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Climate variability and agricultural productivity in Semi-Arid Zimbabwe: a case of the Midlands Province

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ABSTRACT

Climate variability is undermining agricultural productivity in semi-arid Zimbabwe, where rural households depend on rain-fed crop and livestock production for food, income, and livelihood security. This study examined how rainfall variability, rising temperatures, and heat stress affect agricultural productivity and rural livelihoods in the Midlands province of Zimbabwe. A qualitative approach and exploratory research design were adopted to capture farmers' lived experiences and perceptions. Purposive sampling was used to select 30 participants involved in crop production, livestock rearing, and/or both. Data were collected through in-depth interviews and one focus group discussion conducted at participants' homesteads. The findings reveal that rainfall variability disrupted planting calendars, caused poor germination, increased replanting costs, and reduced maize yields in the Midlands province. Although farmers adopted coping strategies such as replanting, mulching, manure use, crop diversification, and livestock management adjustments, these remained constrained by limited resources and weak institutional support. The study concludes that climate variability is weakening agricultural resilience and recommends investment in irrigation, water harvesting, drought-tolerant crops, soil fertility improvement, livestock services, and climate information.

INTRODUCTION

Agriculture remains the backbone of Zimbabwe's rural economy, particularly in semi-arid zones where rural households are heavily dependent on rain-fed crop and livestock production for food, income and livelihood security (Musinguzi et al., 2025). The agro-ecological regions IV and V are characterised by low and erratic rainfall, recurrent droughts, high temperatures and generally low soil fertility (Chisadza et al., 2025). These conditions make agricultural production highly vulnerable to seasonal climate patterns, particularly for smallholder farmers with limited access to irrigation, credit, improved inputs and climate information services. Madamombe et al. (2024) found that smallholder farmers in semi-arid Zimbabwe are increasingly aware of extreme weather events and have responded through strategies such as water-harvesting, mulching, improved crop varieties and tree planting. Likewise, Muoni et al. (2025) show that smallholder maize

production in semi-arid Marange is still highly vulnerable to climate change, with low yields being linked to both climatic exposure and socio-economic constraints. Climate variability is not only an environmental issue but also a livelihood and food security issue for rural Zimbabwean communities. Climate variability is defined as short and medium-term fluctuations in rainfall, temperature, and extreme weather events (Kaua, 2022; Kumsa et al., 2024).

In semi-arid Zimbabwe, this variability is a key determinant of agricultural outcomes, as even small changes in rainfall timing or distribution could have large impacts on planting, crop growth, and harvesting. Farmers in south-western semi-arid Zimbabwe are increasingly facing late arrival of rains, erratic seasonal patterns, long dry spells, and recurring droughts that are disrupting the traditional farming calendar (Ndlovu et al., 2020). Rainfall variability is especially damaging as it directly affects germination, soil moisture availability, and

crop development. Farmers may be forced to replant, reduce the area cultivated, or accept poor yields when rains start late, cease early, or are interrupted by mid-season dry spells (Madamombe et al., 2025; Musinguzi et al., 2025). Farmers who depend almost entirely on natural precipitation to plan their agricultural activities have found this increasingly problematic because of the uncertainty about rainfall.

In semi-arid Zimbabwe, rising temperatures have further added to the vulnerability of agriculture. IPCC (2022) states that climate change is already impacting African food systems by decreasing crop yields, impacting rangelands, incurring livestock losses, and affecting food security. Higher temperatures in semi-arid farming systems of Zimbabwe increase evapotranspiration, reduce soil moisture, and increase water stress for crops and livestock (Mwadzingeni et al., 2022; Chari & Ngcamu, 2022). Muoni et al. (2025) also demonstrate that rain-fed maize systems in the semi-arid Marange are particularly vulnerable to climate-related stress, with productivity influenced by agronomic practices, access to information, and household-level adaptive capacity. Drought and heat stress decrease pasture availability, compromise animal health, and increase the risk of livestock mortality for livestock farmers. According to Ndlovu et al. (2020), climate-related pressures have resulted in crop and livestock losses in traditional farming systems, further increasing humanitarian support dependence in some semi-arid communities. These effects contribute to chronic food insecurity, rural poverty, and declining resilience among smallholder farming households. IPCC (2022) points out that climate change is already threatening food security in African dryland systems, especially where livelihoods rely on climate-sensitive agriculture. Examining the effects of rainfall variability, drought frequency, and increasing temperatures on crop and livestock production can provide insights for policy and practice. This study therefore seeks to investigate the effects of climate variability on agricultural productivity in semi-arid Zimbabwe with a specific focus on Midlands province.

The impact of climate variability in semi-arid Zimbabwe has become more evident, consistent with general regional patterns of climate change impacting the dryland farming systems of Southern

Africa (Moyo et al., 2025; Chivangulula et al., 2025; Omotoso et al., 2023). According to the IPCC (2022), African drylands are increasingly vulnerable to climate-related risks such as rising temperatures, variability of rainfall, recurring droughts, and stresses on climate-sensitive livelihoods. In Zimbabwe, these changes are particularly acute in agro-ecological regions IV and V where agricultural systems are already hampered by low rainfall, limited water availability and fragile natural resources (Cosmas et al., 2025). As Ndlovu et al. (2020) note, erratic rainfall, droughts and declining reliability of traditional rain-fed farming systems are increasingly impacting semi-arid districts in south-western Zimbabwe, Mangwe, Matobo and Gwanda among them.

This points to climate variability as a now permanent structural challenge to agricultural sustainability in semi-arid Zimbabwe, not an occasional disruption. Rainfall variability remains one of the most important dimensions of climate variability in these regions. Ndlovu et al. (2020) report that in semi-arid Zimbabwe, rainfall seasons are increasingly perceived by farmers to be more unpredictable, with delayed onset, early cessation, and poor distribution of rainfall disrupting traditional agricultural calendars. These changes shorten the effective growing season and impact farmers' ability to determine appropriate planting dates. Similarly, Madamombe et al. (2024) show that smallholder farmers in semi-arid Marange are aware of extreme weather events and are increasingly facing production uncertainty due to rainfall instability. When rains are late or end early, farmers may have to replant, reduce the area they farm, or grow less preferred crops. Such disruptions are especially damaging in rain-fed agricultural systems where irrigation infrastructure is limited, and crop production is almost entirely dependent on seasonal rainfall.

Mid-season dry spells have also emerged as a major threat to agricultural productivity in semi-arid Zimbabwe. Such dry spells are particularly damaging when they occur at sensitive stages of crop growth such as germination, flowering, and grain filling. Crop failure and livestock losses in traditional farming systems have been attributed to repeated dry spells and drought events (Ndlovu et al., 2020). Madamombe et al. (2024) further show that farmers have responded to these pressures

through soil-water management such as mulching, water harvesting, improved crop varieties, and tree planting. But it means that even with enough total rainfall in a season, dry spells still exist, so a poor harvest can still occur if the rainfall is patchy. This highlights the importance of the intra-seasonal distribution of rainfall rather than the total annual rainfall in determining agricultural outcomes in semi-arid environments. The low levels of agricultural productivity in semi-arid Zimbabwe are generally attributed to the high exposure of crop and livestock production systems to low and erratic rainfall, frequent droughts, water stress, and poor soil fertility.

According to Chiturike et al. (2024), in Zimbabwe's semi-arid smallholder areas, crop production is largely rain-fed, but low, erratic and unreliable rainfall, frequent droughts and infertile sandy soils have resulted in crop failure, low economic returns and poor grain harvests. Baudron et al. (2024) show that mixed crop-livestock farms in semi-arid Zimbabwe are still characterised by very low levels of crop and livestock production. Average annual cereal production was only 362 kg per farm, and average livestock offtake was 0.64 Tropical Livestock Units per farm. Such productivity is well below levels required to meet household food requirements and points to the wider vulnerability of rainfed maize systems in semi-arid environments. Likewise, Kugedera et al. (2024) reported that maize productivity in semi-arid smallholder farming systems is still low, with many farmers harvesting less than 500 kg ha⁻¹ and only a few harvesting more than 1,000 kg ha⁻¹. The trends show that falling agricultural productivity is not only a climatic issue but also a structural livelihood challenge due to limited access to inputs, poor extension support, low soil fertility, and inadequate climate information.

MATERIALS AND METHODS

Methods

This study adopted a qualitative method to examine the effects of climate variability on agricultural productivity in semi-arid Zimbabwe. A qualitative approach was appropriate because the study sought to understand farmers' lived experiences, perceptions and interpretations of changing rainfall patterns, rising temperatures, heat

stress, crop failure and livestock productivity decline. Qualitative research is particularly useful where the aim is to obtain rich, contextual and meaning-centred accounts of how people experience social and environmental phenomena (Creswell & Poth, 2018). An exploratory design was employed, and it helped to uncover how farmers interpret delayed rainfall onset, mid-season dry spells, rising temperatures, declining soil moisture, livestock stress, and changing agricultural productivity, as stipulated by Creswell & Poth (2018).

Population and sampling

Participants were selected using purposive sampling. This sampling technique was appropriate because the study targeted individuals with direct knowledge and experience of rain-fed crop and livestock production in semi-arid communities. Purposive sampling allows researchers to deliberately select information-rich participants who can provide detailed insights into the phenomenon under investigation (Patton, 2015; Palinkas et al., 2015). A total of 30 participants took part in the study from three rural agricultural communities in the Midlands province, namely Somabhula, Lower Gweru, and Chiwundura. These participants were selected because they were actively involved in crop farming, livestock rearing, or both, and were therefore able to provide relevant information on the effects of climate variability on agricultural productivity.

Data collection

Data were collected through in-depth interviews and one focus group discussion. In-depth interviews were used to obtain detailed personal accounts of farmers' experiences with rainfall variability, poor germination, crop failure, heat stress, livestock losses, and livelihood insecurity. Focus group discussions are useful in qualitative research because they allow participants to reflect collectively on shared experiences and generate data through group interaction (Morgan, 1997). The focus group discussion therefore enabled the study to capture community-level interpretations of climate variability and agricultural decline. Participants were approached at their homesteads, where interviews were conducted in familiar and natural settings. This helped to create a comfortable environment for participants and allowed the researcher to engage with farmers within the

context of their everyday agricultural activities. Conducting interviews at homesteads was also useful because it enabled the researcher to observe the local farming environment, including fields, gardens, livestock conditions, water sources, and other visible indicators of agricultural vulnerability. This strengthened the contextual understanding of the findings. Data collection continued until data saturation was reached. Saturation was achieved when additional interviews no longer produced substantially new information, themes, or insights. Saturation is widely used in qualitative research to guide sample adequacy, particularly where the aim is to ensure that recurring patterns have been sufficiently explored (Guest et al., 2006; Hennink & Kaiser, 2022). In this study, saturation was reached when participants began repeating similar experiences concerning delayed rains, mid-season dry spells, heat stress, poor harvests, livestock weakness and limited adaptation options.

Data analysis

The data were analysed using thematic content analysis. This method was appropriate because it allowed the researcher to identify, organise and interpret recurring patterns within the interview and focus group data. Braun and Clarke (2006) describe thematic analysis as a flexible method for identifying and reporting patterns or themes within qualitative data. In this study, the analysis involved repeated reading of interview notes and transcripts, coding of meaningful statements, grouping of similar codes, and development of major themes. The main themes included rainfall variability, delayed planting, poor germination, mid-season dry spells, heat stress, declining maize yields, livestock losses, reduced pasture and water availability, food insecurity, and local adaptation strategies.

Trustworthiness

To enhance the trustworthiness of the study, member checking was used. Participants were given an opportunity to confirm whether the interpretations of their responses accurately reflected their views and experiences. Lincoln and Guba (1985) identify member checking as an important strategy for improving credibility in

qualitative research because it allows participants to verify the accuracy of the researcher's interpretations. This process helped to reduce misrepresentation and strengthened the credibility of the findings. The study also used direct quotations to preserve participants' voices and to ensure that the findings remained closely connected to their lived experiences.

RESULTS AND DISCUSSION

Impact of rainfall variability

The findings indicate that rainfall variability is one of the most serious factors affecting agricultural productivity among smallholder farmers. The timing, duration, and distribution of rainfall are not reliable, and farming has become more uncertain. Most households in Lower Gweru rely on rain-fed crop and livestock production. Changes in rainfall patterns impact planting decisions, availability of soil moisture, and household food security. One consistent finding was that the rainy season was coming later than expected. Farmers said that in the past they were more confident to start preparing and planting because the rainfall patterns were relatively predictable. However, many participants stressed that the first rains are now often late or unreliable. One farmer said: "Long ago we knew that when the rains started, it was time to plant. These days the rain may come once, then disappear for many weeks, and the seed just dies in the soil. Sometimes we are forced to plant again, but by then some households will no longer have enough seed. This has made farming very difficult because we now plant with fear, not knowing whether the rains will continue." (Participant 3; Female- 62 years). The finding shows that the late arrival of the rains has disturbed traditional farming calendars in Lower Gweru. Farmers are less certain when to plant, and the risk of crop failure has increased. In some households, the first rains are followed by the sowing, but the rains are gone before germination is complete. Others wait for normal rains to plant, but this shortens the growing season, with the result that crop yields are lowered.

Table 1. Description of Activities Contributing to Livelihoods of People in the Study Area

Activity	Description
Crop production	Households cultivate crops such as maize and small grains, mainly under rain-fed conditions, to provide food for household consumption and sometimes surplus for sale.
Livestock rearing	Households keep cattle, goats and other livestock for draught power, manure, meat, milk, income, savings and household security.
Vegetable gardening	Some households grow vegetables near homesteads, wells, boreholes or other water sources for household nutrition and small income.
Casual labour	Household members engage in temporary work such as farming labour, construction, domestic work, or other informal jobs to earn cash or food.
Petty trading	Households sell small goods, vegetables, grain, livestock products, or other items to supplement income.
Natural resource use	Households collect firewood, wild fruits, thatching grass, and other natural resources for domestic use or sale.
Small-scale irrigation or watering	Some farmers use boreholes, wells, buckets, or nearby water sources to water vegetables or crops during dry periods.
Crop diversification	Farmers plant drought-tolerant crops such as sorghum, millet, or other small grains to reduce dependence on seasonal rainfall.
Livestock diversification	Some households keep goats or smaller livestock that are more tolerant of dry conditions and easier to manage during drought periods.

Participants also indicated that poor germination has become common due to inadequate rainfall during the early stages of crop development. This compels some farmers to replant, raising the demand for labour and the costs of production. However, not all households can afford to purchase more seed when the first planting fails. One participant said: “If the first crop fails, we are forced to plant again, but sometimes we do not have enough seed. You end up reducing the field because you cannot plant the whole area again.” (Participant 8; Female- 48 years). This implies that the impact of rainfall variability on farmers is dependent on their resource capacity. Those households which have access to seed, draught power and labour may try to replant, while poorer households may reduce the area under cultivation or abandon some fields. In this way, rainfall variability exacerbates existing livelihood vulnerabilities in Lower Gweru. Mid-season dry spells were also cited as a major cause of declining crop productivity. Even if the crops germinate well, participants explained that they often fail later in the season when rainfall stops at critical stages such as flowering and grain filling. One farmer presented the situation as follows: “The

maize can look healthy at first, but when the dry spell comes during flowering, the cobs do not fill properly. In the end, you harvest very little.

Sometimes the plant remains standing in the field, but when you open the cob there is almost nothing inside. This is painful because you would have already used seed, fertiliser and labour, but the harvest does not match the effort.” (Participant 16; Male – 37 years). This result shows that the distribution of rainfall is important. In Lower Gweru, farmers may receive some rain during the season, but if it is poorly distributed, crops still undergo moisture stress. Maize was said to be especially vulnerable as it requires dependable rainfall at critical stages of its growth cycle. This means that in a season that looks very promising at the beginning, farmers will often end up with a lower harvest.

Temperature increases and heat stress

The findings show that increasing temperatures and heat stress are increasingly affecting agricultural productivity, particularly in rain-fed farming systems. Participants from both regions explained that farming has become more challenging because the heat is now more intense,

soils dry quickly after rain, crops wilt before maturity, and livestock struggle during prolonged dry periods. These findings substantiate the paper's wider argument that temperature increases compound the effects of rainfall variability by increasing evapotranspiration, reducing soil moisture, and intensifying water stress on crops and livestock. Farmers in Somabhula revealed that the high temperatures were resulting in less moisture being retained in the soil, especially after short spells of rain. Participants said the extreme heat caused the soil to dry quickly, even when it rained. This affects germination, early crop development, and crop survival during dry spells. As one participant explained: "The rain may come, but after a few days the ground becomes dry again because the sun is too hot. The crops start wilting even when we thought the rain was enough. Even if we weed the field properly, the crops cannot survive when the soil has no moisture. This makes us feel helpless because the rain comes, but the heat takes away its benefit before the crops can grow." (Participant 4; Female – 67 years).

This finding suggests that rainfall is becoming less effective as temperatures increase. Farmers used to be able to rely on rain to keep crops alive longer, but rising temperatures are causing moisture to evaporate more quickly. Consequently, crops experience water stress even in seasons with some rainfall. Somaabhula farmers also associated poor crop development with increased temperatures. Now crops dry up before producing a good harvest or mature too quickly, participants noted. One farmer had this to say: "The maize no longer grows the way it used to. The heat makes it dry before the cobs are full, and at harvest time you find very little grain." (Participant 9; Female – 53 years). This means that heat stress has an impact not only on crop survival, but on quality of yield. High temperatures reduce the growing period and disturb proper grain formation. Even if crops survive dry periods, the final harvest may be poor because the crop does not get enough moisture at critical growth periods. As such, it was viewed by participants as one of the factors that have contributed to the decline in agricultural productivity in Somabhula.

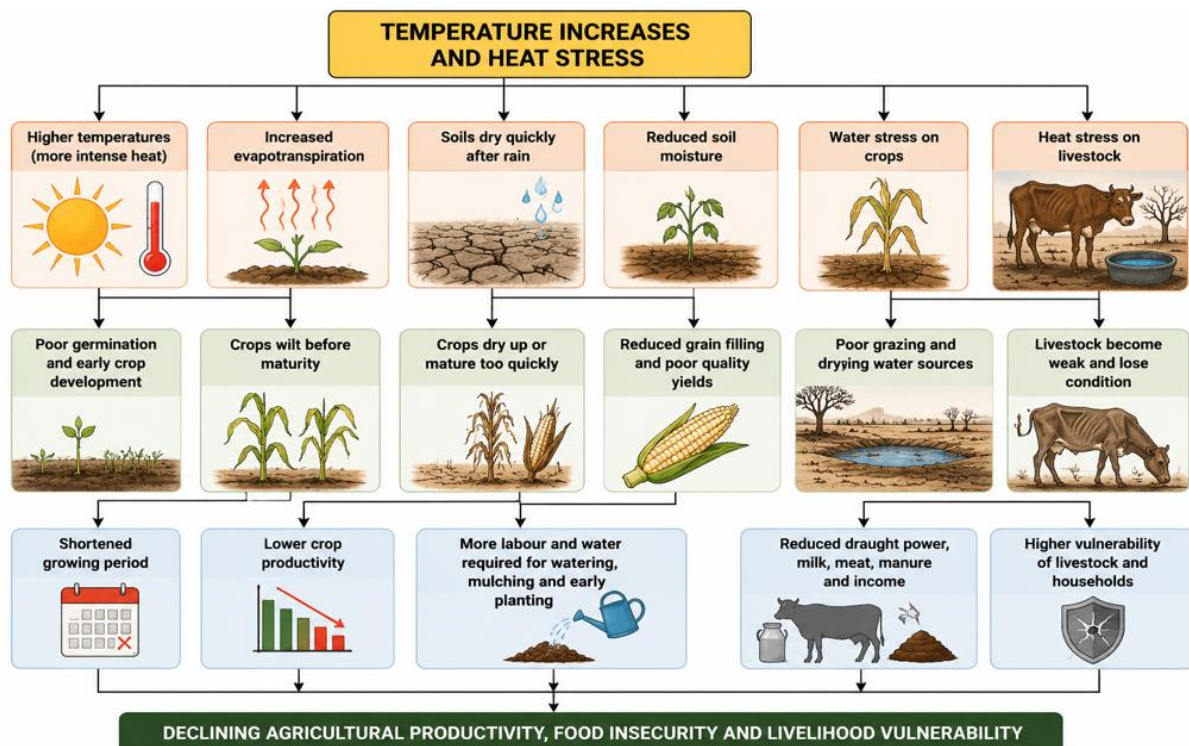


Figure 1: Effects of Temperature Increases and Heat Stress on Agricultural Productivity

The findings also show how the burden on farmers trying to protect their crops through watering, mulching, or early planting has increased with heat stress. However, these strategies are not

always successful due to the limited availability of water sources and the high demand for labour. "We try to water the vegetables and cover the soil, but the heat is too much. The water finishes quickly,

and not everyone has a borehole or enough buckets to keep watering. Sometimes we spend the whole morning carrying water, but by afternoon the soil is dry again. Those with water sources can save some crops, but for many of us the vegetables just wither before they are ready for harvest.” (Participant 24; Male – 60 years). This finding points to the uneven ability of households to cope with heat stress. Farmers with boreholes, wells, or gardens close to water sources are better able to protect their crops, while poorer households are more exposed. As such, the rising temperatures worsen existing inequalities, as adaptation requires access to water, labour, equipment, and financial resources.

The production of livestock has also been affected by rising temperatures. The participants from Somaabhula said that cattle and goats become weak in the hot and dry periods due to the deterioration of the grazing land and the early drying up of the water sources. “Asked one livestock farmer: “When it is very hot, the grass dries quickly, and the cattle move long distances looking for water. Some become thin, and they do not have strength for ploughing.” (Participant 11; Male – 40 years). This finding is important because livestock are central to rural livelihoods in Somaabhula. They provide draught power, manure, income, milk, meat, and household security. When heat stress weakens livestock, it also affects crop production because households may lose access to animal traction for land preparation. Thus, temperature increases affect crop and livestock systems in connected ways.

Decline in crop and livestock productivity

The findings reveal that climate variability has caused a significant fall in crop and livestock productivity. Participants from both areas stated that farming was no longer as reliable as it once was due to the unpredictability of rainfall, increased temperatures, less productive soils, and increasing shortages of water and pasture for livestock. These results support the paper’s larger point that the degradation of agricultural productivity in semi-arid Zimbabwe is driven by the combined impacts of rainfall variability, drought, heat stress, and poor soil conditions. Farmers in Lower Gweru revealed that maize production had been severely affected by late rains, mid-season dry spells and poor soil moisture. Participants attested that maize is still the main crop grown by most households, but it is

becoming increasingly difficult to get a meaningful harvest. One farmer told me: “We still plant maize because it is our main food crop, but these days the harvest is very poor. Sometimes you work the whole season and get only a few bags.” (Participant 16; Male – 37 years).

The finding suggests that maize production in Lower Gweru is becoming less reliable. Farmers continue to grow maize because it is a preferred food in the household and a staple crop. However, it is a crop that is highly sensitive to moisture stress. The poor distribution of rainfall is detrimental to germination, growth, and grain filling of maize. This means that households often get smaller yields than they anticipate, which leads to lower food stocks and endangers their livelihoods. Participants in Chiwundura also reported falling crop yields, especially where farmers are wholly dependent on rain-fed production. One participant had this to say: “The crops may come out well at first, but when the heat becomes too much, and the rains stop, they dry before producing anything useful. You can see that the crop wanted to grow, but the heat burns it before it reaches maturity. Even when we apply manure or fertiliser, it does not help much if there is no moisture in the soil. This is why many farmers now harvest far less than they expected, even after working hard in the field.” (Participant 7; Male – 44 years). This suggests that crop failure is not only caused by lack of rainfall, but also by the interaction between rainfall variability and rising temperatures. Heat stress increases soil moisture loss and exposes crops to water shortages during critical growth stages. In Chiwundura, farmers linked this to poor grain formation, reduced yields, and repeated crop losses.

The findings of this study show that climate variability has become a major determinant of agricultural decline in the Midlands province of Zimbabwe. Across the three study sites, farmers associated declining productivity with unreliable rainfall, rising temperatures, poor soil moisture, recurrent dry spells, reduced grazing resources, and weakening livestock health. These findings demonstrate that agricultural productivity in semi-arid Zimbabwe cannot be explained by climatic factors alone. Rather, it is shaped by the combined effects of biophysical and household-level conditions. Rainfall distribution, soil fertility and moisture availability determine the productive

potential of farming systems, while access to inputs, labour, draught power, timely planting decisions and household adaptive capacity influence farmers' ability to respond to climate-related stress. This means that farmers who experience the same climatic conditions may achieve different production outcomes depending on their resource base and capacity to adapt.

The findings therefore align with Makuvaro et al. (2017) and Rurinda et al. (2013), who argue that agricultural performance in Zimbabwe's semi-arid smallholder systems is influenced by the interaction between rainfall variability, soil conditions, farm management practices and household resource constraints. The evidence presented in this study is consistent with Mupangwa et al. (2011), who show that smallholder agriculture in semi-arid southern Zimbabwe is strongly dependent on the seasonal characteristics of rainfall, particularly the start, end and length of the growing season, as well as the occurrence of dry spells. Similarly, Mushore et al. (2021) found that smallholder farmers relying on rain-fed agriculture in Zimbabwe are highly vulnerable to reduced rainfall reliability, prolonged dry spells, droughts and poor intra-seasonal rainfall distribution. These studies support the present finding that rainfall variability has disrupted traditional farming calendars and reduced farmers' confidence in seasonal planning. In Lower Gweru, for example, farmers' uncertainty about when to plant reflects the wider challenge faced by rain-fed agricultural systems that are increasingly exposed to delayed rainfall onset, mid-season dry spells and shortened growing seasons.

Farmers indicated that the onset of rainfall has become increasingly unpredictable, making it difficult to decide when to plant. This is important because rain-fed agriculture depends not only on the amount of rainfall received, but also on its timing, distribution, and reliability. This finding is supported by Raes et al. (2004), who argue that determining appropriate first planting dates in Zimbabwe depends on reliable rainfall-onset criteria, since false starts to the rainy season can expose farmers to crop failure. Similarly, Mavhura (2015) shows that small-scale rain-fed agriculture in Zimbabwe's arid and semi-arid areas is highly vulnerable to erratic rainfall and frequent droughts, which makes temporal water shortages a major challenge for smallholder farmers. When farmers

plant after the first rains and rainfall stops soon afterwards, seeds fail to germinate, or young crops die before establishment. This forces farmers to replant, reduce the size of cultivated land, or abandon some fields. The findings therefore show that rainfall variability increases both production risk and production costs. This supports Ndlovu et al. (2020), who observed that farmers in semi-arid Zimbabwe experience delayed rainfall onset, prolonged dry spells and unreliable seasonal patterns, all of which undermine traditional agricultural calendars. The findings further show that rainfall variability has direct implications for household food security. Farmers reported that harvests no longer last until the next agricultural season, forcing households to buy food, depend on casual labour, seek remittances, or rely on external assistance.

This finding confirms that rainfall variability is not only an environmental problem, but also a livelihood and socio-economic challenge. Murungweni et al. (2014) similarly found that farmers in semi-arid south-eastern Zimbabwe adopt various livelihood strategies to close household food gaps when agricultural production is insufficient. Pindiriri et al. (2024) further show that climate variability affects rural poverty and cereal productivity in Zimbabwe, while non-agricultural livelihoods such as employment and remittances play an important role in reducing household vulnerability. Poor rainfall reduces crop yields, while repeated crop failure weakens household income and reduces the ability to invest in inputs for the next season. The findings show that rising temperatures and heat stress are intensifying the effects of rainfall variability. Farmers in both areas explained that even when rain falls, high temperatures cause soils to dry quickly, leaving crops exposed to moisture stress.

CONCLUSION

Climate variability has emerged as a critical challenge to agricultural productivity in semi-arid Zimbabwe, with the findings showing that both crop and livestock systems are increasingly under stress. The study found that rainfall variability remains one of the most damaging climatic factors, particularly because smallholder agriculture in these areas depends largely on rain-fed production. Farmers in the study reported that delayed rainfall

onset, early cessation of rains, and mid-season dry spells have disrupted traditional planting calendars and made farming decisions increasingly uncertain. These changes have resulted in poor germination, repeated replanting, reduced cultivated area, poor grain filling, and declining harvests. The findings further show that rainfall variability is not only a production problem, but also a livelihood challenge, as reduced yields directly affect household food availability, income, and resilience. The study also found that rising temperatures and heat stress are intensifying the effects of rainfall variability. Participants explained that even when rainfall is received, high temperatures cause soils to dry quickly, reducing soil moisture and weakening crop growth. Heat stress was reported to cause wilting, premature drying of crops, and poor grain formation, especially in maize, which remains the dominant staple crop but is highly sensitive to moisture stress. The findings therefore demonstrate that rainfall variability and temperature increases do not operate separately; rather, they interact to deepen agricultural vulnerability. Rising temperatures also affect livestock productivity by reducing pasture availability, drying up water sources, weakening animals, and increasing their vulnerability to disease. This is particularly serious because livestock provide draught power, manure, income, food, and household security.

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