping of the development of research themes in both pictorial as well as advanced approaches like Callon's centrality and Callon's density measures to derive two-dimensional thematic networks and strategic diagrams (Cobo et al. 2011; Callon, Courtial, and Laville 1991). The centrality measures the strength of keywords externalities and association with other themes; hence, the value represents the importance of the theme and the development of the research field (Cobo et al. 2011). On the other hand, the density measures the internal strength of the keywords and describes the research themes. The centrality and density represent the characteristics of the research theme using the mean and median values in classifying the research themes into four groups (Cobo et al. 2011; Cahlik 2000; Callon Courtial, and Laville 1991; Coulter, Monarch, and Konda 1998). These four groups are represented through a two-dimensional space called a strategic diagram (see Figure 7) according to the keyword clusters centrality and density rank values (Cahlik 2000). The themes can be identified according to the quadrants in which they are placed (Courtial 1994; Coulter, Monarch, and Konda 1998; He 1999). The four quadrants of the two-dimensional strategic diagram represent the following themes and trends of the research field (Cahlik 2000):

- The upper-right quadrant represents the "motor themes", i.e.., both developed and important for the mapping and structuring of a research field.
- The lower-right keyword clusters in the quadrant represent the basic and transversal themes, which are important but are not developed.
- The upper-left quadrant keyword clusters represent the well-developed themes, having internal ties but no external connections. They are peripheral in characteristics.
- The lower-left quadrant keyword clusters represent weakly developed themes, having low centrality and density values.

1 This is a free software environment for statistical computing and graphics.

RESULTS AND DISCUSSIONS

This section presents the results of the review analysis of the literature based on keyword strength and clustering of the themes. Specifically, the section showcases the trends and linkages of NTFP research in terms of the value chain and livelihoods. This provides an overview and comprehensive linkages of NTFP for sustainable growth, encompassing several different themes, concepts, and some recent developments of research in this field.

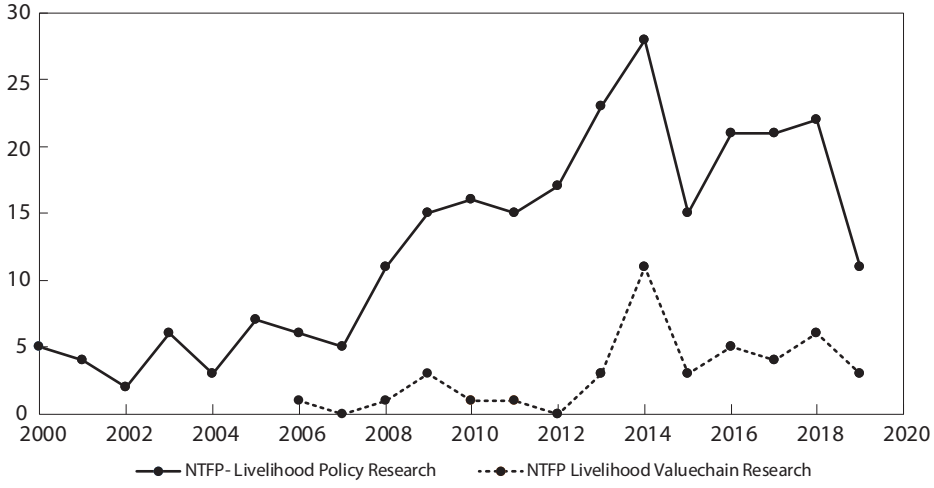
Annual Trend of NTFP Research in Livelihood and Policy for Sustainability

The earliest article on NTFP yielded by the general search was from the year 1987 and the literature has since grown rapidly with an annual scientific production growth of 21.6 percent. The growth of NTFP research in the field of livelihood, policy support, and the value chain had also increased over the decades (Figure 2). Specific to the value chain, the first relevant study showcasing the linkage of NTFP, including livelihood and policy support, was in 2006. Researchers modeled the five types of capital assets required to support sustainable livelihoods, specifically those that affect the success and failure of the commercialization of NTFPs. By studying these assets, which include natural, human, socioeconomic, physical, and financial, researchers, potential policy and other related interventions on livelihoods were elucidated (Newton et al. 2006).

During these years, NTFP research has contributed toward the understanding of the drivers responsible for exploitation and inequity in NTFPs (Choudhary et al. 2014). The other aspects of NTFP studies explored in the literature are related to the management suggestions toward the promotion of low intensity and non-deleterious consumption of NTFPs, as well as forest conservation along with sustainable livelihoods (Harbi et al. 2018). The implications of NTFPs for forest governance, management, and policy will be an added economic dimension contribution of NTFP to people and livelihoods (Wahlén 2017). Furthermore, they provide reliable value estimates for the valuation of NTFP value chains (Jensen 2009).

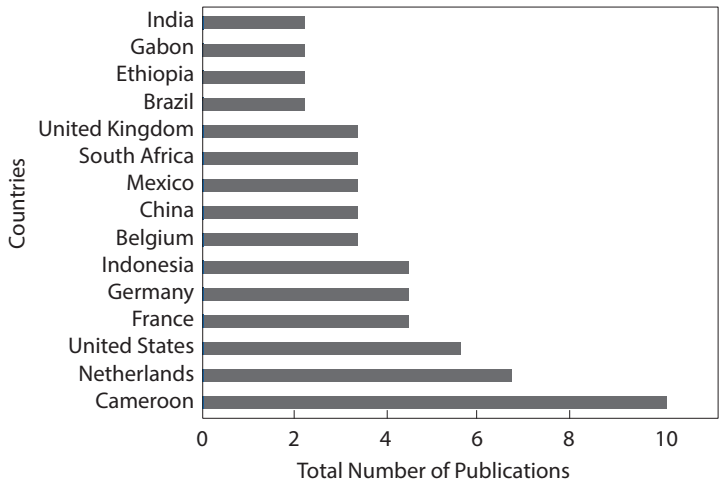
It is evident that the NTFP sector research has seen growth from the traditional approach of consumption, people, and natural resources to the integration of sustainability, policy-orientation and value chain addition and appropriation in

Figure 2. NTFP research supporting livelihood, policy, and value chain trends over the years



Source: *Scopus online database*

Figure 3. NTFP research linking livelihood, policy, and value chain by country



the past recent years. Most of the NTFP research linking livelihoods to the policy and value chain studies have been reported by Cameroon followed by the Netherlands and the United States. Figure 3 illustrates the NTFP research in the aspects of policy and value chain contribution from the top 15 countries or territories, as evident from the Scopus search results between the years 2006 and 2019. The results state that the policy focus in NTFP research toward the management and value chain is a global occurrence involving both developed and underdeveloped countries.

Main Theme Clusters and Research Fronts of NTFP Domain Linking Livelihood to Policies and Value Chain

Analysis of the articles selected from the SCOPUS database confirms that NTFP research is evidently multidisciplinary based on the source publications (Table 1) as well as the results of keyword clustering (Table 2).

In the sample of articles linking NTFP to livelihood and policy (n = 250) during 2000–2019, we obtained 122 keywords that met the threshold of the minimum number of occurrence of 15 or more out of the total 6,069 identified keywords. For each of these 122 sorted keywords, the relevant score is calculated for the 60 percent more relevant terms used in the contents of NTFP, livelihood, and policy research represented by 73 keywords. The relevant score of these pertinent keywords is stated in Table 2. According to the relevant score mapping of keywords, the terms "Household", "Income", "Species", "Management", and "Impact" were the most relevant due to their greater intensity and amount of connection with other words.

Based on these associations and relevant score strengths, the network visualization mapping reveals four groups (Figure 4). This clustering of the keywords aids in the theme identification and setting major headings of research conducted in

Table 1. Subjects covered in journal articles used in the analysis

Subject Area Coverage	Number of Articles Collected*
Agricultural and Biological Sciences	36
Environmental Science	26
Social Sciences	22
Economics, Econometrics and Finance	9
Energy	3
Business, Management and Accounting	1
Medicine	1

Note: *Each article generally represents overlapping subject coverage areas.

Table 2. Relevancy score of most relevant keywords and cluster groups

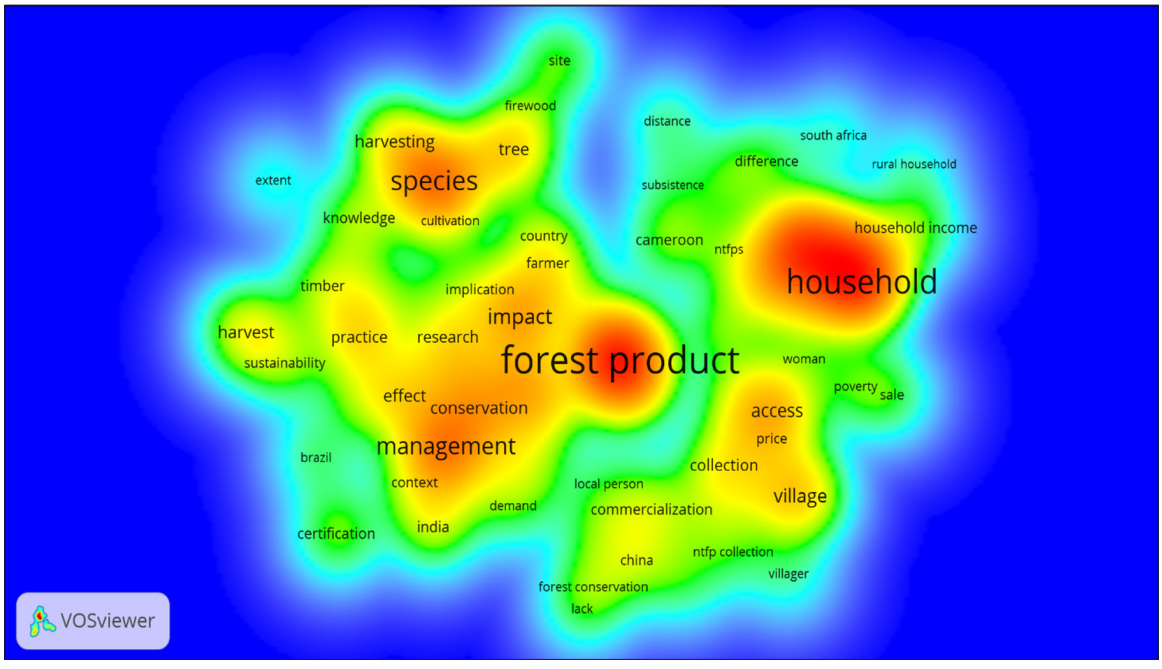
Words	Cluster	Occurrence
Management	1	139
Practice	1	60
Knowledge	1	49
Household Income	1	42
Sustainability	1	39
Process	1	32
Conservation	2	98
Collection	2	57
Commercialization	2	43
Marketing	2	23
Household	3	219
Income	3	203
Impact	3	109
NTFP	3	103
Livelihood	3	80
Rural Livelihood	3	37
Harvesters	4	71
Regulators	4	69
Trader	4	34

the field of NTFP livelihood and policy areas based on the keyword occurrence and its strength of associations (Figure 5).

Cluster 1 includes 29 items with impact, effects, extent, harvesting, implications, and management as the prominent keywords. The group refers to the traditional approach of NTFP research, which is mostly the consumptive dealing with the impacts (both qualitative and quantitative) and knowledge management of the NTFP species and products including processes, practices, and research in NTFP domain leading to sustainability. Ingram et al. (2014) emphasized over-harvesting and discussed the importance of recognizing the informal and invisible nature of value chains and improving value-added opportunities NTFP can provide to rural women.

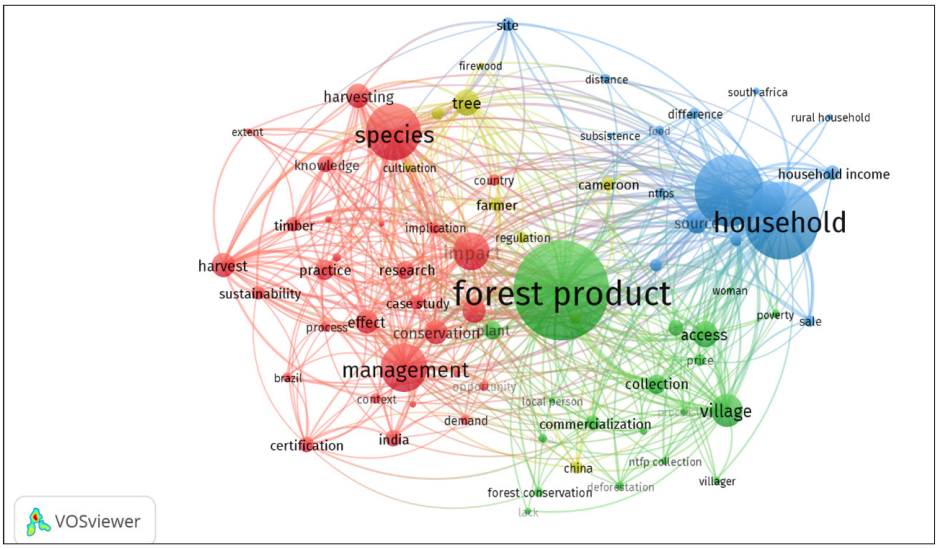
Cluster 2 includes 19 items with forest product, collection, commercialization, forest conservation, and deforestation as the prominent items. This cluster depicts the higher order of research in terms of the traditional way of NTFP reporting

Figure 4. Density visualization of themes identification in NTFP livelihood and policy research



Note: N = 250

Figure 5. Network visualization of NTFP linkages with livelihoods and policy



Note: N = 250

research in its initial years. This group refers to the works evolved from the traditional research that transitioned into more value-based and/or stakeholder-based studies. This resulted in the conservation of natural resources on one hand, and the structuring process of commercialization of NTFP, on the other hand. The studies with the highest citations review the values of trees to rural communities through various stages of production and in providing support to livelihoods, considering wider conservation and sustainability issues (Dawson et al. 2014; Syampungani et al. 2009). The challenges of posited links between cultivation, commercialization, and conservation to enhance value were also discussed (Dawson et al. 2014; Mendelson, Cowlishaw, and Rowcliffe 2003). Various studies supported these linkages through the role of governance and stakeholders. Ingram (2017) identified the role of different stakeholders and discussed the role of governance structure in impacting the livelihood of those involved in the NTFP value chain. The role of processing and storage techniques was also identified for long term value chain sustainability (Ndumbe et al. 2019). Community forests and NTFP were also discussed as a social enterprise (Foundjem-Tita et al. 2018).

Cluster 3 includes 16 prominent keywords like household, income, rural household, rural livelihood, source, type, and NTFP, showing higher relevancy score. This group clustering of keywords and the associations visualized refer to the NTFP research focus on its contribution to income source, rural livelihood, inventorying of NTFP types, and livelihood and income security through the NTFP. The role of NTFP on income of rural households is crucial (Melaku, Ewnetu, and Teketay 2014; Awono et al. 2016; Ndumbe et al. 2019; Iponga et al. 2018). Many studies focused on the alternative livelihood possibility for supporting forest protection (Liu and Xu 2019).

Cluster 4 includes nine items including harvesters, regulators, cultivation, trade, and sale of NTFPs. This group refers to exploring the commercial values and value chain adding to the NTFPs. In a study for Cameroon, a revision in the regulation was recommended for better transparency and dealing with corruption issues (Tieguhong et al. 2015). The issues of poaching and illegal logging as the reason for conflicts suggest that these need to be dealt with (Levang et al. 2015) for the sustainable trade and sale of the NTFPs.

The results elucidate that the first and third groups are traditional ways of NTFP research.

The second and fourth groups refer to the transition of the traditional approach of the NTFP sector toward the commercialization- and marketing related contribution for the livelihood and financial security of the rural communities. It is important to note that one of the key clusters includes trade and sale of NTFPs, which is one of the most important aspects of the policy on NTFPs.

Similarly, the refined search of the literature to focus on the NTFP livelihood domain research for policy and value chain coverage reveals three clusters of aggregation of the keywords from the published literature (n = 42). The three clusters so formed has a total of 13 key terms showing the strength of association and relevance amongst each other. The three clusters related to the NTFP value chain are shown in Figure 6.

Cluster 1 shows the value chain, product chain, and trader as close linkages of research. This cluster networking represents the value chain components that are considered in the NTFP livelihood, involving policy as research components.

Cluster 2 shows major key terms "contribution", "forest", "household", and "income". These key terms association linkages depict the NTFP traditional approach and benefits of livelihood for stakeholders.

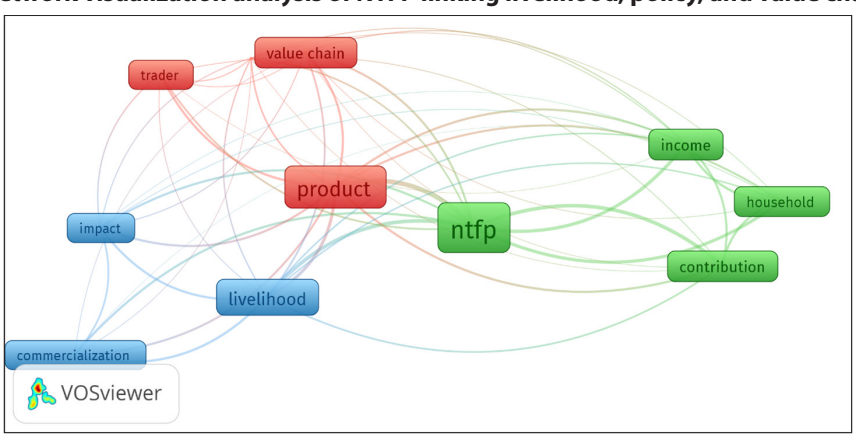
Cluster 3 shows key terms "commercialization", "impacts", and "livelihood", depicting the trend of cluster 1 (components of NTFP) and cluster 2 (traditional approach) to the business value addition and commercialization of NTFP for sustainable livelihood.

Therefore, the results of network visualization show that the majority of NTFP research contributions in the field of livelihood for policy-related concerns are on impacts, commercialization of product chain, forest conservation, or as a source of livelihood income source for rural communities and households.

Research Themes and Trends in NTFP Research for Sustainable Livelihoods and Value Chain

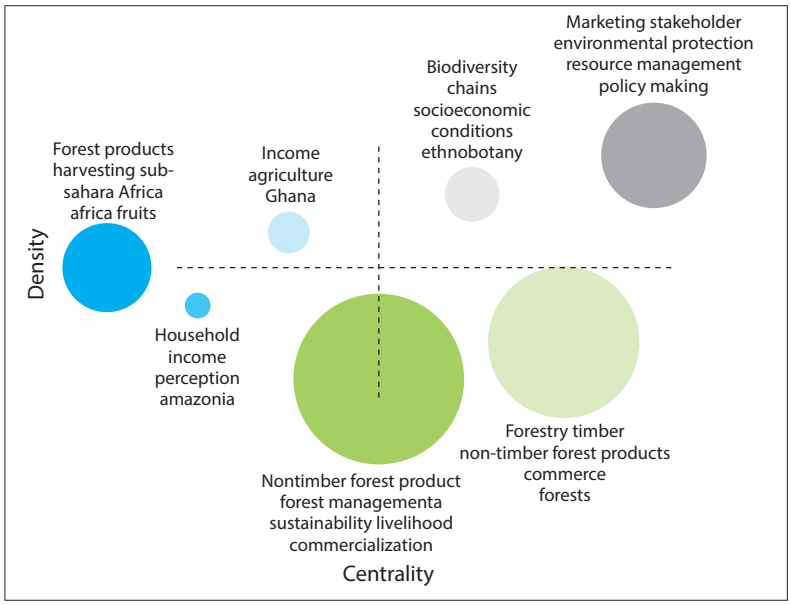
The above sections of network visualization were only capable of clusters and interconnections among the evolution of the keywords. They do not represent the actual thematic research structure of the NTFP research. In order to reveal further information on evolutionary trends, the association of topics, and gaps in the NTFP research important for deriving future directions, a two-dimensional strategic diagram that explores the thematic structure and research trends are explored using R-package for the NTFP research in livelihood and value chain aspects (Figure 7).

Figure 6. Network visualization analysis of NTFP linking livelihood, policy, and value chain domain



Note: N = 42

Figure 7. A two-dimensional strategic diagram representing the thematic structure of NTFP research



The following trends and themes surfaced from the analysis of the NTFP research focusing on livelihood and value chain domain:

Motor theme of NTFP research (upper-right quadrant). The keyword cluster in this section represents the well-developed and important keywords, which has resulted in the structuring of the NTFP research field in livelihood and value chain studies. These include studies on marketing of NTFP, resource management using NTFP, and environmental protection and policymaking concepts and applications. The placement of two sets of different clusters in this section implies that they are related externally to concepts applicable to other themes in the development of other conceptual themes. Therefore, socioeconomic studies, resource management, value chains of NTFP, and environmental considerations present the strong bonding and foundation for the NTFP research to date on the bases of the literature published and are still relevant in their application and use, thereby benefiting the large academic community and knowledge bank in this field.

Highly developed but isolated themes of NTFP research (upper-left quadrant). This section represents the themes that have a higher density, therefore, presenting higher internal ties but low centrality. These present very weak and unimportant externalities. Therefore, the results reveal that the NTFP studies focusing on forest products, harvesting of forest products, an additional source of household income, among other things, are well-developed themes but are of marginal importance for the field in NTFP research. They represent very specialized and peripheral themes in character.

The lower-left quadrant section of the two-dimensional strategic plot generally represents the themes that are marginal and are weakly developed because of low centrality and density values. The results reveal the overlapping of some themes like NTFP and forest management research, NTFP for sustainability, commercialization, and livelihood topics with the transverse theme sections. These topics that have medium centrality values and lower density values present emerging fields in NTFP research. Therefore, the topics

of commercialization, value chain studies, and sustainable forest management using NTFP could emerge as an opportunity for future directions of research in NTFP.

Generic, basic themes and transversal themes of NTFP (lower-right quadrant). Topics in this section have high centrality, which means that these topics are important but are not well developed. These topics along with the emergent theme topics as described in point 3 above reveal the gap in NTFP research, and opportunities for future research directions. These topics represent the basic themes and can be amalgamated with the evolved (developed) themes for future research in the NTFP studies that could contribute to sustainable livelihoods and improved value chains (commercialization of supply chains).

CONCLUSION

NTFP and livelihood research has evolved according to expanding focus challenges in rural development, from sources of income to key stakeholders' involvement, value chain enhancement and business value addition, on to sustainable growth and resource conservation. Furthermore, the thematic structure of the NTFP research indicates that marketing, natural resource management, and environmental issue have emerged as the most developed themes among NTFP studies. Themes like forest products, harvesting of forest products, and its relationship with income generation are highly developed areas, but less research has been done on them. Commercialization and value chain were among the transversal basic topics that are foundations but less addressed and developed over time and, pointing to opportunities for future research. It is important to note that commercialization and value chain themes are also related to the income generation aspect of NTFP research. It is evident from the findings that increased focus on NTFPs' commercialization and value chain will help in developing other areas as well and contribute to enriching the domain.

Further research gaps identified include need for an NTFP policy, guiding standards, and certification of NTFP products for sustainable livelihoods and rural development to better link livelihood and development. Future research could also look into limiting the risk associated with weak regulation and lack of proper streamlined policies based on standard practices. The aim of the supporting studies should be to add value at each stage of the value chain, guiding activities within the chain based on the identification of threats and opportunities, and the creation of new collaborations to address sustainable livelihood actions.

To address the study's limitations, a more comprehensive and elaborate bibliometric analysis can be done by widening the scope of the search, quality of citations, authors, and co-authorship contribution. This would result in a detailed geographical distribution pattern and trends of NTFP livelihood research in different domains. There are also opportunities to focus on traded and non-traded NTFP products. Finally, the pattern of the value chain (including mapping of all stages) and commercialization aspects amalgamated with basic and emergent themes will help in addressing the policy-related NTFP issues for the betterment of society and communities involved in NTFP collection and consumption.

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