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Agricultural Innovative Techniques and Food Production Challenges on The Eastern Slope of Mount Cameroon

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ABSTRACT

A global phenomenon that has bedevilled humanity overtime is food insecurity. This situation can be reverse by adopting agricultural innovative techniques. Despite the utilisation of agricultural innovative techniques, food production challenges have become the new status quo on the eastern slope of Mount Cameroon. This study analysed food production challenges and the utilisation of agricultural innovative techniques on the eastern slope of Mount Cameroon. A mixed research design that incorporates both qualitative and quantitative techniques was utilized. Through a simple random sampling technique, 200 household farmers were selected within the eastern slope of Mount Cameroon to administer questionnaire. Also, through surveys, interviews, and direct field observations, data were collected and complemented with secondary sources like magazines, public-related articles, offline and online libraries and grey literatures on food production and agricultural techniques. These data were analysed using inferential and descriptive statistical techniques in order to correlate the effect of the utilisation of agricultural innovative techniques on food security. Results revealed that farmers cultivate different crop species with dominance of maize (50%) and 28% vegetables. 57% of farmers' perceptions indicated that farm production remains very low, due to over-cultivation of farmlands, and poor application of chemical fertilizers. In responding to this challenge, farmers have adopted innovative techniques such as chemical fertilizer (50%), organic manure (30%), and improved seeds (15%) which have fairly improved agricultural production. However, the continuous decline in food production amidst innovative techniques is explained by financial challenges (36%), limited farmers union and cooperative societies (25%), limited knowledge (21%), and geographical factors (17%). The study recommends that objective and holistic innovative measures such as agroforestry, careful application of chemical fertilizer, improved seeds, organic farming, irrigation practice, improve agricultural infrastructures and institutions must be encourage for sustainable agricultural production to thrive.

Keywords: *Food production, agricultural challenges, innovation techniques, food security, Mount Cameroon*

1. Introduction

As the world's population continues to grow, the need for food production has become increasingly urgent. In order to meet this need, it is important to explore and implement agricultural innovation techniques that can help to improve soil health and increase food production. While these techniques can be challenging to implement, the benefits they offer have a significant and lasting impact on our ability to feed the world's population in a sustainable way [1].

Agriculture remains a cornerstone of many economies, particularly in regions where poverty and food insecurity are prevalent. The role of the sector in alleviating poverty and ensuring food security has garnered considerable attention from policymakers and researchers [2].

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Food insecurity continues to be a significant challenge in Africa, intensified by a combination of economic, social, and environmental factors. Despite global advancements in agricultural productivity, Sub-Saharan Africa has witnessed a troubling rise in food insecurity, particularly since 2015. According to recent statistics, approximately 30% of the population in Sub-Saharan Africa is undernourished, which translates to about 381 million people suffering from hunger [3].This situation has been further aggravated by the COVID-19 pandemic and the ongoing conflict in Ukraine, which have disrupted food supply chains and increased food prices globally [1] [4].

The multidimensional nature of food insecurity in Africa can be attributed to several interrelated factors. Economic challenges, such as low growth rates and high inflation, have severely limited the purchasing power of households, particularly in rural areas where the majority of the population relies on agriculture for their livelihoods [5].

The Food and Agriculture Organization [2] noted that agricultural innovation and technology are vital elements of strategies designed to address these urgent challenges. Innovations in agriculture encompass the introduction of new technologies, practices, and systems, such as precision farming, agroforestry, and integrated pest management, all of which can significantly enhance productivity and sustainability in farming practices. However, over the last several decades, agricultural innovative technologies, including high-yielding crop varieties and complementary inputs such as synthetic fertilizers, pesticides, and irrigation water, have contributed substantially to productivity growth in the degraded lands for agriculture and improvements in global food security, [6].

Countries like Ethiopia and Kenya have implemented innovative programs focusing on soil and water conservation and precision farming, demonstrating the potential of technology to enhance food security across the continent [2].

The establishment of initiatives like the Alliance for a Green Revolution in Africa (AGRA) reflects the commitment to fostering agricultural innovation as a pathway to economic stability [7]. Despite the challenges, the potential for agricultural growth through innovation is significant, enabling farmers to improve yields, reduce environmental impact, and contribute to global food security. Although there are challenges, the potential for agricultural growth through innovation is considerable. This advancement allows farmers to enhance yields, minimize environmental impact, and play a vital role in global food security.

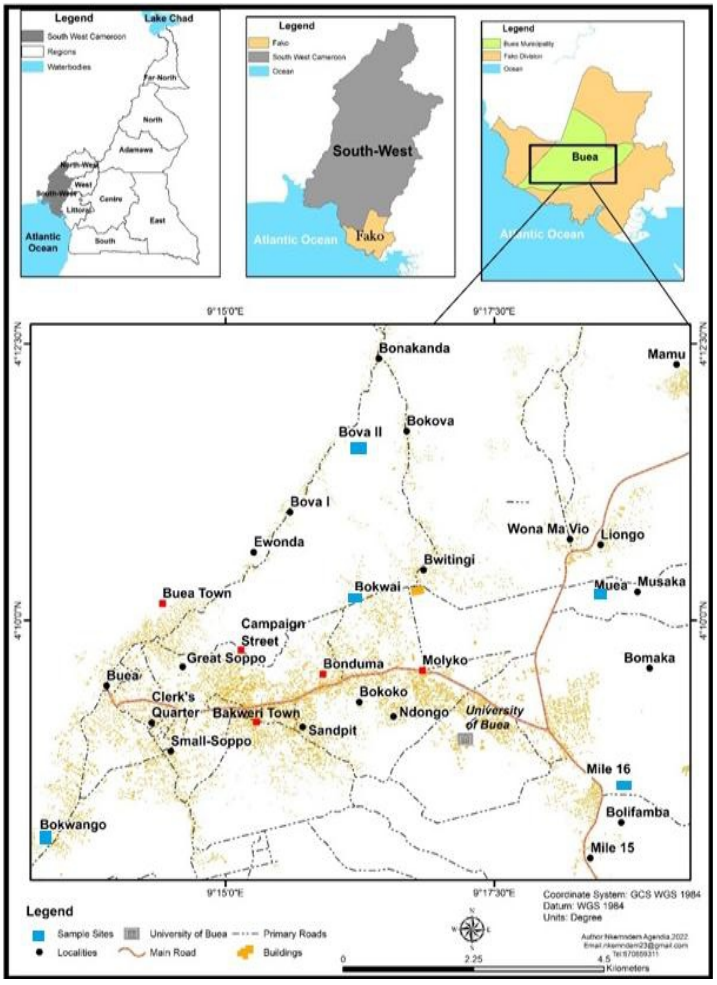
Cameroon, with a predominantly agrarian economy, has experienced profound transformations from the pre-colonial era to the present day. The government has prioritized agriculture through various development plans aimed at achieving food self-sufficiency and empowering smallholders. The integration of innovative agricultural techniques has become vital in meeting the food demands of both local and regional markets, emphasizing the importance of sustainable practices in enhancing food security and economic resilience.

However, the Eastern Slope of Mount Cameroon faces persistent food production challenges linked to unsustainable agricultural practices. Intensive land use has led to severe soil degradation, nutrient depletion, and declining crop productivity. Despite the introduction of various agricultural innovations, including improved seed varieties, organic farming, and pest management, the excessive use of synthetic fertilizers has resulted in soil acidification and a decline in soil fertility, ultimately lowering crop yields. This study seeks to analyze the adoption of agricultural innovative techniques and the associated food production challenges on the Eastern Slope of Mount Cameroon. The study was guided by the following hypothesis: the adoption of agricultural innovative techniques does not significantly improve food production and addresses challenges faced by farmers on the Eastern Slope of Mount Cameroon.

2. Materials and Methods

2.1. Location of study

The study area is located on the lower slopes of the eastern flank of Mount Cameroon, the highest peak in West and Central Africa, with an elevation of 4,095 meters above sea level. Mount Cameroon is an active stratovolcano, having experienced eight recorded eruptions since the early 20th century. Geographically, it extends between latitudes 04°00'–04°13'N and longitudes 09°00'–09°30'E. The eastern slope of Mount Cameroon is characterized by a warm and temperate climate, with noticeable variations in temperature and humidity across elevations. The upper elevations are generally cooler and cloudier, while the lower elevations experience warmer and less humid conditions (Map 1).



Map 1: Location of the Mount Cameroon Eastern slope

The study area exhibits a bimodal seasonal pattern comprising distinct dry and wet seasons, which create favorable conditions for agricultural activities. The wet season typically extends from mid-March to October, while the dry season lasts from November to February [8] [9]. The rainy period is marked by changeable weather conditions, with intense storms and high rainfall variability from mid-March to June, followed by relatively steady and sustained rainfall from mid-June to September [10].

Vegetation in the area is characterized by a diverse blend of tropical rainforest and savanna ecosystems, resulting in well-defined vegetation zones that enhance soil stability and fertility, key factors supporting agricultural productivity [11] [12]. Human activities are varied, with hunting being predominant in the forested mountainous areas, and traditional subsistence farming practiced on the slopes of Mount Cameroon [13]. Women play a central role in local livelihoods, engaging in farming activities as well as the harvesting and marketing of game meat and non-timber forest products [14] [15].

2.2. Methods

This research study utilized a mixed-methods design, combining both qualitative and quantitative approaches.

This design allowed for a comprehensive examination of the state of food security, the challenges individuals face in accessing food, and the various agricultural innovation techniques adopted by farmers to address these challenges and promote sustainable agricultural production.

A random sampling technique was used to select 200 household farmers, who served as key informants for the study. Primary data were collected through structured questionnaires and interview guides, while direct field observations enriched the understanding of on-ground realities. In addition, secondary data were obtained from peer-reviewed articles, magazines, offline and online libraries, agro-based institutions, and relevant grey literature to provide contextual and empirical support.

Considering the dual nature of the data, various analytical techniques were utilized. For the qualitative data, thematic analysis was conducted to identify recurring patterns and perceptions regarding innovative agricultural practices. Content analysis was also employed to interpret the interview transcripts, enabling a deeper understanding of respondents views. For the quantitative data, both descriptive and inferential statistical techniques were utilized. Descriptive statistics (e.g., frequencies, means, percentages) provided a general overview of trends in agricultural innovation and food access. Inferential statistics (e.g., correlation analysis, regression analysis) were applied to examine relationships and projections, particularly the impact of agricultural innovations on productivity and food security outcomes.

3. Results and discussion

3.1 Food crop production species

Investigations were initially done on the species of food crops produced by farmers in the eastern slope of Mount Cameroon as presented on Figure 1.

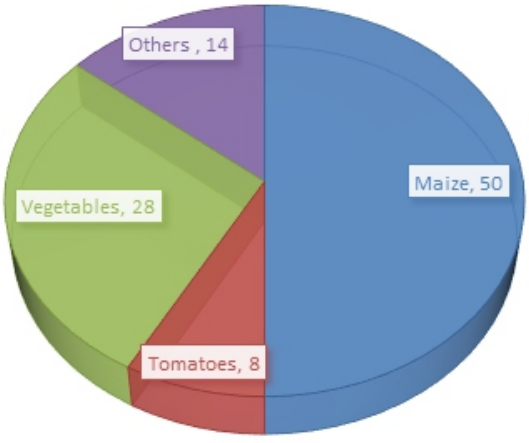


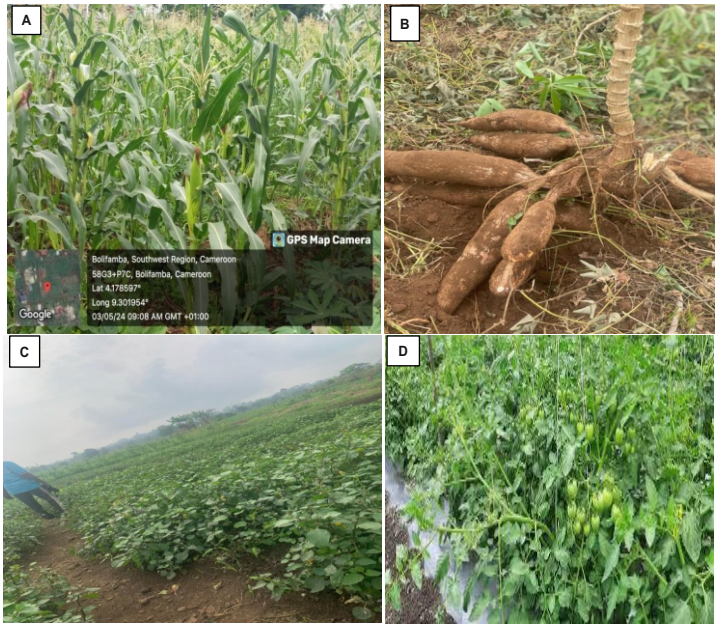
Figure 1: Food crop production species

Source: Fieldwork (2024)

According to Figure 1, half of the surveyed farmers (50%) engage in maize cultivation, primarily due to the crop's suitability to the local climate, its high market demand, and its status as a staple food for both humans and livestock. Additionally, farmers emphasized that maize can be cultivated in both the rainy and dry seasons, making it a flexible and reliable crop throughout the year. This is followed by vegetables, cultivated by 28% of the respondents. The main reasons cited for vegetable cultivation include their short growing cycle (1 to 2 months) and the ability to harvest multiple times a year, which allows for quick turnover and increased income opportunities. Only 8% of farmers reported cultivating tomatoes, citing the labor-intensive nature of tomato farming, along with the high financial, time, and energy requirements, as key deterrents. The remaining 14% of farmers cultivate other crops such as cassava, plantain, and cocoyam. These are primarily grown for household consumption, but also serve as a source of income through local sales.

The study identified maize, tomatoes, vegetables, and other crops such as cassava, yam, and cocoyam as the primary crop types cultivated on the Eastern slope of Mount Cameroon. The preference for these crops is largely due to their short cultivation periods, enabling quicker harvests and returns. These findings are consistent with [16].

, who similarly reported the prevalence of maize, cassava, cocoyam, and plantain in the Tombel Subdivision as part of a broader study on farming practices and soil degradation.



A: Maize B: Cassava C: Huckleberry D: Tomatoes
Plate 1: Samples of food crop produced by farmers
Source: Fieldwork (2024)

3.2 Farmer's perceptions of the state of farm productivity

Analysis revealed spatial variability in farm productivity across the eastern slope of Mount Cameroon, with a general declining trend as illustrated in Figure 2.

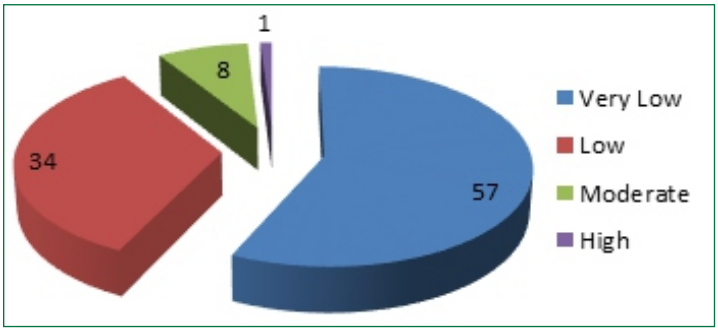


Figure 2: farmers' perceptions on the state of farm production
Source: Fieldwork (2024)

From Figure 2, 57% of the surveyed participants state that agricultural production is very low, mainly due to reduced soil fertility. This was followed by 34%, due to low power output from overcultivation of certain arable land. In the meantime, 8% of those surveyed said their soil production was moderate, indicating stable productivity. This is probably due to sustainable agricultural practices such as the use of organic fertilizers. Ultimately, only 1% of respondents say the country's

overall production is high. This addresses wider concerns regarding soil closures in agricultural areas, as highlighted in [17].

3.3 Factors Contributing to Decline in farm production

An investigation was conducted to identify the factors responsible for the decline in farm production. The findings revealed four major contributing factors, as presented in Figure 3.

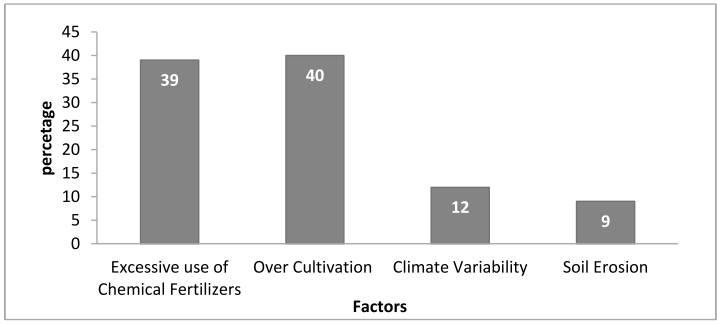


Figure 3: Factors responsible for the declined in farm production
Source: *Fieldwork (2024)*

Figure 3 shows that 40% of farmers identified over-cultivation as a major cause of the decline in farm production. Continuous cropping on the same piece of land without fallow periods or proper soil management depletes soil nutrients, rendering the soil infertile over time. Specifically, 40% of the respondents identified over-cultivation as the leading cause of declining food production, demonstrating a clear link between intensive farming and reduced agricultural output. This finding is further supported by [18], who highlighted that unsustainable agricultural practices are key contributors to declining productivity and food insecurity.

Additionally, 39% of respondents pointed to the excessive use of agro-chemicals as a key factor contributing to soil infertility, primarily due to nutrient imbalances. Commonly used chemical fertilizers, such as NPK (nitrogen, phosphorus, potassium), when applied without regard to crop-specific nutrient needs, can cause certain nutrients to become excessive This may hinder the absorption of vital elements, including calcium, magnesium, and micronutrients.

Furthermore, 12% of farmers attributed the decline in production to climate variability, particularly water stress. Soil moisture deficits, especially during dry seasons, limit plant growth and nutrient uptake, while also reducing microbial activity crucial for nutrient cycling and organic matter decomposition. Conversely, excessive rainfall in the area negatively affects soil fertility by causing flooding in some farmlands, creating anaerobic (oxygen-deprived) conditions detrimental to soil health. Finally, 9% of respondents blamed soil erosion exacerbated by heavy rainfall, particularly on farms located on the upper slopes, where soil is washed away, further decreasing soil fertility.

3.4 Types of Agricultural innovative techniques used

Findings on the different types of agricultural innovative techniques are summarized in Figure 4.

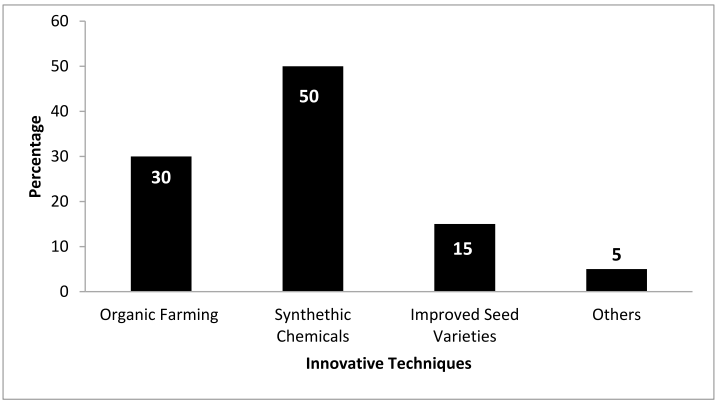


Figure 4: Various agricultural innovation techniques adopted by farmers
Source: *Fieldwork (2024)*

Based on the findings presented in Figure 4, a significant majority (50%) of respondents reported using synthetic agricultural inputs such as fertilizers, insecticides, and herbicides as their primary innovative technique. These inputs were credited with effectively controlling pests and diseases while enhancing crop productivity. This was followed by 30% of respondents who favored organic farming, citing its affordability, sustainability, and minimal health risks to humans. Additionally, 15% of participants indicated the use of improved seed varieties—particularly high-yield maize varieties supplied by the Southwest Development Authority (SOWEDA) as the key innovation implemented on their farms. Lastly, 5% of respondents mentioned other techniques, including integrated pest management (IPM). These findings suggest that synthetic chemical inputs are the most widely adopted agricultural innovation among farmers in the study area, primarily due to their immediate impact on crop yield. Plate 2 provides visual examples of the various agricultural innovative techniques currently being practiced in the region.

Moreover, 95% of the respondents reported the use of synthetic chemicals, organic farming methods, and improved seed varieties. These practices aligned with the findings of Sheoran et al. [19], who found that converting from conventional to organic farming improved soil quality across physical, chemical, and biological dimensions, contributing to enhanced productivity and food security. Likewise, the implementation of agricultural innovations on the Eastern slope of Mount Cameroon has enhanced soil fertility, boosted crop yields, and strengthened food security.These findings are consistent with the Green World Report [20].on Rwanda, which documented significant improvements in farm productivity following the application of chemical fertilizers

Plate 2: Types of agricultural innovative techniques adopted by farmers

Plate 2 illustrates various types of agricultural inputs and innovative techniques utilized by farmers in the study area. Plate 2a displays an improved maize variety adopted by farmers due to its high yield potential. Plate 2b shows a selection of insecticides and chemical inputs commonly used to control pests and diseases in farmlands. While these chemicals are widely applied, excessive or improper use has occasionally contributed to reduced crop productivity. Plate 2c presents a hybrid tomato seed variety, which is widely available in local agrochemical shops and preferred for its resistance to pests and improved shelf life. Plate 2d depicts the use of poultry manure, which is a popular organic fertilizer among farmers in the area. Most farmers favor dry poultry manure over wet forms due to its faster decomposition rate and ease of application, which enhances soil fertility more effectively.

3.5 Durations of farmers in the implementation of agricultural innovation techniques

Data on the length of time farmers have been implementing agricultural innovative techniques are presented in Figure 5. This information provides insights into the level of experience and adoption trends among farmers in the study area.

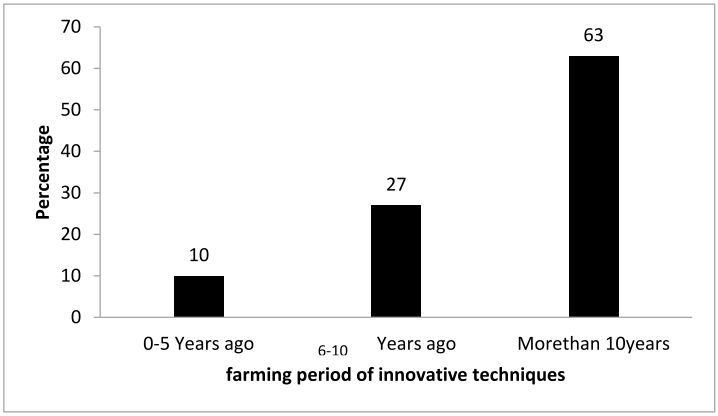


Figure 5: Durations of farmers in the implementation of agricultural innovation techniques

Based on Figure 5, a significant majority (63%) of the respondents were of the opinion that they have been using agricultural innovative techniques for more than 10 years and this means that they have a good experience on farming. This was followed by 27% of the respondents who said they started using agricultural innovative techniques 6-10 years ago and finally, 10% of the respondent said they started using agricultural innovative techniques less than 5 years ago implying that the techniques are new to them.

Although 63% of farmers indicated that they had been using agricultural innovative techniques—including improved seed varieties, organic practices, and synthetic inputs—for more than 10 years, many still experience poor farm yields.

This indicates a gap between adoption and successful implementation. As noted by [21], adoption of new techniques does not automatically translate to success, particularly in the absence of adequate training, access to resources, and context-specific adaptations.

3.6 Farmers' perceptions on the impact of agricultural innovation techniques on food production

Figure 6 presents data on crop output resulting from the use of agricultural innovative techniques by farmers, including improved seed varieties, synthetic chemical inputs, and the application of organic manure. The figure illustrates how these techniques have influenced productivity levels in the study area.

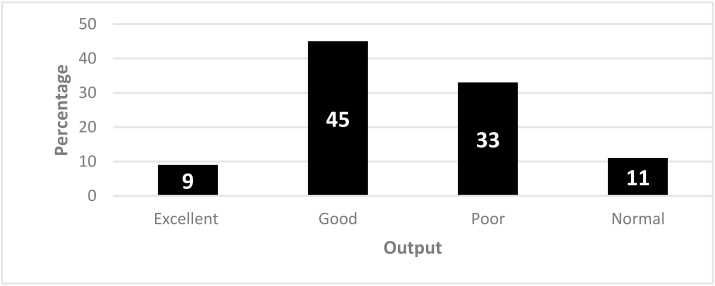


Figure 6: Farmers' perceptions on the impact of agricultural innovation techniques on food production

Based on the findings presented in Figure 6, a majority of respondents (45%) reported that their overall food production was good, attributing this to the use of agricultural innovative techniques such as synthetic chemicals, effective pest and disease management through insecticides, and the use of high-quality seeds. Additionally, 33% of respondents indicated that their crop production was poor, primarily due to challenges such as pest and disease outbreaks, limited access to farmland and quality seeds, and a lack of knowledge regarding innovative farming practices. Furthermore, 11% of respondents described their output as average, citing access to essential resources such as fertilizers, seeds, and water for irrigation as contributing factors. Finally, a minority (9%) of respondents reported excellent production outcomes, which they attributed to adequate resource availability and a strong understanding of agricultural innovative techniques.

Findings revealed that the use of agricultural innovative techniques is perceived to lead to good food production, which respondents consider beneficial. This aligns with the conclusions of [22], who found that innovative practices significantly improve food production outcomes. Their research highlighted that farmers who adopt these techniques experience better yields and improved resilience against climate variability, reinforcing the positive impact of innovation in agriculture.

3.7 Challenges in implementing agricultural innovation techniques

During the fieldwork survey, respondents identified several challenges they face in the adoption and use of agricultural innovative techniques. These findings are presented in Figure 7.

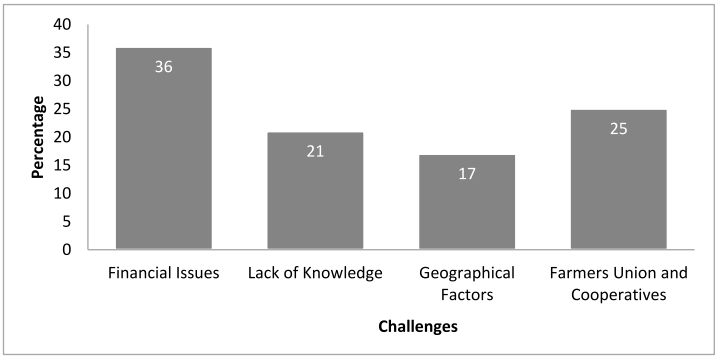


Figure 7: Challenges in implementing agricultural innovation techniques

According to fieldwork investigations, a significant majority of respondents (36%) identified financial constraints as the primary challenge to adopting agricultural innovative techniques. Farmers reported lacking the financial resources needed to purchase essential inputs such as chemical fertilizers, pesticides, herbicides, spraying equipment, irrigation pipes (particularly for tomato cultivation), and improved seed varieties. Many also noted their inability to secure loans from microfinance institutions, which further limits their capacity to invest in modern practices. This was followed by 25% of respondents who cited limited access to farmers' unions and cooperatives as a key barrier. Most farmers in the study area do not belong to cooperatives, which are typically better positioned to implement innovative techniques and benefit from government and NGO subsidies. As a result, unaffiliated farmers often miss out on support such as seedlings, chemicals, and farming tools. Another 21% of respondents highlighted knowledge-related challenges, emphasizing a lack of awareness and technical know-how regarding the correct application of innovative techniques. Many farmers reported uncertainty about appropriate nutrient and chemical dosages, leading to the overuse or underuse of fertilizers. This misapplication often results in nutrient imbalances, negatively affecting soil health and crop yields. Finally, 17% of respondents pointed to geographical factors, including difficult topography and variable rainfall intensity, as barriers to the adoption of modern techniques. In particular, farmers in hilly regions such as Bova and Bokwango expressed difficulty in transporting farm inputs like fertilizers and irrigation equipment, which complicates the use of agricultural innovations in those areas.

Farmers on the Eastern slope of Mount Cameroon face several challenges in the adoption and use of agricultural innovative techniques. Key among these challenges are financial constraints, lack of membership in farmers' unions and cooperatives, inadequate technical knowledge, and geographical limitations such as difficult terrain and variable rainfall patterns. These findings are consistent with the study [23], which examined the determinants of agricultural technology adoption among smallholder farmers in developing countries. Their research revealed that limited financial resources, insufficient knowledge, and lack of institutional support are among the primary barriers hindering the effective adoption of modern agricultural technologies.

4. Conclusion and recommendations

In conclusion, the analysis of food production challenges and agricultural innovative techniques on the Eastern Slope of Mount Cameroon reveals a complex interplay of factors that significantly impact food availability and nutritional access for local communities.

Despite the introduction of innovative agricultural practices, including improved seed varieties and organic farming methods, persistent issues such as soil degradation, nutrient imbalances, and the excessive use of synthetic fertilizers continue to undermine agricultural productivity. Moving forward, it is imperative to adopt a holistic approach that integrates sustainable farming practices, enhances soil health, and promotes equitable access to resources. Addressing these issues will not only improve food security on the eastern slope of Mount Cameroon but also contribute to the overall resilience of agricultural systems against the backdrop of climate change and economic instability.

In conclusion, the study of food production challenges and the adoption of agricultural innovative techniques on the Eastern Slope of Mount Cameroon highlights a complex interplay of environmental, socioeconomic, and institutional factors that influence agricultural productivity and food security in the region. While various innovations such as improved seed varieties, synthetic inputs, and organic farming have been introduced, persistent problems like soil degradation, over-cultivation, nutrient imbalances, and limited access to resources continue to undermine their effectiveness.

Moreover, the excessive use of synthetic fertilizers without adequate training has exacerbated soil acidification, reducing long-term soil fertility. Despite a high adoption rate of innovative techniques, low productivity persists, suggesting a gap between technology uptake and effective implementation. This underscores the need for context-specific agricultural extension services, capacity building, and resource accessibility, especially for smallholder farmers.

To improve food security and build climate resilience, the following recommendations are proposed: promote Integrated Soil Fertility Management (ISFM): Encourage balanced use of organic and inorganic fertilizers while promoting agroecological practices to restore soil health and prevent degradation. Enhance Farmer Education and Training: Strengthen extension services to equip farmers with knowledge on appropriate application of inputs, pest and disease management, and sustainable farming techniques, Support Farmers' Cooperatives and Unions: Facilitate the formation and strengthening of farmer groups to enhance access to inputs, markets, subsidies, and credit facilities.

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