CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Tropical AgriSciences

Assessing the role of non-timber forest products commercialization in ensuring food security among households in the Ankasa conservation area of south-western Ghana

MASTER'S THESIS

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DIPLOMA THESIS ASSIGNMENT

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Utilization of non-timber forest products in protected areas in southern Ghana

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Objectives of thesis

More than 1.5 billion people rely on forest resources as the primary source of livelihood, many others use forests as an alternative source of food or income. Unsustainable collection of forest products however leads to environmental degradation and conflict between farmers' activities and conservation strategies. Despite of the role that forest products play in the livelihood of farmers, no study focused on their collection and commercialization in protected areas in southern part of the country has been carried out yet. The main aim of the thesis will be document current stage of collection and commercialization of non-timber forest products in protected area in southern Ghana. Special attention will be given to potential drivers affecting utilization of forest products and perception of farmers towards current and future challenges.

Methodology

Data will be collected in selected national reserve/park or conservation area in southern Ghana. Suitable locations will be identified in cooperation with local authorities and observed via rapid appraisal methods. Semi-structured questionnaires will be used as the main tool for data collection at household level, snow-ball method will be used for selection of relevant participants. Questionnaire will contain sections on forest products use and commercialization, household characteristics, and perception towards forest use and conservation efforts. Data will be entered to MS Office Excel, cleaned and coded. Standard statistical software will be used for data analysis, and correlation, regression and principal component analysis will represent major analytical methods. Interdisciplinary character of the work will result in using principles of economic botany, social sciences and agricultural economics.

The proposed extent of the thesis

50-55 pages; 18,000 words incl. text, tables, figures and references

Keywords

household survey, use value, comercialization, conservation, drivers, perceptions

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Recommended information sources

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Declaration

I hereby declare that I have done this thesis entitled assessing the role of non-timber forest products commercialization in ensuring food security among households in the Ankasa conservation area of south-western Ghana independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague 16.04.2023

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Nana Fenyi Forson

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Abstract

The extraction, marketing and trade of non-timber forest products have been highlighted as a means of increasing income, enhancing the lives of the rural poor and decreasing food insecurity in developing countries. This study sought to assess the role of non-timber forest products commercialization in ensuring food security among households in the Ankasa conservation area of south-western Ghana. Specifically, the study documented the kind of non-timber forest products collected and their uses, incentives and barriers to commercialization of non-timber forest products, factors influencing income from the forest and the contribution of non-timber forest products to household food security. The convenience sampling technique was employed to select 90 farmers. Household food insecurity access score was used to measure the food security status of the households. Bar charts, percentages and t-tests were used to profile the socio-economic characteristics and farm characteristics of the respondents. Spider diagram and bar chars were used to assess the incentives and barriers to commercialization of non-timber forest products. A multiple linear regression model was employed to assess the factors influencing income from the forest. Propensity score matching and endogenous treatment model were employed to assess the contribution of non-timber forest products to household food security. The results from the study revealed that rattan was the most collected and important specie in the studied area. The majority 52.2 % of the respondents highlighted non-timber forest products as an alternative source of income as the main incentive for non-timber forest products trade and lack of agricultural support as the pressing barrier to commercialization of non-timber forest products. The multiple linear regression model showed that farmer groups and household size had a significant positive effect on income whereas gender had a significant negative effect on income. The results from the propensity score matching and endogenous regression model revealed that commercialization, gender and access to credit had a significant negative effect on household food insecurity. On the other hand, years of education and number of forest products collected significantly affected household food insecurity positively. The study recommends that government should implement policies to support farmers with provision of subsidies. There should be education of farmers on sustainable harvesting of forest species and farmer business school programs to enlighten farmers on safe packaging and marketing as consumers are increasingly aware of the quality of food consumed.

Keywords : Use value, Food security, Commercialization, Endogenous treatment regression

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List of abbreviations used in the thesis

FCS – Food consumption score

HDDS – Household dietary diversity score

NTFPs – Non-timber forest products

NWTPs – Non-wood forest products

UR – Use reports

UV – Use value

1. Introduction

Forest products are the core of research on biodiversity, forest management and poverty alleviation (Lawrence 2003; Abdullah 2013). They represent an important source of livelihood for about 1.5 billion people all around the world with an estimated value generation of US $166-490 billion per year (Liang et al. 2016). They are generally categorized into timber and non-timber forest products (NTFPs). As timber is more commercial and produced in large quantities, NTFPs supply household needs and can serve as a safety cash net during off-season agricultural production (Neumann & Hirsh 2000; Cocksedge 2001; Shackleton & Shackleton 2004; Marshall et al. 2006; Quang 2006; Arnold et al. 2011; Mahonya et al. 2019). Numerous products can be derived from plant species and each part of the plant has diverse uses (Chamberlain 2000; FAO 2018; Peerzada et al. 2022). People living in or near forest areas use products from the forest for both commercial and domestic uses. However, NTFPs are more subsistence and there exist tendencies to commercialise (Roderick & Hirsch 2000; Sills et al. 2003; Tickin 2004; Belcher & Kusters 2004; Belcher & Schreckenberg 2007; Dinda et al. 2020).

Subsistence farming systems enable people to meet basic amenities such as food, clothing, shelter, medicines and spiritual or cultural significance (Ros-Toren & Wiersum 2003; Rankoana 2017). Trading of forest products assists in decreasing unemployment through the creation of job avenues and income generation (Quang 2006). For example, a study conducted in India revealed that non-timber forest products generate US$ 700 million (91%) annually in Madhya Pradesh and US$ 115 million (80%) annually in Maharashtra while its counterparts, commercial wood contributes US$ 72 million (19%) in Madhya Pradesh and US$ 29 million (20%) in Maharashtra (Pandey et al. 2016) .In Miombo woodlands of Zambia, it is estimated that NTFPs contribute about 44% to the total household income (Kalaba et al. 2013).

In West Africa, studies have highlighted the value of NTFPs to the economy and the value chain mapping of NTFPs (Ahenkan & Boon 2010; Lebmeister et al. 2018). Other studies have highlighted the positive implication of sustainable harvesting of non-timber forest products on biodiversity, income generation and food security. However despite the potential of plant-based NTFPs, little is known about their linkage to household food security in Ghana. The economic,

social and environmental role of plant-based NTFPs to household food security remains loosely understudied. Therefore this study seeks to bridge the gap and contribute to existing literature on NTFPs in Ghana.

2. Literature review

2.1 Non-timber forest products

Non- timber forest products (NTFPs) are considered as one of the oldest merchandized goods with historical significance worldwide (Panayotou et al. 1992). Ahenkan (2011), notes that the meaning of non-timber forest products remain debatable. According to Belcher (2003), various researchers have defined the term non-timber forest products in diverse ways and that NTFPs comprise of a very extensive scope of forest products and marketing systems. NTFPs have been defined by de Beer and McDermott (1989) as all natural materials excluding timber that are obtained from forests for human utilization (Belcher 2003). A study by Davidson-Hunt et al. (2001) described NTFPs as all biological organisms except timber, retrieved from several kinds of forestland terrains that are used by humans for both consumption and non-consumption intentions. This description expands the term to include non-consumption goods and services. Again, NTFPs have been categorized by Marles (2001) according to the consumption of different kinds of products like pharmaceuticals, traditional herbal medicines/natural health products, nutraceuticals, functional foods, cosmetics, agrochemicals and fine chemicals. The variety of 'end-of-chain' consumer products that are totally or partially obtained from forest ecosystems and/or traditional knowledge systems are acknowledged in this typology. The idea that NTFPs is a negative term that encompasses all products with the exception of timber that come from forests according to Belcher (2003) is the underlying difficulty. This implies that the various characteristics of NFTPs like the source of the product, function, means of cultivation, industrial scale, and cultural interpretation, have been concealed by the terminology. Products from several sources like animals, plants and other organisms and various ecosystems including grasslands, forests or cultivated fields can be termed as NTFPs. In lieu, NTFPs may encompass several economic products with different purposes. These purposes according to Marles et al. (2000) may be medicinal, ritual, nutritional and technological. A broad description of NTFPs does not clearly spell out significantly different production systems like subsistence, mixed systems as well as products from cultivated systems or the wild (Belcher et al. 2005). A production-to-consumption perspective emphasizes the vastly different pathways, levels (local, regional, national, and international), lengths, and networks of people and organizations between forest products harvested at large scale for regional or

international distribution, processing, value-adding, and marketing. The value chain of actors is mostly left out in the NTFP literature but raw materials with little processing are extremely highlighted (Belcher & Schreckenberg 2007). This is also clear in the distinction of the literature between NTFPs and biogenetic resources, biodiversity and related traditional knowledge.

According to the scale of each NTFP's industry, which can range from small-scale production for household consumption to moderate production for domestic use and some local market sales to substantial industrial production and export manufacturing, it has been challenging to define NTFPs. This is related to the concept of divergent production systems (Davidson-Hunt et al. 2001; Belcher 2003). Last but not the least, NTFPs are sources of material, food, and medicine that have cultural significance for the survival, cultural identity, and spiritual beliefs of resource users like first nations (Turner et al. 2001). On the other hand, due to the demand and value, that a set of customers have placed on NTFPs, they are intended for a variety of places and/or markets. According to anthropologists (Appadurai 1986; Sahlins 1976) commercial goods are socially rooted in the modern, international setting (which is reflected in this concept of culturally significant and meaningful products). The numerous definitions of NTFPs emphasize that the term's significance depends on who defines it and what goal that person or organization adopts (Belcher 2003), suggesting that its significance should not be assumed, and should be researched in cross-cultural or cross-institutional contexts.

Notwithstanding their differences, there is one aspect that all definitions have in common: they all agree that NTFPs are all forest extracts that do not include timber. Examples include fauna, bark, roots, tubers, leaves, fruits, flowers, seeds, and blossoms (Panayotou et al. 1992; Sunderland et al. 2003). The savannah woodlands are one of the many ecotypes from which they are taken. Any good or service generated from the forests that differs from timber is referred to as NTFPs, according to the Centre for International Forestry Research (CIFOR 2021). A variety of barks and fibers, including those from bamboo, rattans, and a variety of different palms and grasses, as well as fruits, nuts, vegetables, fish, and game are also included. "Wood items, such as those used for wood carving or fuel" are also included.

The Food and Agricultural Organization of the United Nations (FAO) coined the term "non-wood forest products" (NWFPs) in 1995 to differentiate between wood products, non-wood forest products, and forest services. NWFPs are goods of biological origin other than wood, derived from

the forests, other woody terrain, and trees outside the forest, according to the FAO's definition. (FAO 1999). This definition includes both items derived from plants and animals as well as the species itself, but strictly excludes all raw materials made of wood. According to de Beer and McDermott (1989), the level of industrial extraction distinguishes timber from non-timber materials, i.e., non-timber woody products can be readily gathered by rural residents without the need for sophisticated technology or skills.

2.2 Forest products and their effects on livelihoods

Over time, there has developed a significant push for the extraction, marketing, and trading of non-timber forest products as a means of increasing income and enhancing the lives of the rural poor in the tropics. According to Marshall et al. (2006) and Ahenkan & Boon (2010), there is an estimated USD 11 billion worth of NTFP trade every year. Another estimate places the number of indigenous people in Latin America, West Africa, and Central-east Asia at 60 million, with an additional 400–500 million people relying directly on these natural resources (IUCN 2007). Non-timber forest covers the entire planet, from Asia to the Americas and from Africa to Europe.

Rural populations are increasingly dependent on products, whether it be for basic nutrition or extra income (FAO 1997). Non-timber forest products are the main source of income for an estimated 80% of individuals in developing nations (FAO 1997). Rural families all around the world harvest non-timber forest products for many different reasons, according to the works of Awe et al. (2011). They vary from person to person, from one home to the next, and from one area to the next. Considering what their absence would entail, NTFPs make a major contribution to national economies. According to estimates from the World Preservation Foundation (2010), 60 million indigenous people are largely reliant on forests. NTFPs generated a sizable portion of revenue while generating millions of employments globally (Ndoye et al., 1997; World Preservation Foundation 2010).

The projected total value of global commerce in non-timber forest products is roughly US$1,100 million. Several million households worldwide rely largely on non-timber forest products for their income (FAO 1997). For the 50 million tribal households in India, NTFPs contributed 10 to 40% of household income (Shiva 1993; Sekar et al. 1996) and 200 to 300 million peasants depend on

NTFPs to varying extent (Shiva 1995). According to surveys conducted by the United Nations Food and Agricultural Organization (1997), 80 percent of people in developing countries use non-timber forest products to supplement part of their nutritional and health needs.

Again, according to WHO estimates from 2003, the global market for herbal medicines was worth US$ 60 billion at the time and was continuously expanding. Nowadays, 25% of modern medications are derived from plants that were first used traditionally. According to FAO (1997), NTFPs in Nepal are utilized both for commerce and sustenance, accounting for 4% of all forestry's economic contributions to the country. In Indonesia, the rattan sector alone employs 200,000 people (FAO 1997). Similarly, almost 300,000 people in Bangladesh are employed by non-timber forest products (Basit 1995). Aiyeloja et al. (2001) made the categorical claim based on cases that were documented in Africa that a variety of non-timber forest products are commercial goods that can significantly boost household and national economies' cash flow. According to CERUT (1999), there are some cases when the value produced by commercial timber exploitation is less than that of the trade in non-timber forest products. In Nigeria, non-timber forest products serve as rural industrial raw materials for home businesses, cultural artifacts, ritual objects, and traditional medicine (Nkwatoh et al. 2010). The revenue from non-timber forest products contributed about 35% of the total household annual income when averaged across wealth categories, according to Muzayen's (2009) commentary on Ethiopia. A research in Tanzania found that non-timber forest products play a considerable role, particularly in the production of firewood (92%), fodder (63%) and beekeeping operations (40%) as well as environmental goods and services, building materials, and medicinal plants (Giliba et al. 2010) They went on to say that this showed a considerable reduction in both income and non-income poverty, which gave plenty of motivation for sustainable forest management.

Anon (2000) found that 80% of people in developing nations take goods from the forest for food and personal care, while Andel (2006) said that millions of people, particularly those living in rural parts of developing countries like Nigeria, collect these products every day. Sale (2006) and Shomkegh et al. (2008) claim that many of these individuals view the sale of NTFPs as a source of income.

Millions of people use wild biological products extensively all over the world (Koziell & Saunders 2001; Lawes et al. 2004). Using Malawi as a case study, Fisher (2004) and Timko et al. (2010),

found evidence of high levels of reliance on forests for income, with sample households generating, on average, 30% of their revenues from forests. Sales of NTFPs contributed significantly to Zimbabwe's overall revenues, accounting for 35.4 percent of average total income per person in 1993–1994 and 36.9 percent in 1996–1997 (Cavendish 2000). Villagers in Guinea, according to recent research by PROFOR (2007), make up to 25 to 30 percent of their incomes from gathering and selling forest products. According to the aforementioned data, which are based on the extent of the available forest cover, NTFPs have made a remarkable contribution to local economies worldwide and improved the lives of many households (incomes). While they have been crucial forest components, generating both money and aiding in the preservation of biodiversity, these resources have historically gone unnoticed but are now receiving more attention in recent literature. The research findings are consistent in Ghana, particularly given that many rural people cannot avoid extracting non-timber forest products. Since the majority of forest products are being used up, the extraction became required. For instance, established primary activities are located near forest resources in both reserved and non-reserved forests in forest fringe communities (Ardayfio-Schandorf 2007). Non-timber forest products have made a significant contribution to improving the lives of many people who depend on the forest. For instance, according to Ahenkan & Boon (2008), 86 percent of farmers in the Sefwi-Wiawso district rely on non-timber forest products for their livelihood, food, and medicine. Likewise, in many places, these items also serve a vital role in supplying nutrition, medications, building materials, and pasture for livestock to people who live in the forests (Falconer 1996). Around two million people were employed by NTFPs, which contributed about 6% of the nation's GDP (Bank of Ghana 2004). Moreover, social benefits are delivered through creating extra sources of income and assisting in meeting basic requirements (Godoy & Bawa 1993). Again, 20 to 25 percent of Ghana's economically active population is thought to earn a living through non-timber forest products (Ahenkan & Boon 2010). This is especially true when individuals, who work primarily in extractive industries, engage with the environment in order to meet their fundamental material requirements for housing, clothes and food (Chima et al. 2012). Falconer (1992) underlined that "for individuals who come face-to-face, without relief, with the dreadful experiences of ill-health, starvation and other types of deprivation, the fact is the enormous contribution NTFPs in all their diverse forms, make to all parts of their life".

As a result of their contribution to food, income, health, habitat, and several other needs for human survival, non-timber forest products are fundamental to the livelihoods of the Ghanaian community (Birikorang et al. 2009).

2.3 Issues of food security

When all people "at all times have both physical and economic access to adequate food to meet their dietary demands for a productive and healthy existence," they are said to be in a state of food security. (World Food Summit 1996). The concept of accessibility, sufficiency, security, and sustainability are all included in the definition of household food security as an extension (Nigatu & Barbara 2011).

Governments, charities, and a wide range of stakeholders around the world have been shocked by the problem of household food insecurity. This is a result of the recent deterioration in the state of the economy. A high degree of inflation, which raises prices for goods and services, interest rates, and output due to a decline in global agricultural production, is to blame for the rising hardship. Particularly in sub-Saharan Africa, the decline in agricultural output is becoming more pronounced. When everyone, at all times, lacks physical and financial access to enough, safe, and nutritious food to meet their dietary needs and food choices for a healthy existence, there is a problem with food insecurity.

Food insecurity (access, availability, and usage) includes famine and hunger because it can result in extreme circumstances when hunger is felt. Although if the lack of access to, availability of, and sufficiency of food may not encompass all aspects of poverty, it may be a sign of poverty and a key welfare indicator. The world's impoverished have limited land for farming and have insufficient money to buy enough food (FAO 2006). The availability aspect of food security is hampered by a number of factors, according to Nigatu & Barbara (2011), including poor or non-existent transportation infrastructure, a dearth of productive resources, issues with land tenure, a lack of education, inadequate storage facilities, socio-cultural barriers, and a lack of information for effective intervention. Also, according to a MoFA assessment, 2 million people are at risk of becoming food insecure, while another 1.2 million Ghanaians or 5% of the nation's overall population suffer from food insecurity (WFP 2009). Also, research reveals that residents of

Ghana's three northern regions, the Upper East, Upper West, and Northern regions are more likely to experience food insecurity. An astounding 507,000 people, or 40% of the area's total population, were estimated. Around 1.5 million people in the remaining seven regions are at risk of food insecurity, according to data from the World Food Program from 2009. Despite the fact that farming is the main source of income in the Brong-Ahafo region, which is a significant food basket for the Ghanaian economy, 11% of the remaining 1.5 million people in the seven regions are at risk of going hungry. Furthermore, IFAD (1995) suggests that Ghana's food insecurity issue is seasonal. It further mentioned that it happens every year between February and July. According to evidence, households in both urban and rural areas spend the majority of their income (70%) on food. It cites the cycle of scarcity and poverty as the cause of the high amount of spending: Poor households are compelled to sell their produce as soon as it is harvested, even at cheap rates, due to necessity and a lack of storage facilities or systems. They are compelled to repurchase the produce at a higher price during the lean (dry) season.

2.3.1 Previous studies on food security indicators

The assessment of food insecurity poses a continual challenge to scholars and many business actors due to its complexity and multidimensional concept. Nonetheless, a number of techniques for determining a household's level of food security have been developed. Even though food intake and production are the two methods used to frequently measure food security according to Bouis (1993), both are prone to measurement errors.

Indicators like anthropometric measurements, dependency ratios, asset holding, store depletion, credit use for consumption, mortgages, and asset sales were also used as food security measures in a number of studies on food insecurity within households Even though caloric intake is used as the "gold standard" indicator of food security, household access scales like the Dietary Diversity Score (HDDS) have gained popularity among researchers in recent years (Chung et al. 1997; Maxwell et al. 1999). This indicator counts the number of calories that are available for household use over a certain period of time.

The individual in charge of food preparation in the home should be questioned about the various foods prepared. The reported food portions are then translated using a caloric conversion technique

into calorie units. According to Haddad et al. (1994), caloric intake was used as the reference for sensitivity and septicity analyses of proxy indicators of food access, availability, and utilization (food security). This was repeated in numerous other works of literature, according to Chung et al. (1997).

Yet, due to low data quality, rising data collecting costs, and parametric assumption, it is typically challenging to obtain an accurate assessment of calorie intake (Careletto et al. 2013). Food recall module capture tower consumption was compared to personal dairy in a study by Beegle et al. (2010) in Tanzania to examine different data collection strategies. This was especially true in poorer families and households with more adult members. Records indicate that the price of the personal journal module is six to ten times greater than the recall module. According to the personal dairy module, under-reporting is more common in urban households and houses with low literacy rates.

Despite the benefits of using caloric intake as a measure of food security, there are some drawbacks. It does not account for the consumption of foods from animal sources like meat, milk, and eggs. Moreover, it ignores the problems of vulnerability to shocks and fluctuating food consumption over time. Household Dietary Diversity Score (HDDS), according to a study by Swindale & Bilinsky (2006), is the next measure that could take the role of calorie consumption. The same was also indicated by Wiesmann et al. (2008). The number of different food types consumed in a certain time period is measured by HDDS. It is a desirable proxy indicator for several reasons, including the fact that a more varied diet improves a number of outcomes, including birth weight, child anthropometric status, and haemoglobin concentrations. A more varied diet is also useful in and of itself. To calculate the average HDDS for the entire sample size, different household scores can be added up and divided by the number of homes. The WFP created a similar statistic called the food consumption score (FCS) or food frequency score that used weighed DDS. Researchers now place a great deal of emphasis on the Nutritional Diversity Score since it takes household food access and calorie availability into account. According to several studies (Onyango et al. 1998; Hatloy et al. 2000; Arimond & Ruel, 2002), dietary diversity is significantly correlated with household nutrition status/level as measured by children's height for age (HAZ) and weight for age (WAZ), as well as socioeconomic status (Hatloy et al. 2000).

Dietary diversity is especially helpful in developing nations and poorer nations where nutrition issues are worrying due to poor diet quality rather than lack calories (Ruel, 2003). However, HDDS has certain limitations, including a lack of quality dimension and fluctuation over any particular time period, just like all other indices of food security.

When calorie intake, self-reported indicators, and the HDDS are compared, it becomes clear that the latter measures the psychological and social aspects of food security. In terms of food security, it is a qualitative and self-assessment measure for households that can take the place of household vulnerability, which is particularly challenging to measure qualitatively. If a family anticipated future food instability, they would see themselves as hungry even though they are actually food secure. The self-reported food security index has several restrictions. According to studies, the order of the questions has a significant impact on how secure Chinese respondents feel about their access to food (Headey 2013).

Studies by Deaton (2011), however, show that question ordering may result in a biased answer on food security. Findings by Deitchler et al. (2010) further raise questions regarding the cross - sectional validity of self-reported measures because perceptions differ with space, time, and the level of financial stability in a household.

Self-reported indicator and nutrition status are associated to some level since studies in rural areas of nations like Bangladesh, Vietnam, and some regions of Africa (Ethiopia and Tanzania) reveal/show substantial correlation between the two variables (Cordeiro et al. 2012; Ali et al. 2013). In Nepal, however, no connection was discovered (Osei et al. 2010).

Up until recently, the majority of family food security indicators such as income and caloric adequacy that evaluate availability to food were technically challenging, data-demanding, and expensive to gather. Indicators that can be used to access food insecurity are needed for the use of USAID Tile II, child survival, and health grant programs. These programs require less challenging, relatively simple, but methodologically rigorous indicators. This will allow them to direct, oversee, and assess the results of program intervention. The FANTA project then created a document to serve as a roadmap for carrying out this agenda. The Household Food Insecurity Access Scale (HFIAS), a modification of the method used to determine the level of food insecurity in the United States on an annual basis, was used. The process is based on the theories that experiencing food insecurity causes predictable behaviours and responses that can be assessed and quantified by a

survey and summed up in a scale. This method makes use of the 18-question U.S. Household Food Security Survey Module (U.S. HFSSM), which is beneficial for describing respondents' attitudes and behaviours in regard to how they respond to found insecurity experiences (Hamilton et al. 1997).

HFIAS food quality questions, however, do not directly address nutritional quality but rather access.

2.4 Issues on protected areas

The ultimate focus of a protected area is to guarantee that ecological diversity, important habitats, and scenic views are recognised, protected from harmful activities, and properly maintained and saved for future generations. A protected area is defined as "a clearly defined geographical space, recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values," (IUCN 2010; Smith 2013). These areas in underdeveloped countries are usually surrounded by people who are generally poor and rely on such regions for their livelihood (King 2010). Instead of inspiring conservation collaboration, this restriction builds conflict and passivity (Amoah & Wiafe 2012). Protected areas not only prevent people from obtaining resources, but they can also result in tremendous difficulties and major losses, such as livestock predation, looted crops, and damage to other property, among other things (Dewu & Roskaft 2017). Setting aside important conservation areas is seen as a critical technique for preserving declining biodiversity. While many people consider protected areas to be an important conservation tool, others see them as a threat to their livelihood and wellbeing (Brockington & Wilkie 2015). Protected areas are established and maintained by restricting access to key resources, evicting residents who live within the new limits, and changing traditional land ownership (Dewu & Roskaft 2017). Protected areas have long been the most effective and widely used method of safeguarding our most valuable, delicate, and endangered habitats, species, and landscapes and this can be achieved by inclusion of local communities. The perceived costs and benefits of protected areas have a big impact on people's attitudes toward them (Tessema et al. 2010).

2.5 Determinants of NTFPs commercialization

Ingram et al. (2012) reported in their study that commercialization of NTFPs can provide additional income and help to alleviate poverty in most poor rural areas. Despite these potential benefits to household and economies of nations as a whole, there are several factors that have been reported in literature to determine the participation in and the commercialization of NTFPs. Some of these determinants are; age, gender, education, farming experience, household size, experience in forest management, and extension visits amongst others. Studies have shown both a positive and negative relationship between age and commercialization of NTFPs. For instance, Blaser et al. (2021) found that younger farmers in Mexico were more likely to participate in NTFP markets due to their greater exposure to new technologies and ideas. Marshall et al. (2006) however reported in their study that older farmers have more experience and knowledge about NTFPs, which may increase their likelihood of commercializing these products. Ottosen & Vorbohle (2014) also added that older farmers may be more risk-averse and less likely to take on the financial risks associated with entering new markets as compared to younger farmers. With the higher recognition for gender studies into almost all spheres of human endeavor, it has been reported that women are less likely to participate in NTFP markets due to traditional gender roles and limited access to resources (Wunder et al. 2005). Thapa & Singh (2021) also reported that women have a comparative advantage in the production of certain NTFPs, such as medicinal plants, due to their knowledge and experience in traditional medicine but their contribution to the sector are limited due to inequalities and gender roles enshrined in the societies. Education has also been identified as a significant determinant of NTFPs commercialization, with studies showing that higher levels of education are positively associated with participation in NTFP markets (Kusters et al. 2006). Education is believed to help improve farmers' knowledge about market opportunities, production techniques, and quality control standards, which can help them to increase their income and competitiveness in the markets (Kusters et al. 2006). Studies have also revealed that larger households are more likely to participate in NTFPs markets. This is because, larger households have more labour available for the engagement in the commercialization and marketing of NTFPs (Kusters et al. 2006).

Experience in forest management is also another important determinant of NTFP commercialization, as it can affect farmers' access to forest resources and their ability to manage them sustainably (Suleiman et al. 2017). Extension visits can also improve farmers' access to information, technologies, and markets at their disposal for commercialization. Zondi et al. (2022) revealed that farmers who receive regular extension visits are more likely to participate in NTFP markets due to access to relevant information about market demand, pricing, quality control, and certification requirements, which can help them to increase their income and competitiveness in the market.

2.6 Factors influencing income from forest.

Jagger et al. (2014) defined income from forest as the economic benefits that individuals or households derive from the use of forest resources, including timber, non-timber forest products, and ecosystem services. Since forests are an integral part of the ecosystem of most developing countries, income from forest can contribute significantly to rural livelihoods and poverty reduction. Some of these incomes from forests specifically come from timber, non-timber forest products (NTFPs), agroforestry products, and ecotourism, amongst others. The Food and Agriculture Organization (FAO) posits that income generated from forests contributes significantly to the economy of many countries and contributes about 1 percent of the global gross domestic product whiles providing employment for about 13 million people across the globe (FAO 2020). The World Bank (2008) also reported that incomes from forest and forest-related activities contribute up to about 25% of income of the poorest 20% of the world's population. Despite these critical roles of income from forests to national economies and the world at large, the levels of income generated and realised are hypothesized to be affected by a myriad of factors. Gerekae et al. (2017) reported that the level of income from forest varies widely across household and individuals based on some socio-economic characteristics and geographical peculiarities. Biland et al. (2021) also emphasized that studying the factors that influence income from forest is very important for understanding the dynamics of forest use and management, as well as for designing effective tailor-made policies and interventions to support sustainable forest-based livelihoods across nations and regions.

A review of relevant literature on incomes from forests suggests that some critical factors influencing incomes from forests are age, gender, household size, farming experience, access to credit, years of formal education, working in other off-farm related activities and membership to farmer-based groups amongst others. For instance, some studies reported that younger and more educated individuals tend to have higher levels of income from forest, as they are better equipped to engage in more complex and lucrative forest-based activities such as agroforestry and value-added processing (Gerakae et al. 2017). On the gender front, women in Ethiopia were reported to have greater levels of income from forests than their counterpart males particularly (Asfaw et al. 2013). Gerakae et al. (2017) also reported in their study that farming experience is a relevant precursor to increased incomes from forest resources as farmers with more experience tend to have developed more efficient and effective forest management practices over the years to warrant their increased and steady incomes from their operations. Biland et al. (2017) also found out that households with larger sizes tend to have higher levels of income from forest, as they are able to mobilize more labour for forest-based activities. Access to credit and working off-farm were two additional factors identified by Gerakae et al. (2017) to influence incomes from forest. Access to credit can enable households to invest in more productive forest-based activities, such as tree planting and value-added processing which eventually results in higher incomes from forests in the future. Off-farm employment can provide households with additional income and reduce their overdependence on forest resources, which can in turn lead to more sustainable forest management practices and improved revenue generation sources. Similarly, farm size, membership to farmer groups, and distance to market were also identified from literature to also influence income from forest. Larger farms tend to have higher levels of income from forest, as they are able to invest in more capital-intensive forest-based activities such as tree planting and agroforestry (Biland et al. 2021). Membership to farmer groups provides households with access to relevant information, resources, and market opportunities that can increase their incomes from forest (Wunder 2008). Distance to market, on the other hand, can limit the ability of households to access market opportunities, thereby reducing their income from forest (Biland et al. 2021).

2.7 Factors influencing food security

Food security is a major challenge for many rural households, particularly in developing countries where poverty and limited access to productive resources are prevalent (FAO 2019). Income from forests has been identified as a potential means of improving food security, as it can provide a source of cash income and a variety of forest products that can be used for food or sold for additional income (FAO 2019). However, the relationship between income from forests and food security is complex, and depends on a large range of factors. A review of relevant literature on food security and forest incomes provides a wide array of factors that influence food security such as; age, gender, education, household size, frequency of extension visits, access to credit, access to input subsidy, farm size, commercialization, number of forest products collected, experience in forest management and farming experience etc. For example, studies have found out that age and gender are important factors that influence food security in relation to income from forest resources. Women and older people are more likely to experience food insecurity, as they may have limited access to productive resources, including forests (Broussard 2019). Jackson et al. (2019) also reported, older people were more likely to experience food insecurity, due to declining health and limited access to productive resources. Also, Abdullah et al. (2019) also found that households with higher levels of education were more likely to have diversified income sources, including income from forest resources, and were less likely to experience food insecurity as compared to households with limited or no educational background. Higher household sizes were hypothesized to have higher food security needs and are therefore likely to engage in forest-based income generation activities (Kabunga et al. 2014). Access to and frequency of extension visits have also been reported to improve food security of farmers engaged in forest income generating activities. This according to Danso-Abbeam et al. (2018) is because, extension visits provide households with information and training on effective forest management practices and income generation opportunities which will improve the returns to the farm families and the resultant improvement in their food security needs. Aidoo et al. 2015 found that access to credit was positively associated with household food security, as it enabled households to engage in income generation activities, including income from forest resources. Farm size and access to input subsidies were also reported to be important factors influencing food security. Solaymani et al. (2019) reported that input subsidies can enable households to increase their agricultural productivity and improve their food

security needs. They found out that removal of agricultural input subsidies led to a reduction in household food insecurity. Similarly, households with higher farm sizes were reported to have higher potential for crop production and the ability to provide more food for their households leading to the improvement in their food security needs (Acheampong et al. 2022). According to Linderhof et al. (2019), commercialization is another important factor that influences food security in relation to income from forest resources. Aidoo et al. (2015) therefore stated that access to markets by farmers where they can sell their surplus agricultural products enhances their ability to produce for commercial purposes and help them generate incomes that can be used in the purchase of food and other household necessities. Finally, experience in forest management and farming experience can also influence food security of farm families engaged in forest-related activities. Households with more experience in forest management and farming tend to have more knowledge and skills related to the efficient and sustainable use of forest resources (Marshall et al. 2006). This can result in increased productivity and income, which can in turn improve food security.

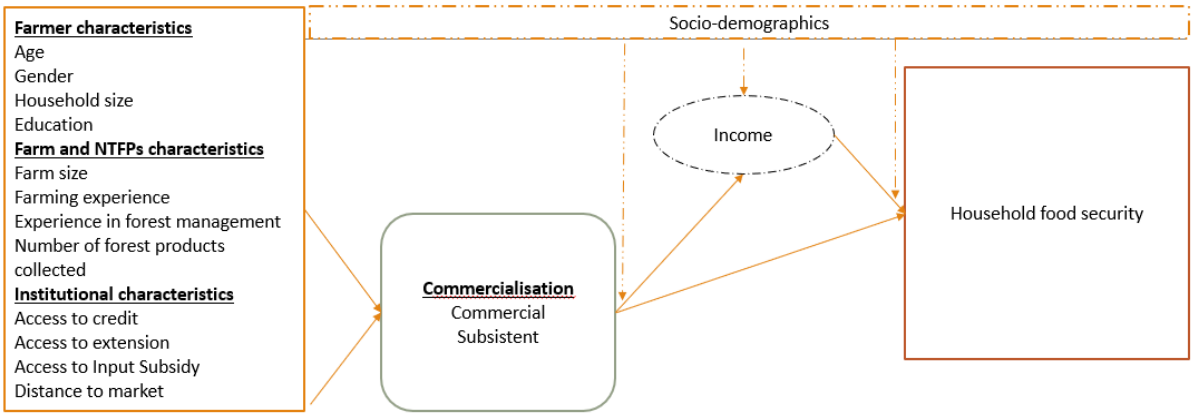

Figure 1. Conceptual framework

The main concept of this study is that the interplay of farmer characteristics, farm and NTFPs characteristics and institutional characteristics affects commercialization of NTFPs and the commercialization of NTFPs impacts on the income generation and household food security.

3. Aims of the thesis

The main objective of the study is to assess the role of non-timber forest products commercialization in ensuring food security among households in the Ankasa conservation area of south-western Ghana.

Specifically,

1. To document what kind of NTFPs are collected and for what purpose.
2. To assess the incentives and barriers to commercialization of NTFPs.
3. To assess the factors influencing income from NTFPs.
4. To determine the contribution of NTFPs commercialization to household food security.

4. Methods

This chapter assists in understanding the role of NTFPs commercialization in Ghana's southwestern region and their relationship to food security. It gives the reader an overview of the research area, research design, data sources, data collection approach, and analytical tools used for data analysis are then discussed.

4.1. Description of the study area

The study was conducted in south-western region of Ghana where the Ankasa conservation area lies. It is approximately 365 kilometers from the capital city, Accra, and bordering Cote d'Ivoire to the west. The forest area lies within the Jomoro district, Ellembelle district, and Wassa-Amenfi district. It is the most diverse forest reserve in Ghana with about 800 plants, 639 butterflies, and an excess of 190 bird species (Tilahun et al. 2016). The Ankasa conservation area covers around 500 square kilometers which incorporates the Ankasa forest reserve to the south and Nini Suhein national park to the North. The average annual precipitation ranges from 1,700 to 2,000 millimeters of rain with yearly temperatures ranging from 30 to 40°C. The forest reserve's climate is characterized by a bimodal rainfall pattern that occurs from April to July and September to November. The annual relative humidity is usually high about 75% in the early morning and peaks to 90% at night (Ankasa conservation management plan 2000).

Jomoro district is the administrative jurisdiction of the entire Ankasa forest reserve. The district is 1,483 km^2 in size with an average population of 126,576 households and a population density of 85.35 per km^2.The annual population change based on the (2010 – 2021) population census stands at -1.6% and most households primarily depend on the forest for their livelihood (Ankasa conservation management plan 2000)

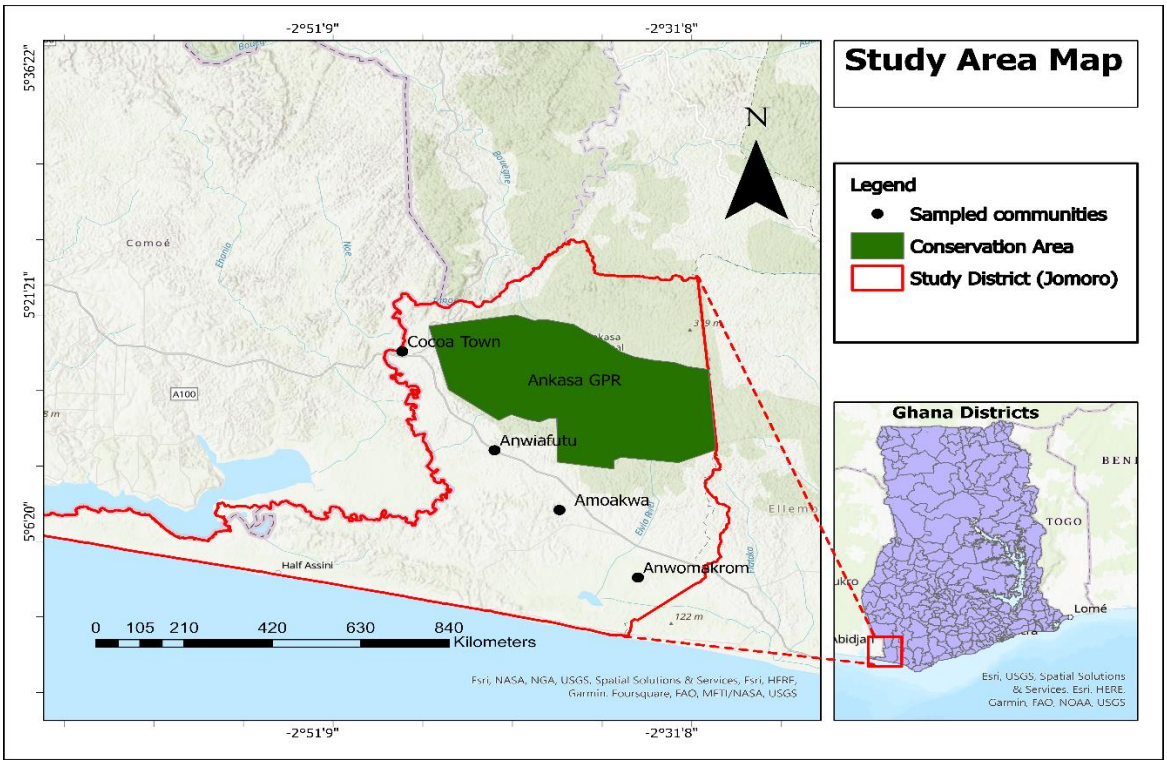

Figure 2. Description of the study area

4.2. Type of research design

A mixed-method approach was adopted for the study. This involved the collection of both qualitative and quantitative data which was analyzed with descriptive and inferential statistics.

4.3. Source and type of data

Primary data on household characteristics, farm characteristics, institutional characteristics, household food security, NTFPs collection and associated incentives and barriers to commercialization of NTFPs were obtained using a structured questionnaire. Secondary sources of information were obtained from the index of journals from the web of science, published theses, books, data repository of FAO and the World bank.

4.4 Data collection approach

Data collection commenced with key informant interviews with personnel of the forestry commission at Ankasa conservation area. The purpose of the interview was to obtain information on the communities primarily involved in the collection of forest products. Following consultation with forest specialists, four communities were chosen. A rapid market appraisal was conducted in the four communities to obtain market information on the various stakeholders involved in the trading of NTFPs. This provided information on the bottlenecks faced by actors involved in trading of NTFPs.

Transect walks were performed with forestry officers to identify forest species that occur and are harvested by households living in close proximity to the forest area. Focus group discussions were also conducted with household heads in each community to obtain information on challenges involved in NTFPs trade. The focus group discussion participants were chosen based on their experience with forest products, length of residing in the community and willingness to participate in the discussion. The focus group consisted of approximately six participants to control the group discussion.

Figure 3. Key informant interview with forestry personnel

4.5 Sampling technique and size

To meet the research goals, a multistage sampling technique was used. The first stage involved the purposive selection of the Jomoro district. The study was conducted in Jomoro because it is the administrative district of the Ankasa conservation area and the forest region lies within the district. In the second stage, four communities that are Cocoa town, Anwiafutu, Amoakwa, and Anwomakrom were selected from 16 communities in the Jomoro district in consultation with the forestry commission of Ghana, Ankasa conservation area. These communities were selected based on the extent of household involvement in forest products collection and their participation in forest sensitization programs organized by the forestry commission. A convenience sampling technique was used to select 90 respondents in these four communities. A non-probability sampling technique was employed because there was no defined list of forest collectors in the study area.

4.6 Data analysis

Data collected was cleaned, entered, and analyzed using Excel, Statistical package for social scientists version 20 and Stata 12. ArcGIS pro was employed for the creation of maps with spatial data obtained from DIVA-GIS. The demographics of forest collectors were shown using descriptive statistics such as mean, percentages, pie, and bar charts.

a. Documentation of NTFPs, ethnobotanical knowledge and their purpose of collection

The free listing method was used to document plant species collected from the forest area and their uses (Quinlan 2018). This method provides an overview of plant species, decision to collect plant species, period of collection, parts of NTFPs used and the purpose of associated species.

Freelisting method is an ethnographic method that reveals cultural salience. It provides knowledge on the ethnomedical beliefs, knowledge, attitudes and practices of people in a cultural domain. Freelisting can be misunderstood for open-ended surveying. Freelisting asks information from respondents about the cultural domain whereas open- ended surveying inquire information about

the informant (Quinlan 2018). For example, a freelist by a respondent will provide information on plant products used in Ankasa to cure malaria where as an open -ended survey will provide information known to the respondent about plant products used to cure malaria irrespective of the geographical setting. The relevance of freelisting in agro-ecological and health research is increasing. Bolton & Tang (2004) recommended freelisting as a quick and reliable data source during a research conducted in post-disaster period. The findings from their study revealed that freelisting is an effective and sustainable approach for obtaining information on local health complications and the associated local interventions to curb the health problems. Several researchers have also employed freelisting in ecological studies (Mathez-Stiefel et al. 2012; Flores & Quinlan 2014; Verner et al. 2020).

Freelisting method is based on three notions. The first assumption is that individuals tend to list items in terms of their level of familiarity. For example, respondents are more likely to mention the use of traditional methods of harvesting forest products such as hoes and cutlass than conventional methods of harvesting forest products (Romney & D'Andrade 1964). The second expectation is that people who have more knowledge on a subject provide indepth information than individuals with less knowledge on the subject area. For example farmers with relatively higher years of experience in forest products collection are more likely to provide indepth information on sustainable harvesting of non-timber forest resources (Brewer 1995).The third assumption is that respondents mention local items popularly known in the geographical terrain. For example farmers are more likely to mention plantation crops such as cocoa and rubber in the south-western region of Ghana as compared to tea and coffee. Most farmers in the south-westem region are involved in the cultivation of cocoa and rubber (Gatewood 1984).

Relative frequency is an ethnobotanical index that compares the number of people collecting one species at a given period to the total number of households involved in the collection of all species. The relative frequency is given as

$RF = N/S$

Where RF denotes the relative frequency

N is the number of respondents involved in the collection of one specie

S is the total number of respondents collecting all the species

Use value is an ethnobotanical index that illustrates the relative significance of regionally prevalent species. The use value is estimated as the number of use reports stated by each informant for a specific plant species (U) to overall number of informants interviewed (S). The use value is given as U/S suggested by Phillips et al. (1994) which reveals the cultural salience of plant species with the most cited plant species receiving a high use value score.

b. Incentives and barriers to NTFPs commercialization

A 5-point Likert scale index was employed to analyze households' perceptions and barriers to commercialization of NTFPs. The scale was on a continuum from 1 to 5 (Strongly agree =1; Agree = 2; Neutral = 3; Disagree = 4; Strongly disagree = 5). Respondents were interviewed on a predefined set of perception statements and constraints.

A bar chart and spider diagram were used to show the incentives and barriers to commercialization of NTFPs.

c. Factors influencing income from the forest

The multiple linear regression model was employed to assess the socioeconomic and institutional factors that influence forest dependency (Gujirat 2004). The dependent variable for the model is was forest income (Veldeld et al. 2004). Income was estimated from the recall approach of the previous production season. The income from the forest formed a share of the total household income obtained from the cultivation of annual and plantation crops, homegardens, livestock production, forest collection, off farm income, regular salary and remittances. The multiple linear regression model was selected due to the continuous dependent variable. All covariates were regressed on the forest income to determine the dependency on the forest. All assumptions of linearity, homoskedasticity, independence of errors, independence of independent variables and normality were satisfied.

i. Empirical specification of the multiple linear regression model

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + \ldots + B_nX_n + \mu_i$$

Y = forest income

B_0= constant

B_i= Vector of estimated co-efficient of the independent variables

X_i= Vector of independent variables and μ_i= error term

Table 1. Description of explanatory variables for the MLR model

Independent variables	Type of variable	Measurement	Apriori expectation	References
Age	Continuous	years	-	Garekae et al. 2017
Gender	Dummy	1=male,0= female	+/-	Asfaw et al. 2013
Education	Continuous	years of education	+	Garekae et al. 2017
Farming experience	Continuous	years of farming	+	Garekae et al. 2017
Working off-farm	Dummy	1= yes, 0 = no	-	Garekae et al. 2017
Household size	Continuous	number of members in household	+	Garekae et al. 2017
Access to credit	Dummy	1 = yes, 0 = no	+	Garekae et al. 2017
Access to input subsidy	Dummy	1 = yes, 0 = no	+	Garekae et al. 2017
Member of farmer organization	Dummy	1 = yes, 0 = no	+	Wunder 2008; Biland et al. 2021
Access to government support	Dummy	1 =yes, 0 = no	+	Garekae et al. 2017
Extension services	Continuous	number of extension contacts	+	Mamo et al. 2007
Distance to market	Continuous	km	-	Biland et al. 2021
Farm size	Continuous	acres	-	Biland et al. 2021
Distance to farm	Continuous	Km	-	Biland et al. 2021

d. Contribution of NTFPs commercialization to household food security

i. Estimation of NTFPs commercialization

Prior to assessing the level of commercialization, the average quantity of NTFPs collected and sold for each specie was estimated. The level of commercialization was measured by the proportion of NTFPs sold to the quantity collected from the forest for each specie per farmer. All farmers with level of commercialization above the average estimated were denoted as commercial farmers and those with an average below were represented as subsistent farmers. (Strasberg et al. 1999; Leavy & Poulton 2007)

ii. Estimation of household food security

The HFIAS score is a four-week continuous measure of the degree of household food insecurity access status developed by USAID FANTA project. It is made up of nine questions on the perception of food vulnerability and bevioural responses related to occurrence of food insecurity situation over four weeks period. The frequency of occurrence is associated to each occurrence question which ranges from 1 to 3 that is rarely, sometimes and often respectively.

The maximum score to be obtained is 27 if a household often experiences a food insecurity situation for all nine occurrence questions (Q1a+Q2a+Q3a+Q4a+Q5a+Q6a+Q7a+Q8a+Q9a =27) .The minimum score to be obtained is 0 if a household selects no for all nine questions and its associated frequency of occurrence should be 0 (for example if Q1=0 then Q1a=0, Q2=0 then Q2a).The higher the score, the greater the level of food insecurity access and the lower the score the lesser the prevalence of food insecurity situation within the month (Bickel et al. 2000; Coates et al. 2013)

iii. Propensity score matching and endogenous treatment regression model

The propensity score matching and endogenous treatment regression model was used to determine the contribution of NTFPs commercialization to household food security.

The commercialization of NTFPs was modelled under the random utility theory, denoting that a farmer chose to be commercialized or not based on the utility they got. Under the assumption of risk neutral nature of farmers, their decision to commercialize or not was influenced by the perceived cost and benefits they derived from the commercialization of the NTFPs.

The perceived benefits of commercialization can be represented by a latent variable D_J^* expressed as a function of the observed characteristics and attributes, denoted as Z in the following latent variable model:

$$D_J^* = Z_J\gamma + \varepsilon_J;\ D_J = 1\ if\ D_J^* > 0;\ D_J = 0\ if\ D_J^* \leq 0 \qquad (1)$$

Where D_J^* is a dummy variable that equals 1 for commercial and 0 for subsistent; γ represents the estimated parameters. A farmer was commercialized when the benefits outweighed the cost. ε is the error term with mean of zero; and Z represents the farm, household, and institutional factors that influenced the level of commercialization.

The binary choice model was estimated using probit regression model to analyze the determinants of NTFPs commercialization and to generate propensity scores for consequent matching between the commercial and subsistent farmers.

Following Zakari et al. (2014) and Linderhof et al. (2019) the independent variables for the binary model were the personal and demographic characteristics, such as age, gender, educational level of the household head, household size, frequency of extension services, access to credit, access to input subsidy and farm size.

The impact of NTFPs commercialization on household food security was analyzed by adopting propensity score matching (PSM) by Rosenbaum & Rubin (1983). PSM was adopted to control

selection bias due to the observable characteristics between the commercial and subsistent farmers. In the first stage, propensity scores or covariates $\mathrm{P(x)}$ was generated from the probit regression model, which showed the probability of farmer to be commercial or subsistent. We constructed a control group by matching the commercial and subsistent farmers according to the generated propensity scores. The commercial and subsistent farmers whom we cannot find appropriate matches were then dropped. In the second stage, the impact of NTFPs commercialization on the outcome variables (y) was estimated using matched observations of commercial and subsistent farmers. Empirically, ATT is represented as:

$$ATT = E_{P(X)(C=1)}\{\mathrm{E[y\ 1|C = 1, P(x)]|} - \mathrm{[E\ y\ 0|C = 0, P(x)]} \quad (2)$$

Where Y(1) and Y(0) are the outcomes for those farmers in the treated (commercial) and control groups without treatment (subsistent), respectively, while C=1 for treated farmers and C=0 for control farmers. The difference between the two outcomes refers to the treatment effect on the treated (ATT).

However, the PSM controls for only observable factors that influenced the level of commercialization of NTFPs but not the unobservable factors such as the motivation for collecting NTFPs. Therefore, the linear regression with endogenous treatment effect model was used to account for selection bias in our estimation of the impact of NTFPs commercialization on household food security. Farming experience, experience in forest management and distance to market were used as instruments in the estimation of the endogenous treatment model estimation.

Table 2. Description of explanatory variables for the endogenous treatment model

Variables	Measurement	Apriori expectation	References
Age	number of years	+/-	Broussard 2019
Gender	male =1 , female = 0	+/-	Zakari et al. 2014; Ngome et al. 2020
Forest products collected	number of forests products collected	-	Carr & Hartl 2008
Education	number of years in school	-	Abdullah et al. 2019
Household size	number of individuals in the household	-	Kambunga et al. 2014; Zakari et al. 2014
Frequency of extension services	Number of times HH received extension services in the last year	-	Zakari et al. 2014
Access to credit	HH has access to credit (yes =1, no = 0)	-	Zakari et al. 2014
Access to input subsidy	HH has access to input subsidy (yes =1, no = 0)	-	Zakari et al. 2014
Farm size	acres	-	Zakari et al. 2014
Commercialisation	1= commercial 0 = subsistent	-	Linderhof et al. 2019

5. Results

5.1 Demographics

Table 3. Socioeconomic characteristics of the farmers

	Commercial	Std. Dev	Subsistent	Std. Dev	Mean Diff	P value
Age	**49.76**	**9.385**	**46.53**	**11.045**	**3.227**	**0.073**
Education	8.86	6.109	10.16	6.639	-1.294	0.176
Farm experience	23.93	9.397	21.22	10.646	2.712	0.107
Household size	3.52	2.146	3.53	2.396	-0.014	0.955
Number of collected forest products	2.69	2.226	2.53	2.501	0.158	0.378
Experience in forest management	22.22	10.502	20.00	10.800	2.224	0.171
Frequency of extension	5.36	3.161	4.72	2.203	0.643	0.154
Farm size	1.912	1.8824	1.809	2.8185	0.103	0.488
Distance to market	**2.574**	**2.9067**	**0.663**	**1.5595**	**1.912**	**0.000**
HFIAS	**5.60**	**4.705**	**9.97**	**4.789**	**-4.365**	**0.000**
Gender (Male=1)	86%		84%		0.020	0.407
Access to credit (Yes=1)	0.40		0.53		-0.135	0.111
Access to input subsidy (Yes=1)	0.53		0.56		-0.028	0.400

Table 3 shows the socio-economic characteristics of the farmers. The results revealed that commercial farmers had a relatively higher age of 49.76 years than subsistent farmers, which were 46.53 years. This opined that both commercial and subsistent farmers had exceeded their youthful exuberance. The average distance to the market for commercial and subsistent farmers was 2.574 km and 1.5595 km respectively. The average household food insecurity score was 5.60 and 9.97 for commercial farmers and subsistent farmers respectively suggesting that commercial farmers were more food secure than their counterparts.

5.2 Farm characteristics

5.2.1 Crops grown

Figure 4 depicts major crops grown by farmers in the study area. The results showed that 82.22% of farmers were involved in cocoa production. On the other hand, 26.67% were involved in the cultivation of cassava, 15.56% in rubber plantation, 14.44% in orange production and a lesser percentage in the production of other agricultural commodities. Cocoa is a main cash crop in Ghana which serves as an employment avenue for the majority of farmers in the rainforest zone. It generates income and improves the welfare of households living close to the Ankasa conservation area. The cocoa value chain also serves as huge foreign exchange earnings for Ghana. Cassava is one of the main staple crops grown in the area. It is predominantly intercropped with cocoa between three to five years of establishing the field. Both men and women are involved in harvesting, processing and marketing of rubber, which also serves as income for the farm household.

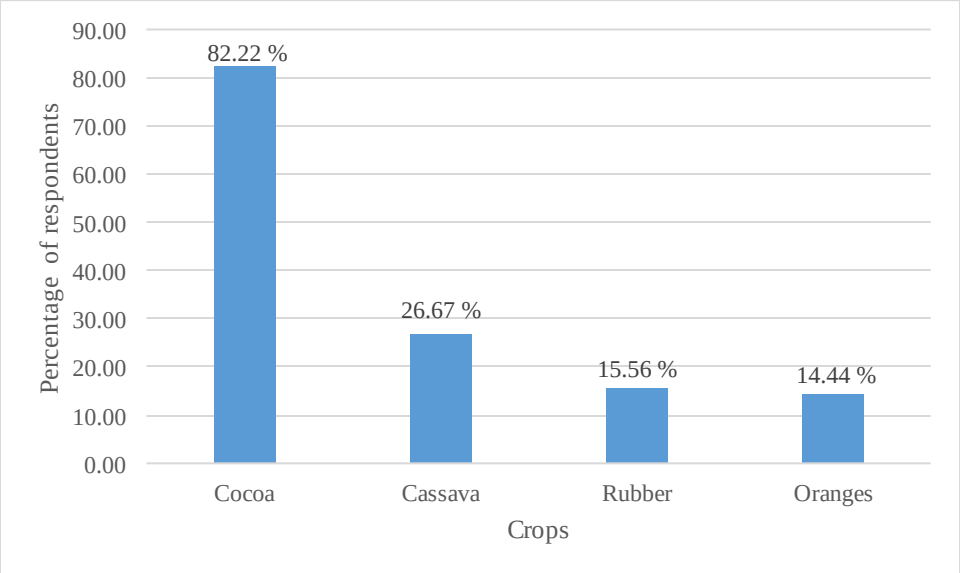

Figure 4. Crops grown

5.2.2 Ownership structure, size, terrain, soil quality and water availability

Table 4 shows the farm characteristics in the study area. The results revealed that the majority, 60% of the farmers, are under a contractual rent agreement, whereas 40% of farmers own the lands. Cocoa is the most cultivated crop in the area, and the land tenure agreement varies in three forms as Abunu, Abusa and Nkotokuano. Abunu is a rent agreement where the farmer cultivates cocoa on a piece of land and divides the share of income equally among the owner and the tenant. Abusa takes a different form where the income generated from cocoa production is divided into three equal parts. The tenant takes 2/3 of the proceeds, the owner obtains 1/3 of the share income, and all other farm expenditures, such as the cost of labourers, are catered for by the tenant. Nkotokuano, on the other hand, involves the owner paying labourers based on the returns generated from cocoa harvested. This is a fixed sum of money on the load price obtained by the farmer.

The average farm size for crop production was 1.88 acres. This suggests that farmers cultivate a relatively large piece of land. The majority, 58.9% of the respondents, mentioned that the terrain of the land is steep, 21.1% of respondents described the landform to be flat, whereas 20% of them described the land as very steep. The terrain of the land varied across the communities surrounding the Ankasa conservation area. The undulating land structure in the area is different from the Northern regions of Ghana, where land is usually flat. 44.4% of the farmers perceived the soil quality as good, and 34.4% highlighted the quality of the soil as very good. This suggests that the soil is rich in nutrients for crop production.45.6% of respondents highlighted good water availability during the dry season, whereas 14.4% of respondents mentioned water availability as very poor during the lean season.

Table 4. Structure, terrain, soil quality and water availability

Characteristic	Detail	Frequency	Percentage (%)
Ownership structure	Rent	54	60
	Own	36	40
Terrain	Flat	19	21.1
	Steep	53	58.9
	Very steep	18	20.0
Soil quality perception	Very good	31	34.4
	Good	40	44.4
	Rather poor	17	18.9
	Very poor	2	2.2
Water quality in the dry season	Very good	17	18.9
	Good	41	45.6
	Rather poor	19	21.1
	Very poor	13	14.4

5.3 Prevalence of food insecurity

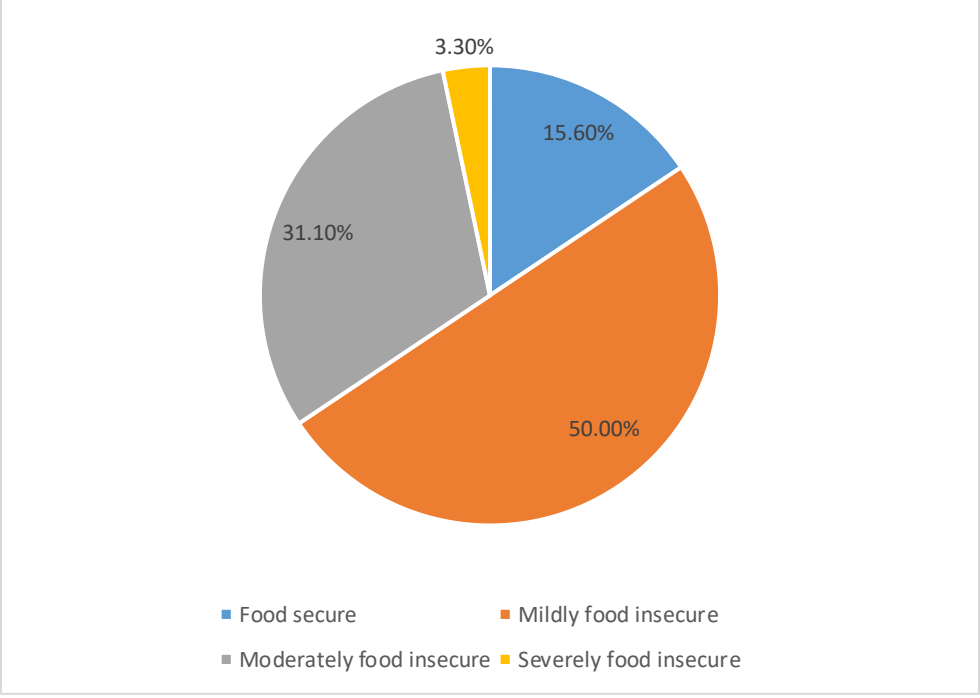

Figure 5. Food insecurity status

Figure 5 shows the food insecurity status of the households. The results revealed that the majority 50% of the households were mildly food insecure, followed by moderately food secure (31.1%), food secure (15.6%) and severely food insecure (3.3%).

5.4 Documentation of NTFPs

Table 5. Freelist of NTFPs

Species	Scientific name	Family	Decision to collect	Collection distance from home	Parts used	Purpose of specie	N	RF	UR	UV
Rattan	*Calamus rotang*	Arecaceae	M	1 – 7 km	stem	construction	20	0.22	8	0.09
Bush mango	*Irvingia gabonensis*	Irvingiaceae	M, F	2 – 11 km	fruits	food, medicine	16	0.18	7	0.08
Bush pepper	*Piper nigrum*	Piperaceae	M, F	1 – 15 km	fruits	food, medicine	15	0.17	6	0.07
Bamboo	*Bambusa vulgaris*	Poaceae	M	0.8 – 15 km	stem	construction, firewood	12	0.13	8	0.09
Cola	*Cola acuminata*	Malvaceae	M, F	0.2 – 10 km	fruits	food, medicine	12	0.13	7	0.08
Mushrooms	*Agaricus bisporus*	Agaricaceae	M, F	0.5 – 8 km	fruits	food	12	0.13	3	0.03
Aidan fruit	*Tetrapleura tetraptera*	Fabaceae	M, F	1.3 – 10 km	fruits, seeds	food, medicine	11	0.12	6	0.07
Bush onion	*Cyperus bulbosus*	Cyperaceae	M, F	1 – 15 km	fruits	food, medicine	11	0.12	8	0.09
Honey	*Apis mellifera*	Apidae	M, F	1.3 – 15 km	fruits	food, medicine	11	0.12	3	0.03
Almond nut	*Prunus dulcis (Mill.) D.A. Webb*	Rosaceae	M, F	2 – 9 km	fruits	food, medicine	10	0.11	5	0.06
Dawadawa	*Parkia biglobosa*	Fabaceae	F	0.3 – 2 km	fruits, leaves	food, medicine	9	0.10	6	0.07
Wild yam	*Dioscorea villosa*	Dioscoreaceae	M, F	1.5 – 10 km	tuber, roots	food, medicine	9	0.10	5	0.06
Thatch	*Thamnochortus insignis Mast.*	Restionaceae	M, F	1 – 8 km	leaves	construction	6	0.07	2	0.02
Bitter leaf	*Vernonia amygdalina*	Asteraceae	F	1 km	leaves	food, medicine	5	0.06	4	0.04
Dandelion	*Taraxacum officinale*	Asteraceae	M, F	0.2 – 1 km	leaves, roots	food, medicine	5	0.06	6	0.07
Bush pear	*Dacryodes edulis*	Burseraceae	M, F	2 km	fruits	food, medicine	4	0.04	5	0.06
African oil bean	*Pentaclethra macrophylla*	Fabaceae	M, F	2 – 4 km	seeds	food, medicine	3	0.03	7	0.08

N: Number of collectors; M: Male; F: Female; RF: Relative frequency; UR: Use reports; UV: Use value

Table 5 provides information on the forest products collected and the reasons for their collection. In all 17 species were documented by households living in the study area. The Fabaceae family was the most represented of the species collected, made up of dawadawa, african oil bean and aidan fruit. The decision to collect NTFPs were dominated by both gender other than males, that were solely involved in the collection of rattan and bamboo and females in the collection of dawadawa and bitter leaf. Males were involved in collecting rattan and bamboo due to the tedious work required for their harvesting. The collection of rattan and bamboo requires a lot of manpower in harvesting, gathering and conveying the products to the home, with the distance ranging from 1 - 7 km and 0.8 – 15 km for rattan and bamboo, respectively, and females were not willing to be involved in these operations. Females were into the collection of bitter leaf and dawadawa. Bitter leaf is usually collected in the morning, boiled in a pan with water and used to prepare medicine for the farm household. Dawadawa on the other hand is ground in an earthenware bowl and used in the preparation of traditional stews and eaten with yams or plantain. Females were involved in collecting these species due to their role in cooking for the household in the rural community. The most collected specie was rattan which was used for the construction of handmade artefacts such as baskets, bags and mats and sold through street vending to people connecting from neighbouring Cote d'Ivoire. Bush mango was the second collected specie followed by bush pepper and bamboo. Bush mango was eaten as fruit providing essential nutrients to boost the immune system of the households to undertake farm operations. Bush pepper was sold in smaller quantities on the market and used in the preparation of traditional cuisines. Bamboo, on the other hand, was used in home construction works and firewood for cooking.

Table 5 further shows the significance of ethnobotanical knowledge in understanding the link between people and the natural environment and offers useful information on the richness and significance of plant species in the studied area. The species with the highest relative frequency were rattan (0.22), followed by bush mango (0.18) and bush pepper (0.17). This implies that these species are commonly found or used in the studied region. Rattan, bamboo and bush onion were the species with the greatest use value of 0.09. This suggests that these species are particularly significant to the local population due to their diverse uses, including food, traditional medicine and constructural works.

5.4.1 Cultural importance of species

Table 6. Use reports of species collected

Species	Uses
Rattan	• used to manufacture furniture, including chairs and tables. • used in the production of crafts such as mats, baskets and hats. • used in construction as a support structure for thatched roofs. • used in agriculture as a support for creeping plants such as peas and beans. • used in the manufacture of trellises.
Bush mango	• the fruit is used in the preparation of soups and stews, providing flavour. • it is used in the treatment of ailments such as diarrhoea, dysentery and stomach pains. • the oil from bush mango is used to manufacture body lotion due to its moisturising effect. • the fruit pulp and seed cake are used for feeding livestock such as poultry and pigs.
Bush pepper	• used as a flavour in soups and stews. • used as a traditional medicine to treat digestive and respiratory problems. • used to control some pest infestation on farms. It is used as an ingredient for fall armyworm control. • oil extracted is used as massage therapy to relieve stress.
Bamboo	• used in the manufacture of furniture such as chairs and tables. • used in manufacturing crafts such as baskets, mats and hats. • supporting climbing crops such as beans, peas and used in the production of trellises. • used in the construction of bridges and building materials for homes.
Cola	• chewed as beverage which improves human energy levels. • used to cure sicknesses such as headaches and fever. • used to additives in food and beverages. • used in traditional ceremonies and regarded as sacred plant for rituals.
Mushrooms	• used as feed for livestock. • used in the preparation of stews and soups which provides the body with essential vitamins such as potassium and selenium.
Aidan fruit	• used as spice in soup and stews. • treatment of sicknesses such as cold, coughs and stomach pains. • Dueto its anti-inflammatory and antioxidant qualities, it is utilized in cosmetic preparation.

Species	Uses
Bush onion	• treatment of diarrhoea, stomach aches and dysentery. • used as additives providing taste in soups, sauces and stews. • used in cultural ceremonies and rituals.
Honey	• used as traditional medicine in the treatment of coughs and colds. • used as sugar in porridge.
Almond nut	• used in baking food such as bread. • treatment of sicknesses such as constipation, coughs and skin rashes. • oil extracted from the nuts is used for cooking.
Dawadawa	• used to prepare soup and stews. • used for treating ailments such as malaria, cough and diarrhoea. • used to feed livestock.
Wild yam	• boiled and eaten as food with stews and soup. • the roots are washed, boiled and used for traditional medicine to cure ailments such as rheumatism, digestion problems and menstrual cramps.
Thatch	• used for roofing in rural areas. • used as covering in the night for cocoa beans during the drying process.
Bitter leaf	• used in traditional medicine to cure malaria. • used in the preparation of stews and soups, providing the body with essential nutrients. • used for rituals
Dandelion	• used to treat ailments such as fever, kidney and liver problems. • used in the preparation of stews and soup, providing the body with iron, vitamins A and C. • used as supplements in feeding due to its high mineral content.
Bush pear	• eaten as food. • used for treating malaria, fever and diarrhoea. • the seeds are used for soap making.
African oil bean	• seeds are roasted, boiled and fermented and eaten as a food source, providing proteins, fats and vitamins. • used in the production of soaps, lotions and creams. • the bark and leaves are boiled and used as traditional medicine for treating ailments such as fever, malaria and diarrhoea.

5.5 Incentives and barriers of NTFPs trade

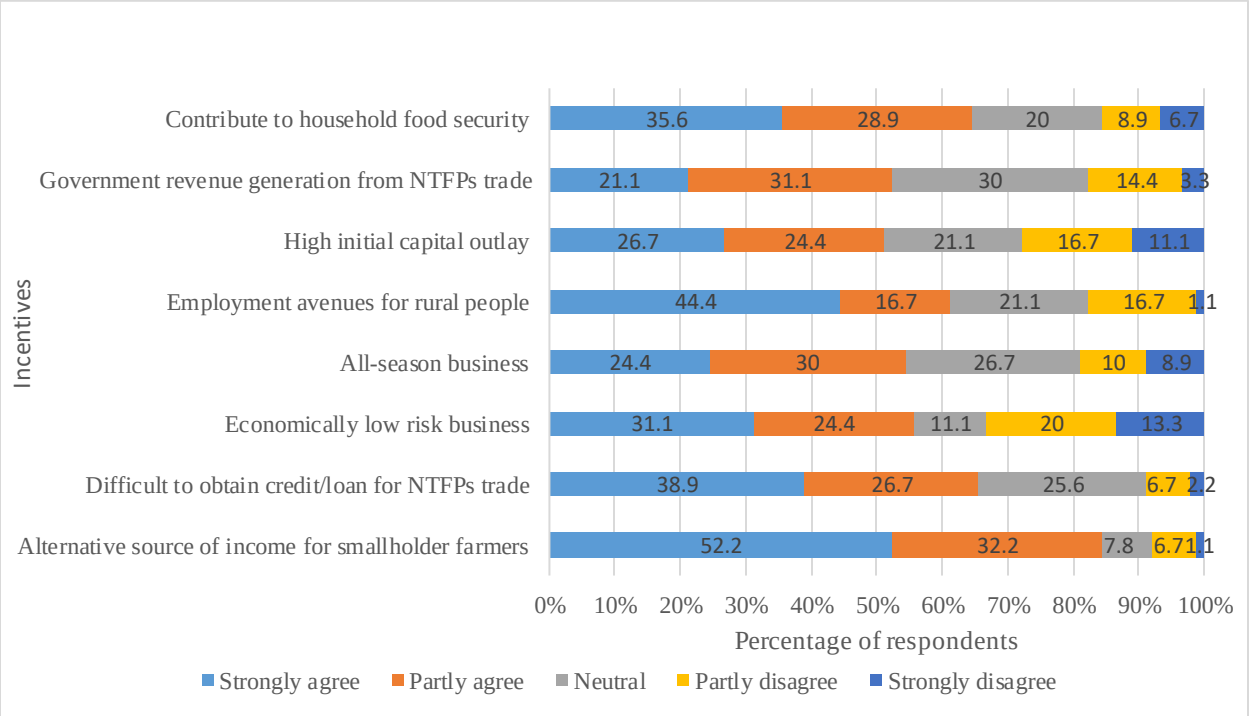

Figure 6. Incentives of NTFPs trade

Figure 6 shows the incentives for households engaging in non-timber forest product trade. The results revealed that a little more than 30% of the respondents strongly agree that NTFPs contribute to household food security, it is an economically low-risk business, and it is difficult to obtain loans or credit for NTFPs trade. The majority, 52.2% of the households interviewed, strongly agree that NTFPs serve as an alternative source of income, with 44.4% strongly agreeing to the perception statement of employment avenues for rural people from NTFPs. On the other hand, 30% of the respondents had a neutral view of government revenue generation from NTFPs, whereas 30% of the respondents partly agreed that NTFPs is an all-season business.

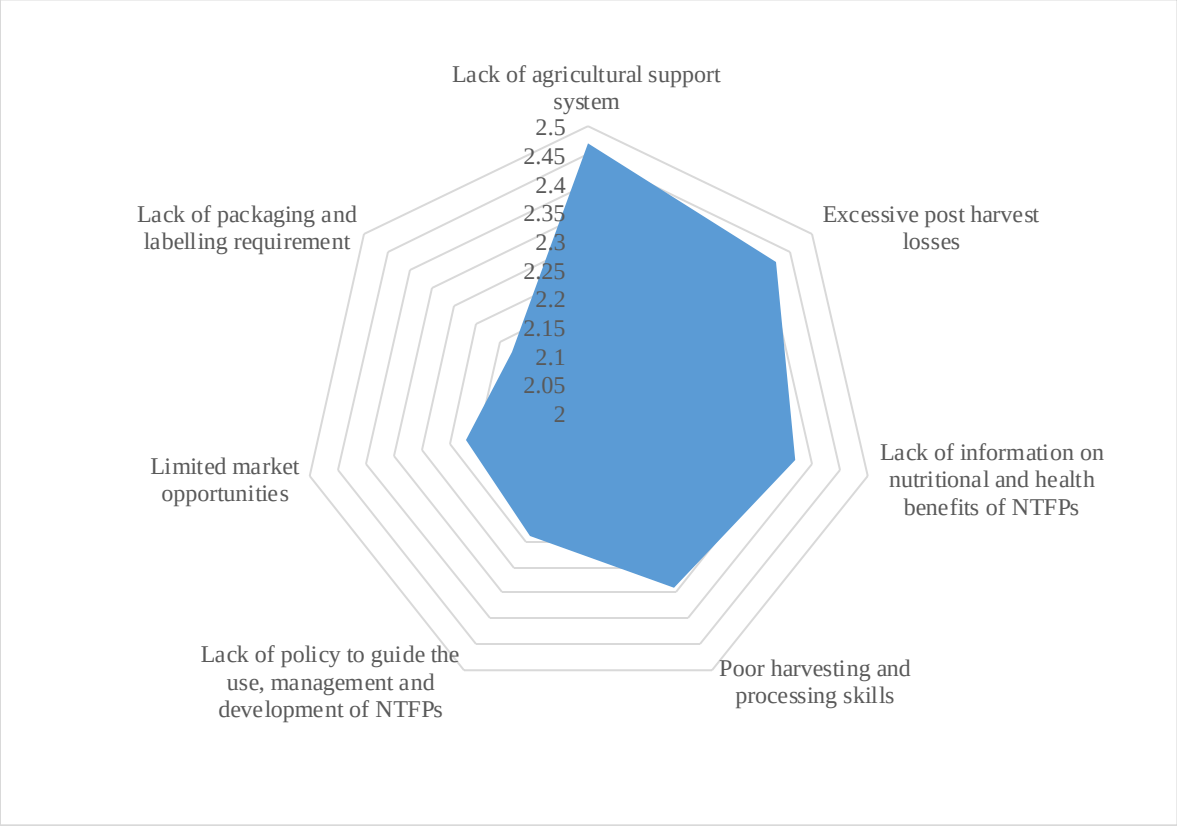

Figure 7. Barriers to NTFPs commercialization

Figure 7 depicts a spider diagram which shows the barriers to NTFPs commercialization. The most pressing barrier to the commercialization of NTFPs was lack of agricultural support system. This was followed by excessive post-harvest losses, lack of information on the nutritional and health benefits of NTFPs, poor harvesting and processing skills, lack of policy to guide the use, management and development of NTFPs and limited market opportunities. Lack of packaging and labelling requirement was highlighted as the least barrier to commercialization of NTFPs.

5.6 Factors influencing income from the forest

Table 7. Multiple linear regression model estimates

Predictors	Coefficient	Std. error	t	p value
Age	-20.647	17.228	-1.20	0.234
Gender	**-992.280**	307.125	-3.23	**0.002*** **
Years of education	30.421	24.7093	1.23	0.222
Farming experience	-4.185	18.907	-0.22	0.825
Working off-farm	241.137	334.041	0.72	0.473
Household size	**145.848**	66.782	2.18	**0.032** **
Access to credit	-50.076	309.131	-0.16	0.872
Farmer groups	**557.535**	315.414	1.77	**0.081***
Frequency of extension services	-88.234	57.848	-1.53	0.131
Distance to market	44.109	53.831	0.82	0.415
Farm size	67.558	88.0887	0.77	0.445
Constant	3138.524	953.144	3.29	0.001
n	90			
F (11, 78)	2.54			
Prob > F	0.009			
R-squared	0.129			

Std: standard; n: number of observations; *** *p<.01*, ** *p<.05*, * *p<.1* are the significance level for 1%, 5% and 10% respectively.

Table 7 below shows the factors influencing income generation from the forest. Farmer groups, household size and gender were factors found to influence income obtained from the forest. Farmer groups and household size had a positive effect on income from the forest, whereas gender had a negative effect on income from the forest. The reported R-square shows that 12.9% variation in income from the forest is explained by gender, household size and farmer groups. The F value of

0.009 shows that the model is statistically significant at 1%, regressing the independent variables on the income from the forest.

5.6.1 Propensity score matching estimates

All the PSM matching algorithms showed that farmers who were commercialized are more food secure than subsistent farmers. In other words, commercialization has a negative effect on household food insecurity.

Table 8. Propensity score matching for NTFPs commercialization and food security

HFIAS	Commercial	Subsistent	Mean Diff	Standard Err	Z
Unmatched	5.603	9.968	-4.365	1.042	-4.19***
Nearest neighbour	5.725	11.15	-5.425	2.171	-2.5***
Radius	6.000	11.723	-5.723	2.159	-2.51***

5.6.2 Endogenous treatment regression estimates

The correlation of the two error terms (rho) showed that there is no unobserved bias in the endogenous treatment model. This means that the estimation of the PSM model was not affected by unobserved bias.

The outcome model of the endogenous treatment regression model confirmed the findings of the PSM that commercialization of NTFPs has a significant negative effect on household food insecurity. Apart from commercialization of NTFPs, gender of household heads and access to credit had a significant negative effect on household food insecurity. However, the number of forest products collected, and years of education significantly affected household food insecurity positively.

The selection equation or treatment model showed that access to input subsidy and distance to market had a significant positive effect on the level of commercialization of NTFPs. In contrast, years of education, household size and access to credit had a significant negative effect on the level of commercialization of NTFPs.

Table 9. Endogenous regression estimates for NTFPs commercialization and food security

HFIAS	Coef.	St.Err.	t-value	p-value	Sig
Age	0.022	0.053	0.42	0.674	
Number of forest products collected	**0.455**	**0.209**	**2.18**	**0.03**	**
Gender	**-3.63**	**1.399**	**-2.6**	**0.009**	***
Education	**0.15**	**0.084**	**1.8**	**0.073**	*
Household size	0.099	0.247	0.4	0.689	
Frequency of extension	-0.08	0.179	-0.45	0.653	
Access to credit	**-2.657**	**1.381**	**-1.92**	**0.054**	*
Access to input subsidy	2.045	1.284	1.59	0.111	
Farm size	0.088	0.204	0.43	0.665	
Commercialization	**-4.067**	**2.263**	**-1.8**	**0.072**	*
Constant	**9.166**	**2.766**	**3.31**	**0.001**	***
Level of Commercialization					
Age	0.025	0.018	1.34	0.182	
Gender	-0.029	0.498	-0.06	0.953	
Education	**-0.053**	**0.029**	**-1.79**	**0.073**	*
Farming experience	0.045	0.062	0.73	0.468	
Household size	**-0.167**	**0.094**	**-1.79**	**0.074**	*
Experience in forest management	-0.041	0.058	-0.71	0.479	
Frequency of extension	0.094	0.091	1.03	0.302	
Access to credit	**-0.805**	**0.439**	**-1.83**	**0.067**	*
Access to input subsidy	**0.836**	**0.483**	**1.73**	**0.083**	*
Farm size	0.023	0.066	0.35	0.728	
Distance to market	**0.382**	**0.113**	**3.4**	**0.001**	***
Constant	-0.956	0.888	-1.08	0.281	
rho	-0.082	0.347	-0.24	0.813	
lnsigma	1.455	0.076	19.25	0	***
Number of obs	90	Chi-square	22.464		
Prob > chi2	0.013				

**** p<.01, ** p<.05, * p<.1*

6. Discussion

6.1 Ethnobotanical knowledge and non-timber forest products

The results from the study revealed that forest products obtained in the Ankasa reserve continue to support the households in meeting their food, medicinal and construction needs. In total, 17 species with 96 use reports were documented, with more than 2/3 of the species providing the households with essential body nutrients and treatment of ailments.

The Fabaceae family was the most dominant family of the species collected with *Parkia biglobosa* being the most culturally salient for treating malaria with a lower relative frequency of 0.10. These findings can be supported by previous literature on the ethnobotanical use of plant species from developing regions. A study conducted by Tugume et al. 2016 around the Mabira central forest reserve of Uganda listed 190 plant species belonging to 61 families. The Fabaceae family was the most represented, accounting for 14% of the species used by herbalists and collectors in treating several ailments such as malaria and blood system disorders. *Vernona amygdalina* was the most preferred species belonging to the Fabaceae, which was used in treating malaria. Similarly, a study conducted by Asase et al. 2005 in the Wenchiau sanctuary area in Ghana found that *Parkia biglobosa* was used to treat malaria with a lower relative frequency of 1.8. The lower relative frequency of *Parkia bigblosa* was due to the readily availability and efficacy of species such as *Afzelia africana* and *Anogeissus leiocarpa* in treating malaria.

Rattan was the most important specie used by households with a high use value.It serves as an alternative source of income reducing poverty levels and improving the livelihood of farmers in neighbouring communities around the Ankasa reserve. This finding is similar to that described by Andesmora et al. (2016) that revealed that rattan was the most highly utilized non-timber forest products by people living along the Tampa River. Rattan was used in the construction of fishing traps, weaving of baskets for storing food items, making furniture and used in the construction of houses.The average returns from the sales of rattan and bamboo in Kelawat of Malaysia accounted for 31.8% of the total household income improving the socio-economic conditions of the people (Rahim & Idrus 2018).

6.2 Incentives and barriers to NTFPs commercialization

The descriptive results from the study revealed that non-timber forest products serve as an alternative source of income for people living close to the Ankasa forest reserve. The income from forest resources is used to offset losses from major crop production such as cocoa and rubber. This helps to stabilize the overall household income, creating job avenues for people during the lean season of agricultural production which helps to improve the livelihoods of the people in the studied area. This result is consistent with the findings of Maske et al. 2011 in India that highlighted provision of technical skills on forest product collection and marketing as an alternative source of income to forestry, aquaculture, poultry and livestock production. Similar studies have also identified non-timber forest products as an alternative source of income and employment avenue for rural people (Pyhala et al. 2006; Pokharel et al. 2009; Reshad 2017). Microfinance and banks are not willing to provide credit facilities such as loans to farmers due to lack of collateral security, huge default rate and uncertainty of income generation from forest collection due to issues of climate change. This is supported by previous literature on farmers' access to credit in developing countries (Ibrahim & Aleiro 2012 ; Acikgoz & Demirkol 2019).

Lack of agricultural support system was highlighted as the most pressing barrier to commercialization of NTFPs. Farmers are not provided with adequate extension services to ensure sustainable harvesting of forest resources. Also there are poor roads linking the farm gate to the market which makes it difficult to convey farm produce to the market for sale. Due to poor roads and inadequate storage facilities, farmers experienced post-harvest losses which was indicated by households as the second issue to commercialization of NTFPs from the survey. Similarly, a study conducted in Sefwi Wiaso district of western Ghana highlighted the lack of NTFP policy as problem to commercialization and suggested the implementation of structured government policy for NTFP trade which was the fourth barrier indicated by farmers in the Ankasa forest reserve (Ahenkan 2010). Packaging and labelling requirements was the least barrier as indicated by households but in recent times most consumers are increasing being aware of the health attributes, the source of the products and the safe packaging of food (Jevsnik et al. 2008).

6.3 Forest dependency and livelihood

Income generation from the forest helps to improve the livelihood of people in terms of their purchasing power, financing of farm operations and payment of household utilities.

The results from the study showed that farmer groups had a significant positive effect on income from the forest. Farmer groups improves productivity and efficiency of farmers. Farmers who enter into farmer based organisations such as cooperatives stand to benefit from increased bargaining power in marketing their crops, shared knowledge on sustainable harvesting of forest products, reduction in transaction costs and shared labour in processing of farm produce based on farmer groups arrangement. The results from the study revealed that an increase in farmer groups increases income from the forest by GH₵ 557.54. This highlights that all things being equal, farmers stand the chance to benefit from forest income through farmer groups. The results align with Fonta et al. 2013 in Nigeria which revealed that membership of forest user groups and management institutions had a significant positive effect on the amount of income obtained from forest gathering. Similar results were found in Ethiopia (Tesfaye et al. 2012).

The study revealed that household size had a significant positive effect on income from the forest. Households with lot of members involved in forest product collection are expected to realize more income from forest. There is enough labour to be involved in harvesting, conveying of forest produce to the market and their level of involvement in processing forest resources. It was shown that a one member increase in household size increases income from the forest by GH₵ 145.85. Similarly researches have shown that increased household size has led to improvement in income and livelihood of the farming households (Masozera et al. 2004; Cordova et al. 2013)

The study revealed that gender had a significant negative effect on income from the forest. Male headed households were more willing to venture into cash crop production than forest product collection due to the well-established value chain and producer contract arrangements. This can be linked to the negative influence of gender on income obtained from the forest. The results revealed that an increase in male-headed household decreases income from forest by GH₵ 992.280. Similarly, a study conducted in Malawi revealed that females generated more forest income than their male counterparts from Malawi's forest co-management program (Jumbe & Angelsen 2006).

6.4 NTFPs commercialization and household food security

Commercialization of NTFPs improves the livelihood and the food security status of the farming household. This helps improve farmers' welfare with access to capital to engage in farm and household activities. The results from the study revealed that commercialization, access to credit and gender negatively influenced food insecurity. Food insecurity status decreased by 4.067 with an increase in commercialization of NTFPs . Commercialization helps to improve the availability of food with improvement in the nutrition of people. In addition, commercialization leads to improvement in the rural household income during the major cropping season and the lean season when there is less returns derived from farm commodities. Food insecurity status decreased by 2.657 units with an increase in access to credit. Farmers who have access to credit from banks, micro-finances and village savings and loans (VSLA) can patronize equipment to aid in gathering of forest products. Also, access to credit helps to off-set the associated transaction costs in conveying harvest to the market. Furthermore , it helps to improve the availability of safe food by reducing post-harvest losses. Post-harvest losses has been highlighted as a major threat to food insecurity situation in Ghana and other developing economies. Similarly studies have highlighted the positive effect of credit access to food security (Fitzpatrick et al. 2014; Bochar et al. 2017; Bidisha et al. 2017). Food security status decreased by 3.63 units with an increase in males. Males are usually the heads in the studied area with the decision right on the crops to be cultivated or harvested. The level of involvement of males helps to improve the labour required for forest products collection. Similar study conducted by Ngome et al. (2020) showed that males had more access to forest resources and productive assets and are less likely to experience food insecurity.

The results from the study revealed that number of forest products collected and education had a positive effect on food insecurity. This results is not in line with the findings of Carr & Hartl (2008) which revealed that farmers with improved knowledge of farming operations are willing to adopt improved techniques and skills to decrease food insecurity status.

6.5 Limitation of the study

There were issues encountered in the quantification of plant-based forest species and this may result in problems in the estimation of the forest income. The data was collected from March to April of 2021 accounting for the previous season of 2020.

7. Conclusion and recommendations

The extraction, marketing and trade of non-timber forest products has been highlighted as a means of increasing income, enhancing the lives of the rural poor and decreasing food insecurity situation in developing countries. This study sought to assess the role of non-timber forest products commercialization in ensuring food security among households in Ankasa conservation area of south-western Ghana. The study focused on plant-based non-timber forest products as animal based non-timber forest products represents a subject of illegal activity. Specifically, the study documented the kind of non-timber forest products collected and their uses, incentives and barriers to commercialization of non-timber forest products, factors influencing income from the forest and the contribution of non-timber forest products to household food security.

The convenience sampling technique was employed to select 90 farmers involved in forest product collection in Cocoa town, Anwiafutu, Amoakwa and Anwomakrom. Non-timber forest products commercialization was measured as the proportion sold to the quantity harvested. Household food insecurity access score was used to measure the food security status of the households. Bar charts, percentages and t-test were used to profile the socio-economic characterestics and farm characteristics of the respondents .Spider diagram and bar chars were used to assess the incentives and barriers to commercialization of non-timber forest products. Multiple linear regression model was employed to assess the factors influencing income from the forest. Propensity score matching and endogenous treatment model was employed to assess the contribution of non-timber forest products to household food security. The results from the study revealed that rattan was the most collected and important specie in the studied area. The majority 52.2 % of the respondents highlighted non-timber forest products as an alternative source of income as the main incentive for non-timber forest products trade and lack of agricultural support as the pressing barrier to commercialization of non-timber forest products. The multiple linear regression model showed that farmer groups and household size had a significant positive effect on income whereas gender had a significant negative effect on income. The results from the propensity score matching and endogenous regression model revealed that commercialization, gender and access to credit had a

significant negative effect on household food insecurity. On the other hand, years of education and number of forest products collected significantly affected household food insecurity positively.

The study recommends that government should implement policies to support farmers with provision of subsidies to improve forest products collection. There should be education of farmers on sustainable harvesting of forest species and this can be done in consultation with the Forestry commission and extension officers of the Ministry of food and agriculture in the local region. Lastly, there should be farmer business school programs to enlighten farmers on safe packaging and marketing as consumers are increasingly aware of food consumed.

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APPENDIX

Questionnaire

Introduction,

Hello, Nana Fenyi is my name and a student of the Faculty of Tropical AgriSciences of the Czech University of Life Sciences Prague. This research is focused on assessing the role of non-timber forest products commercialization in ensuring food security among households in the Ankasa conservation area of south-western Ghana. To fulfil the aims of this study, your honest and genuine participation by responding to the questions prepared is very important and highly appreciated.

Your answers are completely confidential, and participation is voluntary. No one will be told what you said in connection to your name.

However, your responses to these questions will help us to better understand the situation and provide policy recommendations on non-timber forest products in south-western Ghana.

We would greatly appreciate your help in participating in this study.

Section 1: Household characteristics (indicate Household head with '×')

Specify people who <u>live together</u> with you in a household most of the year:	**Age/ Year of birth**	**Gen-der**	**Ethnicity**	**Religion**	**Marital status**	**Years of educati on**	**Farm experienc e**	**Working on-farm**	**Working off-farm**	**Working in forest product collection**	**Experience in forest products managemen t (collection)**
e.g. farmer, wife, children, parents, relatives, friends etc.	[years] / [year]	[M/F]	[Akan 1, Ga 2, Ewe 3, other 4] *adults only*	[Christian 1, Muslim 2, Traditional 3, others 4	[single 1, married 2, widowed 3, divorced 4	[years] *adults only*	[years] *adults only*	[yes=1]	[yes=1]	[not=0, or more options collection=1, processing=2, selling=3]	[years]

Section 2: Farm characteristics

Plot/Field	**Size**	**Ownership**	**Location from the house**	**Terrain**	**Soil quality perception**	**Water availability (rainy season)**	**Water availability (dry season)**	**Main water source**
e.g. maize field, plantation, pond, homegarden etc.	[ha, m^2, local unit]	[1 - own, 2 - rent]	[distance, time]	[1-flat, 2-steep, 3-very steep]	[1-very good, 2-good, 3-rather poor, 4 very poor]	[1-very good, 2-good, 3-rather poor, 4 very poor]	[1-very good, 2-good, 3-rather poor, 4 very poor]	[1-river, 2-well, 3-rain, 4-other, specify]

Section 3: Institutional Characteristics

1. How many times did you meet an extension agent in the last year .....?
2. Did you get access to credit in the last year of farming operations? Yes ( ) No ( )
3. Did you get access to input subsidy in the last year of farming operations? Yes ( ) No ( )
4. Are you a member of farmer organization or cooperative? Yes ( ) No ( )
5. Are you any project beneficiary? Yes ( ) No ( )
6. Did you get any Government support (advice, input etc.)? Yes ( ) No ( )

Section 4: Please estimate your cash income GHS from last year (2020) from the activities listed below. If you have no income from the listed activity write down zero (0)

Annual crops	**Plantation / Trees**	**Homegarden**	**Livestock**	**Forest and wild**	**Off-farm job**	**Regular wage/salary**	**Remittances**	**Other, please specify**
(e.g. maize, rice, soybean, groundnut, etc.)	(e.g. cocoa, fruits etc.)			(e.g. collecting fruit outside farm, honey collection etc.)	(own business, ship, restaurant, etc.)	(working, seasonal job etc.)	(cash from relatives)	(government pension, forest products, etc.)

Section 5: Use of income from forest products.
Please estimate how you use extra income from forest products [%]

Farm	**Household**	**Health care**	**Education**	**Paying back for credit**	**Other**
(e.g. fertilizer, seeds, fuel, fodder, farm equipment, etc.)	(e.g. electricity, energy, firewood, water, land, house repair, transport)	(e.g. medicine, doctor)	(e.g. school fees, books)	(e.g. loans, credits,	(government taxes, gifts, memberships etc.)

Section 6: Household Food Security.
Please fill the following table as it applies to the situation in your household

NO	QUESTION	RESPONSE OPTIONS	CODE
1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes	….|____|
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|____|
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes	….|____|
2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|____|

3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes	….|___|
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	….|___|
4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….| |
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	….| |
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….| |
6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes	….| |
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….| |
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1 = Yes	….| |
7.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….| |
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1 = Yes	….| |

8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….| |
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes	….| |
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….| |

Section 7: Constraints and Barriers

Please indicate your level of agreement to the following statement regarding benefits of NFTPs[x]

Perception Statements	**Strongly agree**	**Partly agree**	**Neither agree nor disagree**	**Partly disagree**	**Strongly disagree**
NTFPs serve as an alternative source of income for smallholder farmers					
It is difficult to obtain credit/loan for NTFPs trade					
NTFPs is an economically low risk business					
NTFPs is an all-season business					
NTFPs trade create employment avenues for rural people					
Initial capital outlay for NTFPs business is high					
Government generates revenue from NTFPs trade					
NTFPs contribute to household food security					

Please indicate your level of agreement or disagreement with the following statement regarding commercialisation constraints of NTFPs [x]

Constraints	**Strongly agree**	**Partly agree**	**Neither agree nor disagree**	**Partly disagree**	**Strongly disagree**
Lack of agricultural support system					
Lack of policy to guide the use, management and development of NTFPs					
Lack of packaging and labelling requirements					
Limited market opportunities					
Poor harvesting and processing skills					
Excessive post-harvest losses					
Lack of information on nutritional and health benefits of NTFPs					

C. Please specify plant forest products apart from timber you collected in last year:

Species name	**Who decided to collect? Who is collector?**	**Collection place location**	**How many times a year you collect a product**	**Month?**	**Part used**	**What do you use this specie for apart from food**	**Quantity harvested/ collected (last season)**	**If the specie is grown for the market, indicate the selling price**	**If you sell it as a collector on a market, indicate market distance**	**Inspiration to grow this species**	**Would like to grow the species in future**
	M-Male F-Female	Km, hours	Once, more often …		A - Seeds B - Flowers C - Fruits D - Leaves E - Bark F - Stem G - Roots	A-Food B-Medicine C-construction D-Fodder E-Firewood F-Other	kg or local unit	M-market MM-middlemen FG-Farmgate	How far is the market from your HH (km, hours)	M-market F-family N-neighbours G-government O-other	4-more 3-rather same 2-rather less 1-less 0-discontinue
