

Adoption of Climate-Smart Livestock Production Systems by Small-Scale Farmers in Zimbabwe

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ABSTRACT: The adoption of climate-smart agriculture systems is a promising approach to farming adaptation and mitigation, gaining increasing relevance in the face of climate change. Livestock production strategies, crucial for food security and livelihood improvement, are likely to be severely impacted by climate change. This study investigates the adoption of climate-smart livestock production systems and their impact on livelihoods in Chivi district, Zimbabwe. Data were collected from three administrative wards through Focus Group Discussions with 27 purposively sampled small-scale livestock farmers (nine per ward) and one-on-one interviews with four Agricultural Technical and Extension officers, professionals who work to improve agricultural practices and rural development by communicating knowledge and providing support to farmers. Braun and Clarke's (2006) reflexive thematic analysis framework was used to analyze the data. The study reveals that conservation of fodder and dried crop residues are the most widely adopted climate-smart livestock production systems due to their ease of practice, low capital requirements, and labor-intensive nature. The adoption of these systems enhances livelihoods by providing household income and food. The study recommends the adoption of climate-smart livestock production systems, particularly in vulnerable and dry areas, to improve the sustainability of livelihoods.

KEYWORDS: Adoption, Climate change, climate-smart agriculture, climate-smart livestock production systems, small-scale livestock farmers.

INTRODUCTION

Because of climate change and variability, foodstuff and environmental welfare concerns have taken centre stage worldwide in recent years. Efforts to increase food security and environmental sustainability to enhance livelihoods all over the world frequently reinforce each other thereby permitting agriculturists to adapt and mitigate the consequences of the changing climate and associated challenges. Mitigation of climate change and food security initiatives are anticipated to be centred on proper technologies and practices that restore natural environments as well as improve agricultural resilience, thereby heightening food security. Climate-smart agriculture (CSA) technology and practices compromise prospects for undertaking climate change concerns and agricultural sector for commercial development. The term CSA was established to signify an approach geared to facilitate attainment of worldwide food safety and charting a sustainable route for agricultural development in the face of climate change (Workie et al., 2020).

The core constituents of CSA were established in reaction to quarrels and differences concerning climate change and agricultural rule for long-term developments at the United Nations Framework Convention on Climate Change (UNFCCC). Despite the fact that climate-smart agriculture is a new concept, it has advanced since its presentation at the 2010 Hague Conference on Agriculture, Food Security, and Climate Change (FAO, 2010). Lipper and Zilberman (2018) posit that it was argued that ensuring food security needs to undergo a long-term reorganization of the agricultural sector, and that climate change mitigation strategies must be outlined in this context. Globally, CSA practices vary in different areas as climate conditions vary with areas. However, livestock producers face a variety of constraints due to a consequence of climate change (CC) which has adversely impacted their livelihoods. Livestock farming is a rapidly growing sector globally and it makes a significant contribution to global food security apart from being a source of livelihood to small-scale livestock farmers.

Climate change and extreme weather conditions, including severe droughts and crop failure initiate food insecurity crises aiding further challenges to the continent's sustainable development (Aggarwal et al., 2018; FAO, 2012). FAO (2012) reported that in Africa subsistence farmers depend on farming as the basis of livelihood for a third of the global population. According to Aggarwal et al. (2018) approximately 60% of people who depend on farming for a living are animal owners. Livestock facilitates farming activities through provision of draft power and soil nutrients especially to small-scale farmers whose livelihood greatly depend on agriculture. Drought intensity and duration, as well as long-term climate changes, can have a substantial impact on forage production

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and animal stocking rates. As a result of climate change, the battle in contradiction to poverty and the enhancement of rural livelihoods in places such as sub-Saharan Africa to encounter new problems. Most regions that are susceptible to CC, specifically South Asia and sub-Saharan Africa are also areas where small-scale agriculturalists and rural societies depend on livestock rearing for foodstuff, revenue, and livelihood maintenance. As a result, there is a pressing need to assist small-scale animal farmers in becoming more climate resilient by considering climate-smart livestock technologies seriously. Climate change at present is having a negative effect on Zimbabwe's agricultural economy, which is heavily reliant on rain-fed pastures due to its location in one of the most vulnerable regions. Small-scale farmers face a number of barriers and challenges, including outbreak of livestock pests and diseases, which may spread and change in frequency and range as a cause of climate change. The adoption of climate-smart agriculture systems is an agricultural adaptation and mitigation strategy which is aimed at improving livelihoods (FAO, 2018). To activate this evolution, government and non- governmental organization (NGOs) must introduce useful low-emission and climate resilient farming practices in the plots of livestock farmers. They must adopt an extensive idea of agricultural expansion that delivers support to farmers to adopt new practices. Examples of Climate Smart Livestock production systems rotational grazing, silvopasture systems, feed supplementation and improved breeding, and manure management systems.

Small-holder farmers in the developing world, particularly in United States of America (USA), have resource restrictions that prevent them from completely implementing CSA despite the potential benefits (FAO 2010). Nevertheless, most of the studies on CSA adoption mainly concentrated on one approach of crop farming, the most popular in Africa, being conservation or minimum tillage. The theory of CSA incorporates a set of strategies that farmers accept in diverse groupings. There is fewer information known considering the implementation of Climate Smart Livestock (CSL) systems in Zimbabwe, particularly in the perspective of small-scale farming.

Climate Smart Livestock Production is a crucial approach to sustainable agricultural development in the face of climate change. According to the Food and Agriculture Organization (FAO), climate-smart agriculture aims to "sustainably increase agricultural productivity and incomes, adapt and build resilience to climate change, and reduce greenhouse gas emissions" (FAO, 2013). Climate smart livestock practices can enhance the resilience of livestock systems to climate change impacts, such as droughts and floods, while reducing greenhouse gas emissions from livestock production.

Livestock farming is a significant contributor to climate change, accounting for around 14.5% of global greenhouse gas emissions (Gerber et al., 2013). However, by adopting climate smart livestock practices, farmers can reduce the environmental impact of livestock production while improving productivity and resilience to climate change. Examples of climate smart livestock practices include rotational grazing, silvopasture systems, manure management, and selecting climate-resilient breeds (FAO, 2019). By implementing these practices, farmers can reduce methane and nitrous oxide emissions, promote carbon sequestration, and improve the livelihoods of livestock farmers

This study sought to the adoption of climate-smart livestock production systems and the effects of the adoption on improving livelihoods in Chivi district in Zimbabwe.

Statement of the research problem

Small-scale livestock farmers evolve various livestock production systems in order to handle the special effects of CC to enhance their livelihoods. However, there is differential adoption of Climate- smart livestock production systems by small-scale farmers in Chivi district of Masvingo province in Zimbabwe. Macheke et al. (2021) states that the drought-prone area of the country receiving an average of 450 mm rainfall per year, the small-scale livestock farmers are exposed to the negative effects of climate change. The study also sought to expose how livelihoods of small-scale livestock farmers were improved through adoption of CSL technologies. Trainings in agroforestry and strengthening awareness of conservation agriculture have contributed to improve the adoption of the Climate- smart livestock production systems. Climate-smart livestock production, according to this study, is an increasingly promising strategy geared to bring out the concerns of climate change impacts and preventing food insecurity among small-scale farmers.

Research questions

The study sought to answer the following research questions:

- Which Climate-smart livestock production systems do small-scale farmers in Chivi district of Masvingo province in Zimbabwe use?
- How has adoption of Climate-smart livestock production systems improved livelihoods in Chivi district?

LITERATURE REVIEW

Climate-smart livestock production systems

Global climate change is increasingly affecting agricultural and livestock production, with an overwhelmingly negative effect on animal health and welfare as well as the whole farm systems. The animal sector is working in the direction of added proficient and maintainable output as well as meeting higher standards of animal health and welfare by adopting CSL production systems. In a related view, Shea (2014) suggests that CSA is a focus-based concept that involves developing new technologies that can help

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farmers to transition from current strategies to more climate-aware practices and encourage farmers to abandon or lessen reliance on methods that increase GHGs. According to Wekesa et al. (2018), despite the benefits and continued support from national and transnational institutions, the uptake of the CSA practices among the farmers is weak and uneven.

Animal genetics and conservation of indigenous breeds is another CSL production system practiced by farmers. Diversity of animal genetics as an important and irreplaceable aspect farmers need to take into considerations. According to FAO (2017) conservation and sustainable use of genetic resources will be critical for the development of CSL strategies.

Breeding strategies of animals can possibly be planned to address several factors such as improving food security, drought mitigation and adaptation all at once. In developing countries such as Zimbabwe crossbreeding of various livestock breeds is being practiced combining desired traits that fits the impacts of CC. For example, there are composite cattle breeds developed in Australia that have high tolerance for heat, disease resistance and better reproductive traits compared to other breeds (FAO, 2017). FAO (2016) states that in general, cross-breeding strategies that make use of locally adapted breeds, which are not only tolerant to heat and poor nutrition, but also to parasites and diseases, may become more common with climate change.

Lipper and Zilberman (2018) argued that new technology like CSA enhance food security and poverty reduction, by potentially increasing the income of farming households as well as reducing the market price of staple foods. Moreover, acceleration of the movement of animals is a traditional tactic of nomadic farmers which was carried out as an attempt to provide enough feed, water and pastures to animals to compact the effects of CC. Grassland management and growing of improved pastures is one of the CSL production systems that comprises the growing of value-added pasture varieties naturally substituting intrinsic pastures which good outputs apart from being easily digestible fodder. According to Sova et al. (2018) lucerne fodder has got high growth rate and therefore can be used to cover the existing grazing shortages initiated by extended dry periods and harsh ecological circumstances. The growing and use of legumes in livestock pastures aids in production of fodder as well as good digestibility of the foodstuffs, thus enhancing production. Agroforestry is significant in the perspective of CSL as trees plays a role of carbon sequestration as well as providing animal feed especially to browsing animals. For accelerating animal production, selection of breeding systems is important to combine desirable traits in one breed. Selection can be carried out through use of inbreeding, crossbreeding as well as growing productivity of animal improvement method such as artificial insemination of animal. Studies in Australia reviewed composite cattle breeds that have high tolerance for heat, disease resistance and better reproductive traits compared to other breeds (FAO, 2017).

After a reasonable time, the preservation of livestock genetic variety can guarantee that animal keepers will have availability of high performing livestock for all areas as they continue selection. In general, cross-breeding strategies that make use of locally adapted breeds, which are not only tolerant to heat and poor nutrition, but also to parasites and diseases, as noted by FAO (2016), may become more common with climate change. For instance, camels were implemented as part of a livelihood approach of a society that traditionally does not rear camels and this adjustment indorsed them to overcome a deterioration in their livestock economy after being affected, livestock diseases, drought and raiding of livestock (FAO, 2016).

The mixed group method farming is a unique adaptation measure that is being practiced in developing countries. Animal farmers and keepers retain a combination of farming animals where different animals are breed and reared to utilise yields and performance such as donkeys, goat, camels, goats and chickens are reared in order to benefit from all their different traits and uses and to spread risk from disease outbreaks and drought.

Some authors have suggested the increased use of synthetic or algae-based proteins as animal feed (Minx et al., 2017) whilst the considerable increases in reforestation projected, if well planned and designed could also provide feed for livestock. Within mixed crop livestock farming, there are possibilities of shifting to more water efficient and drought tolerant feed and fodder crops (sorghum vs maize or Lucerne); water and soil conservation techniques that cushion against rainfall variability and improve yields maturing varieties and early planting as seen in Ghana (Thornton et al., 2018; Antwi-Agyei et al., 2018).

Rigolot et al. (2017) and FAO (2016) noted that integrated systems are not without their challenges, and they may not be adaptive in all circumstances. Encouraging or expanding cropping systems into dry rain fed areas could actually increase vulnerability of poor households due to climate variability unless irrigation is available or farmers have enough income or alternative access to finance and credit to cover the shortfalls in dry seasons.

African dry lands are facing land degradation aspects in terms poor soil nutrients, loss of ecology and erosion of soil as an outcome of the occurrence of CC. Reseeding programmes can conserve soil to a greater extent than land management and grazing alone by improving vegetation cover and increasing biomass (Mganga et al., 2019). Pasture conservation can be accomplished through enclosures (Oduor et al., 2018), exclosures (Rossiter et al., 2017) and other management practices like resting periods and reducing stocking rates. According to Kassam et al. (2009) an extensive cultivation of the high biomass grass, *Brachiaria ruziziensis*, was introduced to farmers in Burkina Faso under some projects to promote the use of this grass as livestock feed. Moreover, the livestock farmers were motivated to gather remains of plants such as of some legume foliage (e.g., soybean foliage, *Mucuna pruriens* and cowpea foliage) for integration into animal feedstuff portions throughout the drought periods. In spite of these attempts, the challenges of availability of sufficient animal feeds for animals in Africa specifically Zimbabwe remains a challenge to livestock rearing.

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Diversification of both livestock and shifts to more drought tolerant breeds such as camels, sheep and goats have become common in Sub-Saharan Africa (Thornton et al., 2018; Waha et al., 2017). From a study of 18 African countries emerged the view that the best opportunities for diversification of food and cash crops and livestock occur in areas with low rainfall (Waha et al., 2017). Reducing water consumption and adoption of irrigations to improve crop farming (Geest et al., 2019) is crucial in countries where cereals and crop residues are important in the livestock system, as well as in ensuring resilience. According to Nardone et al. (2010) there are some broad global recommendations that crop and livestock should be produced in systems that require less water or in areas with water abundance.

Improved feed conversion ratios have already greatly reduced the amount of feed required per unit of animal product. Further progress is expected to be made in this area through improvements in feed management and livestock breeding.

The productivity of animal feedstuff can be improved by improving animal genetics and make use of breeds that has got high food conversion rate and fat growth rate. FAO(2017) stated that efficacy of feed can be enlarged by taking into consideration of maintaining good well-being of the animals which can be carried out through provision of well veterinary facilities and nutritional aspects. Some of the major CSL technologies involves maintenance of grazing management for production of livestock quality fodder.

Livelihoods enhancement and the adoption of the CSL production systems

Adoption of agricultural technology is an essential strategy for the understanding of achievement under CC management. The realization of performance of adoption of CSL technologies can be measured through improvement of livelihoods specifically of small-scale farmers. It also contains inventive practices such as early-warning systems, improved weather foretelling and safety assurance which decrease food insecurity. Lipper and Zilberman (2018) supported the adoption of CSL production systems by stating that new technology like CSA enhances food security and poverty reduction, by potentially increasing the income of farming households as well as reducing the market price of staple foods. Effectiveness is one of the major stages of scaling up of CSA technologies, which represents a general sequence of investments, shifts and outcomes on the path to CSA adoption and impact at different scale (Korten, 1980).

Effectiveness of CSA intervention depends on whether it leads to food security, adaptation and mitigation benefits in the specific local climatic, socioeconomic, biophysical and developmental context (Williams et al., 2015; Rosenstock et al., 2016). According to Murage et al. (2015) the effectiveness of a dissemination pathway depends not only on the number of farmers that receive information, but also on how successfully that pathway influences to adopt a given technology.

According to Sova et al. (2018) a recent study reviewed CSA in 33 developing countries from Africa, Asia, and Latin America, which covers 300 distinct production systems indicates that technologies considered climate-smart demonstrate synergies between productivity, adaptation, and mitigation pillars, revealing opportunities for co-benefits and potential triple-wins. As a result, more than 1,700 unique combinations of production systems and technologies across key indicators like yield, water use efficiency, impact on carbon stocks and others generally confirms that CSA is highly effective (Dinesh et al.,2018; Balafoutis et al., 2017). For example, increased food security may result from changes in availability of food such as yield, accessibility of food, increased income and increased food safety (Rosenstock et al., 2016). Adoption of CSL production systems is seen as having a beneficial impact in many Nigerian communities as it has improved their food security and generation of incomes for household activities. According to field evidences the farmer training program has assisted to higher Climate Smart Animal Production systems (CSAPs) acceptance which has resulted in improved food safety and profitability through income generation (FAO and ICRISAT, 2019) or (FAO, 2019; ICRISAT, 2019).

Some studies indicated that grazing land improvement is regarded as posing a negative effect of the adoption of CSL production systems to some extent. FAO (2013) further supported the view that CSA is not a new agricultural system nor is it a new set of approaches. It is rather an approach to guide the needed changes in agricultural systems given the necessity to jointly address food security and climate change. Specific challenges of CSA are identified as poor funding and efficient risk-sharing schemes (Williams et al., 2015). Huge investment is required for widening the acceptance and adoption of CSL technologies to motivate and support subsistence farmers who faces difficulties in accepting new technologies which has potential to boost their livelihoods.

FAO (2010) stated that Climate Smart (CS) systems if given enough proficient assets, it has the potential for uplifting the agriculture sector as well as enhancing livelihoods through generation of household incomes and promoting household food. With the right practices, policies and investments, the agriculture sector can move into CSA pathways, resulting in decreased food insecurity and poverty in the short term while contributing to reducing climate change as a threat to food security over the longer term.

Before 2050, the global population is expected to swell to more than 9.7 billion people (Nino, 2015). The consumption food worldwide has been affected due to CC which reduces production of feedstuffs. Alexandratos and Bruinsma (2012) agreed that if the current trends in consumption patterns and food waste continue, it is estimated that we will require 60% more food production by 2050. CSA helps to improve food security for the poor and marginalized groups while also reducing food waste globally (Aggarwal et al., 2018). Ethiopia actively promotes the use of CSA to assist farmers improve their livelihoods and buffer against

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climate variability and change (Jirata et al., 2016). Small-scale farmers are the one that are more vulnerable to climate-related risks so adoption of promising new technologies can be a good option.

METHODOLOGY

This multiple case study utilized a qualitative research approach to investigate the adoption of climate-smart livestock production systems among small-scale farmers in three wards of Chivi District, Masvingo Province, Zimbabwe. Purposive sampling, a non-probability sampling technique, was employed to select the wards and villages that best suited the study's objectives. Following permission and informed consent from the Ministry of Lands, Agriculture, Fisheries, Water, Climate and Rural Development, data were collected through three Focus Group Discussions (FGDs), each consisting of nine research participants (n=27), and one-on-one interviews with four agriculture extension officers (three Ward AGRITEX officers and one District AGRITEX officer). In total, 31 research participants were involved in the study. The FGDs and interviews were used to gather data from purposively selected small-scale livestock farmers and AGRITEX officers. The collected data were analyzed using Braun and Clarke's (2006) reflexive thematic analysis.

RESULTS AND DISCUSSION

Demographics of research participants

A total of 31 research participants were involved in this study. The majority of the livestock farmers who participated were male (80%), while 20% were female. This gender disparity reflects the local context, where males in Chivi district tend to dominate livestock farming, while females focus on other household responsibilities such as cooking. A typical family in the research area consisted of six members on average, with a quarter regularly engaged in livestock herding and farming, while others were either school-going children or employed adults. Notably, many of the livestock farmers were elderly, which presented challenges in adopting new technologies. As one elderly farmer shared during a focus group discussion:

I preferred our traditional methods of livestock farming considering my old age. It is difficulty to absorb new technologies that are emerging due to climate alteration.

The majority of livestock farmers in Chivi district wards had completed primary school education, suggesting that the adoption of new technologies and Conservation Agriculture (CSL) production systems holds promise. The study utilized three Focus Group Discussions (FGDs) as a data collection instrument, each consisting of nine research participants, totaling 27 participants. Additionally, four agriculture extension officers participated in in-depth interviews. The overall number of research participants was 31. The FGDs lasted approximately one hour, while the interviews lasted around 40 minutes. Notably, the response rate was 100%, with all livestock farmers attending the FGDs and the AGRITEX officers participating in the interviews. This high response rate was facilitated by timely arrangements with local leaders, councilors, and extension workers. Furthermore, the relaxed COVID-19 lockdown restrictions enabled effective engagement with all research participants. To accommodate the participants' schedules, they were given the autonomy to decide the date and time for the FGDs, which coincided with their existing ward and farmers' meetings.

Climate-smart livestock production systems in Chivi district

In response to the challenges posed by climate variability and change, livestock farmers in Chivi district wards have adopted various measures to adapt to the changing climate and environment.

Table 1. Climate-smart livestock production systems in Chivi District (N=31).

Climate-smart practice	Frequency
Crop residues (maize stalks)	7
Hay bailing	5
Water conservation, dams	3
Planted pastures	3
Indigenous breeds, animal improvement	3
Silage	1
Feed formulation	1

Source: Field data.

Smallholder livestock farmers in the area have gradually adopted different Conservation Agriculture and Sustainable Livestock (CSL) systems. Notably, research participants across the wards practiced similar CSL technologies, likely due to their exposure to similar climatic conditions and high temperatures. The challenges faced by these farmers are summarized in Table 1. The results revealed that conservation of fodder and crop residues was the most widely practiced CSL production system, with the highest frequency of 7 (Table 1), indicating the highest level of adoption. Participants in all focus groups consistently preferred this method, citing its effectiveness in providing feed during dry periods. Specifically, the conservation of dried crop residues, particularly maize stalks, was a common practice across all wards in Chivi district. As one participant noted:

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Conservation of dried crop fodder was a traditional method they were familiar with in their area since the method is easy and does not require money or finance to practice so that's why we stick to the method.

According to research participants in Ward 5's focus group discussion, they practiced conservation of fodder and crop residues due to the availability of maize stalks, even during dry periods. As one participant explained, they would collect maize stalks or other crop residues from their fields, which was particularly relevant during the 2022 drought spell when rainfall was scarce and maize crops were wilted. During such periods, they would harvest the wilted maize stalks as crop residues and conserve them to feed their livestock. One of the livestock extension officers noted:

Conservation of dried fodder and hay was the common method practiced because livestock farmers considering their old age do not accept new technologies due to a number of factors such as unavailability of labor, they mainly depend on hired labor for farming activities which requires finance.

According to research participants in Ward 5's focus group discussion, they practiced conservation of fodder and crop residues due to the availability of maize stalks, even during dry periods. As one participant explained, they would collect maize stalks or other crop residues from their fields, which was particularly relevant during the 2022 drought spell when rainfall was scarce and maize crops were wilted. During such periods, they would harvest the wilted maize stalks as crop residues and conserve them to feed their livestock. One of the livestock extension officers noted:

Silage making method allows other products to be added and mixed such as molasses for feed formulation to come up with a complete feed ration.

However, many farmers in Chivi district faced constraints that limited their adoption of this method, including lack of knowledge, as silage can be spoiled if not prepared correctly. Another commonly practiced CSL production system was cutting hay, which was adopted by 5 wards (Table 1). Hay baling involves cutting and compacting green or dry grass into bales for conservation and use during dry periods. In contrast, feed formulation was the least adopted method, with a frequency of 1. This may be due to the costs associated with implementation and the perceived usefulness of this farming system. Additionally, some CSL practices like silage making and feed formulation are relatively new to smallholder agriculture societies in Zimbabwe. Improved forage species and pastures were another climate-smart approach adopted by some smallholder livestock farmers in Chivi district to enhance feed provision and availability. Field observations revealed that some farmers in Ward 9 had planted pastures and forages for their livestock, and the local AGRITEX officer noted that farmers were beginning to appreciate the benefits of improved pastures in the face of climate change. However, this practice had not been adopted in Wards 13 and 5, possibly due to factors such as large cultivable land areas, labor availability, and access to information on balanced livestock feed. Some livestock farmers were actively engaged in goat and cattle fattening, which was found to positively impact their livelihoods by attracting higher prices when selling. As one participant noted:

In recent years in our area, the availability of feed close to homestead has also reduced free grazing and overgrazing as well as reducing land degradation that impacts on pasture productivity resulting in poor pastures and long drought seasons.

This finding is consistent with Thornton et al. (2017), who noted that the adoption of improved fodder aids in restoring degraded land, thereby enhancing livestock well-being in diverse systems. In Ward 9, livestock farmers have adopted various fodder and pasture species, including *Acacia angustissima*, sun hemp, *mucuna-pruriens*, and lab-lab. According to focus group discussions and interviews with livestock officers, rearing indigenous breeds such as Mashona goats, Matabele goats, Mashona cattle, and Roadrunner chickens is another CSL production system practiced in Chivi district, albeit with a relatively low frequency of 3 (Table 1). This finding is supported by FAO (2017), which emphasizes the importance of conserving and sustainably using genetic resources for the development of climate-smart livestock strategies. The adoption of indigenous breeds is also highlighted by Kadzere (2018), who notes that these breeds thrive with minimal input compared to imported breeds and are crucial for the development of climate-smart animal agriculture. One of the AGRITEX officers observed:

Cross breeding is a technique of animal improvement we are currently training and encouraging the livestock farmers to practice not only in this ward but to all dry regions to maximize hybrid vigour and to combine desirable traits that suits the changing climate. Desired traits include reproduction performance, fast growth rate, heat tolerance and resistance to diseases.

This result is also consistent with studies in Australia, which have shown that composite cattle breeds exhibit high heat tolerance, disease resistance, and improved reproductive traits compared to other breeds (FAO, 2017).

Enhancement of livelihoods by adoption of climate-smart livestock systems

The adoption of Climate-Smart Livestock (CSL) production systems by small-scale livestock farmers is beneficial for

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Table 2. How Adoption of Climate-Smart Livestock Systems Enhanced Livelihoods (N=31).

How adoption improves livelihoods	Frequency
Household income, school fees, business capital	7
Household food	7
Multiplication of livelihoods, fast growth rate, less diseases	6
Drought power	6
Manure production	4
Reduces stress, health improvement	3
Environmental conservation	2
Improved standards of living	2
Less effect by climate risks	1
Provision of livestock for social-cultural functions, source of bride price, special ceremonies, funerals, ancestral communion	1
More time for non-farming activities when livestock graze on planted pastures and are being pen fattened	1
Means of transportation, scotch cart	1
Job creation	1

Source: Field data

improving their livelihoods. According to the study's results, the adoption of CSL production systems had a significant impact on household income and capital for small-scale businesses, such as poultry production, with the highest frequency of 7 (Table 2). Additionally, the study found that CSL production systems also improved household food provision, with the same frequency of 7 (Table 2). Both livestock AGRITEX officers and FGD research participants agreed that the generation of income through CSL production systems led to positive livelihood improvements. As one participant reflected:

Adoption of CSL promoted us to get income for children's school fees and other educational requirements of our children. It also resulted in improvement of our livelihoods in our area. As small-scale livestock farmers, through adoption of CSL systems, we could see a bright future for our children and development of communities as well.

The focus group research participants in Ward 9 reported that adopting Climate-Smart Livestock (CSL) practices, such as silage making, enabled them to fatten their goats and cows, resulting in increased income. This income was then used to form cooperatives and create money-lending societies, ultimately improving their livelihoods. The participants testified that poverty was no longer a significant issue, and they had adopted better livelihoods for their communities. These findings are consistent with research conducted by FAO and ICRISAT (2019), which found that farmer training programs contributed to higher adoption of Climate-Smart Agricultural Practices (CSAPs), leading to improved food security and income for farmers.

In Ward 13, focus group research participants reported that in response to climate change, they cultivated drought-resistant grains such as sorghum, pearl millet, and finger millet (rapoko) to provide feed for their indigenous poultry and other livestock. They also practiced breed improvement by crossing Roadrunner chickens with Sasso and Boschveld chickens. Through these CSL practices, they generated income and improved their livelihoods.

The study found that the adoption of CSL systems had a significant impact on household income and food provision, but had a lower impact on job creation, transportation, and provision of livestock for social-cultural functions (Table 2). The AGRITEX officer noted that while CSL production systems improved household food and income, other benefits such as job creation, improved living standards, environmental conservation, and health benefits were not as widely recognized, with frequencies below 4 across all districts (Table 2).

The study concluded that small-scale livestock farmers in Chivi district, Masvingo Province, adopted various Climate-Smart Livestock (CSL) production systems, including conservation of dried crop residues, hay baling, silage production, improved pastures, animal improvement, water conservation, and feed formulation. The most commonly adopted CSL systems were conservation of crop residues and hay baling, which were manageable and did not require significant capital outlays. However, the adoption rate of CSLs was still low, with conservation of dried fodder being the most dominant method. The study identified several constraints to adoption, including lack of knowledge, limited access to funds, labour, and skills.

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The study also found that the uptake of CSL production systems had great potential to improve the livelihoods of livestock farmers, but few farmers had adopted these systems. The most poorly adopted CSL technologies were feed formulation, silage making, and water harvesting, which required significant resources and skills. The study concluded that the key constraints to adoption were lack of initial funds and poor climatic conditions, which exacerbated poverty and vulnerability among small-scale farmers.

The study highlighted the importance of providing capital resources and access to climate information to enhance the adoption of CSL practices. The adoption of CSL production systems was found to improve livelihoods in Chivi district wards through various ways, including provision of household income, household food, environmental conservation, draft power, and means of transportation. The most dominant way in which livelihoods were enhanced was through provision of household income and food. The study recommended the adoption of CSL production systems that suit the climate conditions of Chivi district, including irrigation farming, small-stock livestock farming, diversification of livestock, farming of improved pastures, paddocking, agroforestry, access to climate information, small grains farming, feed formulation, and silage production. Irrigation farming for pastures and small grains farming for livestock feed were identified as the most dominant CSL production systems recommended in the study.

Overall, the study provided valuable insights into the adoption and impact of CSL production systems in Chivi district, highlighting the potential for these systems to improve the livelihoods of small-scale livestock farmers.

Implications of the study

To enhance the impact of Climate-Smart Livestock (CSL) practices on farmers' livelihoods and the national economy, there is a need to test more CSL technologies in various dry areas to identify those that are most suitable for specific regions. The government of Zimbabwe should promote the establishment of Climate-Smart Villages (CSVs) in dry areas as a mechanism for implementing CSL approaches among small-scale livestock farmers. This would help reduce the risks associated with climate change and ensure food security sustainability.

To encourage the uptake of CSL practices, communal livestock farmers should be encouraged to form associations and participate in livestock production cooperatives and programs to share agricultural information. The study recommends that AGRITEX officers continue to work closely with small-scale farmers in rural areas to provide them with information on climate change and CSL practices.

Livestock farmers require support with seeds for improved pastures to establish experimental plots on their farms, which can be used to demonstrate and teach new farming strategies. Capacity-building programs, such as training sessions and field days, are also necessary to equip farmers with the knowledge and skills needed to adopt CSL technologies.

To address financial constraints, farmers should be encouraged to form cooperatives and engage in resource mobilization activities, such as table banking, group credit access, and cost-sharing. These cooperatives can help farmers access funds and resources to adopt CSL practices and improve their livelihoods.

Finally, small-scale livestock farmers should be encouraged to integrate CSL practices to achieve greater impact on food security and livelihoods. Farmers should also be made aware of the importance of investing in productive assets to enhance their resilience to climate change and improve their capacity to adopt and implement CSL practices.

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