Dissertationes Forestales 354

Evaluating local perceptions of sustainable utilisation of non-timber forest products and their potential to improve livelihoods in Ghana's forest fringe communities

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Doctoral dissertation

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ABSTRACT

The sustainable utilisation of Non-Timber Forest Products (NTFPs) holds significant promise for livelihood improvement within forest fringe communities in Ghana. While local communities benefit from NTFPs, there is limited understanding of the locals' perceptions with regard to the potential of NTFPs to alleviate poverty. This research evaluated the intricate interplay of local perceptions with regard to climate change, value addition and the multiple uses of NTFPs, and their influence on livelihood improvement. The study employed a multidimensional approach, incorporating quantitative, qualitative and systematic review methodologies. Surveys and interviews were conducted to gather data on the perceptions of local communities of climate change, value addition to NTFPs and the multiple uses of NTFPs, as well as social factors that influence their perception. In addition, a systematic review using the PRISMA method was used to assess the potential of NTFPs to alleviate poverty. The findings underscored the significance of education, religion and gender, which are pivotal in shaping local perceptions of NTFPs and their potential to improve livelihoods. The systematic review showed the potential of NTFPs to alleviate poverty in Ghana and in other parts of the world. Initiatives that enhance market accessibility and create value-addition opportunities should be considered to uplift communities economically. Furthermore, policy frameworks and institutional support can emerge as essential elements in shaping local perceptions. In conclusion, this research elucidated the vital role of local perceptions for the sustainable utilisation of NTFPs to improve livelihoods within Ghana's forest fringe communities.

Keywords: Climate change, non-timber forest products, perception, value addition, multiple use, local, communities, Ghana.

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I dedicate this thesis to my mother, Mrs Rose Afukaa; my brother, Charles Akwasi Boateng; my wife, Bertha Korange Gyimah; my son, Theodore Kenross Asamoah; my daughter, Evangeline Annorhemaa Asamoah; and my son, Obed Asamoah junior. I acknowledge their unwavering support, understanding, and patience throughout this journey. Lastly, I'd like to express my gratitude to the University of Eastern Finland and to the wider Finnish society for the free education they offered me for my studies.

LIST OF ORIGINAL ARTICLES

This thesis is based on the following five articles, referred to in the text by the Roman numerals **I**, **II**, **III**, **IV** and **V**. Reprints of articles **I** and **III** are provided with permission from the respective journals.

I. Asamoah, Obed, Jones Abrefa Danquah, Dastan Bamwesigye, Nahanga Verter, Emmanuel Acheampong, Colin J. Macgregor, Charles Mario Boateng, Suvi Kuittinen, Mark Appiah, and Ari Pappinen. (2023) The perception of the locals on the impact of climate variability on non-timber forest products in Ghana Ecological Frontiers 44(3): 489-499. https://doi.org/10.1016/j.chnaes.2023.07.004

II. Asamoah, Obed, Jones Abrefa Danquah, Dastan Bamsiegwe, Nahanga Verter, Emmanuel Acheampong, Charles Mario Boateng, Suvi Kuittinen, Mark Appiah, and Ari Pappinen. (2023). The perception of locals on commercialisation and value addition of non-Timber Forest products in forest adjacent communities in Ghana. Discover Sustainability 4: 30 https://doi.org/10.1007/s43621-023-00146-6

III. Asamoah O, Danquah JA, Bamwesigye D, Appiah M, Pappinen A. (2024). Assessing the Influence of social factors on local perceptions of climate change, product value addition, multiple uses of NTFPs, and their influence on poverty alleviation in Ghana. *Forests*. 2024; 15(2):248. https://doi.org/10.3390/f15020248

IV. Asamoah, Obed, Jones Abrefa Danquah, Dastan Bamwesigye, Nahanga Verter, Emmanuel Amoah Boakye, Asante Samuel, Charles Mario Boaten, Suvi Kuittinen, Mark Appiah, and Ari Pappinen. (2024). The multiple contribution of NTFPs to the livelihoods of forest fringe communities in Ghana. *Forests* 2024, *15*(5), 861. https://doi.org/10.3390/f15050861

V. Obed Asamoah, Jones Abrefa Danquah, Dastan Bamwesigye, Nahanga Verter, Ebo Tawiah Quartey, Charles Mario Boateng, Suvi Kuittinen, Emmanuel A. Boakye, Mark Appiah, Ari Pappinen A Review of the Potential of Non-timber Forest Products to Alleviate Poverty. Manuscript. https://doi.org/10.20944/preprints202312.2145.v1

AUTHOR'S CONTRIBUTION

Obed Asamoah served as the lead author in all articles, overseeing data collection and analysis, interpretation of the results, and drafting the initial manuscripts of articles **I–V** Ari Pappinen, Mark Appiah and Jones Abrefa Danquah supervised and planned the design of the studies presented in articles **I**- V. Dastan Bamsiegwe, Nahanga Verter, Emmanuel Boakye, Charles Mario Boateng, and Suvi Kuittinen contributed to proofreading of the published articles. Jones Abrefa Danguah supervised, designed and planned the studies presented in article **V**.

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ABBREVIATIONS

AUCC	Awareness and Understanding of Climate Change
AS	Adaptation strategies
AUVA	Awareness and Understanding of Value Addition
CC	Climate change
CSV	Cultural and Social Values
EVLI	Economic Value and Livelihood Improvement
KII	Key informant interview
MDCP	Market Demand and Consumer Preferences:
STC	Skills and Technical Capacities
PBC	Perceived Benefits and Challenges
SCF	Social and Cultural Factors
TEK	Traditional Ecological Knowledge
ToM	Theory of Mind

1 INTRODUCTION

1.1 Non-Timber Forest Products

Non-Timber Forest Products (NTFPs) are diverse forest resources, excluding timber, that hold significant value for local populations (Shackleton & Pandey, 2014; Shackleton & Shackleton, 2004). In forest fringe communities in developing countries, the sustainable utilisation of NTFPs holds promise for poverty alleviation (Bannor et al., 2021). In Ghana, forests harbour a rich diversity of NTFPs, which include medicinal plants, fruits, nuts and fibres, and provide a range of economic opportunities for local communities (Opoku Mensah, 2012; Shackleton et al., 2007). Moreover, NTFPs serve as a source of income for many rural households in the country. Through the harvest and sale of these products, individuals can earn supplementary income to support their families and improve their livelihoods (Adongo et al., 2019).

An awareness of how the locals understand the benefits of NTFP is crucial for the design of sustainable management strategies that align with community needs and traditional ecological knowledge (Charnley et al., 2007; Orlovic Lovren, 2020). Local perceptions of the benefits of NTFPs and their potential to livelihood explore how communities perceive NTFPs in terms of their advantages and their role in poverty reduction (Ambrose-Oji, 2003; Das & Chatterjee, 2015; Shackleton & Pullanikkatil, 2019a). For sustainable development and poverty alleviation to be achieved in forest fringe communities, it is essential to understand local perceptions with regard to value addition to NTFPs and their potential to increase commercialisation and improve household incomes (Ahenkan & Boon, 2010; Akomaning et al., 2023; Appiah, 2009). It is possible to significantly increase the market value of NTFPs by adding value to them (Chakravarty et al., 2015). Locals recognise this potential and see an opportunity to increase their household incomes and economic growth (Chakravarty et al., 2015; Uprety et al., 2016a). To demonstrate the potential of NTFPs for their sustainable utilisation and poverty alleviation for poor communities in developing countries, it is crucial to understand and incorporate locals' perceptions with regard to the multiple uses of NTFPs (Melese, 2016; Paumgarten, 2005). In many cases, NTFPs are recognised by locals as having multiple uses beyond a single function (Shackleton & Shackleton, 2004; Shackleton et al., 2011). The locals' understanding of the multifaceted uses of NTFPs promotes sustainable harvesting practices (Bruschi et al., 2014; Shanley et al., 2015a) and the locals understand that overexploitation of NTFPs may jeopardise current income and future potential uses (Belcher, 2005; Donovan & Puri, 2004). The perception of multiple uses highlights the necessity to preserve the environment and its resources.

Understanding the local's perception of climate change and its impact on NTFPs is essential to effectively manage NTFPs (Asamoah et al., 2023a; Gurung et al., 2021b). Forest-adjacent communities often experience the impact of climate change on their environment and their livelihoods (Marin & Berkes, 2013). Insights from local sources are useful to identify particular vulnerabilities of NTFPs to climate change, such as altered growth patterns, changes in distribution or increased pest infestations (Macchi et al., 2015). This knowledge is crucial to assess the risks to NTFP availability and sustainability. Local communities often have traditional or indigenous knowledge with regard to climate change adaptation (Makondo & Thomas, 2018). By understanding adaptive strategies, we can develop sustainable NTFP management plans that incorporate climate-resilient practices (Temphel, 2021). This exploration delves into how NTFP resources are understood by

communities, both in terms of their economic and non-economic benefits, and how they can be harnessed to improve livelihoods and mitigate poverty. Understanding the local perception of NTFPs and other social factors in improving the utilisation of NTFPs is crucial for the design of sustainable and community-centric strategies that effectively leverage the potential of NTFPs to uplift individuals and communities from poverty (Bhattarai et al., 2021; Saini et al., 2016).

1.2 Economic Benefits of NTFPs in Ghana

Studies have shown that NTFPs contribute significantly to the income of individuals, communities, and even entire regions (Melaku *et al.*, 2014a; Mukul et al., 2016). In rural and forest-dependent areas in Ghana and other West African countries, sustainable harvesting, processing and sale of NTFPs provide economic opportunities (Tieminie *et al*., 2021a; Uduji & Okolo-Obasi, 2019). In addition, NTFPs offer a source of income for individuals, families and communities, particularly in rural and forest-dependent areas (Phumee & Pagdee, 2021; Rahman et al., 2021). Through the collection and sale of NTFPs, poverty can be reduced, and living conditions can be improved (Asamoah et al., 2023; Reta, 2020). As a supplement to household income or as a means of augmenting household resources, NTFPs can be valuable. Studies have shown that NTFPs can contribute significantly to household income, from 32.7% to 48.7% in some cases (Alkali et al., 2022; Maua et al., 2019). Moreover, NTFPs facilitate the diversification of income sources, thereby reducing dependence on a single livelihood activity, such as agriculture (Kimengsi & Balgah, 2021; Tieminie et al., 2021a).

Diversification enhances economic resilience and mitigates the risks associated with fluctuations in traditional income streams (Cline et al., 2017; Landreth & Saito, 2014; Rosenstock et al., 2016). Solely dependent on one income source, such as agriculture, may expose individuals and communities to several risks (Adu et al., 2018; De Silva & Kawasaki, 2018). These risks may include crop failures due to adverse weather conditions, pests or diseases. By participating in NTFP activities, people can spread the risk associated with income generation across multiple sources (Rahman et al., 2021). For example, if one NTFP is scarce or experiences a poor harvest in a particular year, other NTFPs or income streams may still provide some financial stability. There can be adverse effects on traditional income sources, such as agriculture, due to economic downturns, price fluctuations or unforeseen events (e.g. disease outbreaks) (Harvey et al., 2018; Muluneh, 2021). Diversification of income through NTFPs reduces the vulnerability of communities to these external shocks since the communities have alternative sources of revenue that are not subject to the same risks (Razafindratsima et al., 2021; Smith et al., 2017).

Research has shown that NTFPs stimulate local economies by supporting small-scale enterprises, cottage industries and local markets (Cunningham et al., 2017; Magry et al., 2022). The processing, packaging and sale of NTFPs can create job opportunities and foster economic growth in rural and remote areas (Zhu & Lo, 2021) through the creation of jobs and increased economic growth (Asamoah et al., 2023; Nambiar, 2019; Shrestha et al., 2020). Small-scale enterprises can establish and grow through NTFPs. Business opportunities exist for local entrepreneurs to collect, process and sell NTFPs. For example, a community may establish a small-scale herbal medicine production facility or a wild mushroom processing facility. As a result of these enterprises, locals generate income and can obtain employment. As such, NTFPs are frequently sold in local markets, providing economic support to rural and remote areas (Uprety et al., 2016a). The NTFP traders and vendors in these markets can

attract buyers and tourists, thereby stimulating economic activity in the region. Regions rich in NTFPs often attract eco-tourists interested in experiencing the natural environment and local culture (Das & Chatterjee, 2015; Perera, 2022). The influx of tourists can generate additional income for communities through lodging, guided tours, and from the sale of NTFPs and similar products (Hoang et al., 2020; Ko et al., 2020). The activities of NTFPs often allow for income distribution among a broader population segment, including women and marginalised groups (Ingram et al., 2010, 2014), which can help reduce income inequalities within communities.

1.3 Perception of the benefits of NTFPs

A community's perception of NTFPs will undoubtedly differ depending on the cultural, socioeconomic and environmental contexts (Meinhold & Darr, 2019b; Meinhold et al.,2022; Suleiman et al., 2017). As part of the social-ecological system, local perceptions of natural resource conservation, such as wildlife, forests and water resources, have been useful to better understand the relationship between humans and nature (Allendorf, 2007; Allendorf et al., 2012). To understand people's perceptions of NTFP conservation, sustainable utilisation, management, commercialisation, value addition and their ability to alleviate poverty, we define perception as what people know, believe or understand (Fischer & Schär, 2010; Hoang et al., 2020) comparatively to attitudes that are based on how one feels or thinks about NTFPs (Ashok et al., 2002; Ntuli et al., 2019).

Many local communities recognise the economic value of NTFPs. They view these products as essential sources of income, livelihoods and economic opportunities (Nguyen et al., 2020). Evidence shows that NTFPs can provide supplemental income for rural communities, particularly those living in or near forested areas (Mahonya et al., 2019). Locals have been made aware that NTFPs can provide them with a means of diversifying their income sources, reducing their reliance on agriculture or timber, and improving their economic well-being (Timko et al., 2010). Local cultures and traditions are often deeply ingrained in NTFPs (Fan et al.,2022; Ingram, 2017). It is possible to use NTFPs in rituals, ceremonies, traditional medicines, crafts and other forms of cultural expression (Darmadi, 2018; Rival, 2021). Due to their cultural heritage, locals may have a strong attachment to these products and may actively engage in the sustainable harvest and management of these products. Many communities recognise the importance of sustainable harvesting of NTFPs to maintain the health of the forest ecosystem and ensure their long-term availability (Ndoye & Tieguhong, 2004; Sheppard et al., 2020; Singh & Chatterjee, 2021).

1.4 Role of NTFPs in poverty alleviation

In recent years, NTFPs have emerged as a crucial component in poverty alleviation efforts in forest communities (e.g. Issaka, 2018). With their significant potential to generate income and improve livelihoods, these products have gained recognition and attention from policymakers, researchers and development practitioners (Jaffee *et al*., 2018; Mukul *et al*., 2016; Scoones, 2015). Studies have shown that one of the critical benefits of NTFPs is their ability to provide income-generating opportunities for rural communities, especially those living in or near forest areas (Rahman *et al*., 2021; Verma & Paul, 2016). Many of these communities heavily rely on forest resources for their livelihoods. The collection, processing

and sale of NTFPs offer these communities a means to generate income and improve their living conditions. In addition, NTFPs have a relatively low entry barrier compared to other income-generating activities (Chakravarty et al., 2015; Meinhold & Darr, 2019). This makes them particularly suitable for marginalised groups, such as women, youths and indigenous communities, who may face limited access to resources and opportunities. By engaging in NTFP activities, these groups can enhance their economic empowerment and reduce their vulnerability to poverty (Djoudi et al., 2015; Kassa & Yigezu, 2015). Moreover, NTFP-related activities generate significant employment opportunities, especially in rural and forest fringe areas (Lepcha et al., 2022; Talukdar et al., 2021). This impact is particularly pronounced in regions with scarce or limited formal job opportunities. Furthermore, NTFP-related activities encompass a range of tasks from harvesting, processing, packaging, transportation, marketing and sales. These activities require diverse skills and labour (Chakravarty et al., 2015; Vega et al., 2023). Local community members often engage in these activities, which provide them with direct employment opportunities within their locality.

The harvest and processing of NTFPs often align with seasonal patterns of resource availability. This leads to predictable employment patterns, which provide stability and consistent income during specific times of the year when these resources are abundant (Saxena & Güneralp, 2022; Vaughan et al., 2023). Engaging with NTFPs can foster entrepreneurship and the development of small enterprises. Individuals or small groups may start businesses related to value addition, such as processing NTFPs into marketable products, such as herbal medicines, handicrafts or food items (Bannor et al., 2021; Harbi et al., 2023). This entrepreneurial spirit contributes to local economic development. The nature of NTFP activities often promotes community collaboration as communities may come together to harvest, process or market these products, which encourages a sense of unity and shared responsibility, while distributing the benefits of the enterprise (Dentoni et al., 2018; Paudel, 2016).

1.5 Aims of the study

Value addition has been shown to influence the commercialisation of NTFPs (Belcher, 2005; Chakravarty et al., 2015). The impact of climate change on NTFPs has also been studied, as has its influence on NTFP production and impact on local forest communities (Gurung et al., 2021a; Tieminie et al., 2021b). Other studies have demonstrated the multiple values of NTFPs and their potential to increase incomes in forest communities (e.g. Adam et al., 2013; Shrestha et al., 2020). However, less attention has been given to the locals' perception and understanding of the abovementioned factors and how they influence NTFPs resources (Msalilwa et al., 2013). More research is required to assess the locals' perceptions of climate change, how it influences NTFPs production, the multiple values of NTFPs and how it can help increase local household incomes. In addition, knowledge of how locals understand value additions is required, as are the technicalities involved in addition to NTFPs and the potential to increase income generation (Belcher & Schreckenberg, 2007; de Blas et al., 2009; Karki, 2020). This warrants an assessment of the locals' perceptions of climate change, value addition and multiple uses of NTFPs and their potential to increase household income and improve livelihoods. The main aims of the study were to:

I. Assess the perceptions of the local forest communities in Ghana on the impact of climate variability on NTFPs (Paper **I**).
II. Assess the perceptions of the local forest communities in Ghana on the commercialisation and value-addition of NTFPs (Paper **II**).
III. Assess the perception of the local forest communities in Ghana on the multiple contributions of NTFPs to the livelihoods of forest fringe communities (Papers **III** & **IV**).
IV. Assess NTFPs and their potential to alleviate poverty (Paper **V**).

2 CONCEPTUAL FRAMEWORK

2.1 Perceptions of climate change, value addition and multiple use of NTFPs

Awareness and Understanding of Climate Change (AUCC) and its implications for NTFPs as perceived by the local communities are paramount for the sustainable utilisation of NTFPs (Gurung et al., 2021b; Msalilwa et al., 2013; Tieminie et al., 2021a). In Ghana, climate change awareness and knowledge by the locals is paramount (Yaro et al., 2015) and an understanding of the local community's awareness and understanding of climate change, its causes, effects and potential implications on ecosystems and NTFPs is imperative (Das & Mishra, 2022; Datta et al., 2012). Locals' understanding of how climate change affects NTFP availability, quality and sustainability, including growth patterns and species distribution (Kunwar, 2011; Sonwa et al., 2012), is essential for NTFP management. Integration of Traditional Ecological Knowledge (TEK) is crucial as it involves combining the insights and wisdom about the environment, ecosystems, and sustainable practices handed down through generations (Hernández-Morcillo et al., 2014; Martin et al., 2010). The purpose of this knowledge is to preserve cultural heritage, promote harmonious coexistence with the environment and utilise traditional methods, understandings and beliefs to sustain interactions with the natural world (Johnson et al., 2016; McGregor, 2004). This information enhances the locals' sense of climate-related changes in NTFPs (Balama et al., 2017; Gurung et al., 2021b; Kunwar, 2011). Understanding the local perceptions of TEK with regard to NTFPs is crucial to effectively leverage local resources to improve local livelihoods (Charlton, 2013; Dawson et al., 2021). A range of social factors, including gender, education and personal experiences, significantly influence individuals' perceptions of climate change. Lujala et al. (2015) and Nakayama et al. (2019) both highlighted the role of personal experience on climate change. Education emerges as a pivotal factor, as evidenced by Nakayama et al. (2019), which indicates its more significant impact compared to religion or culture. Wu et al. (2018) and Poortinga et al. (2019) further validated this assertion, highlighting education as a substantial determinant of climate change beliefs and concerns. By incorporating local perspectives and practices into poverty alleviation strategies, communities can sustainably manage NTFPs, promote economic empowerment and preserve their cultural heritage, while fostering environmental conservation.

Sociocultural factors (SCF) influence the sustainable utilisation of NTFPs by shaping community values, traditional knowledge and practices, thus ensuring the preservation of cultural heritage, while promoting environmentally sound resource management (Adomako-Kwabia, 2021). Understanding the perception of local SCFs with regard to NTFPs is crucial

for the design of culturally sensitive interventions that align with community values and traditions, thereby fostering greater acceptance and participation (Arce, 2019; Devisscher et al., 2021). By respecting sociocultural perspectives, interventions can promote the sustainable management of NTFPs, preserve indigenous knowledge, strengthen social cohesion, and ultimately enhance livelihoods within the community (de Mello et al., 2020). Moreover, NTFPs hold cultural and social significance within a community, shaping perception of climate change and its effects on traditional practices and values (Gurung et al., 2021b; Matias et al., 2018; Uprety et al., 2016b). Cultural and social values (CSV) significantly influence the perception and utilisation of NTFPs within communities, and reflect traditional knowledge, practices and identities tied to local ecosystems. These values often dictate the management and harvesting practices associated with NTFPs, which ensures sustainability and conservation of forest resources, while honouring cultural heritage and promoting social cohesion. Understanding and respecting these cultural and social values is essential for the implementation of effective conservation strategies, the fostering of community engagement, and maintaining the integrity of NTFP-dependent livelihoods.

An essential component of the framework is an understanding of the perceptions and beliefs of the local community with regard to the concept and significance of adding value to NTFPs. Examining the Awareness and Understanding of Value Addition (AUVA), the extent to which the community is aware and comprehends what value addition involves with regard to NTFPs and their potential benefits, is paramount in NTFP utilisation (Muhammad, 2017; Walle & Nayak, 2022). This comprehension provides the foundation to make informed decisions with regard to how to sustainably enhance the value of these products, thereby positively impacting both the community and the environment (Ajmal et al., 2018; Larsen et al., 2022). Economic Value and Livelihood Improvement (EVLI) initiatives aim to harness the economic potential of NTFPs to alleviate poverty by fostering sustainable income opportunities and by the promotion of economic resilience within local communities through responsible harvesting, processing and marketing practices (Peerzada et al., 2021). It is essential to gain an understanding of how locals perceive value addition as a process to enhance the economic value of NTFPs (Chakravarty et al., 2015; Epanda et al., 2020; Negi et al., 2011). It is crucial to convey a multifaceted understanding of how strengthening the value of these forest products can significantly improve livelihoods and overall financial security. It is common for locals to perceive value addition as a strategic approach aimed at enhancing the market value and desirability of NTFPs (Belcher, 2005; Belcher & Schreckenberg, 2007). Locals see increased profitability and market competitiveness potential by adding value through processing, packaging or conversion of raw materials into finished or semi-finished products. A value-added product can be sold at a higher price, resulting in more significant financial gains and improving local livelihoods (Negi et al., 2011; Parrish et al., 2005). Evaluating the skills and technical capabilities (STC) of a community, as well as the available resources for the implementation of value addition techniques and how these influence their perception of the feasibility and potential outcomes of value addition is critical. These capabilities guide sustainable practices, encourage adaptive measures and promote responsible resource management, thereby directly affecting how the community perceives and adapts to climate-related changes (Beyerl et al., 2018; Kemp et al., 2015).

At the framework's core lies a comprehensive understanding of the local community's perceptions and beliefs with regard to the diverse uses and potential of NTFPs. The comprehension delves into how these perceptions influence the community's utilisation and the value placed upon NTFPs (Khanal et al., 2023; Vanni, 2018). It involves acknowledging

and incorporating TEK and customary practices related to the myriad uses of NTFPs, while taking their enduring value and integration into contemporary applications into consideration. The cultural and social significance of NTFPs cannot be underestimated, as it influences how locals perceive, respect and utilise these products within the fabric of their cultural rituals, traditions and collective identity. Furthermore, an understanding of local perceptions of the health and medicinal value of NTFPs is crucial, as they encompass traditional medicinal uses and emerging understandings of their potential health benefits. This perception emphasises the vital role NTFPs play in the promotion of health and well-being within the community.

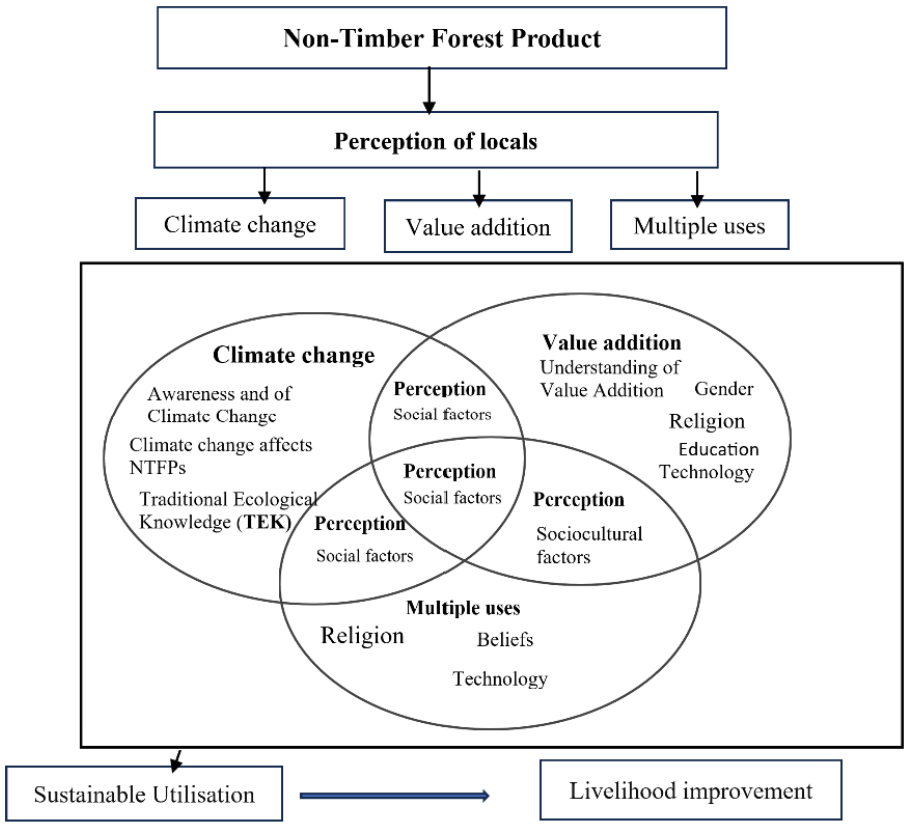

Figure 1: Conceptual framework of the perception of Non-Timber Forest Products (NTFPs).

2.2 Theory of the mind: A key factor in influencing perceptions

The "mind sponge" theory metaphorically illustrates how individuals absorb and process information from their environment, thereby shaping their perceptions, beliefs and attitudes (Nguyen et al., 2022; Vuong et al., 2023). This theory suggests that people act as mental sponges, continuously absorbing and filtering information from various sources, including personal experiences, social interactions, media and cultural influences (Nguyen et al., 2021). The information processed by individuals influences their perceptions, attitudes and behaviours and shapes how they view themselves, others and the world around them. This, in turn, guides their decision-making processes, actions and interactions with others. Just as a sponge can release water when squeezed, individuals can adapt and modify their beliefs and attitudes based on new information and experiences. The mind sponge theory emphasises the dynamic nature of human cognition and the continuous process of learning and adaptation throughout life. When applied to the perception of climate change, multiple uses, commercialisation and value addition of NTFPs, the theory can offer insights into how local people understand and respond to these phenomena. Locals' perceptions of climate change can be influenced by the information they absorb from various sources, including media, community discussions and personal experiences (Bloodhart et al., 2015; Fernández-Llamazares et al., 2015). The mind-sponge theory suggests that individuals may interpret climate change differently based on the information they receive, their cultural beliefs and their level of exposure to environmental changes (Kahan et al., 2011; Xue et al., 2014). Kahan et al. (2007) explored how cultural values influence individuals' perceptions and interpretations of climate change. Local perceptions of cultural values profoundly influence the utilisation of NTFPs, serving as a foundation for sustainable management practices that enhance livelihoods and preserve cultural heritage within communities (Hwang, 2017; Shanley et al., 2015a). The perception of locals with regard to changes in rainfall patterns, temperature and the causes of climate change, whether attributed to natural factors or human activities, such as overexploitation, could raise awareness of the decrease in NTFP productivity and exacerbate poverty within affected communities (Ayeni et al., 2016; Negi et al., 2017).

The mind sponge theory can explain how locals perceive the multiple uses of NTFPs in their daily lives. The "mind sponge mechanism" (Aisdl, 2021) can be applied to the local perception of the multiple uses of NTFPs in daily life, as it explains how individuals absorb and apply cultural values based on their environment. This mechanism is influenced by the depletion of local, task-related resources (Jubera-Garcia et al. 2020), which can be linked to the practical and utilitarian aspects of NTFP use. In addition, the Theory of Mind (ToM) system (Enrici et al. 2019) plays a role in this perception, as it allows individuals to attribute mental states to others' actions, potentially influencing their understanding of the uses of NTFPs in their community. Local perceptions and understanding of the multiple uses of NTFPs can be influenced by social factors, such as education, gender, religion, age and geographical location, thereby shaping their attitudes and utilisation practices accordingly (Gouwakinnou et al., 2019; Mushi, 2019).

Locals may absorb information related to the economic opportunities associated with commercialising NTFPs, such as their sale in local markets or to external buyers (Arnold, 1996). The mind-sponge theory suggests that individuals may weigh potential benefits and risks of commercialisation based on their understanding of market demand, resource availability and environmental sustainability (Goldsmith et al., 2016; Manzoor et al., 2016). The mind-sponge theory emphasises individuals' considerations of market demand, resource

availability and ecological sustainability in commercialisation decisions, which is supported by the work of Gattig and Hendrickx (2007), Schwering (2011) and Goldsmith (2016), who highlighted the importance of environmental risks, responsible decision-making. Manzoor (2016) further explored environmentalism and social-ecological relevance in resource consumption and noted their impact on sustainable decision-making, collectively underscoring the intricate interplay of cognition, environmental awareness and market dynamics in commercial decisions.

The mind sponge theory, which posits that individuals absorb and process information from their environment, can help explain how locals perceive the value addition of NTFPs through processing, packaging and branding. Mukul (2011) highlighted the importance of creative marketing and product appearance in sustaining the market for NTFPs. This finding would suggest that locals may value NTFPs more when they are presented in an appealing manner. Both (Davvetas & Halkias (2019) and Batra et al. (2000) discussed the influence of brand origin on consumer attitudes, with non-local brands often being preferred for their perceived quality and status. This implies that locals may perceive NTFPs as more valuable when they are processed, packaged and branded in a way that aligns with their preferences for non-local products. Tippakoon (2020) further emphasised the role of non-local knowledge sources in product innovation, which would suggest that locals may also value NTFPs more when they are processed using non-local knowledge and techniques.

As people absorb information of value-added products, such as herbal teas, cosmetics or handicrafts, they may perceive increased economic opportunities and cultural recognition associated with NTFPs. By understanding locals' perceptions and attitudes towards climate change and NTFPs, policymakers and development practitioners can design interventions that align with local knowledge systems and socio-economic priorities. Leveraging the mind-sponge theory can help facilitate participatory decision-making processes, promote sustainable resource management practices, and support community-led initiatives for poverty alleviation and livelihood improvement.

3 MATERIALS AND METHODS

3.1 Study areas

This research (**I**, **II**, **III**, **IV**) focused on five regions in Ghana where large tropical forests, both reserve and off-forest reserves, are located, and NTFPs play a significant role: Western North, Bono, Ahafo, Ashanti and Eastern regions. These regions are also locally recognised for their abundant and diverse NTFPs. In these regions, the main economic activities revolve around agriculture (farming), trade, commerce and services (hotels, auto mechanics, sawmills, banks, etc.). The study areas have dense vegetation, which includes tall canopy trees, understory plants, as well as a wide variety of plant and animal species (Asamoah et al., 2023). In these regions, the climate is tropical rainforest, with warm temperatures and heavy rainfall throughout the year. Heavy and consistent rain occurs during the wet season, particularly from April to July, and a second peak occurs from August to October. In the hottest months (February and March), temperatures can reach 31–33°C, while in the coldest months (August), temperatures can reach 19–21°C.

3.2 Method of survey and study approach

To investigate local perceptions of climate change (**I**), value addition (**II**) and the multiple values (**III** & **IV**) of NTFPs in rural Ghana, we conducted 732 interviews in the five regions. A preliminary questionnaire was formulated in March 2022 following thorough consultations with economists, market stakeholders, community members and representatives from the Ghana Forest Commission. Subsequently, the questionnaire underwent review by three lecturers: one from the School of Forest Science, University of Eastern Finland, another from the University of Cape Coast, Ghana, and a third from the Forest Research Institute of Ghana. Their invaluable inputs helped to refine the questionnaire language and ensured conceptual clarity. A well-defined schedule was followed from April 2022 to June 2022, during which data collection occurred through interviews within various regions, districts and local communities. Focus group discussions were carried out in June 2022 within the vicinity of the study areas to gauge the comprehension of NTFP collectors, marketers and farmers with regard to climate change, value addition and the multiple uses of NTFPs in Ghana, along with their potential to enhance the quality of life of the communities in those areas. In-person interviews were conducted in selected communities within the regions from May to June 2022. With the valuable assistance of a lecturer from the University of Cape Coast, Ghana, the subsequent phase of the study involved the collection, cleaning, evaluation and management of data between July and August 2022. A systematic review was carried out to examine the potential of NTFPs to alleviate poverty (**IV**).

3.3 Data collection and sample design

Purposive sampling was used to select regions, forest districts and communities for the study (**I**, **II**, **III**, **IV)**. Five (5) regions (Ahafo, Ashanti, Bono, Eastern, Western-North) out of sixteen (16) regions in Ghana were selected. Ten (10) forest districts (Bia West, Bia East, Bibiani Bekwai Awhiaso, Asunafo North Municipal, Asunafo South, Antima Mponuaa, Doramma East, Dormaa West, Sefwi Wiawso and Kwahu East), in the selected regions were also selected.

A total of 61 communities were selected within their respective forest districts and regions. These regions, districts and communities were selected due to the substantial coverage of tropical forests, both off-reserve (Off-reserve forests refer to forest areas located outside of officially designated forest reserves or protected areas) and reserved forests in the country. Again, the 61 communities were selected based on their proximity to the forest reserves within their respective forest districts. The purposive sampling method was applied to obtain detailed information from locals in the regions and districts directly involved in the collection, process, trade and use of NTFPs. This method ensured that every region, district and community of the chosen population had detailed information related to NTFPs, thereby reducing the possibility of inconsistent information and ensuring that the sample was representative of the entire population in the region, district and communities in Ghana.

In choosing the households of the respondents, we first visited all the 61 communities. Simple random sampling was used to randomly select 10 households each from the 61 communities. The simple random sampling method was applied to ensure that each member of the population had an equal chance of being selected, making the sample representative of the entire population. This helps to minimise bias and increases the likelihood that the sample accurately reflects the characteristics of the population. Each of the randomly selected

households was numbered by writing the name of the region, the district, the community, and its respective number. In total, 610 households were numbered. A total of 300 of the numbered households were randomly selected, and these households were those visited, of which our interviews were administered. Parents, family heads, and locals who were actively involved in the utilisation of NTFPs were contacted in each household.

Among these selected households, the market centres of each of the selected communities were visited, and some of the key stakeholders in the trade of NTFPs and its process were also interviewed. Furthermore, individuals prominently engaged in NTFP collection were identified and interviewed, and a discussion was held with them. These key individuals were identified with the assistance of residents, who helped pinpoint those actively involved in NTFP collection within the community.

The sample size of the study included 732 respondents, considering their age, gender, educational level, religious beliefs, occupation, the number of years they have lived in the community, the kind of NTFPs they collect, their perception of the multiples used to the NTFPs and social factors that are possible to influence their perception in the utilisation of NTPs. To calculate sample size, we used Cochran's formulas and procedures as described by (Krejcie & Morgan, 1970). Data were collected from respondents who relied on NTFPs as a source of livelihood and subsistence utilisation in the study area. Primary data were obtained through a structured questionnaire and key informant interviews where a series of questions, both closed and open-ended questions and discussion, on the local's perceptions of NTFPs and the multiple uses of NTFPs, were administered to the relevant individuals or key stakeholders (traders, hunters, gatherers, and farmers) who are involved in NTFPs utilisation.

To calculate sample size, we used Cochran's formulas and procedures:

$$n_o = \frac{w^2(p)(1-q)}{e^2} = \frac{(1.96)^2 0.5(1-0.5)}{0.040^2} = 600.25$$

Where n_o = sample size, w^2= is the critical value for a given confidence level. For a 95% confidence level, $w^2 \approx 3.8416$ (which corresponds to a W value of 1.96). (p)(q) = estimate of variance = 0.25. Where e = acceptable margin of error for the proportion of the sample population estimated = 0.035 (the level of error that the researcher is willing to accept). An anticipated non-response rate of 18.1% was calculated and added to the sample size:

$$Nfs = \frac{\frac{W^2 * p * (1-q)}{e^2}}{1 - anticipatedNon - response} = \frac{600.25}{1 - 0.181} = 732$$

The overall sample size (*Nfs*) comprised 732 individuals. In addition, the study investigated the types of NTFPs collected and whether there were changes in their collection practices. Mushrooms, snails, chewing sticks, game and honey were the specific NTFPs examined, and were chosen for their anticipated significance in the NTFP trade within the study areas.

With the systematic review presented in Paper **V**, we followed the Preferred Reporting Items for Systematic review and Meta-Analysis Protocols (PRISMA-P) (Moher, 2009; Page et al., 2021) to systematically retrieve and categorise the relevant literature on NTFPs and their potential to alleviate poverty. Our research inquiries were wide-ranging, and our review fell under the category of a systematic map (Roe et al., 2014). PRISMA-P can serve as a robust framework for performing systematic reviews on a wide range of subjects (Moher, 2009). Sierra-Correa & Cantera Kintz (2015) have emphasised that PRISMA-P is adept at formulating research questions for systematic reviews and can effectively establish the criteria for inclusion or exclusion of studies in an analysis. Our searches were conducted in English, primarily because the review team members were proficient in this language. This approach also served as a practical means to narrow the scope of the review. As we wanted to explore the multifaceted relationship between NTFPs and poverty, we developed an extensive set of search terms that were designed to encompass a variety of aspects of NTFPs, as well as various dimensions of poverty alleviation.

Table 1: Keywords used in the search string.

Database	Keywords
Web of Science	Non-timber forest products" OR "NTFPs*" AND "Potential" AND "poverty" OR "livelihood" OR "Improvement" OR "Alleviation" AND "forest communities" OR "Locals" OR "Fringe" OR "Adjacent"
Scopus	Non-timber forest products" OR "NTFPs*" AND "Potential" AND "poverty" OR "livelihood" OR "Improvement" OR "Alleviation" AND "forest communities" OR "Locals" OR "Fringe" OR "Adjacent"
ScienceDirect	Non-timber forest products" OR "NTFPs*" AND "Potential" AND "poverty" OR "livelihood" OR "Improvement" OR "Alleviation" AND "forest communities" OR "Locals" OR "Fringe" OR "Adjacent"
Google Scholar	Non-timber forest products" OR "NTFPs*" AND "Potential" AND "poverty" OR "livelihood" OR "Improvement" OR "Alleviation" AND "forest communities" OR "Locals" OR "Fringe" OR "Adjacent"

3.4 Data analysis

This study aimed to explore local perspectives of climate change, value addition and the diverse uses of NTFPs. To achieve this goal, we categorised respondents based on their roles in the NTFP value chain and distinguished between collectors, buyers and consumers. Descriptive statistics for the study were analysed using SPSS Statistics 20.0 (IBM, New York, USA) and R Studio. Based on the survey results, frequencies and percentages of responses were analysed for each indicator related to locals' perception of climate change, value addition and multiple uses of NTFPs. The significance of local people's perceptions of climate change, value addition, multiple uses of NTFPs and socioeconomic factors was examined using logistic regression. We used a logistic regression model to analyse the factors that influenced the perceptions of the locals and their potential to improve their livelihoods. The ordinal logistic regression model was selected since it has been widely used to study the factors that influence locals' perceptions of different technologies (Li et al., 2022; Mwaura et al., 2021). The logistic regression method is used when the dependent variable is binary (0/1, True/False, Yes/No). In a binomial distribution, the logit function is used as a link function (Edgar & Manz, 2017; Peng et al., 2020). In logistic regression, the logistic function (also known as the sigmoid function) transforms the output into a probability value between 0 and 1. Logistic regression can be expressed as follows:

$$Logit\ (Y)\ =\ ln\ [\pi j\ /\ (1\ -\ \pi j)]\ =\ \alpha j\ +\ \beta i\ X\ i\ j\ =\ 1\ldots,k\ -\ 1\ A = \pi r^2$$

Where: Y = dependent variable (perception of the main variables, i.e. climate change, value addition and multiple use), ln = natural log, j = Likert scale that ranges from 1 to K-1, αj = threshold values where α the intercept, βi (i = 1, …, n) is the logit coefficient to be estimated, and $X\ i$ (i = 1, …, n) is the explanatory variable. A more detailed description of our approach can be found in Asamoah et al. (2024).

3.5 Analytical framework to determine the potential of NTFPs to alleviate poverty

In this section, we delved into a comprehensive evolution of the concepts that stemmed from a range of studies that extensively elaborated on the contributions and versatile utilisation of NTFPs, and how NTFPs play a pivotal role in the generation of income for both local communities and for the countries engaged in harvesting and processing these resources. Our exploration encompassed studies with different categories of NTFPs and documented their commercialisation and income-generating aspects. In addition, we investigated how NTFPs contribute to poverty alleviation by examining their sale, local household utilisation, and export for foreign exchange.

The analysed studies were divided into two sections: (1) Studies that focused on the collection of NTFPs for household use, and (2) studies that examined NTFPs utilised for commercial purposes. The analysed studies covered Africa, Asia, South America and Europe. The studies also examined the potential of a NTFP-based bioeconomy for livelihood security and income inequality mitigation among locals. The reviewed studies have sought to understand the role of NTFPs in household subsistence and income generation and their impact on the local and national economies.

4 RESULTS

4.1 Local participation in the use of NTFPs

Given the traditional roles in Ghana, where men are considered as head of the family and are primarily engaged in farming activities, and in gathering and hunting NTFPs, it was expected that more male participants would be involved in this study. In addition, a significant number of women displayed a reserved demeanour when answering questions, often seeking permission from their husbands before actively participating in the survey. The survey was conducted with 215 female respondents (29.37% of total respondents) and 517 male respondents (70.63%) (**I**, **II**, **II**, **IV**). The majority of the surveyed individuals fell within the 50–59 age range, which constituted 298 respondents (40.71%). Conversely, the 18–20 age group had the lowest representation with only 5 respondents (0.68%), likely due to the survey coinciding with school hours and with many individuals in this age group attending school. Education level among the locals varied, with a significant portion having only attained primary education. Among the respondents, 371 individuals (50.68%) had completed only primary education, while 41 (5.60%) held graduate degrees. Financial constraints in the study area may have influenced educational distribution. With regard to religious affiliation, a substantial portion of the respondents identified as Christian, which constituted 59.8% of the respondents (438 individuals). The predominant occupation among the respondents was farming, accounting for 88.4% (620 individuals), while a smaller number worked as teachers (0.1%) and nurses (0.3%). Trading was the second most common occupation (11.2% of total respondents, 109 individuals).

The NTFPs that are common and largely gathered by the local communities in the selected study regions were herbs, mushrooms, snails, honey, game, chewing sticks, leaves, straw, pestle and raffia palm. The findings of the survey indicated that snails, herbs and honey account for 14.07%, 16.12% and 13.39% of all NTFPs harvested in the study regions, respectively. In the survey, 14.34% of respondents reported that they collected mushrooms. In addition, 10.25% of study participants hunted for game, 9.56% collected leaves, 7.51% collected chewing sticks, 6.56% harvested straw, 3.42% collected raffia palm and 4.78% collected pestle. Within one season, some locals visited the forest more than three times to gather and collect NTFPs.

4.2 Perception of climate change and its impacts on NTFPs (Paper I)

As described by the mind sponge theory, individuals absorb and process information from their environment in different ways; This was also the case in this study where locals provided a range of perceptions about climate change and its causes. Some saw climate change as caused by human activities, while others had the notion that God's anger, sinful acts, population increase, industrialisation and illegal cutting of trees were the causes. A small number of respondents indicated that they were not certain as to the key causes of climate change. With regard to local perceptions of climate change, 208 of the respondents (28.4%) suggested that human activities were the cause, 190 respondents (25.9%) specifically attributed the changes to the rampant illegal logging of trees, while 75 respondents (10.3%) indicated that industrialisation had contributed to the observed climate changes in their area. Even though some locals mentioned anthropogenic causes of climate change, others

attributed it to spiritual causes: 54 (7.4%) of the respondents mentioned that climate change was the result of human sins, and 51 of the respondents claimed that the gods of the land were angry with mankind due to the bad behaviour of humans, and that this has resulted in drastic changes in weather patterns and change in climatic conditions. In total, 52 respondents (7.2%) made it known that they were uncertain about the cause of the changes in the climate and suggested that most of these changes were bound to occur as they were natural phenomena.

The discussion with the locals with regard to their perception of climate change was mainly based on observed variations in temperature and annual precipitation/rainfall, as well as changes in the length of wet and dry periods. From the locals' response, temperature variations have already occurred, and respondents reported experiencing previously unprecedented warmer temperatures and prolonged wet/dry periods. However, these changes have only been noticeable over the last two decades. The locals have witnessed a pattern of brief rainy periods followed by prolonged dry seasons. Unfortunately, this climatic trend has been a catalyst for forest fires, during which many organisms crucial for NTFP production have been affected and destroyed. The respondents attributed most of these alterations to ongoing deforestation that has persisted for several decades. It was observed that a significant portion of the forest has been cleared due to illegal mining activities and by logging conducted by both registered and unregistered timber merchants, and by the Forestry Commission of Ghana. The locals highlighted that this has led to a scarcity of NTFPs and a decline in living organisms, such as bees and ants, essential for NTFP production, which has consequently affected overall NTFP production levels. A respondent emphasised this concern by stating, “The Ghana Forestry Commission is the primary instigator of the alarming deforestation rates within our local communities”. The respondent further elaborated, stressing that the commission's recruitment practices have led to the appointment of corrupt officials who lack a comprehensive understanding of the significance of NTFPs and the overall role of the forest ecosystem. This lack of awareness as to the invaluable contributions of the forest exacerbates the issues at hand, resulting in detrimental consequences for the environment and climate, “If they know the benefits of the forest, they would not encourage these high deforestation rates in our reserves forest.” The Forest Commission has turned a blind eye to mining in reserved forests and this has contributed to the scarcity of NTFPs.

During the discussion with local forest fringe communities with regard to how climate change has affected their lives, we categorised their views according to the perceived changes, the impact on their lives, and the types of changes observed. The locals mentioned erratic, untimely delayed rainfall patterns as a perceived change that has occurred. Others also noted that there has been decreased water availability and increased dry conditions. Locals also mentioned rising temperatures and warmer and shorter rainy seasons with less rainfall, which has increased pests and disease outbreaks. Locals openly expressed the impact that they have experienced. They said that there has been a decline in NTFP availability, which has impacted the rate of collection. They further noted that climate changes have affected agricultural NTFP production. The respondents also mentioned that shortened and unpredicted rainfall seasons had affected soil moisture conditions, had lowered groundwater levels and affected plant growth. These changes have negatively influenced other living organisms that promote the production of NTFPs, for example, bees (honey), mushrooms and snails. Also, it was mentioned that increased temperatures could result in health issues for plants and animals, thereby impacting NTFPs production and sales. Not only do these changes affect NTFP production, but they also increase expenditure as the pests and diseases

must be treated, which increases household expenditure. In other situations, increased temperatures can result in crop and livestock failure, which is detrimental to the local community's livelihood.

This study has shown that social classes, such as gender, education, religion, occupation and age have an influence on the perception of climate change. Age, gender, education and occupation had little influence on the locals' perception of climate change and its subsequent influence on NTFPs. However, religion was found to have a significant influence ($p<0.03$) and could be attributed to the fact that most locals are religious. Education, not having any influence on locals' perception of climate change, could be attributed to the fact that changes in weather patterns are clear and easily observed. One need not to have a formal education to observe the changes. Also, this could be a result of direct experience of climate change, which affirms the mind sponge theory that information can come from direct experiences.

4.3 Perception of value addition and its impact on NTFPs commercialisation (Paper II)

Locals were asked about their perception of value addition to NTFPs and if value addition can potentially increase the price of NTFPs. Of the 732 respondents, 548 (74.9%) made it clear that they do not add value to NTFPs when they gather and collect them from the forest. The respondents were asked if they perceived value addition could increase the price of NTFPs: 437 respondents (59.7%) answered that value addition could increase sales and improve the commercialisation of NTFPS in the local communities instead of selling the NTFPs directly to the locals or passers-by. Respondents were asked whether their religious background influenced their perception of value addition: 438 of respondents (59.8%) considered themselves as Christian, 259 of respondents (35.4%) identified as traditionalists and 35 (4.8%) as Muslim. Religious beliefs of the locals in the study area were not found to have strong influence on their perception of the value addition of NTFPs. Locals were also interviewed on their perceptions of the constraints behind adding value to the NTFPs that they collect or gather from the forest. Their responses were grouped into financial, time and skills constraints: 173 of respondents (23.6%) indicated that their financial situation did not permit them to wait for the value addition process to be completed. They also indicated that there are some NTFPs that when you add value to them, reduce the product price but have a higher price when sold directly from the forest, e.g. mushrooms, snails and leaves. Also, 292 of respondents (39.9%) declared that they needed to upskill in order to add value to most of the NTFPs that are collected on the farms. At present, they prefer to sell the NTFPs immediately after collection. A total of 265 respondents (36.2%) mentioned that some products require time and attention to process, and that it is better to sell the products in the raw state than to spend too much time processing them. Our results revealed that gender, education, religion and financial constraints influence how value addition to NTFPs is perceived by the local communities: Gender ($p<0.003$) and education ($p<0.004$) were found to be statistically significantly, while religion and constraints (time, finance, skills) did not influence locals' perceptions.

4.4 Perception of the multiple values of NTFPs and their potential to alleviate poverty (Papers III & IV)

Locals in the forest fringe communities expressed different perceptions to the use of NTFPs, which were grouped into artefacts, construction, food, leisure, medicine, religious and sales purposes. In this study, 112 respondents (15.3%) mentioned that they collected and harvested NTFPs to make artefacts, which were sent to the market for sale. Also, 180 respondents (24.59%) perceived that most NTFPs collected are used for food. A small number of respondents (15/2.05%) indicated that NTFPs were used for leisure purposes. Some respondents indicated that NTFPs can be used for religious purposes. Of the locals interviewed, 115 (15.71%) perceived that NTFPs could be used for medicinal purposes, while 170 (23.22%) perceived that NTFPs are for sale, and 95 respondents (12.98%) used NTFPs for construction purposes.

The response of the locals with regard to their perception of the multiple uses of NTFPs was found to be linked to other social factors (gender, education, religion, household size, occupation). Our results show that gender ($p<0.001$), education ($p<0.007$) and religion ($p<0.008$) had a significant influence on the perception of multiple uses of NTFPs in Ghana, although household size showed minimal influence. The study suggests that gender, particularly in the context of harvesting, gathering and sale of NTFPs, may influence perceptions of their use. Employment type did not appear to impact perception of NTFP utilisation within the communities.

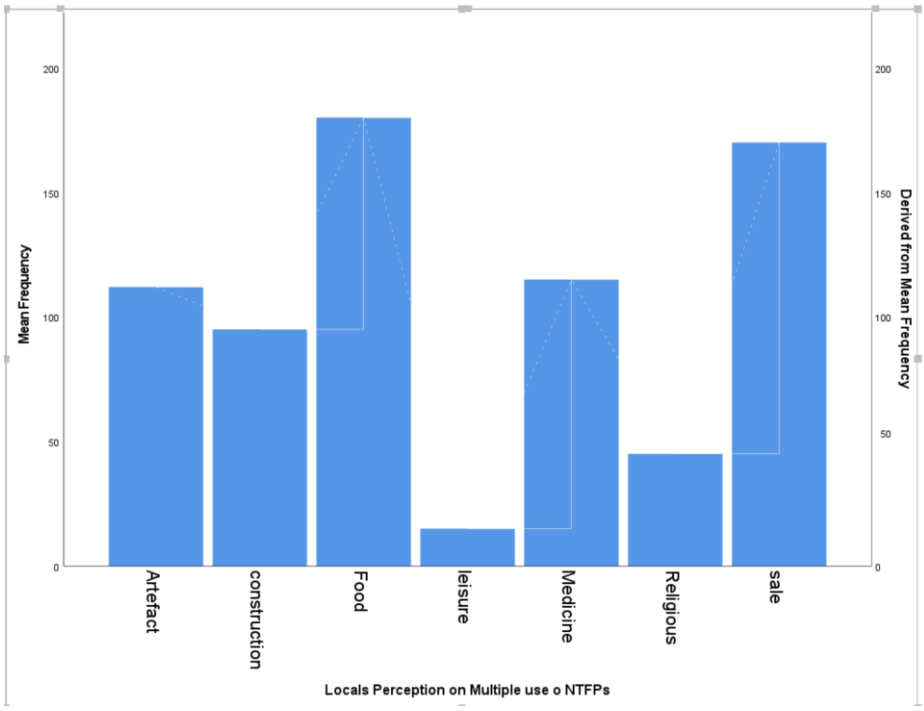

Figure 2: Locals' perceptions of the multiple use of Non-Timber Forest Products (NTFPs).

4.5 Potential of NTFPs to alleviate poverty (Paper V)

Table 2: Studies on Non-Timber Forest Products (NTFPs) and their potential for poverty alleviation.

Country	Specific NTFPs collected	% Contribution of NTFPs to Household Income	Reference
Tanzania	Firewood, fodder, honey.	**40**	(Giliba et al., 2010)
Myanmar	Bamboo shoots, charcoal, firewood, broom grass.	**43.7**	(Moe & Liu, 2016)
Ethiopia	Forest coffee, honey, spices (Ethiopian cardamom and long paper), fuelwood, medicinal and edible plants, bamboo.	**47**	(Melaku et al., 2014b)
Nepal	Fruits, leaves, seeds, shoots, bark, roots.	**44–78**	(Rijal et al., 2011)
India	Medicinal plants, mushrooms, wild vegetables, fuel wood, gum resin and tannin, millet, seeds.	**19–32**	(Saha & Sundriyal, 2012)
Uganda	Fuel wood, wild vegetables, mushrooms, medicinal plants.	**26**	(Jagger, 2012)
Benin	Fodder, twigs, wild fruits, fuelwood, medicinal plants.	**39**	(Heubach et al., 2011a)
Myanmar	Fuel, fodder, food, medicinal plants, wildlife.	**50–55**	(Aung et al., 2015)
Cameroon	Fodder, medicinal plants, roots, tubers, leaves, flowers, game, dyes, etc	**31**	(Ngwatung & Roger, 2013)

The search yielded information from studies that had quantified the specific contributions of NTFPs to households in local communities situated within forest areas (Table 2). The search also provided studies that provided valuable insights into the contribution of NTFPs to household income and poverty alleviation in various countries in Africa and the world as a whole. The review showed that income generated from NTFPs varied depending on the specific type of NTFPs that were harvested, gathered and utilised. In Asia and Africa, food resources hold significant value as they can contribute to income when sold or can reduce household expenses when consumed.

5 DISCUSSION

This dissertation examined locals' perceptions concerning the value addition of NTFPs and how commercialisation can be improved to increase their livelihoods. In addition, the study explored the locals' perceptions of climate change and its influence on NTFPs, the locals' perceptions concerning the multiple uses of NTFPs and how to enhance their sustainable utilisation. Finally, the study reviewed the potential of NTFPs to alleviate poverty.

5.1 Perception of climate change and its impacts on NTFPs

As set in the conceptual framing of this research (components 1 and 2 in Figure 1), an understanding of the causes of climate change is crucial to evaluate how locals perceive its impact on NTFPs (Magry et al., 2022; Tieminie et al., 2021b). Climate change awareness and understanding can significantly impact local perspectives on NTFP availability, quality, harvesting seasons, preservation and commercialisation changes. Furthermore, it plays a vital role in determining whether or not the locals are willing and capable to adapt traditional NTFP harvesting techniques or explore alternative sources (Ambrose-Oji, 2003).

The study revealed that locals have different perceptions as to the causes of climate change. Some locals attribute the causes to sinful acts of people, while others consider that it is punishment from the gods. In the local community, evil acts, such as deforestation, hatred between people, abortion, homosexuality, hatred and hostility, are regarded as significant contributors to climate change (Koehrsen, 2021; Veldman, 2019). Some locals view climate changes as direct consequences of human behaviour and moral choices. Furthermore, traditional beliefs and superstitions shape some perceptions where climate change is believed to be the result of divine punishment or supernatural forces (Halperin, 2017; Salite, 2019). However, other groups perceive the causes of climate change as industrialisation and the illegal cutting of trees.

Climate change has had severe consequences in the study areas in this study and a significant increase in global warming due to greenhouse gas emissions has intensified these changes, leading to fluctuations in rainfall patterns, increased extreme weather events, and disruption of ecosystems (Bakun & Weeks, 2004; Kumar et al., 2021) that adversely impact NTFP production levels and the livelihoods of local communities (Magry et al., 2022). Climate change further exacerbates these effects, leading to shifts in rainfall patterns and temperature extremes, which negatively impact agricultural outputs, NTFP productivity and water resources (Gurung et al., 2021a; Kelkar & Bhadwal, 2007; Nkondze et al., 2014). In this study, locals reported that climate changes have resulted in an increase in temperature, a

decrease in precipitation, a shorter duration of the rainy season and, in some cases, intensified rainfall and flooding. This has impacted NTFP production (Chitale et al., 2018; Yadav et al., 2021; Gurung et al., 2021a; Tieminie et al., 2021a) and has increased the mortality rate of trees and other living organisms that contribute to the production of NTFPs. In addition, the decrease in precipitation and the shorter duration of the rainy season reduce water availability for NTFPs, further affecting their production (Rautela & Karki, 2015; Saalu et al., 2020). Intensive rainfall events have also negatively impacted NTFPs, resulting in damage and loss. Climate-induced changes have disrupted the ecological balance and have long-term consequences.

In our study, education, occupation and gender were not found to have influenced the perception of the impacts of climate change, but this is in contradiction to the findings of Gurung et al., (2021a) and Vo et al., (2021). Most of the locals have experienced direct observation of the changes. Local experiences of changes in weather patterns, seasons and the availability of NTFPs can influence perceptions of climate change, which affirms the work of Darjee et al. (2022) and Tieminie et al. (2021b). Religion had a significant influence on the locals' perception of climate change. Ghana is home to indigenous African religions and to Christian and Islamic faiths (Golo & Awetori Yaro, 2013; Murray & Agyare, 2018). These religions often connect with the environment and natural resources in their beliefs and practices (Awuah-Nyamekye, 2019). Specific religious beliefs and practices must be explored to understand how religion impacts perceptions of climate change and NTFPs in Ghanaian forest-dependent communities. Studies have shown that religion can effectively address climate change challenges, such as environmental degradation and the protection of natural resources (Golo & Awetori Yaro, 2013; Golo & Yaro, 2013). Evidence suggests that religious beliefs and practices may influence how local people perceive and respond to climate change impacts on NTFPs (see Li et al., 2020), which was also observed in our studies.

5.2 Perception of value addition and its impact on NTFP commercialisation

Local perceptions with regard to adding value to NTFPs are crucial for commercialisation and local livelihood improvement (Epanda et al., 2020). To enhance the market opportunities for NTFPs, it is essential to understand how locals perceive value addition.

Locals strongly perceive that adding value to NTFPs will increase commercialisation and price increases, improve local livelihoods and alleviate poverty. Adding value to NTFPs will increase their commercialisation opportunities. Economic growth and job creation within local communities can be enhanced by transforming these products into marketable goods (Belcher, 2005; Belcher & Schreckenberg, 2007). In this study, the locals were aware of value addition and how value addition could increase commercialisation. However, locals only add value to their products after the product is sold to the buyer, and this can be attributed to religious, financial, time and skill constraints needed to add value to products.

The perception and practices of locals with regard to adding value to NTFPs can be influenced by their religious beliefs (Li et al., 2020). According to the study results, there was not much information on the influence of religion in this context. However, it is possible that certain religious beliefs or practices could discourage or limit the adoption of value-adding practices. On the other hand, it was observed that education and gender strongly influence the perception of the locals of value addition. Education may significantly impact gender roles and attitudes, which, in turn, may affect local perceptions of value addition

(Rivera-Garrido, 2022). The education level of individuals, both men and women, may affect their participation in value addition, especially in the lean seasons (Donkor et al., 2022), which affirms the findings of our studies. However, it is essential to note that education can have a robust causal effect on gender-role attitudes for women from poorly educated families, potentially leading to a more positive perception of the importance of their role (Rivera-Garrido, 2022). Various social and cultural contexts, particularly in rural areas, may lead to varying perceptions of gender equity (Lahiri & Jha, 2022).

It is imperative to understand the perceptions of locals, particularly those living in forest fringe communities, to develop effective strategies for the commercialisation and value addition of natural resources (Shackleton & Pandey, 2014). It is common for women in rural areas to rely on communal lands to acquire forest products, whereas men may have greater access to higher-value NTFP resources. This difference in resource access is likely a result of social and gender norms that have shaped the roles and responsibilities of men and women in the community (Jalonen et al., 2023). In addition, several NTFPs are primarily designed for men to process, while others are considered taboo and very cumbersome and time-consuming for women to handle (Jemase & Chesikaw, 2021; Nkengla, 2014). For example, honey harvesting, as well as hunting and fishing products may be culturally designated as activities for men as a result of the physical demands or traditional roles (Dash et al., 2016; Shanley et al., 2015a; Verma & Paul, 2016). Conversely, certain roles, such as the collection of medicinal plants or herbs, mushrooms, snails and leaves, are designated as women's responsibilities based on traditional beliefs and practices (Adewumi, 2021; Konlan, 2015). Women need assistance to handle cumbersome NTFPs, which limits their access to these resources. This gendered division of labour has socio-economic implications for women, as well as environmental consequences (Jewitt, 2019; Rustagi et al., 2013). To promote gender equality in the NTFP sector, it is crucial to empower women in collection and processing activities and encourage men's participation in non-traditional NTFPs (Chakravarty et al., 2015; Gurung et al., 2015). Policy interventions are also needed to ensure gender inclusive NTFP management.

Value addition often requires additional resources, including equipment, packaging materials and marketing efforts (Lahti et al., 2018). Forest fringe communities may need more financial resources to invest in these resources, which makes value addition activities difficult. However, we observed the opposite in our studies where constraints, grouped into time, finance and technology, did not influence the locals' perception of value addition. Based on the low income of the locals, it is likely that they need more time to process the NTFPs that they collect. At present, they sell them at the local market or to passers-by to get rapid source of income to resolve their financial problems.

Value addition is crucial to enhance the commercialisation of NTFPs, and lead to increased household income. This, in turn, elevates the financial well-being of the local communities, thereby contributing to poverty alleviation (Chakravarty et al., 2015; Dinda et al., 2020). It is possible to increase the marketability and profitability of NTFPs by adding value through processing, packaging, quality control and product diversification (Chakravarty et al., 2015; Karki, 2020). In addition to contributing to sustainable livelihoods and community development, value addition empowers local communities to engage in economic activities related to NTFPs (Akomaning et al., 2023; Pandey, Tripathi, & Ashwani Kumar, 2016). Moreover, it allows new market opportunities to be explored and the development of branding and marketing strategies to meet consumer demand. The significance of value addition lies in its ability to enhance the economic viability of NTFPs,

as well as the well-being of the individuals and communities that rely on them (Reta, 2020; Schaafsma et al., 2014).

Commercialisation of value-added NTFPs contributes to the sustainability of livelihoods and the development of communities (Ormbsby et al., 2021; Roy, 2010). NTFPs provide marginalised communities with economic independence and a platform for socio-economic growth through improved access to markets, distribution channels, branding and marketing strategies (Uduji & Okolo-Obasi, 2019; Wahlén, 2017). Therefore, value-added NTFPs can transform communities by lifting them out of poverty and fostering long-term sustainable development.

5.3 Perception of multiple values of NTFPs and their potential to alleviate poverty

A local understanding of NTFPs involves understanding their uses, perceiving their economic value, and being aware of their potential to improve livelihoods (Shackleton & Pullanikkatil, 2019). The studies in this thesis have shown that local communities are familiar with the various NTFPs available in their area and understand how they can be used for multiple purposes, such as medicine, food, leisure, religion, sales, construction and handicrafts or artefacts (Figure 2). Furthermore, the locals are aware of the economic value of NTFPs and realise that they have the potential to generate income and contribute to the livelihoods of households. This affirms the studies of Kumar (2015), Pandey et al. (2016), Rahman et al. (2021) and Uprety et al. (2016b). Also, the locals understand that NTFPs have the potential to contribute to poverty alleviation by providing sustainable income generation opportunities and improving the overall well-being of the local community (Peerzada et al., 2022).

The studies in this thesis observed that most locals gather and harvest NTFPs for different purposes and that NTFPs serve various purposes in the lives of local communities beyond their economic value. For example, in religious practices, these natural resources play an essential role in rituals and ceremonies and represent a connection between the community and nature.

5.3.1 Perception of NTFPs for medicinal purposes

NTFPs play an essential role in traditional medicine due to their cultural significance and historical use as medicine (Talukdar et al., 2021; Uprety et al., 2016b). Local communities value natural resources and consider them integral to their traditional knowledge and practices (Nyumba et al., 2018). As a result of personal experiences and testimonials, locals consider some NTFPs as medicinal remedies. The perceived effectiveness of NTFP medicines varies between individuals and can be influenced by factors, such as cultural beliefs, accessibility and the availability of alternative treatments (Schunko et al., 2019). Despite the challenges in conservation and sustainable harvesting, there are economic opportunities associated with NTFPs medicines that make them a valuable resource in traditional medicine. Various beliefs and attitudes exist among locals regarding the efficacy of NTFPs as medicinal remedies (Astutik et al., 2019; Chamberlain et al., 2020). The cultural and historical significance of these products within local communities has led some to perceive them as highly effective in treating various ailments. Personal experiences and testimonials from locals who have used NTFPs further fuel these positive perceptions.

However, a lack of scientific evidence and the influence of modern medicine contribute to a more sceptical view of NTFP efficacy (Lindberg et al., 2023; Xaba et al., 2022).

5.3.2 Perception of NTFPs as food

The perceptions of NTFPs by locals as a food source are complex (Famuyide et al., 2013; Hutauruk et al., 2018; Rahman et al., 2021). The nutritional value, cultural significance and economic benefits of NTFPs are highly valued by local communities (Heubach et al., 2011b; Negi et al., 2011; Sharma et al., 2015). In addition to providing a rich source of nutrients, they contribute to the diversity and flavour of local cuisine. The indigenous communities have extensive knowledge of how to identify and harvest NTFPs, as well as traditional recipes and cooking methods that enhance their utilisation (Delang, 2006; Verma & Paul, 2016). Moreover, NTFPs provide essential nutrients that contribute to a balanced diet. Vitamins, minerals, proteins and fibre are abundant in NTFPs, making them an essential source of nutrition. Furthermore, they provide an alternative to conventional agricultural crops, thus diversifying the local diet and ensuring food security (Jemal et al., 2018; Sardeshpande & Shackleton, 2019). Moreover, NTFP consumption not only improves the nutritional status but also contributes to the cultural heritage of local cuisines. These products are characterised by unique flavours and cooking methods rooted in indigenous knowledge and traditional practices. In local communities, NTFPs have a profound influence on local cuisine. There is a special place for these products in the area's unique culinary traditions and recipes, which reflect the region's unique seasonings and palates. Indeed, NTFPs are valued not only for their nutritional benefits but also for their connection to the cultural heritage of their communities. In addition to preserving time-honoured cooking techniques, the use of NTFPs in local dishes illustrates the ancestral wisdom and customs carried over generations. By weaving NTFPs into their diets, locals uphold cultural identities. Preservation of these products and the spread of awareness is essential to ensure that future generations know the cultural importance of NTFPs.

5.3.3 Perception of NTFPs for leisure

Diverse demographics have shown an increasing interest in engaging with NTFPs for leisure (Dash et al., 2016; Howell et al., 2010). Many people are interested in exploring the numerous benefits that NTFPs can provide with regard to leisure activities and experiences (Dash et al., 2016; Rahman et al., 2021), although we observed the opposite in this study. Most locals in the study areas did not consider NTFPs for leisure, and this could be attributed to the fact that most of the local farmers do not have leisure time. However, other studies have shown that NTFPs are widely perceived as a source of relaxation and enjoyment (Kilchling et al., 2008) and some NTFPs are viewed as a means of escaping the fast-paced urban lifestyle and connecting more meaningfully with nature (De Almeida Campos et al., 2016; Mateer, 2022).

Our exploration focused on the perception of locals. Specifically, we were interested in their views on how NTFPs can provide relaxation and enjoyment. According to our results, engagement with NTFPs offers locals an opportunity to unwind and enjoy the natural environment. These resources serve as a unique way for them to connect with nature and to bring them a sense of tranquillity and peace. Whether it involves foraging for wild berries or collecting plants for herbal remedies, interacting with NTFPs allows locals to escape the stresses of their daily lives and fully immerse themselves in the serene beauty of nature. By

using NTFPs for leisure activities, locals can take a break from the fast-paced world and appreciate the simple joys that the natural world has to offer.

5.3.4 Perception of NTFPs for religious purposes

In religious practices, NTFPs are essential resources for various rituals and ceremonies Anthwal et al. (2010) Poudel. (2009) where they are often used as offerings or as items of spiritual significance. It is widely believed that NTFPs possess unique properties that connect individuals with the divine, as they are deeply entwined with spiritual beliefs (Anthwal et al., 2010; Dudley et al., 2010). Moreover, NTFPs are closely associated with religious traditions and with specific plants or materials used in certain religious practices (Andel, 2006; Poudel, 2009). As a result of their use in religious contexts, NTFPs have a wide range of cultural and social impacts and influence local customs and traditions. They are often used in social gatherings and celebrations as symbols of faith and devotion. However, efforts must be made to protect and preserve these valuable resources so that NTFPs can be used for religious purposes in the long term. Furthermore, NTFPs in religious settings have economic implications that must be considered. In addition to providing economic benefits, these NTFPs contribute to the growth of local economies that are heavily dependent on the trade and market demand for NTFPs in religious settings (John et al., 2013).

5.3.5 Perception of NTFPs for sales purposes

NTFPs offer numerous advantages to local residents. First, they provide additional revenue and enhance economic stability and livelihoods (Shackleton & Pullanikkatil, 2019b). Trading of NTFPs enables local people to expand their earning options, thereby reducing their reliance on conventional careers, while NTFP transactions provide a gateway for entrepreneurial initiatives and self-reliance, potentially improving local livelihoods. Locals can cultivate and showcase their talents and inventiveness while fostering a sense of self-sufficiency. Similarly, trading in NTFPs promotes societal and communal growth, driving camaraderie and unity amongst community inhabitants. Furthermore, the commercialisation of NTFPs also reinforces cultural ties since it is primarily based on indigenous wisdom and traditional customs passed down through the generations. In addition, the sale of NTFPs creates a heightened awareness of their significance and importance, which propels conservation initiatives and safeguards biodiversity.

5.3.6 Perception of NTFPs for construction, handicraft or artefact purposes

NTFPs hold much sway in local community construction and handicraft sectors. Traditional construction techniques in these communities rely heavily on NTFPs for their robustness and adaptability under diverse environmental conditions (Harbi et al., 2023; Heubach et al., 2011a). These resources are harnessed in many ways, including the creation of one-of-a-kind handicrafts and relics that proudly display the area's rich cultural legacy. With regard to construction, NTFPs offer several advantages, including affordability and reduced environmental impact. Undoubtedly, NTFPs are essential for the creation of unique and culturally significant artefacts (Shackleton & Pandey, 2014). The local population has traditional knowledge and practices to identify, harvest, process and preserve NTFPs. Handicrafts that utilise NTFPs provide economic opportunities and livelihoods for communities and contribute to the conservation of these resources (Harbi et al., 2018; Lepcha

et al., 2019). As a result of the locals' use of NTFPs in their handicraft industries, they can produce unique and culturally significant items. For the local communities, these handicrafts provide a source of income and a means of livelihood.

The combination of cultural values, economic opportunities, as well as the desire for environmental preservation shapes locals' perception of NTFPs for handicrafts or artefact purposes. Locals also perceive NTFPs as handicrafts and artefacts as a positive development since it provides them with economic opportunities and enables them to showcase their cultural heritage. In addition, NTFPs have a wide range of applications in the construction industry, primarily as materials for building houses, furniture and tools.

5.3.7 Social factors that influence the perception of the multiple uses of NTFPs

This doctoral thesis has shown that gender, religion and education significantly influenced the locals' perception of the multiple uses of NTFPs in Ghana. The connections between gender, religious beliefs and educational experiences shape the local's understanding of the multiple uses of NTFPs in the country (Amoah & Wiafe, 2012; Awudu Iddriss, 2022). Gender ($P<0.001$), religious belief ($P<0.008$) and education ($P<0.007$) significantly influenced the perception of locals of multiple use of NTFPs. An embodied approach to these factors outlines how the personal beliefs and knowledge gained from education creatively collaborate with gender identities to form perceptions of NTFPs. A comparative exploration across gender, religion and education spheres on such perceptions might reveal nuanced and detailed correlations and effects. A comprehension of the layered implications of this combined impact is fundamental to strategically address and foster the sustainable utilisation of NTFPs throughout Ghana. Household size and occupation are independent of the locals' perception of the multiple uses of NTFPs. In Ghana, NTFPs are used for a variety of purposes and gender plays a significant role in influencing this perception. Males exhibit differing perspectives to females (Camou-Guerrero et al., 2008; Nhem & Lee, 2019) and it is also important to note that both men and women have unique perspectives on the multiple uses of NTFPs.

There is also a significant influence of religion on perception (Carswell & Rolland, 2004; Jamal & Sharifuddin, 2015), with Christians, Muslims and adherents of traditional religions exhibiting differing views. Depending on the denomination and interpretation of religious and cultural contexts, Christian beliefs about the environment and NTFPs can vary. Some Christian groups emphasise the importance of stewardship of the environment, reflecting their belief that humans are the custodians of God's creation. The emphasis here may be placed on using NTFPs responsibly and managing natural resources in a sustainable manner. Stewardship (Khilafah) is also emphasised in Islamic teachings with regard to the environment and resources, including NTFPs (Kamla et al., 2006; Mamat & Mahamood, 2017). There is a strong emphasis on the responsible use of natural resources and avoidance of waste and excess. The ethical teachings of Islam may influence the collection and utilisation of NTFPs through the promotion of sustainable practices. Furthermore, followers of traditional or indigenous religions commonly hold deeply rooted beliefs and practices related to the natural world and natural resources (Dudley et al., 2010). Nature and its resources, including NTFPs, play a significant role in many indigenous cultures' spiritual and cultural identities. Religious beliefs significantly impact how locals perceive the multiple uses of NTFPs. There is no doubt that religious beliefs influence the level of perception, as an individuals' interpretation and understanding of their faith influence how they exploit

natural resources. Traditional rituals, ceremonies and community norms may guide NTFP collection and use.

One of the factors that contributes to the divergent perceptions is education level, which specifically impacts the individuals' understanding of the multiple uses of NTFPs. Intersectionality plays a significant role in shaping perception when gender, religion and education are considered together. A comparative analysis of these factors reveals their varying influence on the perception of NTFPs. The locals' perception of NTFPs in Ghana must be understood in light of the implications of these combined influences. Depending on factors (product type, region and available resources), NTFPs and their potential to alleviate poverty are perceived differently by locals, who recognise the economic value of NTFPs as essential sources of income and livelihood. Value addition is viewed as a means to increase the profitability and economic benefits of NTFPs, which can help alleviate poverty. Local perceptions of the multiple values associated with NTFPs can also influence their attitudes towards sustainable resource management. When locals understand the importance of NTFPs to their livelihoods, they may be more inclined to engage in practices that promote forest conservation and sustainable management.

5.4 A systematic review of the potential of NTFPs to alleviate poverty

5.4.1 Studies in other regions

Globally recognised for their contributions to conservation, income generation and rural development, NTFPs have been extensively examined in developing countries (Peerzada et al., 2022). Notably, Zambia and Tanzania lead in honey production, and have experienced significant export growth and positive impacts on local livelihoods (Shackleton & Gumbo, 2010). In Nigeria, NTFPs contribute significantly to household incomes and studies conducted by Muhammad (2017) in Kano State revealed that 45% of the surveyed households received between 20.5– 40.5% of their total income from NTFPs. Moreover, about 22% of these households derived 41–60.5% of their total household incomes from NTFP sales, while only 2% of all the households interviewed reported that a significant portion, exceeding 80.5% of their incomes, was generated through NTFP-based enterprises in the study area.

Economic estimates project a global value of around US$90 billion annually for NTFPs, with a third of this value circulating within local economies (Mahapatra et al., 2005). In Central and West Africa, income shares from NTFPs can rival or surpass minimum wages, as seen in studies in Democratic Republic of Congo (e.g. Jimoh et al., 2013). Indeed, NTFPs play a crucial role in Nigeria, where they contribute to energy needs and have evolved from subsistence use to international trade (Onuche, 2011). Various regions in Nigeria showcase diversified income sources from NTFPs, including game meat, snail collection and honey production (Onuche, 2011). Similar positive roles of NTFPs in enhancing rural welfare are documented in other African nations, such as Kenya and Tanzania (Mbuvi & Boon, 2009; Schaafsma et al., 2014). The global trade in wild mushrooms, valued at over US$2 billion annually, is driven by temperate and tropical varieties (Hall et al., 2003). In Ghana, mushrooms are considered a vital resource by 76% of rural women, and contribute significantly to food and incomes (Ahenkan & Boo, 2011). In addition, the bushmeat trade in tropical regions, which targets various species, has considerable value, with estimates suggesting billions of US dollars in trade and consumption (Brashares et al., 2004; Shanley

et al., 2015a). In Bangui (Central African Republic), bushmeat consumption is valued at US$16 million annually, exceeding 1% of the country's Gross Domestic Product (GDP) (Fargeot et al., 2017).

5.4.2 NTFPs, income generation and poverty alleviation

Aside from fuel and timber resources, forests offer diverse products that can enhance local livelihoods and help reduce poverty (Djoudi et al., 2015; Shackleton & Pandey, 2014). Nevertheless, accurate documentation of the role of NTFPs remains a challenge in numerous areas, mainly because a substantial portion of the trade occurs in informal markets. Consequently, the actual contribution of NTFPs has yet to be formally integrated into the national economy (Djoudi et al., 2015). Nonetheless, there is empirical support for certain noteworthy NTFPs; for example, shea butter in Burkina Faso is the country's third most crucial export (Schreckenberg, 2004). In Tanzania, Ethiopia, Nigeria, India and Zambia, honey, mushrooms, wood fuel, fruits, leaves, etc, provide between 4–60% of income to locals in these countries (Mulenga et al., 2012; Nandi & Sarkar, 2021; Tincani, 2012). In Ethiopia, gums and resins rank second to livestock in their impact on household livelihoods (Mekonnen et al., 2013), while 10–50% of rural households' income in Sudan is obtained from NTFPs, such as gums, resins and wax (Elmqvist & Olsson, 2006).

Forest products, such as medicinal herbs, honey, mushrooms and fruits, hold significant importance as marketable commodities. Extensive research has focused on assessing their role in bolstering local incomes, primarily within the Miombo in India (Djoudi et al., 2015). Studies by Shackleton et al. (2007) have estimated that South Africa alone has more than 300,000 traditional healers, with a significant portion of the population believed to rely on forest products for the treatment of ailments, which also assist those unable to attend a hospital for financial reasons. Nevertheless, the nature and significance of such trade exhibit regional variations. Research spanning both Asia and Africa suggests that dry forest foods frequently serve as substantial supplements to purchased food, with the value of foods collected and consumed by households in many cases depending entirely on dry forest products during specific seasons when locals are able to save money on food (Hegde & Bull, 2008). In Mozambique, the forestry sector (which provides NTFPs) plays a vital role in the national economy by contributing about 4% of the country's GDP and about 80% of energy needs (Hegde & Bull, 2008).

Among the various NTFPs that originate from tropical forests, medicinal plants are one of the most extensively researched categories (Shanley et al., 2015b). Research findings indicate that traditional medicine serves as the primary source of healthcare in numerous regions (e.g. 80% in Africa) (Shanley et al., 2015b). The global botanicals market is currently experiencing an annual growth rate of over 7%, amounting to approximately US$85 billion in annual sales (Dhiman et al., 2016). The natural personal care and cosmetics sector generates about US$31 billion in annual sales and is expected to reach US$46 billion by 2018 (Laird & Wynberg, 2016). In 2003, the collective export of shea nuts from Ghana, Burkina Faso, Togo, Mali, Cote d'Ivoire and Benin amounted to over 140,000 tonnes, with an approximate value of US$24 million, as reported by UN Comtrade. One of the most famous tropical nuts is the Brazil nut (*Bertholletia excelsa*) (Baldoni et al., 2019), which is primarily harvested from the wild in the Amazon Basin, adding to its allure and exotic nature (Shanley et al., 2015b). Its unique flavour and nutritional benefits have made it a popular choice among consumers worldwide (Shanley et al., 2015a). The significant export figures from Bolivia,

Brazil and Peru in 2012, amounting to over 35,000 tonnes and valued at US$190 million, highlights the global demand for this product (Shanley et al., 2015b).

Throughout human civilisation, people have harnessed various forest fibres and construction materials to construct homes, thatch roofs, craft tools and weave cordage, baskets and mats. Bamboo and rattan stand out among the critical tropical forest fibres in international trade. Both woody and herbaceous bamboo are part of the Poaceae family and are distributed across tropical and temperate regions. Renowned for their exceptional tensile strength, woody bamboos have a rich history of utilisation in Asia, where they have been employed in the creation of residences, tools, paper and musical instruments. The global trade in bamboo and rattan products has expanded considerably, surpassing US$3.42 billion in 2019 (Zhao et al., 2022). Asia and notably China, serves as the principal origin of these products and holds a substantial portion of the global market (Sigit, 2020). At various processing levels, bamboo and rattan are used for multiple products, including construction materials, furniture, papermaking, musical instruments, toys and food markets (Huang et al., 2019). China, for example, earns US$130 million annually from exports of edible bamboo shoots and US$117 million from woven bamboo products (Kumar & Sastry, 1999). India's incense stick industry, estimated to be worth US$400 million, relies on bamboo as a raw material. Previous studies by Kumar & Sastry (1999) revealed that in many Asian countries, rattan is second only to timber in economic importance, with a global trade and subsistence value estimated at US$6.5 billion.

Studies conducted by Nataliya (2012) in Ukraine revealed that locals reported earning more than 3,000 Ukrainian Hryvnia (UAH) per season from selling berries, which roughly translates to €300 and equates to two months of rural salaries. The average price for one litre of blueberries was approximately 10–15 UAH, which would imply that people collected and sold around 200 litres of berries. Wild strawberries fetched around 50 UAH per litre (approximately €5), and a kilogram of penny bun mushrooms sold for 60 UAH (about €6). Interviewees noted that one could earn 100 UAH (approximately €10) daily, exceeding the average daily wage in rural areas. While interviewees were somewhat reserved about disclosing their earnings from mushroom and berry sales, they emphasised that such income could sustain them for several months. Local residents marketed their berries and mushrooms in nearby cities and towns and along the main roads within the region. The distance to these markets ranged from 2–60 km. In villages near the Polish border, locals sold berries, primarily blueberries, to foreign companies, which then transported the berries to Poland for value-added production. Respondents mentioned the ease of selling to Polish companies as they purchased all the collected berries. The average price for one litre of blueberries in these transactions was 10 UAH (approximately €1). In addition, residents gathered NTFPs for personal use.

6 CONCLUSION

This study delved into the multifaceted realm of locals' perception of climate change, value addition, multiple uses and the potential of NTFPs to enhance the livelihoods of forest fringe communities in Ghana, ultimately aiming to alleviate poverty. Through an in-depth exploration of local perceptions, several key dimensions were addressed. The study explored the perception of NTFPs and their potential to improve their livelihoods and alleviate poverty in forest fringe communities. In doing so, the perception of climate change and its influence on the production of NTFPs was assessed, as was the perception of value addition to NTFPs to improve its commercialisation to increase the locals' income, as well as the multiple uses of NTFPs and its potential to improve the livelihood of the locals. The study also assessed the key social factors, e.g. gender, education and religion, and how they influence the perception of locals with regard to climate change, value addition and the multiple uses of NTFPs. Among the critical aspects of the study was an assessment of local perceptions of how climate change affects the production of NTFPs. It was shown that locals are aware of climate change and how it has impacted the production of NTFPs. Recognising the impact of climate change on NTFPs is essential to craft adaptive strategies that safeguard NTFP availability and quality amidst evolving environmental conditions. In addition, the study explored how locals perceive value addition to NTFPs and its impact on commercialisation, which directly affects community income. The study findings indicate that a significant portion of the local population tends to refrain from enhancing the value of their harvest products. This reluctance stems from limited time, insufficient skills and financial constraints, which impedes their ability to process the gathered forest products. The locals recognise that certain products could fetch higher prices and enhance commercialisation, ultimately increasing their incomes, provided value is added. To enhance marketability and financial gains for individuals and communities involved in the trade of NTFPs, it is crucial to understand local perspectives on value addition. Furthermore, examination of locals' perceptions with regard to the multiple uses of NTFPs and their potential impact on livelihoods revealed that these products had diverse roles within forest fringe communities. The study revealed that community members employ NTFPs for a range of purposes. Some locals view NTFPs as valuable resources for crafting artefacts, construction, food, leisure, medicinal purposes, religious rituals and commercial sales, all of which contribute positively to the utilisation and significance of NTFPs. The exploration of how locals perceive the manifold utilisation of NTFPs and their capacity to improve livelihoods vividly illustrates the varied roles that these products play within forest fringe communities. In many cases, NTFPs serve both subsistence and commercial purposes and are valuable assets for trade, underscoring their adaptability and potential to holistically enhance the community's well-being. The study also revealed that social factors play a crucial role in how locals perceive NTFPs and their utilisation. To conclude, this study has furnished significant insights into the complex interactions involving the perceptions of locals, climate change, value addition, the multiple uses of NTFPs, and the capacity of NTFPs to improve the well-being of forest fringe communities. These findings emphasise the necessity for comprehensive, tailor-made interventions that account for local viewpoints and adhere to sustainable approaches, with the aim to optimise the beneficial effects of NTFPs in the alleviation of poverty and the fostering of comprehensive community advancement.

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