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**INNOVATSIOONIVÕIMALUSED GHANA
KOHVITOOTMISES**

INNOVATION OPPORTUNITIES FOR COFFEE PRODUCTION
IN GHANA

Master's thesis
Curriculum in Agri-food Business Management

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<p>Ghana kohvitootmise Kwahu lõunapiirkonnas Ida-Ghanas, seisab silmitsi suurte väljakutsetega hoolimata selle suurest potentsiaalst parandada kohalikku elatustaset ja panustada riigi majandusse. Käesolev töö uurib innovatsiooni võimalusi selle piirkonna kohvikasvatavate tootmis- ja ekspordivõimsuse suurendamiseks. Uuringu andmed koguti küsitlusuuringuga 76 kohvitootjalt Ntomemi ja Bepongi olulistes kohvitootmise piirkondades kasutades kvantitatiivset uurimismeetodit. Uuringu tulemused näitavad, et kuigi osad tootjad on rakendanud turustamisel ja tootmisel uusi tehnikad, napib tootjatel endiselt teadmisi ja vähe on rakendatud uuenduslikke põllumajandustavasid nagu täppispõllumajandus ja märgjahvatus. Põhilisteks taksituseks innovatsioonide rakendamisel on suured finantskulud, valitsuse vähene tugi ja ebakindlus turul. Uuringu tulemusel soovitatakse nende takistuste ületamiseks koolitusprogramme, rahalisi toetusi, turu stabiliseerimisele suunatud algatusi ja ühistegevuse edendamist. Nende meetmete eesmärk on edendada innovatiivsete tavade kasutuselevõttu, suurendades seeläbi Ghana kohvisektori tootlikkust ja jätkusuutlikkust.</p>			
Märksõnad: kohvi, innovatsioon, Ghana			

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Abstract: The coffee industry in Ghana, particularly in the Kwahu South District of the Eastern Region, faces significant challenges despite its potential to improve local livelihoods and contribute to the national economy. This study explores innovative opportunities for coffee farmers in this district to enhance production and export capacities. Data were collected through questionnaires from seventy-six coffee growers in the important coffee-producing communities of Ntomem and Bepong, using a quantitative research approach. The results show that although some farmers have embraced new techniques in marketing and production, there is still a lack of knowledge and use of innovative farming practices like precision agriculture and wet milling. High financial expenses, a lack of government assistance, and market uncertainties were major constraints to innovation adoption. The study recommends comprehensive training programs, financial incentives, market stabilization initiatives, and the promotion of cooperative memberships to overcome these obstacles. These measures aim to enhance the adoption of innovative practices, thereby boosting productivity and sustainability in the Ghanaian coffee sector.			
Keywords: coffee, innovation, Ghana			

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INTRODUCTION

The demand for agricultural products has increased dramatically as a result of globalization and population growth (Ray et al., 2013). According to projections, there could be 10 billion people on the planet by 2050, which means that in order to reduce the widespread food insecurity, food production will need to rise by 70% (Paustian & Theuvsen, 2017). The significance of innovation, especially those that support sustainable agricultural practices and healthier food choices, has been highlighted by Groher et al. (2020) in the food production industry. Additionally, Abegunde et al. (2019) also highlighted in their study that the importance of agricultural technology in maintaining sustainable agricultural production to satisfy future food demands cannot be overemphasized. Nonetheless, it is realized that not only does efficient use of agricultural technologies contribute to increasing production to meet the world's food, but it is also essential for increasing living standards of many producers (Otchia, 2014). For example, the International Coffee Organization (2015) stated that many developing countries, like Ghana, rely heavily on coffee export revenue, as it is a highly sought-after agricultural product on the world market.

Despite the recognized significance of agricultural technology and innovation in fostering agricultural production, as well as rural economic growth and development, the Ghanaian coffee sector persists in employing traditional farming methods. This adherence to traditional practices diminishes production and export potential (Weyori et al., 2018). The industry has experienced decline in output, despite its historical significance as one of the country's first exported commodity before cocoa (Traore, 2009).

Wongnaa et al., 2021, also highlighted in their study that coffee contributes significantly to the economic well-being of smallholder farmers in Sub-Saharan Africa, but its production in Ghana is underdeveloped, and its enormous potential for improving smallholder farmers' livelihoods goes unmet. Innovation is critical to agricultural and economic development. The lack of contemporary agricultural technologies and innovations may limit the industry's production and profitability potential (Makini et al., 2016). Adu-Gyamerah (2015) stated that the situation has gotten worsened to the point that some farmers have destroyed their coffee farms in order to grow cashew and cocoa instead of coffee. This development has weakened the coffee industry's potential to contribute to the nation's economy and jeopardized its sustainability. According to

FAO (2018), the full potential of agricultural innovation remains untapped in many emerging nations including Ghana. The key to realizing innovation's promise and bringing about revolutionary change is understanding and implementing the innovation drivers and procedures. Family farmers and other innovators are hampered by institutional, technological, social, institutional, organizational, and policy obstacles, all of which must be removed. This raises the concern of how agricultural producers will integrate agricultural innovations into their current and future practices, thereby influencing the adequacy of food provision to society and the world at large.

In an attempt to help contribute to revamping the coffee industry in Ghana, the overall objective of the research is to find possible innovation pathways that meet the objectives of the coffee farmers to increase production and export.

Research Questions

1. What are the current farming practices of the farmers and how familiar are they with innovative practices for coffee production?
2. How willing are coffee farmers in Ghana to adopting innovative methods for growing coffee?
3. What are the constraints to adopting innovative practices to their farming approach?

The study was conducted in the Kwahu South District of Ghana's Eastern Region, a key area for coffee production with diverse landscapes and a tropical climate. A quantitative research methodology was used to explore innovative opportunities for coffee farmers. The target population included all coffee farmers in the district. Due to the lack of specific data, a multi-stage sampling technique was employed. Two key communities, Ntomem and Bepong, were selected for their coffee production prominence. Snowball sampling was then used to identify and recruit participants, resulting in 78 responses. Data collection involved a questionnaire with both closed-ended and open-ended questions, distributed via social media and local contacts. The data was analyzed using descriptive statistics to summarize current farming practices and Likert scales to measure farmers' familiarity with and willingness to adopt innovative practices, as well as to identify constraints.

Significance of the Study

This study is important because it seeks to tackle important issues that the Ghanaian coffee industry faces, which affects not just the local economy but also global food security and sustainable development. This study intends to give a thorough understanding of the underlying difficulties impeding the growth and productivity of the coffee sector in Ghana by examining the present farming techniques and challenges faced by coffee farmers (Weyori et al., 2018). Additionally, identifying potential obstacles to the adoption of innovative practices by stakeholders is imperative to recommend effective strategies that foster the adoption of innovations in production by coffee farmers (Abegunde et al., 2019). Through an analysis of innovative models that have proven effective in other coffee-producing regions and an assessment of their suitability for Ghana, this study provides insightful information on possible avenues for the coffee industry's revival. The goal of this research project is to help improve understanding and help to support promotion of innovative practices in the coffee industry in Ghana. Furthermore, this research offers stakeholders practical suggestions for fostering inclusive growth and optimizing the industry's contribution to national development goals by undertaking a thorough examination of the possible advantages and difficulties connected with different innovation pathways. This research seeks to close the knowledge gap between research and practice, enabling stakeholders to adopt sustainable practices that can increase production and promote economic growth.

1. LITERATURE REVIEW

1.1. Coffee

Coffee has a long history and cultural significance, making it one of the most consumed drinks in the world (Krishnan, 2017). Coffee comes from the Ethiopian highlands, and people have been drinking and growing it all over the world. It is now an essential part of many economies and communities. Millions of people work in the production, processing, and distribution of coffee, making it an essential commodity in international trade. Two most popular coffee varieties grown worldwide include coffee arabica and coffee *canephora* (robusta coffee). These are the two most popular and valuable coffee varieties traded in the world coffee market. While the former does well at high altitudes (1000–2000 m above sea level), with average temperatures ranging from 15 to 24°C and 2000 mm of annual precipitation, the later can be cultivated at altitudes of around 800 m above sea level since it can withstand hotter and drier circumstances (Ogundeji et al., 2019). It takes coffee trees three years to reach full maturity and start bearing fruit. Typically, the trees are planted as seedlings at a tree farm and are later moved to a coffee plantation when they reach a specific height. The coffee tree begins to flower every year following a period of rain followed by a dry spell. The physiological reaction of the plant to water scarcity is flowering. The maturation of the coffee berries occurs roughly 6–9 months after the tree blossoms. The berries are initially green and then turn red as they ripen. Because not all trees age equally, it can occasionally be more convenient to harvest the berries by hand in order to distinguish between ripe and unripe coffee berries. This guarantees the best possible coffee quality. The entire fruit is called a coffee berry, but we don't grind and roast it to make coffee. The coffee seed is covered by a skin, pulp, and parchment on the coffee fruit. Two seeds are found inside the fruit, and it is from these that we manufacture coffee. A device known as a depulper is used to remove the pulp and outer skin from the coffee berries after they have been harvested. After that, the seeds are submerged in a tub of water to ferment and eliminate any extra pulp and skin. After the seeds have fermented, the coffee is cleaned and allowed to dry in the sun, with numerous rotations of the beans to guarantee uniform drying of every seed and bean. Following this, the beans are then prepared for export, either raw or roasted (Ogundeji et al., 2019).

1.1.1. Overview of coffee production in the world

Coffee is an international commodity and apparently one of the most traded commodities in the world, second only in value to crude oil. The coffee business employs millions of people worldwide through its cultivation, processing, and trading (Amaravathi, 2014). Grown in more than 70 countries, coffee is the key crop in most of its producing countries and it contributes significantly to their total export earnings. Nonetheless, over 97% of the world's production is produced in 45 countries. A significant portion of tax revenue and GDP, as well as the main source of foreign exchange earnings, come from the coffee-producing nations. Vietnam, Colombia, and Indonesia have risen to the second, third, and fourth ranks, respectively, after Brazil as the top producer of the commodity. Brazil is both the world's largest producer and one of its biggest consumers (Adugna, B. G. (2021).

According to the International Coffee Organization (ICO), over 169 million bags of coffee were produced worldwide in the 2021–2022 crop year, indicating the commodity's continued popularity and significance to the global economy (ICO, 2023).

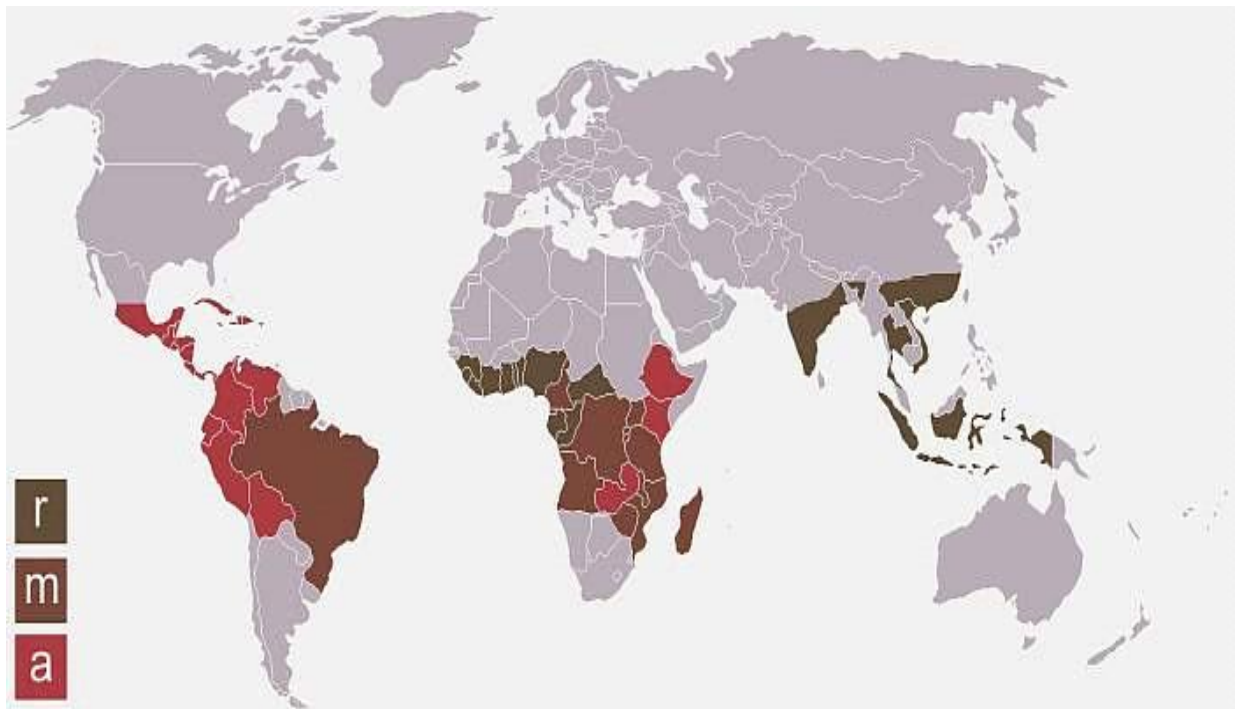


Figure 1. Coffee growing regions and coffee type produced.

Source: (Roldán-Pérez et al., 2009)

1.1.2. Coffee production in Ghana

Ghana should be a major player in the coffee production industry since coffee and cocoa both require nearly identical environmental conditions. But coffee production hasn't had the same impact as cocoa (Yeboah, 2020).

Bellachew (2011) also noted in his study "Some Impressions on the State of Coffee Sector In Ghana" that, in comparison to other African nations, Ghana is one of the major losers of foreign earnings from coffee production and export because of the country's drastically decreased annual production despite its enormous potential. According to the study, a few reasons for the sharp decline in coffee production in the nation are a lack of an internal marketing system; low coffee prices; low productivity; a lack of or insufficient extension services; inadequate infrastructure and coffee processing facilities; poor quality coffee; and competition from other cash crops, primarily cocoa, which the Ghanaian government has given a comparative advantage over coffee. Bellachew (2011) offered some further recommendations in light of the difficulties the study pointed out in order to assist in revitalizing the coffee sector. These suggestions include creating an internal marketing system to ensure that farmers have access to markets and a fair price; creating a workable extension system that educates the farmers and stakeholders on correct processing method to produce speciality coffee that attracts higher returns. The coffee specie that flourishes in Ghana is the Robusta which is developed principally in nine (9) out of the sixteen (16) regions of the country. The planting time frame begins in May at beginning of the downpours and collection begins in September and sometimes as early as August for the fly picking. Coffee yield in Ghana was assessed at 2.0 tonnes of dried cherries per hectare in 2014 (ICO, 2018). Figure 2 below shows the stages of coffee processing from fresh cherries to brewed in Ghana.

1.2. Innovation in Agriculture

Innovation is a multifaceted notion that may be used in many industries (Nigrini, 2013). Addressing the effects of food insecurity and changing food systems—which include crops, livestock, fisheries, aquaculture, agroforestry, and forestry—are crucial in the agricultural industry (Pardo & Durán-Romero 2022). There are many publications on the role that extension plays in supporting farmers; however, little is known about the function that

agricultural innovation systems play. A prevalent assumption is that innovations in agriculture can contribute to the reduction of poverty. The number of publications on inventions and innovation systems that have been published, as well as the quantity of international conferences that draw world leaders, provide as evidence (Zwane, (2020).

According to Food and Agriculture Organization (FAO 2018), agriculture innovation is the process by which people or organizations use previously developed or unproven goods, procedures, or organizational structures for the first time in a particular setting with the goal of enhancing efficiency, competitiveness, shock resilience, or environmental sustainability and thereby promoting food security and nutrition, economic growth, or sustainable management of natural resources. They further emphasized that the process of innovation is complex, and it involves many players in various roles. Governments and other important stakeholders, such as the corporate sector, civic society, farmer organizations, and research institutions, all have a part to play in fostering an atmosphere that fosters agricultural innovation and leads to solutions. Shy (1996) also defined innovation as “the search for, and the discovery, development, improvement, adoption, and commercialization of the new processes, new products, and new organizational structures and procedures”. This definition is sufficiently inclusive to include a wide range of distinct factors related to innovation and the adoption of technology. According to (OECD, 2005), innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. The key to success is identifying the factors that affect the adoption of new ideas. Zwane (2020) in his study mentioned that technology can be thought of as the central theme of innovation; here, technology is separated into software and hardware. While the hardware is made up of actual physical items like tools, equipment, and genetic material, the software is made up of techniques and abilities.

1.2.1 Types of Agricultural Innovation

Innovation is essential to the agricultural industry because it boosts production, sustainability, and efficiency at every point of the supply chain. Innovations can be classified into four main categories: product, process, marketing, and organizational innovation. Each of these categories has unique effects at different phases of the supply chain (Ghazalian & Furtan, 2007; Materia, et al., 2014).

Innovations in processes are especially common at the farm level. These developments are mostly directed toward improving manufacturing methods to increase yields and efficiency. High-yielding seed types and more effective irrigation techniques are two examples of how farming practices can be optimized to maximize resource consumption and boost production while also promoting more sustainable farming practices chain (Ghazalian & Furtan, 2007; Materia, et al., 2014).

Innovation in new products is often driven by downstream sectors within the agriculture supply chain. The creation of fresh, enhanced products that satisfy shifting consumer needs is the outcome of these advances. Instances of traditional product innovation include the launch of more healthful food options and the creation of novel chemical or pharmaceutical goods designed to improve crop protection and productivity chain (Ghazalian & Furtan, 2007; Materia, et al., 2014). Along the whole supply chain for agriculture, marketing innovations are likewise becoming more and more crucial. New approaches to marketing and selling agricultural products, adapting to changing customer demands, and breaking into untapped areas are all part of these advances. To reach customers more successfully and efficiently, businesses and agricultural producers use social media marketing, e-commerce platforms, and digital marketing strategies. Eco-friendly certification programs and sustainable branding are also employed to set products apart from competitors and draw in eco-aware customers chain (Ghazalian & Furtan, 2007; Materia, et al., 2014).

Throughout the whole supply chain, organizational innovations are becoming more and more popular in addition to marketing innovations. To increase coordination, efficiency, and adaptability, these innovations concentrate on reorganizing supply chain arrangements, management techniques, and business models. Collaborative alliances among farmers, processors, and merchants, for instance, provide more precise integration and coordination, guaranteeing the prompt delivery of goods to markets. Materia, et al., 2014 further argued that in addition to the above definition of innovation, other factors should be considered when defining innovation in the agro-food sector. New types of fodder, new feeding systems, new packaging, new methods of conservation, new additives, new flavours, new consumer products that are constantly brought to the market, and new types of logistics are among the innovations in the agro-food sector in addition to those covered (product, process, market, and organizational innovations). Grunert et al. (1997) also offer further noteworthy contrasts regarding the notion of innovation. They emphasize, for example, the distinction between

invention and innovativeness. The former refers to a particular product, process, or organizational feature within a corporation, whereas the latter is thought to characterize a company as a whole. Furthermore, supply chain management systems and powerful data analytics improve traceability, quality control, and response to market demands. All things considered, these many forms of innovation play a critical role in developing the agricultural sector, efficiently addressing commercial and environmental concerns, and facilitating the industry's further expansion.

1.2.2. Significance of agricultural innovation

There are many significant obstacles facing global agriculture, some of which are existential in nature. The main issue is climate change, which poses a threat to desertification and the resulting rise in salinity, animal and insect infestations, and floods (along with droughts). These effects will force some places out of cultivation at a time when it's expected that there will be 9.7 billion people on the planet by 2050, up from the current predicted 7.2 billion (Blakeney, 2022). For many people in developing and less developed countries the agricultural sector provides work and a means of subsistence. It also generates significant amounts of foreign exchange, supplies raw materials to regional industries, and holds significant promise for the economic advancement of those nations. The industry hasn't been strong, though. It has failed to promote other industries and provide a foundation for further socioeconomic development, as well as to guarantee small farmers a stable income and food security at the national and family levels. The causes for issues include challenges with storage and transportation; structural issues with the marketing of agricultural products; and the application of agricultural technologies and practices that have been passed down from generation to generation with little to no improvement (Blakeney, 2022).

The necessity for improving both the quantity and quality of agricultural products—food, fodder, and secondary products—as well as the growing environment—is the main driver of agricultural innovations (Van der Veen, 2010). In addition to the relevance of innovation to increase quantity and quality of agricultural output, Sayer & Cassman (2013) in their study “Agricultural innovation to protect the environment” also argued that the role of agricultural innovation to mitigate environmental issues that arises from production cannot be overemphasized. They further stated that poor farmers will inevitably continue to encroach on previously uncultivated land in huge numbers unless they are able to implement creative

systems that enable agricultural intensification and the growth of the farm equipment, farm input, and food processing businesses. Thus, Innovation helps us to do more with less.

In addition to the aforementioned importance of innovation, Gremmen et al., (2019) explained in their study “Responsible Innovation for Life: Five Challenges Agriculture Offers for Responsible Innovation in Agriculture and Food, and the Necessity of an Ethics of Innovation” that innovation helps to protect animal welfare, environmental and agricultural ethics. They explained that Western European agriculture faces many challenges, such as decreased animal welfare in housing systems during the 1970s, increased pesticide use in the early 1980s, increased vulnerability to infectious diseases in the 1990s, and erosion and overuse of antibiotics and vaccines at the start of the twenty-first century. Innovation presents opportunities in the context of agriculture and food since it might give rise to a fresh push for the ethics of food, agriculture, and animals. One such would be contemplation on the slaughter of day-old male chicks (Bruijn et al. 2015; Gremmen et al. 2018). This means innovation goes beyond improving quantity and quality of agricultural outputs, and helping to achieve more with less, but also helps to battle climate change, and improves, ethics of food, agriculture, environmental and animal welfare.

1.3. Innovations in Coffee Production

Coffee is one of the most significant agricultural commodities traded in the world market. The global value chain has undergone numerous changes in an effort to become more sustainable. Innovation is the engine that propels improvements in quality, sustainability, and efficiency along the whole supply chain in the ever-changing coffee manufacturing landscape. The coffee industry has evolved through different forms of innovation, from farming to consumption. According to Dewi et al., (2021) along with Bliska et al. (2013), the implementation of various innovations is crucial for enhancing coffee production. These innovations encompass the adoption of high-yielding planting material, effective pest and disease control measures, advanced pruning technology, and improvements in postharvest handling and processing techniques. Thurston, (2013) also mentioned that mechanized harvesting has allowed Brazil, which is still the world's largest producer of coffee, to produce much more than it could have with hand picking.

By integrating these innovations into coffee cultivation and processing practices, stakeholders in the coffee industry can optimize yields, enhance product quality, and ensure sustainable production systems. For example, in Brazil, the development of cultivars suited to various soil types and climates is one of the main innovations in the production of coffee beans. Strong growth and output potential across a range of environmental circumstances are guaranteed by these cultivars' exceptional agronomic and technological features (Bliska et al., 2013). Their capacity to create superior coffee beverages and satisfy the exacting requirements of both producers and consumers further distinguishes them. In addition to improving coffee cultivation's resilience and adaptation, this innovation raises the industry's overall sustainability and profitability. On the other hand, Bengkulu's, Indonesia's low coffee output can be linked to a number of factors, including a lack of intensive plant management, the prevalence of pests and diseases, the use of random planting materials, and the existence of older, less productive trees in Indonesia (Dewi et al., 2021).

Although innovative practices can be used anywhere in the world, its use is primarily focused on developing countries because of their high rates of food insecurity and susceptibility to climate change. However, the implementation of innovative practices indiscriminately shouldn't be the foundation of CSA. It is crucial that innovative initiatives adjust to the local context, considering institutional, political, social, and climatic factors in addition to the preferences and opinions of smallholder communities (Pardo & Durán-Romero, 2022). Gebreeyesus (2017) clarified in his study the important role that agroforestry systems play in Kenya's coffee production, highlighting the many ways in which they support sustainable agricultural practices and help mitigate and adapt to climate change. Agroforestry systems are essential for preserving natural resources, encouraging low-input farming practices, and improving socioeconomic livelihoods since they combine the production of food crops and cattle with coffee. Farmers in Kenya use a variety of agroforestry system typologies to grow coffee, combining varying amounts of food crops and animals with coffee farming. Food security is aided by this integrated strategy in two different ways. First off, coffee agroforestry boosts revenue streams through international trade for farmers, increasing their purchasing power for vital food crops. This is achieved by diversifying income sources (Gebreeyesus, 2017). Secondly, farmers improve local populations' food security and lessen their reliance on outside food sources by encouraging increased domestic production of food crops inside agroforestry systems. All things considered, the use of agroforestry techniques in Kenya's coffee production is an innovation and sustainable approach that not only

strengthens the resilience of coffee farming systems but also supports regional efforts for food security and wider socioeconomic development. Other innovative approach to coffee farming include irrigation to supplement inadequate and irregular rainfall pattern.

According to Ho et al., (2022) One of the biggest environmental issues in coffee farming is the use of irrigation water in an unsustainable manner. Promoting sustainable water management techniques is a crucial part of the solution to this problem. This has led to a noticeable uptick in the coffee industry's adoption of sophisticated irrigation systems and the growth of sustainability certifications. By introducing radical adjustments to water management techniques across all coffee farming operations, these projects seek to promote more sustainable water consumption. This necessity is emphasized even further by Nguyen et al., (2023) in their paper, "THIRST: Targeted Irrigation Support Tool for Sustainable Coffee Production." According to their findings, Vietnamese coffee farmers mostly rely on irrigation from severely depleted aquifers. A creative solution to the current hydrological problems is needed to ensure productive and sustainable growth within this system, considering this dependence and the increasing depletion of aquifers. It is therefore crucial to put specific plans into action as well as technological interventions to guarantee the long-term sustainability of the environment and coffee production in Vietnam and elsewhere. Exploring further the innovative practices carried out on coffee farms, a study by Ibanez (2010) revealed that the production of certified organic coffee has greater costs and worse productivity when compared to non-certified production. There is a 31% rise in expenses and a 40% drop in productivity. Ibanez suggests that the price premium for certified organic coffee should be about five times higher in order to encourage organic production, despite the fact that in 2007 the premium was 15% less profitable than for non-organic production (Ibanez, 2010; Valkila, 2009). It is crucial to remember, nevertheless, that certified organic farming benefits the neighbourhood, especially in terms of bettering the environment. Farmers also gain from improved market accessibility and a decrease in health issues related to chemical inputs (Ibanez, 2010; Valkila, 2009). According to Ibanez (2010), Colombian cooperatives that sell their certified organic coffee can charge up to 10% more than regular prices, depending on whether they sell their product directly to consumers or through middlemen. Although organic agriculture has a premium, it is still unclear if it makes up for the reduced productivity and possibly greater labour costs when compared to non-organic methods.

During the picking stage of the coffee beans' post-harvest processing, farmers have the option to selectively pick ripped cherries or strip them. Sun drying is the recommended method for the coffee beans' drying stage as well as using machinery throughout the post-harvest stages of hulling, sorting, roasting, and grinding will increase farmers' profits (Buclatin, 2020). Poltronieri & Rossi (2016) also mentioned in their study that collecting ripe coffee berries, reducing the moisture after harvest, and removing the outer layers of fruit using either dry or wet methods all contribute to the quality of coffee beans. Fungal infection during storage and shipping can affect the finished product and result in mycotoxins, primarily ochratoxin A, so it's important to maintain bean quality during these two processes. To maximize efficiency and profit in coffee production business, some farmers capable of affording expensive machineries yet productive incorporate this innovation. For example, in Thailand, the performance of coffee manufacturing was enhanced using automated machine deployment. According to the results realised by Kittichotsawat et al., (2023) in their study "Improvement of coffee production performance via integrated lean and automated mechanization techniques" it was possible to cut the processing time of green bean coffee by nearly 97%, the profit of sorted cherry coffee by 80%, and the overall cycle time by more than 82%. To enhance production, an automated colour sorting machine was implemented. Farmers can increase their responsiveness to future client demands and reap several benefits by implementing integrated lean and automated mechanization strategies. According to Kittichotsawat and Tippayawong (2021), these farmers prioritize enhancing coffee output to become leaders in full-range coffee production and product quality standards. This approach aims to increase business competitiveness and success in both local and international market. They want to create a manufacturing process that can reduce costs, enhance efficiency, and above all respond to clients demands.

To summarize, the most significant types of innovation in the coffee industry include the use of high-yielding planting material, efficient management of pests and diseases, sophisticated pruning techniques, automated harvesting, and enhanced postharvest handling and processing methods. Furthermore, the quality, sustainability, and efficiency of coffee production have all been improved by the incorporation of agroforestry systems, sustainable irrigation techniques, certified organic production, and automated mechanization. All these advances work together to maximize yields, enhance the quality of the product, guarantee sustainable production methods, and increase the worldwide economic feasibility of coffee cultivation.

1.4. Theory of diffusion of innovation

Numerous studies have applied the theory of innovation dissemination in a range of settings and contexts, most notably the globalization of agriculture and its multiplicity of forms and practices (Rogers, 2014).

According to Roger's (2003) theory, the effectiveness of new technology diffusion is often attributed to a change agent's attempts to persuade potential adopters to embrace and utilize such advances. Rogers (2003) coined the term "change agent" to refer to those who help their clients make innovative decisions by pointing them in the direction of a new technology or practice that a change agency thinks is desirable (Haider & Kreps, 2004). As potential adopters choose whether or not to accept innovations, change agents offer guidance (Rogers, 2003). They usually describe and often provide examples of the characteristics of an innovation that influence how soon it is embraced (Rogers, 2003). The five features or attributes that (Rogers, 2003) identified as being most likely to impact an innovation's adoption, particularly during the persuasion stage of the innovation-decision process, are relative advantage, compatibility, observability, trialability, and complexity. Relative advantage is the term used to describe an innovation's perceived value by potential users, especially when compared to advances that have already come before it. How effectively potential adopters perceive an invention to meet their requirements and align with established attitudes, behaviours, and cultural norms determines its compatibility. Observability is a measure of an innovation's capacity to show potential adopters how it functions and yields advantages prior to adoption. Trialability is the opportunity for prospective users to test an invention before deciding to embrace it whole or in part.

According to Rogers (2003), complexity is the degree of difficulty that potential adopters experience while putting an idea into reality, and it negatively impacts the adoption rate. Change agents usually start by educating potential adopters about an innovation and then use the advantages of the invention to sway their choice. If someone chooses to adopt, they go on to the implementation phase (Rogers, 2003). Following that, if the invention proved to be insufficiently compatible or failed to deliver on the relative advantage it had promised, the adopter may move on to the confirmation stage for continued acceptance and use, or it may be discontinued. According to Rogers (2003), this disillusionment discontinuation happens when a user of an innovation chooses to consciously reject it because they are unhappy with how successfully it performs.

2. METHODOLOGY

The current study focuses on exploring innovative opportunities for coffee farmers in Ghana, specifically, in the Kwahu South district of Eastern region of Ghana. This chapter describes the methods the study employed to achieve the goals listed in the preceding chapter. It begins with a description of the study's contextual background and ends with an ethical analysis of the research. The subsequent subsections below provide a detailed explanation and outline of these steps.

2.1. Description of study area

The study was conducted in the Eastern region of Ghana, specifically in the Kwahu South District. The district was purposefully selected because it is well known for its major contribution to coffee production in the region and Ghana as a whole. Ghana's Eastern Region lies in the southeast of the country and is bounded to the west by Volta Lake, to the east by the Volta Region, and to the north by the Ashanti and Greater Accra Regions. Based on the Ghana Statistical Service (2022), it is one of the country's bigger regions, with a land size of about 19,323 square kilometres. Kwahu South District is in the southern part of the Eastern Region of Ghana. It lies within the geographical coordinates of latitude 6.25°N and longitude 0.85°W, covering an area of approximately 1,315 square kilometres (Ghana Statistical Service, 2022). The district is characterized by diverse topography, including rolling hills, valleys, and fertile plains, with the Kwahu Plateau dominating its landscape.

Kwahu South District has a tropical climate with two distinct wet seasons (April to June and September to November) and two dry seasons (December to March and July to August). The district's climate is affected by the trade winds that blow from the northeast and its proximity to the Gulf of Guinea (Ghana Statistical Service, 2022). Kwahu South District's main economic activity is agriculture, with a concentration on products like cocoa, coffee, maize, cassava, and vegetables. Specifically, cocoa production contributes significantly to national export profits as well as local incomes in the district. The district is also well-known for producing various lucrative crops, including palm oil (Ghana Statistical Service, 2010). With localities ranging from little farming communities to major market cities, Kwahu South District is primarily home to rural residents. The district is home to a diverse range of ethnic groups, with the bulk of the population being Akans, specifically the Kwahu subgroup. The

district's commercial and administrative hubs are towns like Mpraeso, Nkwatia, Ntomem and Abetifi. In terms of Infrastructure, Kwahu South District is connected to major highways that connect it to both regional and national capitals, as well as to other parts of Ghana. Additionally, the district has access to telecommunications, marketplaces, health care facilities, and schools, albeit the availability of these services varies depending on the community (Ghana Statistical Service, 2010). The district is well-known for its colourful celebrations and rich cultural legacy, particularly the yearly Kwahu Easter Festival, which draws tourists from all around Ghana and beyond. The festival showcases the distinct culture and hospitality of the Kwahu people through a range of traditional and contemporary entertainment, athletic events, and religious ceremonies (Ghana Districts, n.d.).

Thus, Kwahu South District, with its varied landscapes, agrarian economy, cultural vibrancy, and advantageous location, is a noteworthy region within Ghana's Eastern Region. Examining this district's socioeconomic progress, environmental sustainability, and cultural resilience requires an understanding of its dynamics.

2.2. Research approach

The three main approaches used in academic research in empirical research are method, qualitative, quantitative, and mixed methods. In examining coffee farming practices in Kwahu South, this study employed a methodology to comprehensively explore innovative opportunities for coffee farmers in the region. The present study utilized a quantitative research approach to get insights into the phenomenon being examined (Creswell and Creswell, 2005). The quantitative data helped provide deeper understanding of the realities, and difficulties faced by Kwahu South coffee farmers in their coffee business. Thus, the quantitative insights contributed to a deeper understanding of the community's socioeconomic dynamics, market accessibility, coffee production characteristics, and identified trends and frequencies within the responses.

2.3. Population and sampling

According to Saunders et al. (2009), a population is a collection, a group, or the entire number of individuals or events that share a common trait. According to Malhotra et al. (2020)'s study, a population is a group of entities, individuals, and organizations that have

certain traits in common. The study considered all coffee farmers in the Kwahu South district. According to Ghana's Population and Housing Census in 2021, Kwahu South had approximately 80,358 people, where 38,618 (48.1%) are males and 41,740 (51.9%) are females (Ghana Statistical Service, 2022). Data obtained from the selected number of respondents was used to represent the entire population of coffee farmers in the study area. Unfortunately, there was no data on the population of coffee farmers in the region. Sampling technique describes the methods used to select a subset of individuals, organizations, and things from the entire population that have similar values.

A multi-stage sampling technique was employed to select the respondents for this study. Firstly, two communities namely: Ntomem and Bepong in the Kwahu south district were purposively selected due to their predominance in coffee production in the country. Majority of the smallholder coffee farmers are scattered in these selected communities hence the reason for their selection. First, to get information about the local coffee farming network, important informants or community leaders were contacted upon arrival in each community. Initial participants, recognized as experienced or influential coffee farmers, were identified and approached for participation. They were also asked to recommend other local coffee farmers they thought would be valuable contributions to the research. Referred farmers maintained the iterative snowball sampling procedure by referring other coffee farmers, increasing the sample size. Because the study's target population is coffee farmers exclusively, it uses both purposive and snowball sampling technique to explore innovative opportunities for coffee farmers in the study area. A smaller group selected from a wider population is known as the sample size. The size of the sample is regarded as the study's analytical unit in the empirical analysis, from which conclusions about the total population may be drawn.

According to Ghana Statistical Service 2022, about 63.5% (10,616) of the total households (16,725) in the Kwahu South district are into agricultural production as their primary economic activity. However, there was no data on the total number of coffee farmers in the region. Due to the lack of population of the coffee farmers, convenient sampling was used to select seventy-eight coffee farmers from the two selected communities.

2.4. Data collection method

In this study, a questionnaire was used as primary data collection tool. The questionnaire included both structured (closed-ended) and open-ended questions that were thoughtfully crafted to address a broad range of topics relevant to the research objectives. This approach sought to compile in-depth information about a range of coffee farming approaches, as well as the innovative opportunities and difficulties that local coffee farmers encounter. The quantitative method was the dominant data collection strategy in the study.

Before beginning the data collection procedure, I formally notified the respondents about the advantages of participating in the study via the social media platforms of the coffee farmers in the selected communities. Seventy-eight (78) questionnaires were disseminated by the help of three friends who reside in the Kwahu South Municipality. Forty-two questionnaires were administered in Ntomem, while thirty-six coffee farmers in Bepong community responded to the questionnaire respectively. The seventy-eight (78) responses were successfully received, and results would be used to represent the entire coffee farmers in the region.

2.5. Data analysis tools

This study offers comprehensive instructions on how the data were analysed to meet the objectives of the study. Objective one involves analyzing descriptive statistics, including frequencies and percentages to share light on farmers current farming practices. Responses from open-ended question on any additional information farmers would like to add as a farming practice was summed up to illustrate current farming practices.

Objectives two and three were addressed through the utilization of Likert scales. Objective two aims to assess farmers' familiarity and willingness to adopt innovative practices from different coffee-growing regions. Likert scales will be employed to measure farmers' attitudes, perceptions, and intentions regarding the adoption of these innovative practices. Respondents will rate their familiarity and agreement or disagreement with statements related to the willingness to adopt new farming techniques, with response options ranging from very unfamiliar to very familiar and strongly disagree to strongly agree respectively. Objective three focuses on identifying constraints in adopting the suggested innovative practices. Likert scales will again be utilized to gauge farmers' perceptions of the barriers,

challenges, and limitations they face in implementing the suggested innovative practices. Survey questions will prompt respondents to indicate the extent to which they perceive various factors, such as lack of resources, technical knowledge, or institutional support, as hindrances to adoption. By employing descriptive statistics for objective one and Likert scales for objectives two and three, the research aims to comprehensively explore farmers' readiness and receptiveness to adopting innovative practices from different coffee-growing countries, while also identifying potential barriers and constraints that may impede adoption efforts.

3. RESULTS AND DISCUSSION

3.1. Introduction

This chapter presents the results and discussions of the study. The first section presents the socioeconomic characteristics of the respondents. The second chapter presents the current farming practices of the farmers, while section three and four present's results on willingness of the coffee farmers to adopt innovative practices and constraints to adopting innovative practices respectively.

3.1.1. Respondents Overview

The socioeconomic characteristics of the coffee growers surveyed for the study are shown in table. The age, sex, level of education, farming experience, farm size, and membership to a cooperative were the different socioeconomic factors. The results from the descriptive statistics show that out of the 76 respondents for the study, 55.3% are males whereas 44.7% are females. This was consistent with research by Hill and Vigneri (2014) and Onumah et al. (2013) that indicates men predominate in the cultivation of coffee. Majority of the respondents fall within the ages of 45-54 representing 43.4%. Research by Asamoah (2015) and Omari (2014) further supported the idea that older people dominate Ghanaian coffee growing, with little involvement from younger people. A decline in youth involvement in coffee cultivation may be a sign of doom for the coffee business, particularly in the municipality of Kwahu.

Table 1 presents the educational level of the coffee farmers surveyed. It indicates that 63.2% of them did not complete any formal education, while 34.2% and 2.6% completed primary and secondary school respectively. Many Ghanaian coffee farmers, according to Kleman et al. (2014), lack a formal education, which is in line with the results of this investigation. The table also shows that majority of the farmers have been in the coffee business for a long time. 65% Of the respondents have been in the coffee business for about ten to twenty years, while 25% have over twenty years of coffee farming experience. We can assume this is why they have been using the traditional methods of farming without the exposure to modern technology and innovations which is currently running in the coffee industry. As a matter of fact, most of the respondents considered in this survey had farms with between one and five acres. But according to a study by Ruben et al. (2012), most Peruvian coffee producers run farms that are between 12 and 15 acres in size, which explains the high yearly production of

coffee in the nation. It can also be seen from table 3.1 that most of the coffee farmers in the study area do not join any coffee farmers' cooperative. According to the respondents, they have not seen much impact of the cooperative regarding fixing the marketing problem of their coffee beans after harvest. Some of the respondents claim their appeals to the co-op leaders to create a system that will enable them to achieve a substantial income for their hard work on the farms has not been satisfied. This has led to some previous members of the co-op in the region exiting. Balgah (2018) mentioned in his study “Factors Influencing Coffee Farmers’ Decisions to Join Cooperatives” that not all smallholder farmers join cooperatives despite their many benefits. He further emphasized that Coffee farmers' decisions to join or not join the cooperative were largely influenced by the amount of land used for coffee cultivation, the primary source of income, the size of the household, the farmers' prior experience, and the cooperative's prompt payment of dues.

Table 1. Summary of the overview of respondents. Source: Computed based on survey data, 2024

Variables	Category	Frequency	Percent %
Sex	Male	42	55.3
	Female	34	44.7
Age range	Below 18	0	0
	18-24	1	1.3
	25-34	7	9.2
	35-44	12	15.8
	45-54	33	43.4
	55-64	20	26.3
	65 plus years	3	3.9
Level of Education	No formal education	48	63.2
	Primary education	26	34.2
	Secondary School	2	2.6
	Vocational/tertiary	0	0
Farming experience	Less than 10 year	11	14.5
	10 - 20 years	46	60.5
	Over 20 years	19	25
Farm size	Less than 1 acre	67	13.2
	1-5 acres	47	61.8
	6-10 acres	19	25
	More than 10 acres	0	0
Member of coffee farmers’ cooperative	Yes	23	30.3
	No	46	60.5
	Unsure	7	9.2
Total		76	100

Source: Field Survey (2024)

3.2. Current farming practices of coffee farmers

The results of the survey provide a thorough picture of the farming methods used by coffee growers in Ghana's Eastern region, particularly in the Kwahu South district. Most farms are small-scale, according to the data on farm sizes. To be more precise, 61.8% of farmers oversee plots that are between one and five acres, 25% run farms that are between six and ten acres, and 13.2% work on less than one acre. No responders had a farm larger than ten acres. The region is known for its preponderance of small-scale farming, which is indicative of the subsistence-based agricultural techniques prevalent in many developing nations. Robusta coffee was the variety most grown, as indicated by the data, which came from 100% of the respondents who grew it. No farmers were growing Arabica or any other variety. Because Robusta coffee is more resistant to disease than Arabica and better suited to the local climate, it is grown exclusively in the area.

This constant preference for Robusta shows a chance for future market expansion and diversification should additional coffee kinds be introduced. Regarding planting strategies, all farmers interviewed (100%) said they used transplanting procedures for their coffee seedlings. Direct seeding techniques were not mentioned by any responders. Speaking with farmers about the coffee variety or product, it was discovered that the Ghana Cocoa Board's Seed Production Division provides all the Robusta coffee produced. The division oversees the nursing of coffee seeds and distributing them to farmers so they can be transplanted on their farms. Fertilizer is the most often utilized input in coffee farming, according to the survey, which found that 90.8% of farmers use it. Additionally, 26.3% use pesticides and herbicides, and 23.7% use organic additives like compost and manure. The fact that none of the respondents mentioned employing irrigation systems is noteworthy since it suggests that they are dependent on rainfall naturally and may be vulnerable to changes in the weather. 89.5% of farmers surveyed indicated that they used chemical sprays as their preferred method of managing pests and diseases. 26.8% use cultural methods including shade management and pruning. Nevertheless, no farmers mentioned employing biological control techniques like trap crops or predatory insects, indicating a possible opportunity for the introduction of more environmentally friendly pest management techniques. According to 97.4% of the respondents, handpicking is the primary way of harvesting employed by farmers. Just 9.2% said they had used sprouting techniques. This preference for handpicking is consistent with the small-scale farming practices and the requirement for careful selection

of coffee cherry to guarantee quality.

This finding aligns with the conclusions of Haile and Kang's (2019) investigation, "The Harvest and Post-Harvest Management Practices' Impact on Coffee Quality." They stressed that preserving quality depends on picking mature coffee cherries without endangering the tree. They argued in their study that selective picking produces higher quality results than the stripping method of harvesting. Also, the data collected indicated that all local farmers in the region process their harvested coffee cherries by drying method. None of the responders brought up the wet milling method of post-harvest processing. Table 2 summarizes the above-mentioned current farming practices of the coffee farmers in the study area.

Table 2. Summary of current farming practices of respondents

Farm practices	Category	Frequency	Percent %
Farm size	Less than 1 acre	67	13.2
	1-5 acres	47	61.8
	6-10 acres	19	25
	More than 10 acres	0	0
Coffee variety	Less than 1 acre	67	13.2
	Robusta	76	100
	Arabica	0	0
	Other	0	0
Planting method	65 plus years	3	3.9
	Direct sowing	0	0
	Transplanting	76	100
	Inputs commonly used	Fertilizer	69
Pests and diseases management	Pesticides/Herbicides	20	26.3
	Organic amendments	18	23.7
	irrigation	0	0
	Biological control – predatory insects, trap crops etc.	0	0
Harvesting method	Pruning, shade management	28	36.8
	Chemical sprays	68	89.5
	Handpicking	74	97.4
	Sprouting	7	9.2

Source: Field survey (2024)

Overall, the survey's findings point to several important facets of the region's coffee growers' present agricultural methods. A picture of traditional farming practices with some reliance on contemporary agricultural inputs is painted by the modest scale of operations, exclusive production of Robusta coffee, reliance on transplanting methods, major use of chemical inputs, and handpicking as the primary harvesting method. These results highlight the significance of focused interventions aimed at introducing innovative and sustainable techniques that can boost resilience and production among Ghanaian coffee producers.

3.3. Types of innovative coffee practices employed by farmers

3.3.1. Innovation in coffee product

Respondents were study interviewed to find out if they had made any changes or advancements, such as experimenting with new coffee cultivars, hybrids, or variety. The research shows that among the farmers polled, there is a marked lack of creativity in their coffee variety experimentation. The vast majority, 86.8%, stated that they have not improved or changed the coffee varieties cultivated on their farms recently. This may indicate a strong commitment to conventional farming methods and a reluctance to embrace modern agricultural technologies.

3.3.2. Innovation in coffee process

The data shows that among the coffee producer, process innovation is present to a considerable degree. Most, 60.5%, said they have made adjustments or enhancements to different facets of their methods for growing coffee. This implies a proactive strategy to improve farming techniques' effectiveness, sustainability, and quality. In contrast, 32.9% of the respondents said they have not changed at all, which could be due to a lack of resources and awareness of new approaches, potential obstacles to implementing new practices, or satisfaction with their current approaches. 6.6% of respondents were unsure, suggesting that there may be a misunderstanding of what process innovation is or that they are doubtful of the improvements they have made. One improvement that stood out among those who made changes was the move from sprouting ripped coffee to hand-picking the coffee beans. This is a big development since handpicking makes it possible to choose ripe coffee cherries more precisely, which results in higher-quality beans and possibly higher market pricing. This procedure also lessens the possibility of picking overripe or underripe

cherries, which could degrade the quality of the finished product. These results imply that although a considerable number of farmers have adopted innovative practices in their coffee farm processes, a sizable fraction could still profit from focused interventions. The productivity and calibre of coffee production in the area could be further improved by offering information, tools, and assistance to individuals who have not yet embraced new methods or are dubious about them.

3.3.3. Innovation in coffee marketing

The study results show that the surveyed coffee producers exhibit a moderate level of marketing innovation. 42.1% of respondents said they have improved the way or location in which they offer coffee. This indicates that a sizeable percentage of farmers are investigating novel approaches to marketing in order to improve sales and possibly raise their income. 51.3% of respondents, a somewhat greater percentage, stated they had made no adjustments to their marketing strategy. This shows that most farmers continue to sell their coffee using conventional techniques, which can restrict their access to markets and ability to negotiate better prices. The remaining 6.6% of respondents expressed uncertainty, which may be a sign of confusion or ignorance regarding the marketing tactics they use or the advantages of trying out new media.

Two primary techniques were identified in the responses from people who have innovated in marketing:

1. **Selling as a Cooperative Unit:** A lot of farmers are now selling their coffee in large quantities to other farmers as a cooperative. By working together, they can access more markets, strengthen their negotiating position, and potentially achieve better terms and more steady income. This tactic shows a move toward more coordinated and planned marketing initiatives.
2. **Contract farming:** A few respondents brought up contract farming, citing the fact that it gives them a steady market and frequently higher pricing. Contracts for contract farming sometimes contain provisions that guarantee farmers a consistent income, lower marketing risks, and may provide technical support or inputs from the contracting company.

These findings highlight the ongoing shift among a significant portion of farmers towards more innovative and cooperative marketing strategies. However, with over half of the

respondents not making any changes, there is considerable scope for further education and support to help these farmers explore and benefit from new marketing opportunities.

3.3.4. Organizational Innovation

The study shows that among the coffee growers interviewed, organizational innovation was found to be quite low. Just 27.6% of respondents said they have improved the structure or administration of their farms or companies. This indicates that slightly more than 25% of farmers are embracing new organizational models. These models may involve reorganizing their company operations, introducing new models of cooperation, or altering the types of contracts they sign. A notable instance of an initiative mentioned by the farmers was joining cooperatives to increase their bargaining power during sales of coffee beans. Table 3 below summarises farmers responses to innovations in their current practices in terms of the coffee product, their processes, marketing, and innovations in organization.

Table 3. Summary of farmers current innovative practices

Innovation type	Changes made	Frequency	%	Type of changes made
Product	Yes	2	2.6	Planting high yield coffee variety
	No	66	86.8	
	Unsure	8	10.5	
Process	Yes	46	60.5	Selective picking of cherries
	No	25	32.9	
	Unsure	5	6.6	
Marketing	Yes	32	42.1	Contract farming
	No	39	51.3	
	Unsure	5	6.6	
Organizational	Yes	24	41.5	Cooperative marketing
	No	36	37.4	
	Unsure	16	21.1	

Source: Field survey (2024)

3.4. Farmers familiarity to innovative practices

Figure 2 displays how familiar coffee growers are with different proposed innovative practices in the coffee growing industry. The innovations are prioritized according to the proportion of farmers who are not familiar with them; this helps identify areas that require more attention in terms of awareness-raising and training initiatives.

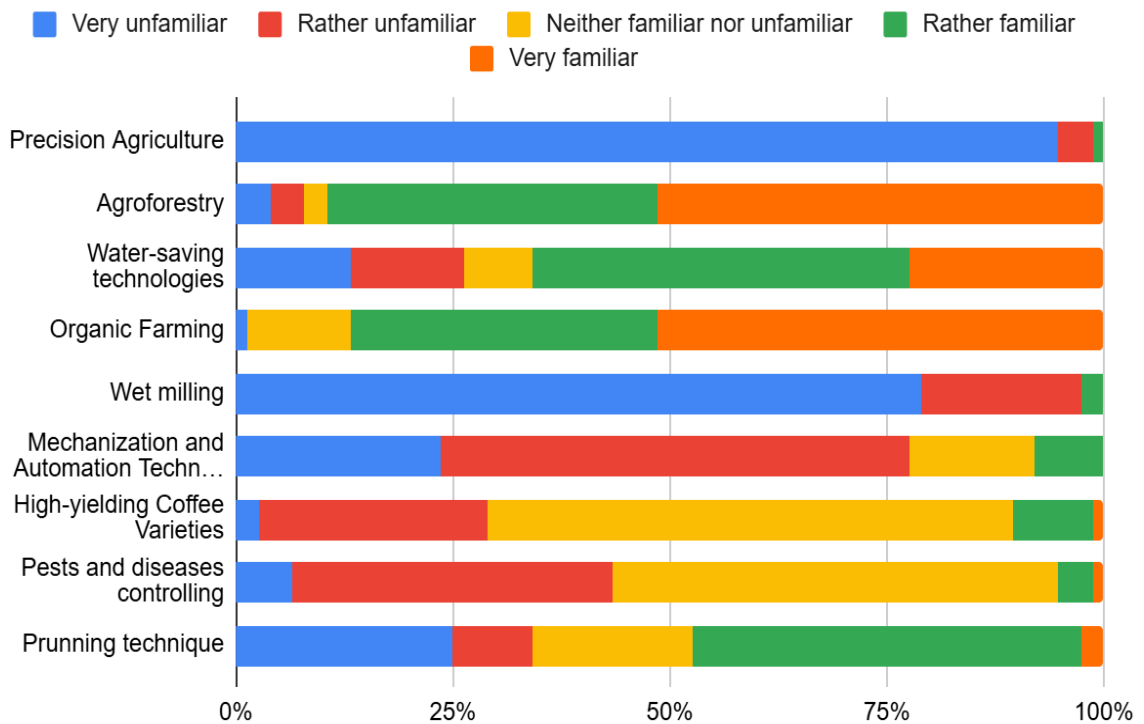


Figure 2. farmers' familiarity to suggested innovations.

(Survey data, 2024).

Results from the analysis shows that almost all the coffee farmers in the study area were very unfamiliar with precision farming methods. This shows that among the farmers polled, precision agriculture is the innovation that they know the least about. Precision agriculture involves the use of technology such as GPS and IoT to monitor and optimize agricultural processes, which can be complex and require specialized knowledge. Bolfe et al. (2020), also mentioned in their study that since many farmers, particularly those with less technical expertise, still require assistance and technical supervision to adjust to and become more familiar with the application of precision agriculture, it is critical that the public and private sectors assess the assistance they provide to maximize the use of these digital technologies.

On-farm demonstration of these technologies to farmers is key to assist them to become more familiar and to bridge the gap between theoretical learning and practical implementation (Athuman, 2023). Majority of the respondents were also unfamiliar with wet milling processing method and mechanization approaches placing them second and third least familiar innovation respectfully. Salengke et al. (2019) mentioned in their study that the wet milling method is usually used for the arabica coffee variety while most farmers who produce robusta coffee, including coffee farmers in Ghana are used to the drying processing method. Aside the above innovations, majority of the respondents were already aware of the use of agroforestry, organic farming, water saving technologies, high coffee yielding variety and pests and disease controlling techniques, however it has not been actively utilised by most of the respondents on their coffee farms.

3.5. Farmers willingness to adopt innovative practices

In this section, the study aimed to gauge the receptiveness of respondents towards integrating innovative practices into their existing farming methods. Figure 4. provides a visual representation of the collected data, illustrating the distribution of responses among participants. Through this analysis, the study sought to shed light on the potential for the adoption of innovative approaches within the coffee community of the study area. It is essential to comprehend farmers' willingness towards adopting innovative agricultural practices to create efficient extension programs and governmental interventions.

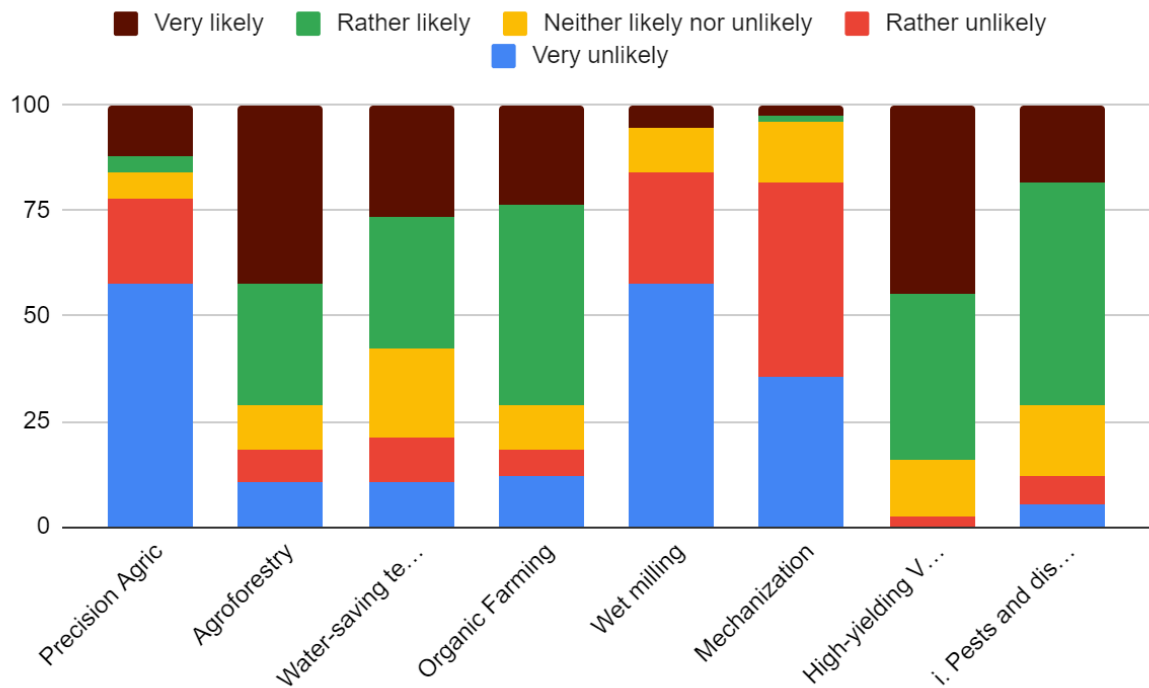


Figure 3. willingness of farmers to adopt innovative practices to their current farming approach.

(Survey data, 2024)

Different levels of willingness to adopt various agricultural innovative practices were found in the analysis of the responses. Remarkably, respondents exhibited a considerable degree of scepticism about precision agriculture and wet milling, judging them as "Very unlikely" to adopt (58% and 58%, respectively). Agroforestry and high-yielding coffee varieties, on the other hand, demonstrated comparatively greater levels of acceptability; 42% and 45% of respondents, respectively, rated them as "Very likely" to adopt. Significant interest was also shown in water-saving technologies, with 32% of respondents expressing a "Rather likely" predisposition towards adoption. Mechanization and organic farming, on the other hand, exhibited mixed results in terms of acceptance; 47% and 46% of respondents, respectively, said they were "Rather unlikely" to be adopted. Farmers' willingness to embrace innovation may be influenced by several things. Economic factors frequently come into play, such as the cost of the initial investment and the possible profits. Due to perceived financial concerns, practices like Precision Agriculture and Wet milling, which call for significant investments in infrastructure and technology, may encounter resistance. However, practical benefits like better soil fertility and higher yields are provided by practices like agroforestry

and high-yielding varieties, which may encourage adoption. Adoption patterns are also influenced by social and cultural variables. It's possible that methods like organic farming, which support consumer demand for sustainable products and environmental ideals, may be more widely accepted. On the other hand, worries about traditional farming methods and employment displacement may make technologies like mechanization unacceptable to other stakeholders. Buyinza et al., (2020) highlighted in their study "Assessing smallholder farmers' motivation to adopt agroforestry using a multi-group structural equation modelling approach" that 40% of Ugandan farmers interviewed were willing to adopt agroforestry to their current farming practices. They emphasized further that Smallholder farmers' adoption behaviour is mostly influenced by social norms and ideas that are prevalent in the society, which encourage the sharing of knowledge instead of relying on traditional methods for knowledge transmission. This is in line with the study of Bravo-Monroy & Tzanopoulos (2016), who concluded in their study that willingness of coffee farmers to adopt new approaches to their current farming practices are influenced by a range of social as well as economical factors. The study also revealed important insights into how the farmers would like to be informed and trained on innovative coffee practices. A resounding majority, representing 86% of respondents said they would be quite keen to take part in training or capacity-building initiatives that teach and use cutting-edge techniques for growing coffee. This suggests that farmers are very motivated to learn new things that will contribute to improving their coffee farming business. In addition, 80.3% of respondents said they preferred field trips or on-farm demos when asked how they would like to learn about or be trained in modern farming techniques. This demonstrates how crucial it is for farmers to have real-world, experiential learning opportunities. Furthermore, 11.8% of respondents preferred webinars or online materials, demonstrating a readiness to use digital learning platforms.

In terms of how they perceive innovation as important for their coffee farming operations, most respondents (63.2%) said it was "very important." And further 25% deemed it "important," underscoring the need of implementing cutting-edge methods to improve sustainability and productivity in the coffee industry. In conclusion, the data emphasizes how eager coffee farmers are to learn and use new techniques. Targeted education and support efforts can significantly improve the coffee sector in Ghana by addressing the demand for hands-on learning experiences and the high value placed on innovation.

3.6. Constraints to adopting innovative practices

From the survey, various constraints were identified using a Likert scale to ascertain the degree to which these constraints affect coffee producers in adopting innovative practices. The analysis revealed that "high financial investment costs" ranked as the most significant barrier. The high cost of implementing new agricultural technologies frequently presents a significant barrier, which is consistent with observations made elsewhere. Access to innovation that could improve productivity and sustainability is hindered by financial constraints for farmers. Similar issues are presented in a 2019 World Bank report, which emphasizes that financial limitations are a major impediment to agricultural innovation in developing nations, affecting farmers' capacity to make investments in and embrace new technology (World Bank, 2019). A considerable proportion of respondents strongly agreed or agreed that low governmental support and Market uncertainty were the next most urgent limitation to adopting coffee innovative practices, ranking second and third respectively.

The promotion of agricultural innovation is greatly aided by government policies and assistance initiatives. Improving governmental support for innovation adoption through incentives, subsidies, and policy support can have a big influence. Research suggests that specific government initiatives can mitigate certain economic and regulatory obstacles encountered by farmers (Van der Burg, Bogaardt, & Wolfert, 2019; McKinsey & Company, 2020). Many respondents mentioned that investments in innovation are discouraged by coffee bean price volatility and shifting market conditions because of the accompanying risks. This situation discourages them to make any new changes in their farming approach as they are not certain about the corresponding benefit, they will get from adopting new approaches. A McKinsey report on agricultural technology adoption from 2020 underscores the importance of stable and supportive market conditions for encouraging innovation in agriculture (McKinsey & Company, 2020).

Surprisingly, the least important restraints were labour cost and infrastructure availability, coming in at seventh and eighth place, respectively. Even though labour accounts for a sizable amount of production expenses in the coffee industry, respondents did not consider this to be a substantial obstacle to adopting innovative practices. This is consistent with research conducted by Cornell University and Fair-Trade USA, which found that although labour costs are high, they are frequently viewed as manageable in relation to other obstacles

(Fair Trade USA, 2020). Furthermore, a Solidaridad Network (2021) analysis revealed that while infrastructure problems are important, they are frequently eclipsed by more pressing financial and knowledge-related limitations. Complexity of technology, Low access to knowledge/training and low access to credit were manageable constraints to the farmers ranking fourth, fifth and sixth respectively. Farmers may find complex technology intimidating, which might impede the adoption of innovation because of a lack of knowledge and experience (Diro et al., 2022).

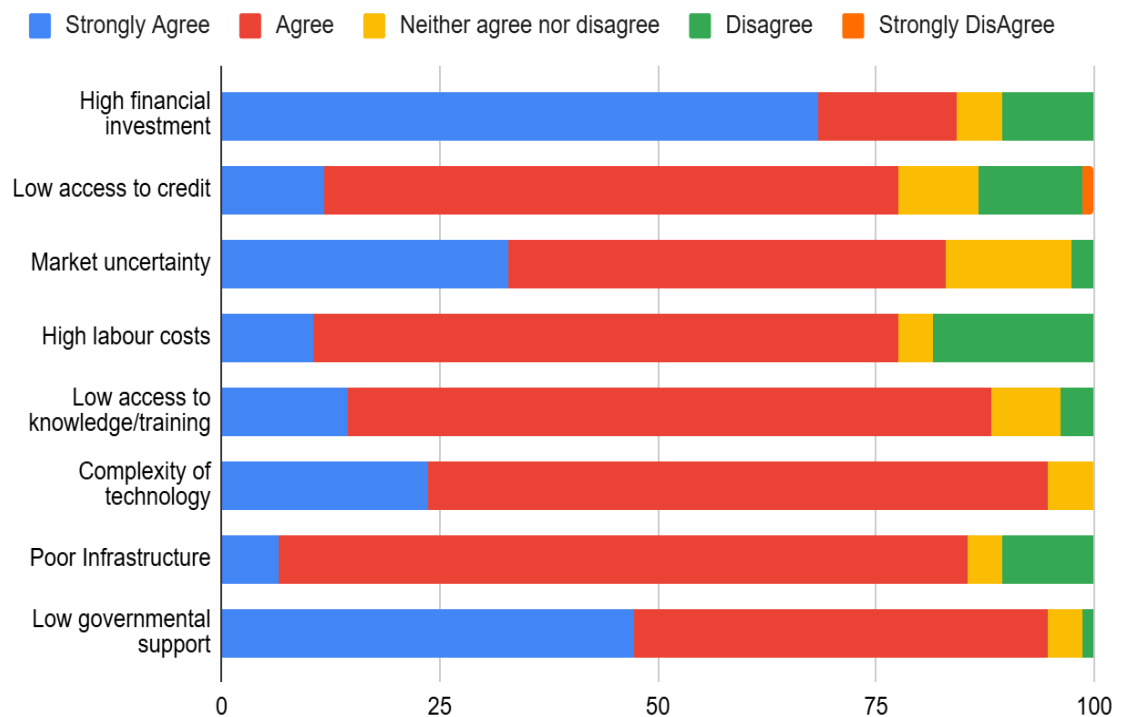


Figure 4. Constraints to adopting coffee innovative practices

Source: (Survey data, 2024).

In response to the question of how these limitations could be overcome, a greater percentage of the respondents pointed out that decision-makers in the coffee business must address the marketing difficulties they encounter. Farmers brought up the point that they frequently receive less money than they deserve for their produce, which lessens their motivation to adopt to innovative practices and possibly expensive techniques. If there is a guarantee of significant gains following their diligent labour, they indicated their willingness to adopt any innovations or ideas targeted at enhancing productivity. For farmers, there seems to be no point in implementing new procedures if there is no guarantee of improved market returns.

Encouraging farmers to invest in and use innovative agricultural practices will therefore depend on resolving these marketing challenges (Survey data, 2024). This situation was confirmed in the study of Wongnaa et al. (2021), where they emphasized that the marketing of coffee in Ghana isn't the best, discourages coffee farmers and need urgent resolution measures. Additionally, the farmers highlighted how important it is for the government to support the coffee farming industry with education, training, and other resources. In order to enhance their methods and boost output, farmers said they would like additional information and training possibilities. They stress the significance of government support and promotion of coffee farming through financial investment, resources, and incentives. A stronger understanding of the role that coffee production plays in economic growth as well as the necessity of stable market prices to support growers are also demanded. Overall, these recommendations show how crucial it is to have stable markets, government backing, and educational opportunities to cultivate a robust coffee farming sector that benefits the national economy and farmers' livelihoods.

3.7. Limitations

Even though this study produced some interesting results, there are still a number of issues that need to be resolved through additional research. First, due to differences in the economic and social foundations, relying solely on data from farmers in the Kwahu South District may restrict the applicability of findings to other coffee-producing regions of the nation. To broaden the study's scope, additional research can be conducted using data gathered from Ghana's many coffee-growing regions. Additionally, information about farmers is largely subjective because the majority of Ghanaian coffee growers do not maintain proper records of their cultivation activities. This study suggests that more research be done more quickly in order to evaluate the information provided by Ghanaian coffee farmers, even though the literature (Wall et al., 2004) indicates that subjective information is reliable and accurate.

SUMMARY

Despite the significance of agricultural technology and innovation, the Ghanaian coffee sector continues to use traditional farming methods, which limits its production and export potential. The lack of contemporary agricultural technologies and innovations hinders the industry's productivity and profitability. The aim of this study was to investigate innovative approaches that Ghanaian coffee producers might use to boost their output and exports. This project investigates creative ways for coffee farmers in the significant coffee-producing regions of Bepong and Ntomem to increase their output and export potential. Seventy-six coffee farmers provided information via questionnaires as part of a quantitative research project.

The findings from the study revealed that coffee production in the Kwahu South District is dominated by men who account for 53.3% of the respondents, are the predominant coffee. The study revealed that all the responders cultivate Robusta coffee, and they all transplant the seedlings received from Ghana Cocoa Board's Seed Production Division. In comparison, 26.3% of farmers use pesticides and herbicides, 23.7% utilize organic amendments, and 90.8% of farmers use fertilizer extensively as part of their farming practices. Farmers only depended on rainfall with no irrigation practices. Chemical sprays account for 89.5% of pest and disease management strategies; cultural approaches account for 26.8% of applications. Small-scale techniques are consistent with handpicking, which accounts for 97.4% of harvesting methods. Without using any wet milling techniques, all growers dry their coffee cherries.

Regarding current innovative practices carried out by the farmers, the study revealed that 60.5% of farmers improved their growing practices, switching to hand-picking coffee beans for higher quality, demonstrating the prevalence of process innovation. In terms of marketing innovation, 42.1% of respondents said they were implementing new tactics, such as contract farming and cooperative sales, while 51.3% were still using conventional techniques. Just 27.6% of farmers improved their farm management or structures, frequently by forming cooperatives to strengthen their negotiating power, demonstrating a lack of organizational innovation. According to these results, process and marketing innovations have made some headway, but organizational adjustments and variety experiments still have a lot of room for growth and support and this could be an innovation pathway that should be further explored in the future.

Additionally, respondents were least aware of precision agriculture and wet milling post-harvest processing technique. On the other hand, respondents were more familiar with organic farming, agroforestry practices and high-yielding coffee. Farmers were also more willing to adopt agroforestry practices and cultivate high yielding coffee varieties opposed to adopting precision agriculture and wet milling coffee cherries after harvest., This demonstrates the respondent's uneven awareness of and acceptance of different innovative practices. According to the survey, "high financial investment costs" are the biggest obstacle preventing coffee growers from implementing innovative practices. The next most pressing barriers were found to be little governmental assistance and market uncertainty. Surprisingly, the least important constraints were labour cost and the availability of infrastructure. In light of other considerations, respondents did not consider high labour costs to be a significant barrier. Manageable obstacles were low access to knowledge and training, low access to credit and complexity of technology.

Recommendations

Several recommendations can be made in light of the study's findings to contribute to promoting innovative practices in the study area.

1. To improve knowledge, training, and awareness of innovative practices in the study area, there should be thorough training sessions, workshops, and educational programs under the direction of local agricultural universities, the Ghana Cocoa Board, and Agricultural Extension Services. The training sessions must cover innovative practices for coffee production including precision agriculture, sustainable farming methods, and coffee variety experimentation.
2. Creating programs for coffee market stabilization in the region such as contract farming, cooperative marketing, establishing fair pricing structures that could support organizational innovation as possible pathway to increase production. Organizational innovation should also be explored in the context of export capacity building through international cooperation agreements, fair trade branding, global initiatives etc. These programs can help farmers gain a fair share for their produce, and they will be more willing to adopt innovative practices when these practices are proposed to them.

3. Additionally, financial support and incentives in the form of grants and subsidies can help farmers to meet the significant upfront expenses of implementing new innovations. This is particularly relevant as the costs were the biggest constraints for innovation adoptions. coffee producers will be able to invest in cutting-edge agricultural innovations without being constrained by excessive interest rates thanks to the development of microfinance programs and lending facilities designed with their needs in mind.

4. Finally, encouraging cooperative membership is crucial for the collective benefits of the farmer and this would also lay foundations on the organization innovations. cooperatives can be made more appealing by revitalizing existing ones, resolving farmer concerns, enhancing governance, and offering concrete advantages like training, input access, and market access. These organizations will be strengthened even more by promoting cooperative membership with rewards like access to special training sessions, group discounts on inputs, and collective bargaining power for lower market prices.

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APPENDIXES 1

QUESTIONNAIRE

Innovation Opportunities for Coffee Production in Ghana

Dear respondent

I'm a master's student at [Name of Institution] in my last year. The purpose of this questionnaire is to collect data for my master's thesis research project about innovative potential for Ghanaian coffee manufacturing. To the best of your knowledge, we humbly ask for your voluntary participation in answering all questions. I pledge to use all collected data solely and strictly for academic reasons, maintaining the highest level of confidentiality. Your involvement is crucial to the accomplishment of this study. I appreciate you taking the time to help.

Objective 1: Current Farming Practices of Ghanaian Coffee Farmers

1. What is the size of your coffee farm in acres?
 - a. Less than 1 acre
 - b. 1-5 acres
 - c. 6-10 acres
 - d. More than 10 acres

2. What coffee varieties do you cultivate on your farm? (Check all that apply)
 - a. Arabica
 - b. Robusta
 - c. Liberica
 - d. Other (please specify): _____

3. What are the primary methods you use for planting coffee seedlings?
 - a. Direct sowing
 - b. Transplanting
 - c. Other (please specify): _____

4. Which agricultural inputs do you commonly use in coffee farming? (Check all that apply)
 - a. Fertilizers
 - b. Pesticides/Herbicides
 - c. Organic amendments (e.g., compost, manure)
 - d. Irrigation
 - e. Other (please specify): _____

5. How do you manage pests and diseases in your coffee farm?
 - a. Biological control methods – like predatory insects, trap crops etc
 - b. Cultural practices (e.g., pruning, shade management)
 - c. Chemical sprays
 - d. Other (please specify): _____
6. How do you harvest your coffee
 - a. Handpicking
 - b. Sprouting
 - c. Other.....

B. Current practices/how innovative farmers have been

Innovation in Product

1. Have you made any changes or improvements to the coffee varieties grown on your farm in recent years? (e.g., trying new varieties, hybrids, or cultivars)

Yes [] No []

If yes, please describe the changes:

Innovation in Process

2. Have you made any changes or improvements in the processes related to coffee cultivation, processing, pest management, or irrigation methods etc in recent years?

Yes [] No []

If yes, please describe the changes:

Innovation in Marketing

3. Have you made any changes or improvements in how or where you sell your coffee, including exploring internet selling or other marketing channels?

Yes [] No []

If yes, please describe the changes:

Organizational Innovation

4. Have you made any changes or improvements in the organization or management of your farm or business, such as adopting new cooperation models, contract types, or business structures?

Yes [] No []

If yes, please describe the changes:

Objective 2: Willingness to Adopt Innovative Coffee Farming Practices

A. Familiarity and Willingness to adopt other innovation:

Are you familiar with any of the following innovative coffee farming practices or technologies?

a. Precision Agriculture: Do you use modern technology like GPS or drones to manage resources like water, fertilizer, and pesticides more efficiently on your farm?

Yes No unsure

If yes, specify.....

If no, indicate your willingness to adopt this innovation.

1. Very likely 2. Likely 3. Unsure 4. Unlikely 5. Very unlikely

b. Agroforestry Systems: Are you planting trees and shrubs alongside your coffee plants to provide shade, improve soil health, and conserve water?

Yes No unsure

If yes, specify.....

If no, indicate your willingness to adopt this innovation.

1. Very likely 2. Likely 3. Unsure 4. Unlikely 5. Very unlikely

c. Water-saving Technologies: Do you employ methods such as drip irrigation or rainwater harvesting to conserve water and optimize irrigation practices?

Yes No unsure

If yes, specify.....

If no, indicate your willingness to adopt this innovation.

1. Very likely 2. Likely 3. Unsure 4. Unlikely 5. Very unlikely

d. Organic Farming Methods: Are you avoiding synthetic pesticides and fertilizers and instead using natural inputs and practices to maintain soil health and biodiversity?

Yes No unsure

If yes, specify.....

If no, indicate your willingness to adopt this innovation.

1. Very likely 2. Likely 3. Unsure 4. Unlikely 5. Very unlikely

e. Advanced Post-harvest Processing Techniques: Do you utilize methods like wet milling or fermentation to enhance the quality and flavour of your coffee beans after harvesting?

Yes No unsure

If yes, specify.....

If no, indicate your willingness to adopt this innovation.

1. Very likely [] 2.Likely[] 3.Unsure[] 4.Unlikely[] 5.Very unlikely []

f. Mechanization and Automation Technologies: Do you utilize machinery and automation to streamline tasks like harvesting and processing, saving time and labour?

Yes [] No [] unsure []

If yes, specify.....

If no, indicate your willingness to adopt this innovation.

1. Very likely [] 2. Likely[] 3. Unsure[] 4.Unlikely[] 5.Very unlikely []

g. High-yielding Coffee Varieties: Are you planting coffee varieties that have been bred for high yields and improved resistance to pests, diseases, and environmental stresses.

Yes [] No [] unsure []

If yes, specify.....

If no, indicate your willingness to adopt this innovation.

- 1.Very likely [] 2.Likely[] 3.Unsure[] 4.Unlikely[] 5.Very unlikely []

h. Pruning techniques (Branch b1 or branch already produced once, for example, is the branch with the highest yield potential because it can contain 8-14 bunches/branch. This branch is much more productive than the b3 branch (branch already produced three times) which is only able to produce 2-6 bunches)

Yes [] No [] unsure C

If yes, specify.....

If no, indicate your willingness to adopt this innovation.

1. Very likely [] 2. Likely [] 3. Unsure [] 4.Unlikely[] 5.Very unlikely []

i. Pests and diseases controlling - such as resistant varieties, predatory insects to regulate pest populations etc.

Yes [] No [] unsure []

If yes, specify.....

If no, indicate your willingness to adopt this innovation.

- 1.Very likely [] 2.Likely[] 3.Unsure[] 4.Unlikely[] 5.Very unlikely[]

5. Would you be willing to participate in training or capacity-building programs focused on learning and implementing innovative coffee farming practices from other countries?

- a. Yes
- b. No
- c. Maybe, depending on the opportunity

6. How do you prefer to receive information or training about innovative farming

practices? (Check all that apply)

- a. Workshops or training sessions
- b. Printed materials (e.g., pamphlets, manuals)
- c. Online resources or webinars
- d. On-farm demonstrations or field visits
- e. Other (please specify): _____

Overall Perception:

7. How important do you consider innovation in your coffee farming practices?

Not important [] Somewhat important [] Neutral [] Important [] Very important []

7. Is there anything else you would like to share about your interest in adopting innovative farming practices from other countries?

[Open-ended response]

Objective 3: Constraints to Adopting Innovative Practices to Their Farming Approach

Constraints to Adopting Innovation in Coffee Production	Strongly Agree	Agree	Moderate	Disagree	Strongly Disagree
Economic Factors:					
High financial investment required	[]	[]	[]	[]	[]
Low access to credit or funding	[]	[]	[]	[]	[]
Market uncertainty or demand fluctuations	[]	[]	[]	[]	[]
High labour costs	[]	[]	[]	[]	[]
Technical Factors:					
Low access to knowledge/training	[]	[]	[]	[]	[]
Complexity of technology	[]	[]	[]	[]	[]
Infrastructure requirements	[]	[]	[]	[]	[]
Low level of governmental support	[]	[]	[]	[]	[]

Other (please specify): _____

2. How do you think these constraints could be addressed or overcome? (Open-ended)

Demographic Questions

1. Age

- a. Under 18

- b. 18-24
- c. 25-34
- d. 35-44
- e. 45-54
- f. 55-64
- g. 65 or older

2. Sex:

- a. Male
- b. Female
- c. Other (please specify): _____

3. Education Level:

- a. No formal education
- b. Primary education
- c. Secondary education
- d. Vocational/technical training
- e. Bachelor's degree or equivalent
- f. Postgraduate degree or equivalent

4. Household Size:

How many people, including yourself, live in your household?.....

5. Years of Farming Experience:

How many years have you been involved in coffee farming?.....years

6. Land Ownership:

Do you own the land where you conduct coffee farming?

- a. Yes
- b. No (If no, please specify land tenure arrangement)

7. Main source of income besides coffee farming?

- a. Agriculture-related activities
- b. Non-agricultural employment/business
- c. Government support
- d. Other (please specify): _____

8. Are you a member of any coffee farmer cooperative or association?.....

9. How do you primarily access information related to coffee farming practices?

- a. Extension services
- b. Agricultural workshops/seminars
- c. Internet/online resources
- d. Radio/TV

Other (please specify): _____

APPENDIXES 2

Non-exclusive licence for depositing the final thesis and opening it for the public and the supervisor's (supervisors') confirmation for allowing the thesis for the defence

Hereby I, **Benjamin Abbam-Baiden**
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