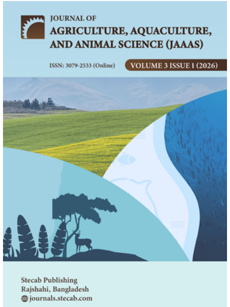

Journal of Agriculture, Aquaculture, and Animal Science (JAAAS)
ISSN: 3079-2533 (Online)
Volume 3 Issue 1, (2026)
https://doi.org/10.69739/jaaas.v3i1.1823
https://journals.stecab.com/jaaas

Published by
Stecab Publishing

Research Article

Challenges Facing Agronomists and Effective Strategies for Promoting Sustainable Agriculture in Zambia's Modern Agriculture: Insights from Mkushi District, Zambia

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About Article

Article History
Submission: March 22, 2026
Acceptance : May 07, 2026
Publication : June 17, 2026

Keywords
Agricultural Extension, Agronomists, Climate-Smart Agriculture, Sustainable Agriculture, Zambia

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ABSTRACT

This study examined the challenges affecting agronomists in promoting sustainable agriculture in Mkushi District, Zambia, and identified possible strategies for improving agricultural sustainability. A quantitative descriptive research design was employed using structured questionnaires administered to 80 respondents involved in agricultural activities within the district. Data were analyzed using descriptive statistics. The findings revealed that limited access to resources was the major challenge affecting sustainable agriculture promotion, accounting for 40% of responses, followed by inadequate training and support (30%), technological constraints (20%), and climate change (10%). The study further established that improved access to resources was considered the most effective strategy for enhancing sustainable agriculture (35%), followed by enhanced technical training (30%), improved technology adoption (25%), and policy support (10%). Although respondents were largely experienced and highly educated professionals, institutional and infrastructural limitations continued to hinder effective promotion of sustainable agricultural practices. The study concludes that sustainable agriculture promotion in Mkushi District requires integrated interventions involving improved resource accessibility, strengthened technical training, enhanced technological support, and effective institutional support systems.

Citation Style:

Kafunda, E., Musenge, D. C., Banda, S., Chola, E., Mubita, S., Mbewe, M., Mubika, D., Nyambose, J. C., Muyabe, O., Tembo, A., & Jestone, M. (2026). Challenges Facing Agronomists and Effective Strategies for Promoting Sustainable Agriculture in Zambia's Modern Agriculture: Insights from Mkushi District, Zambia. *Journal of Agriculture, Aquaculture, and Animal Science, 3*(1), 82-89. https://doi.org/10.69739/jaaas.v3i1.1823

1. INTRODUCTION

Growth and development of the agricultural sector in Zambia remain crucial for socio-economic progress, playing an important role in employment generation, food security, and export earnings (Muyabe *et al.*, 2024; Tembo *et al.*, 2025). This sector accounts for approximately 20% of GDP and employs over half of the labor force, emphasizing the significance of agricultural activities for rural livelihoods and overall progress (Muyabe *et al.*, 2024; Tembo *et al.*, 2025; Phiri *et al.*, 2025). However, the agricultural sector is undergoing dynamic changes due to variations in climate, innovation in technology, and changes in market demand, resulting in increased pressures on agricultural systems and their sustainability. In the emerging context, agronomists play an increasingly crucial intermediary role between scientific research and farming, tasked with increasing agricultural output without compromising environmental sustainability (Mutale & Lungu, 2019). According to FAO (2015), a broad definition of sustainable agriculture, as the process of sustaining agricultural output while protecting natural resources and fostering social justice serves as an important concept in addressing the ongoing agricultural related challenges. Its underlying concepts, such as soil fertility management, water conservation, biodiversity preservation, and rational resource allocation, are highly pertinent in areas experiencing climate and environmental issues. Agroforestry, crop rotations, conservation agriculture, and integrated pest management represent examples of agricultural practices that have demonstrated effectiveness in promoting productivity and sustainability in such conditions (Johnson & Campbell, 2018; Silombe *et al.*, 2025; Peters, 2020).

Conservation agriculture, defined as soil management practices involving minimal soil disturbance, maintaining soil coverage, and crop diversification, have been identified as a method of preventing soil degradation and improving yields in drought-prone areas (Mutale, 2020). The district of Mkushi is located within the Central province of Zambia and is among the country's most productive areas in terms of maize, soybean, and wheat farming (Jones & Smith, 2021). Given the agro-ecological advantages it enjoys and its proximity to markets, this is one of the best examples of analyzing potential and shortcomings of sustainable agriculture. However, agronomists operating in the area face numerous challenges related to the lack of technologies, inadequate knowledge, finances, and ineffective policies (Liywalii *et al.*, 2026; Muyabe *et al.*, 2025; Tembo, 2025). These obstacles can be further exacerbated by changes in the climate manifested by the unpredictable nature of rains, repeated drought periods, and growing temperatures which adversely affect crop yields (Dept. of Agriculture, 2021). Empirical evidence shows that climate change negatively impacts soil fertility, water resources availability, and crop yield in Zambia, including in the areas that depend on rain-fed agriculture, such as Mkushi (Kalaba & Chansa, 2018). Technological barriers present yet another hurdle in efforts aimed at sustainable agricultural development. Despite the evident success of innovations such as precision agriculture, digital soil mapping, and smart irrigation in other countries (Miller & Evans, 2019), their adoption in Zambia has been rather low owing to prohibitive costs, underdeveloped infrastructure, and insufficient technical capacity (Mubanga & Mwansa, 2023; Alubi *et al.*, 2024). This does not only hinder technology-based solutions application but also prevents farmers from adopting more sustainable practices (Chileshe & Mwale, 2020). At the same time, economic barriers, such as lack of funding, continue to pose additional problems for sustainable development of the industry, especially for smallholders (Ngoma, 2021).

Policies intended to facilitate agricultural development, such as the Farmer Input Support Programme (FISP), have made some contribution toward improving access to agronomic inputs. However, the ability of such policies in fostering sustainability in agricultural practices continues to be questionable. There is sufficient evidence showing that such approaches pay more attention to the enhancement of production without taking into account the issue of environmental sustainability. Some of the issues associated with such initiatives include ineffective targeting and logistics, among others (Dept. of Agriculture, 2022a). The problem lies in the inability of the policies to cover all the concerns and needs of both agronomists and farmers. As shown above, there are numerous factors influencing the development of sustainable agriculture in the country. However, the interaction of these factors creates a situation in which the promotion of sustainable agriculture becomes impossible or challenging. Despite the understanding of the benefits that arise from sustainable agricultural practices, it seems that agronomists working in key agricultural areas such as Mkushi encounter various barriers preventing them from being effective in the process of advocating and implementing sustainable practices. The issues related to climate change, technology, and policies make sustainable agricultural practices difficult and almost impossible. The current study seeks to investigate the problems associated with promoting sustainable agriculture in Zambia. It aims at developing a comprehensive assessment of the factors affecting sustainable agriculture in the region. In particular, the research addresses three main topics. Firstly, the focus will be on the evaluation of the environmental, technological, and policy-related challenges faced by agronomists in the region. Secondly, climate change impact on the productivity of the sector will be analyzed. Thirdly, the use of modern technologies will be discussed in relation to agronomy. Finally, the efficacy of FISP will be explored.

2. LITERATURE REVIEW

Sustainable agriculture has become an important strategy for improving food security, environmental sustainability, and climate resilience in Zambia. Sustainable agricultural practices such as crop rotation, conservation agriculture, agroforestry, integrated pest management, and efficient water management contribute to improved soil fertility, biodiversity conservation, and long-term agricultural productivity (Food and Agriculture Organization of the United Nations, 2015; Johnson & Campbell, 2018; Peters, 2020). In Zambia, sustainable agriculture has increasingly been promoted in response to challenges such as soil degradation, declining soil fertility, water scarcity, and climate change (Mutale, 2020). However, the adoption of sustainable agricultural practices remains limited due to several socio-economic, technological, and institutional challenges. Climate change has continued to negatively affect agricultural productivity through erratic rainfall, prolonged droughts, and rising temperatures, particularly in rain-fed farming systems (Zambia Meteorological Department & Ministry of Lands, 2021).

Agronomists play a critical role in promoting sustainable agriculture through farmer training, technology transfer, and implementation of environmentally friendly farming practices (Chanda, 2022). Despite their importance, agronomists face numerous challenges including inadequate funding, limited access to modern technologies, weak extension services, insufficient institutional support, and poor coordination among agricultural stakeholders (Kalungu & Daka, 2019; Mwandila, 2019). Technological limitations have also hindered sustainable agriculture adoption in Zambia. Technologies such as precision agriculture, digital soil mapping, precision irrigation, and mobile-based agricultural advisory systems have remained inaccessible to many small-scale farmers due to high costs, poor infrastructure, and inadequate technical skills (Mubanga & Mwansa, 2023).

Furthermore, limited extension services and inadequate farmer training have reduced awareness and adoption of climate-smart agricultural practices (Mwanza & Phiri, 2018). Several strategies have been proposed for promoting sustainable agriculture in Zambia. These include strengthening agricultural extension services, promoting climate-smart agriculture, increasing access to agricultural technologies, improving farmer training programs, and strengthening institutional and policy support systems (Tembo & Mwanza, 2023). Climate-resilient practices such as drought-resistant crop varieties, rainwater harvesting, and efficient irrigation systems have also been identified as important strategies for improving agricultural resilience and productivity (Nkhoma & Banda, 2021).

Overall, the literature indicates that sustainable agriculture remains essential for enhancing food security, environmental sustainability, and rural livelihoods in Zambia. However, overcoming existing challenges requires coordinated efforts involving policy reform, technological innovation, institutional strengthening, farmer capacity building, and increased support for agronomists, particularly in agricultural districts such as Mkushi.

3. METHODOLOGY

3.1. Study area

The research study took place within Mkushi District, located in the Central Province of Zambia, known to be a critical agricultural center where crops and livestock are cultivated (Daka & Kalima, 2023). Such a district is ideal for the investigation of agricultural practices owing to its strong agricultural background and use of agriculture based on rainfall as well as other inputs. The agro-ecological conditions prevailing there make the case relevant for agronomists' scrutiny of sustainability issues and interventions.

3.2. Study design and sampling

A mixed-method approach was adopted by this study in order to explore agronomic problems and strategies of sustainable agriculture (Smith, 2021a). Sampling was conducted through a mix of random and purposive sampling methods. Sample size

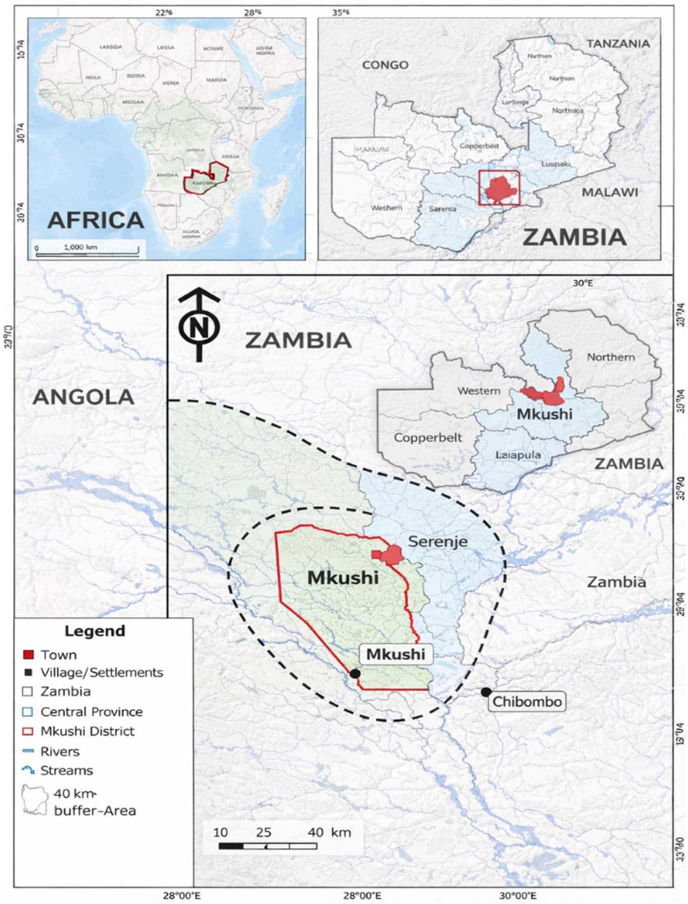

Figure 1. Geographical location of mkushi district.

was determined with the help of the Slovin's formula from a total population of 100 participants (White, 2021). Margin of error was fixed at 0.05 for this particular study. Purposive sampling method was employed for qualitative sampling to choose participants who have knowledge of agricultural systems.

3.3. Data collection

For data collection, use was made of both questionnaires and semi-structured interviews, thereby achieving measurement of quantitative data along with perceptions (Thompson, 2021). Survey questionnaire consisted of both open-ended and close-ended questions that were designed to measure cost-efficiency and availability of agricultural inputs in the context of e-vouchers and direct supply. In addition, perceptions about challenges of sustainable agriculture were also measured.

Moreover, semi-structured interviews were conducted with selected participants, who included agronomists, policymakers and some of the farmers (Mwewa, 2020). Interviews were audio-taped with permission of the interviewees and transcribed.

3.4. Sampling technique

As mentioned before, Slovin's formula was applied to determine the sample size, which was considered an acceptable technique in social sciences, especially when the population is known (White, 2021, Sample Size: Slovin's Equation). The formula is as follows:

$$n = \frac{N}{1 + N(e^2)}$$

Where,
n is the sample size,
N is the population size,
e is the margin of error (generally 0.05). In the current case study, the size of population (N) has been taken to be 100.

2.5. Data analysis

2.5.1. Quantitative analysis

Data analysis involved both descriptive and inferential analyses. Descriptive statistics were used to determine trends and distribution, whereas t-tests and chi-square tests were employed to examine the relationship among variables (Walker, 2021). Statistical software like SPSS or R can be employed to conduct this analysis (Green, 2020; Brown, 2022).

2.5.2. Qualitative analysis

Thematic analysis was applied to qualitative interview data via systematic coding and categorization in order to identify common themes among participants. Comparisons of generated themes between different participant groups (agronomists, farmers, and policymakers) provided valuable insights into challenges related to sustainability promotion in agriculture.

4. RESULTS AND DISCUSSION

4.1. Demographic characteristics of respondents

The socio-demographic characteristics of respondents were considered important in establishing the technical capacity, professional experience, and institutional background of agronomists involved in promoting sustainable agriculture within Mkushi District.

Table 1. Socio-demographic characteristics of participants in Mkushi district (n = 80).

Characteristic	Category	Number (%)
Gender	Male	52 (65.0)
	Female	28 (35.0)
Age Distribution (years)	20–30	12 (15.0)
	31–40	24 (30.0)
	41–50	20 (25.0)
	51–60	16 (20.0)
	>60	8 (10.0)
Mean Age (years)		41.5 ± 1.2
Education Level	High School Diploma	12 (15.0)
	Bachelor's Degree	32 (40.0)
	Master's Degree	24 (30.0)
	Doctorate	12 (15.0)
Years of Experience	1–5 years	8 (10.0)
	6–10 years	12 (15.0)
	11–15 years	20 (25.0)
	16–20 years	20 (25.0)
	>20 years	20 (25.0)
Mean Experience (years)		14.8 ± 2.1

Results presented in Table 1 revealed that male respondents constituted the majority (65%), while females accounted for 35%. The dominance of male participants reflects persistent gender disparities within agricultural extension and agronomic systems across Sub-Saharan Africa. Similar findings were reported by Ragasa *et al.* (2020), who observed that agricultural advisory systems remain largely male-dominated, thereby limiting women's participation in agricultural decision-making and extension delivery systems. The low representation of women may negatively affect inclusiveness in agricultural development because female farmers frequently experience limited access to extension support and agricultural information.

Regarding age distribution, the majority of respondents (55%) belonged to the economically active 31–50 years age category, while the mean age was 41.5 ± 1.2 years. This finding suggests that most respondents were mature professionals possessing substantial practical and institutional experience within the agricultural sector. Comparable observations were reported by Asfaw *et al.* (2012), who established that experienced agricultural professionals contribute significantly toward agricultural adaptation and productivity improvement. However, the relatively low participation of younger professionals may negatively affect innovation diffusion and technological transformation within the agricultural sector.

Educational attainment among respondents was relatively high, with 70% possessing at least a Bachelor's degree and 45% holding postgraduate qualifications. This demonstrates the existence of technically trained personnel capable of supporting sustainable agricultural production. Feder *et al.* (2004) similarly reported that higher educational attainment positively influences evidence-based agricultural decision-making and adoption of climate-smart agricultural practices. Despite this, respondents still reported major operational and institutional challenges, suggesting that technical knowledge alone may not guarantee effective promotion of sustainable agriculture without adequate institutional support.

Results further showed that the majority of respondents possessed more than 10 years of professional experience, with a mean experience level of 14.8 ± 2.1 years. Such experience is important in strengthening practical understanding of local farming systems, climatic conditions, and farmer behaviour. Nevertheless, Rogers (1962), through the Diffusion of Innovations Theory, argued that highly experienced professionals may occasionally demonstrate resistance toward technological change because of reliance on conventional agricultural approaches.

Overall, the demographic findings suggest that agronomic professionals within Mkushi District possess substantial technical and experiential capacity to support sustainable agriculture. However, persistent gender imbalances and low youth participation may negatively affect inclusiveness, innovation uptake, and long-term agricultural sustainability.

4.2. Challenges affecting sustainable agriculture promotion

The study further examined the major challenges affecting agronomists in promoting sustainable agriculture within Mkushi District.

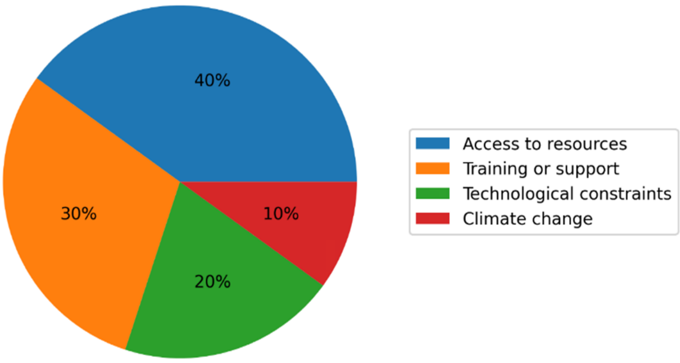

Figure 2. Primary challenges affecting sustainable agriculture promotion in Mkushi district.

Findings presented in Figure 2 revealed that limited access to resources constituted the major challenge affecting agronomists in promoting sustainable agriculture, accounting for 40% of responses. Inadequate training and support represented 30%, while technological constraints and climate change accounted for 20% and 10%, respectively.

The dominance of resource-related challenges highlights the persistent structural limitations affecting agricultural systems in Zambia. Similar findings were reported by Barrett *et al.* (2020) and Smith (2021b), who established that inadequate access to agricultural inputs, financing systems, irrigation facilities, and extension resources significantly constrains agricultural productivity and sustainability within developing countries. In Mkushi District, limited access to mechanization technologies, climate-resilient inputs, and operational support may continue to reduce the effectiveness of sustainable agricultural interventions.

Inadequate training and technical support also emerged as important constraints affecting agronomists. This finding aligns with Davis *et al.* (2012), who emphasized that effective agricultural extension systems depend heavily on continuous professional development and institutional support. Limited exposure to climate-smart agriculture, precision farming, and emerging agricultural technologies may therefore weaken agronomists' capacity to effectively promote sustainable agricultural practices among farmers.

Technological constraints further represented a major challenge within the district. Mubanga and Mwansa (2023) similarly reported that agricultural technology adoption in Zambia remains constrained by high implementation costs, inadequate infrastructure, and weak technical support systems. Although technologies such as precision agriculture, smart irrigation, and digital soil mapping have demonstrated substantial benefits globally, adoption levels remain relatively low within Zambia due to economic and infrastructural barriers.

Although climate change accounted for a smaller proportion of responses, its influence on agricultural sustainability remains substantial. Similar findings by IPCC (2022), Lobell *et al.* (2011), and Thornton *et al.* (2014) established that climate variability negatively affects agricultural productivity through erratic rainfall patterns, droughts, and rising temperatures. Since agriculture within Mkushi District largely depends on rain-fed systems, climate variability continues to threaten crop productivity and long-term food security.

Overall, the findings indicate that agronomists within Mkushi District operate under interconnected financial, technical, technological, and environmental constraints that collectively limit the promotion of sustainable agriculture.

4.3 Strategies for enhancing sustainable agriculture

The study also examined possible strategies for improving sustainable agriculture within Mkushi District.

Findings presented in Figure 3 showed that enhanced access to resources was identified as the most important strategy for improving sustainable agriculture, accounting for 35% of responses. Enhanced training represented 30%, while improved technology accounted for 25%. Policy support constituted the least preferred strategy at 10%.

The emphasis placed on improved access to resources demonstrates the importance of practical support systems in strengthening agricultural sustainability. Similar conclusions were reached by FAO (2021), which identified access to productive resources as a critical determinant of agricultural resilience and sustainability within developing countries. Improved access to irrigation facilities, financing mechanisms, mechanization technologies, and agricultural inputs may therefore significantly improve sustainable agricultural practices within Mkushi District.

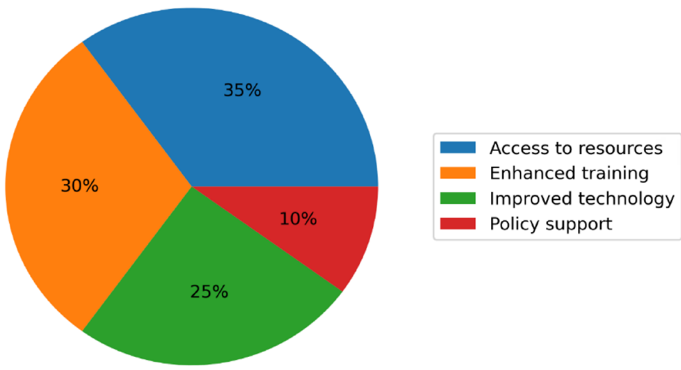

Figure 3. Suggested strategies for enhancing sustainable agriculture in Mkushi district.

Enhanced training also emerged as an important strategy for strengthening agricultural sustainability. This finding supports Anderson and Feder (2007), who argued that agricultural extension systems become more effective when professionals receive continuous technical training and institutional support. Strengthening professional development programs may therefore improve agronomists' capacity to promote climate-smart agriculture and sustainable land management practices among farmers.

Improved technology was equally identified as an important strategy for sustainable agriculture promotion. Similar findings by Fabregas *et al.* (2019) and Aker (2011) demonstrated that technological advancement improves agricultural productivity, efficiency, and environmental sustainability. However, successful technological adoption requires complementary investments in infrastructure development, financing systems, and technical capacity building.

Policy support received the lowest proportion of responses, suggesting that respondents considered operational interventions more effective than policy reforms alone. Similar observations were reported by Ellis and Biggs (2001), who found that agricultural stakeholders in developing countries frequently prioritize practical agricultural support over policy formulation. This finding may further reflect concerns regarding weak implementation of existing agricultural policies and support programs in Zambia.

The findings collectively demonstrate that sustainable agriculture promotion within Mkushi District requires integrated interventions involving improved resource accessibility, strengthened technical training, technological advancement, and effective institutional support systems.

4.4. Chapter summary

This chapter presented and discussed findings regarding the challenges faced by agronomists in promoting sustainable agriculture within Mkushi District, Zambia. The findings revealed that respondents were largely experienced and highly educated agricultural professionals, although the sector remained predominantly male-dominated. Limited access to resources, inadequate training, technological constraints, and climate variability emerged as the major challenges affecting sustainable agriculture promotion.

The study further established that improved access to resources, enhanced technical training, technological advancement, and strengthened institutional support constitute important strategies for improving agricultural sustainability. Overall, the findings suggest that sustainable agricultural transformation within Mkushi District requires integrated interventions capable of strengthening agricultural support systems, technological accessibility, and climate resilience.

5. CONCLUSION

The study examined the challenges affecting agronomists in promoting sustainable agriculture in Mkushi District, Zambia. Findings revealed that although agronomists possessed adequate education and professional experience, sustainable agriculture promotion remained constrained by limited access to resources, inadequate training, technological limitations, and climate variability. The study further established that improving access to agricultural resources, strengthening technical training, enhancing technology adoption, and improving institutional support are critical for promoting sustainable agriculture. Overall, sustainable agricultural transformation in Zambia requires integrated interventions that strengthen agricultural support systems, climate resilience, and technological capacity among agronomists and farmers.

RECOMMENDATIONS

i. Government and agricultural stakeholders should improve access to agricultural resources such as irrigation systems, improved seed, mechanization, and climate-smart inputs.

ii. Agricultural institutions should strengthen continuous technical training for agronomists in sustainable and climate-smart agricultural practices.

iii. Policymakers should promote adoption of modern agricultural technologies through improved infrastructure and affordable agricultural financing.

iv. The Ministry of Agriculture should strengthen implementation and monitoring of agricultural support policies to enhance sustainability objectives.

v. Future studies should include larger samples and multiple districts to generate broader evidence on sustainable agriculture promotion in Zambia.

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