Socio-economic and ecological factors linked to the adoption of foreign livestock breeds by Zimbabwean smallholders farmers in the Great Limpopo Transfrontier Conservation Area

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Summary

Background: In rural areas in Africa, the productivity of small-scale livestock systems is low. Development programmes aim to increase productivity using technical innovations, including the introduction of foreign breeds. The level of adoption of foreign breeds needs to be investigated to assess the effectiveness of the introduction programmes. ***Aim***: This article analyzes the socio-economic and ecological factors associated with the adoption of foreign livestock breeds in Zimbabwean rural communities, in the Great Limpopo Transfrontier Conservation Area. The foreign breeds concerned, include Brahman cattle, Boer goats and Boschveld chickens. ***Methods***: A mixed methodology was used, combining a literature review, individual in-depth interviews (n=100), key-informant interviews and focus group discussions. Triangulation and thematic analysis informed both research and data analyses. ***Results***: The key socio-economic dynamics that influence the perceptions and adoption of specific livestock breeds were linked to productivity, reproduction, management, social criteria and health. The most important ecological factors included livestock predation, heat stress, and shortages of water and pasture. Despite the productive potential of foreign breeds, the level of adoption was low due to the local context, in which foreign breeds were unable to express their full genetic potential. Most farmers keep indigenous breeds because they are well adapted to local climatic conditions and resistant to livestock diseases. ***Conclusions***: To improve the effectiveness of programmes targeting livestock production, governmental services and development, stakeholders should adopt more participatory processes and adaptive management strategies, which better reflect smallholders' demands.

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■ INTRODUCTION

Transfrontier Conservation Areas (TFCA) are an important milestone in nature conservation, poverty reduction and securing peace in Sub-Saharan Africa. They take account of the importance of ecological, physio-geographic, sociocultural and anthropogenic factors that influence an area (Stoldt et al., 2020). TFCAs are complex matrices of land use. They predominantly include protected areas and communal land spanning more than one country. Their double objective is to protect biodiversity, improve local people's well-being and promote sustainable livelihoods (NASCO, 2023). In Southern Africa, eighteen TFCAs at various stages of development cover around 10.5% of land in the Southern Africa Development Community (SADC) (Bollman, 2019).

Many subsistence communities live within TFCAs in semi-arid areas. They share similar livelihood patterns and rely mainly on rainfed agriculture and cattle production (Giller et al., 2013). However, these communities also face specific threats linked to TFCAs, such as human-wildlife conflicts, including wild carnivore predation, elephant raiding and diseases transmitted at the wildlife/livestock interface (Caron et al., 2013). A better understanding of local livelihoods

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and the forces that shape them could provide the basis for locally-relevant action to address similar impacts and problems across the region. Thomson et al. (2013) argue that while the TFCA movement is vital for biodiversity conservation and rural development in Southern Africa, the sustainability of the initiative will only be guaranteed if it accommodates livestock production. Indeed, in the largest TFCAs, livestock are essential for indigenous people's livelihood and culture.

In traditional livestock systems, livestock genotypes have co-evolved with environmental circumstances over millennia. Local breeds have adaptive attributes, such as disease resistance and the capacity to survive and produce in adverse environments, with minimal feed and water (Rege et al., 2011). Crossbreeding is used to improve the productivity of indigenous breeds. It is a common traditional practice that is likely to continue, although it is often unstructured and unspecialized. Genetic 'improvement' has been successful in some places, but spectacularly unsuccessful in (probably) many more (Wilson, 2018). When resources and market demands allow, crossbreeding has the potential to improve livestock production. However, crossbreeding involving exotic and indigenous cattle has largely failed due not only to the lack of biological or technical adaptation, but also because socio-economic factors have been overlooked (Wilson, 2018).

As part of an overall livestock improvement plan, a pro-poor animal breeding programme focuses on issues that are relevant for smallholder livestock keepers or pastoralists (Rege et al., 2011). Crossbreeding programmes depend on continuous access to quality breeding stock (improved livestock breeds) and a reliable market outlets (Leroy et. al, 2016). A pro-poor approach should support livestock keepers and help them overcome poverty. Similarly, this type of approach should prevent progressive, but vulnerable livestock keepers from falling back into poverty. The specific constraints faced by livestock keepers in their environment should be taken into account. Actions should be designed and implemented to help smallholders use their existing assets (land, livestock, intellectual capital, social capital, infrastructure) and improve their livelihoods in sustainable ways (Rege et al., 2011). In low-input systems, many well intended pro-poor genetic improvement programmes have failed. This is primarily because inadequate attention was given to non-genetic factors (Kosgey and Okeyo, 2007) and sustainability issues (Marshall et al., 2009).

In this article, we explore the local key drivers of adoption and non-adoption of foreign breeds by farmers in Zimbabwe, who live in the Great Limpopo TFCA. After characterizing the level of adoption of foreign breeds in the area, our hypothesis was that local farmers failed to adopt foreign breeds as a result of informed negative experiences and perceptions. By investigating this hypothesis, our aim was to shed light on the socio-economic and ecological dynamics linked to the adoption of foreign livestock breeds in the face of climate change in the Great Limpopo TFCA.

■ MATERIAL AND METHODS

Description of the study area

The study was carried out in the South Eastern Lowveld of Zimbabwe in Chiredzi district (Figure 1) in the Great Limpopo Transfrontier Conservation Area (GLTFCA) that was founded in 2002 (Duffy, 2010). The area extends over three countries, Mozambique, South

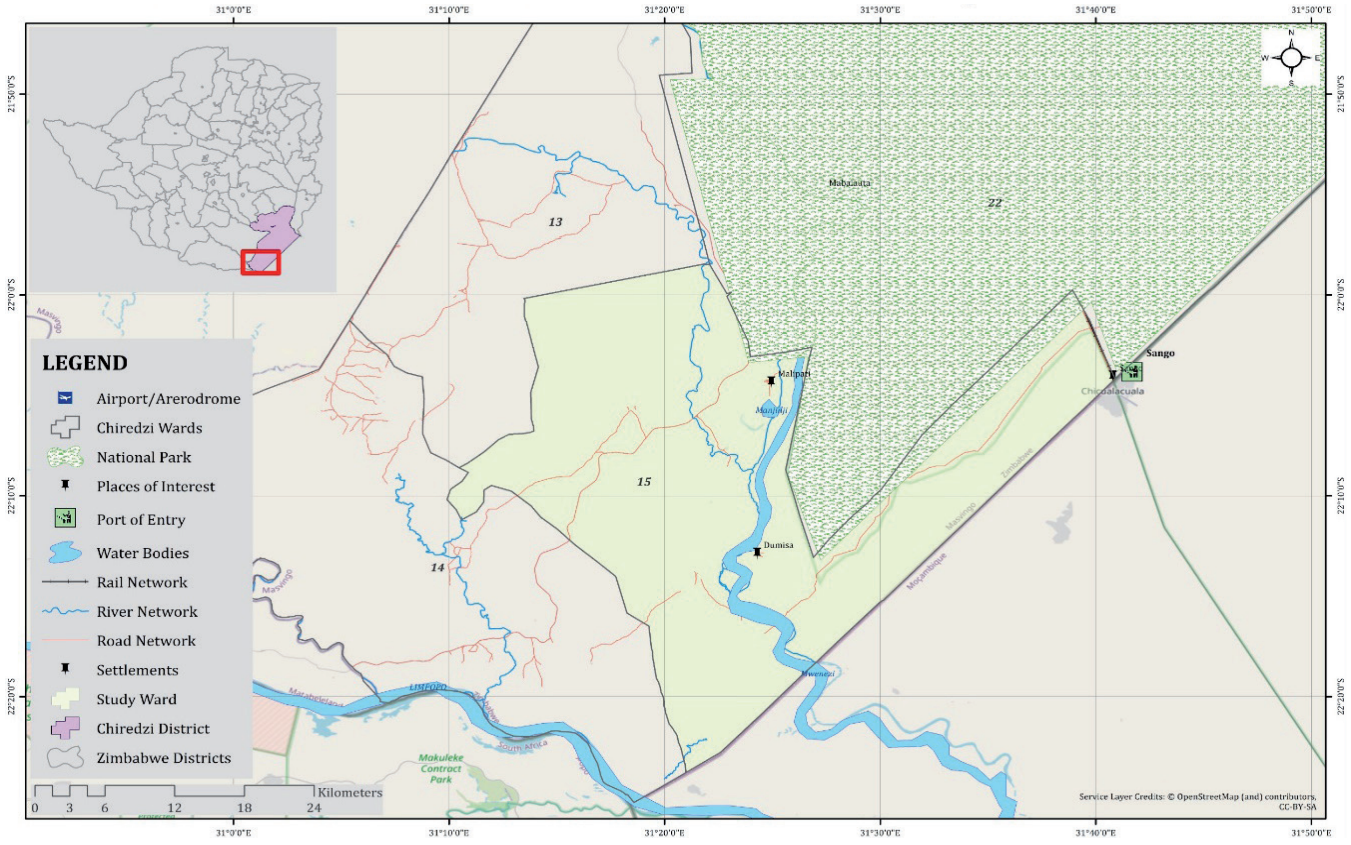

Figure 1: Map of the area including Ward 15 of the Sengwe communal land (yellow area) and Gonarezhou National Park ('National Park'). The south-eastern part of the map shows Mozambique and the area south of the Limpopo River (bottom left) is Kruger National Park in South Africa. The whole area shown on the map is part of the Great Limpopo TFCA (source : Caron et al., 2023) /// *Carte de la zone comprenant le quartier 15 des terres communales de Sengwe (zone jaune) et le parc national de Gonarezhou (« parc national »). La partie sud-est de la carte correspond au Mozambique et la zone située au sud du fleuve Limpopo (en bas à gauche) correspond au parc national Kruger en Afrique du Sud. Toute la zone indiquée sur la carte fait partie de la « TFCA » du Grand Limpopo (source : Caron et al., 2023)*

Africa and Zimbabwe (Manjengwa et al., 2010; Zanamwe et al., 2018). It includes the Kruger, Gonarezhou and Limpopo National Parks, other public and private protected areas and large tracks of communal land in Zimbabwe and Mozambique. The GLTFCA goals include biodiversity conservation, socio-economic development (Anderson et al., 2013), tourism and regional cooperation (Manjengwa et al., 2010). The area is auspicious for livestock production with annual rainfall ranging between 300–650 mm (Manjengwa et al., 2010) and very high diurnal temperatures (Gadaga et al., 2016). Rivers, dams, streams, pans and pools are the major water sources (Tagutanazvo and Bowora, 2019). Runde, Save and Mwenezi are the main river systems (Zvidzayi et al., 2013,). Sengwe communal area is covered by mopane and combretum woodland, which is used for forage, especially during the dry season (Chirozva et al., 2013). Smallholder farmers have traditionally bred indigenous cattle, chickens and goats. The indigenous cattle breeds are the Mashona, Tuli and Nkone (Faye, 2008). Most farmers in the communal area own indigenous Mashona and Matebele goats (Ndlovu et. al., 2020). Cattle are dipped to control ticks and tick-borne diseases (Ndegu et al., 2017).

Gonarezhou National Park is home to wild animals, which are a source of human-wildlife conflicts (Gandiwa et al., 2013). Wild animals, such as kudus, baboons and elephants may destroy crops, while hyenas and lions may attack livestock. Wild fauna may also transmit diseases to livestock. Thus, wildlife is perceived as a source of conflict (Caron et al., 2013, Miguel et al, 2013). Rural households move their cattle into the game parks for grazing and water. This creates opportunities for inter-species disease transmission. Some zoonoses pose a health risk to the local rural communities (Gadaga, 2016). In some parts of the Sengwe communal area, livestock have access to and graze in the park, where they risk being in contact with wildlife, such as buffaloes, zebras and elephants (Caron et al., 2013). In Sengwe, individual farmers either sell at informal markets or transport livestock to Chiredzi, where animals are sold directly to butchers. Most livestock sales occur between farmers (Manjengwa, 2010). Livestock are kept in kraals and pens at night to protect them from predation and theft.

Data collection methods

The study was carried out in 10 villages in Ward 15 (i.e., Mugiviza, Hlengani, Hadama, Chinyakany aka, Samu, Manzini, Ngwenyeni, Maporisa, Mafunjwa and Mphakati), close to Gonarezhou National Park. They were deliberately selected by the ProSuLi project, Promoting Sustainable Livelihoods in TFCAs (Caron et al., 2022). Local citizens were invited to take part in a participatory process to identify key interventions that could improve their livelihoods. They co-designed the interventions with the support of researchers and local development stakeholders (e.g., governmental services, local NGOs) (Bourgeois et al., 2023). Improving livestock production was one of the four interventions identified as a key driving force of local livelihoods (Gobvu et al., 2021).

The longstanding partnership between research institutions and local stakeholders facilitated data collection. The fact that foreign breeds were available in the area was also an important consideration. For example, Boschveld chicken were introduced in 2019, by Plan International and the Agricultural Technical and Extension Services (Agritex), as part of a UNDP funded programme to train farmers and involve them in livestock production (Government of Zimbabwe and UNDP, 2017). Farmers that participated in the data collection process were heads or senior members of households during the periods when the interviews were conducted.

A mixed method approach was used to collect data. Data was obtained from in-depth interviews (IDIs), key-informant interviews (KII), focus group discussions (FGDs) and participant observations. Following the definition of Abadi et al. (2017), we assumed that ownership of foreign livestock breeds signified adoption of foreign livestock breeds. Therefore, farmers who owned foreign breeds or crossbred animals were adopters and those who did not were non-adopters. We collected data on variables, such as gender, age, level of education, ethnicity, as well as sources of income and food.

Traditional community leaders helped select suitable sites for the 5 FGDs and to mobilize farmers. Traditional leaders provided a list of farmers in their villages with cattle, chickens or goats. The participants were randomly selected for the interviews and questionnaires. Random sampling was chosen because it is an unbiased approach for gathering responses from a large group (Depersio, 2024). Consent to collect data was obtained from the heads of households, and suitable times and venues were scheduled with the farmers for the FGDs. Participation in the interviews and group discussions was voluntary and based on verbal consent. Individual responses remained confidential and anonymity was observed. The participants were informed that the purpose of the survey was to understand their experiences of adopting foreign livestock breeds. We explained that the results would be used for academic research and publication purposes.

The IDI questionnaire consisted of structured questions that focused on: the demographic characteristics of respondents; their knowledge and perceptions of the genetic characteristics of livestock breeds; foreign livestock breed adoption; the socio-economic and ecological dynamics associated with the adoption of foreign breeds; and challenges in livestock production.

KIIs were conducted with experts, including agricultural extension officers, and veterinarians working for donors and government departments in Ward 15. KIIs with headmen, traditional leaders and the ward councillor also provided data on individual experiences.

FDGs were grouped according to gender to reduce bias. This allowed marginalized members of the community, such as women, to express their views and thoughts freely. Villages were merged into FGDs according to the distances between them to minimize the distances that farmers had to travel in order to attend the discussions. FGDs and questionnaires were linked to improve our understanding of people's perceptions of foreign livestock breeds.

We drew on secondary sources of existing data, including journals, published books, articles and the Internet to grasp the dynamics associated with the adoption of foreign livestock breeds.

Data analysis

Data was entered into a Microsoft Excel 2013 spreadsheet, edited, coded and then imported to the statistical package for analysis. The STATA package was used for quantitative data analysis and the Atlas package was employed for qualitative data. Triangulation was used to find new ways of understanding the topic. Our mixed methodology generates outputs, which allowed us to confirm findings and cross-check information to further our understanding of the phenomena of adoption or non-adoption of foreign breeds (Bekhet and Zauszniewski, 2012).

■ RESULTS

Demographic characteristics of respondents and elements of context

Results from the IDIs (n=100) indicated that most respondents were female heads of household (70%). Twenty-nine percent of participants had completed primary level education and 24% had some form of primary education, but did not continue to secondary school. The Shangaan ethnic group was dominant (61%), followed by Ndebele

(22%), Karanga (15%), Ndau (1%) and Zezuru (1%). The main food sources in the study area are derived from crop and livestock production (51%) and food aid from social welfare services (27%). The main source of income identified was the sale of livestock and crops, 31% and 23%, respectively.

Only 18% percent of the respondents rated pastures as fair, 9% as good and 73% reported that the pastures were poor. Water access for livestock was dependent on river pools (90%), boreholes or shallow wells. The average distance travelled by livestock to reach pastures and water sources was estimated by farmers to be 7.4 km and 2.9 km, respectively.

Ninety-two percent of the farmers had goats, 87% had chickens and 71% had cattle. Three out of the 100 interviewed farmers had no livestock.

Out of the 97 animal keepers, 57.7% owned at least one animal of a foreign breed or one crossbred from one of the three livestock species. These farmers were considered as 'adopters', of whom 26.8% had two foreign breeds and none had three. Adopters of foreign or crossbred cattle represented 67.7% of the total number of cattle farmers, (17% of pure breed and 66.2% of crossbred animals). Goat breed adopters represented 17.4% and chicken breed adopters 6.9%. The composition and size of livestock herds per species and per breed (local or foreign) are presented in Table 2. All farmers knew about the indigenous breeds of the three species and all adopters knew about the foreign breeds they had adopted. The majority of non-adopter cattle farmers knew about the Brahman breed (96%), while 22.5% and 23.5%, respectively, of non-adopters of Boer goat and Boschveld chicken knew these breeds.

Table 1: Socio-economic demographics of surveyed IDIs in Sengwe Ward 15 /// *Données démographiques socio-économiques des IDI interrogés dans le quartier 15 de Sengwe*

Education level	Count	Prop (%)	Main source of income	Count	Prop (%)
Never attended	18	18%	Crop sale	23	23%
Incomplete Primary	24	24%	Livestock sale	31	31%
Completed Primary	29	29%	Brick making	4	4%
Incomplete Lower Sec	13	13%	Self-employment	2	2%
Lower Secondary	14	14%	Formal employment	9	9%
Incomplete Upper Sec	1	1%	Informal employment	9	9%
Upper Secondary	1	1%	Other	22	22%
Main source of food	**Count**	**Prop (%)**	**Age**	**Count**	**Prop (%)**
Farming	53	53%	18–29	12	12%
Social welfare	27	27%	30–41	22	22%
Work for food programme	8	8%	42–54	36	36%
Gardening	2	2%	55–66	16	16%
Casual work	6	6%	>67	14	14%
Trading bus	1	1%	**Ethnicity**		
Agricultural labour	1	1%	Shangani	61	61%
NGOs	1	1%	Ndau	1	1%
Formal employment	1	1%	Karanga	15	15%
			Ndebele	22	22%
			Zezuru	1	1%

Table 2: Livestock herd structure relative to Adopters and Non-Adopters among interviewed farmers (source IDIs). '%Adopter' indicates the percentage of farmers interviewed with the given foreign breed in their herd. 'Average No.' indicates herd size per livestock species and 'Average %' provides the percentage relative to the sum of animals per species in each category mentioned in the head of columns /// *Structure du cheptel des agriculteurs interrogés, adoptant ou non une race étrangère (source : IDIs). Le « % Adoptés » indique le pourcentage d'agriculteurs interrogés qui possèdent la race étrangère donnée dans leur troupeau. Le « Nb moyen » indique la taille du troupeau par espèce de bétail et le « % moyen » fournit le pourcentage relatif à la somme des animaux par espèce de chaque catégorie mentionnée en tête de colonne.*

	Adopter					Non-adopter	
	% Adopter	Average No. [Min-Max]	Total local breed	Total (%) Foreign Breed	Average No. [Min-Max]	Total local breed	Total (%) Crossbred
Cattle	67.6%	10.6 [2–32]	354	19 (3.7%)	8.4 [2–25]	192	136 (26.7%)
Goat	17.4%	14.6 [5–32]	174	16 (6.5%)	11.6 [2–40]	873	58 (23.4%)
Chicken	6.9%	23.5 [12–40]	89	42 (29.8%)	10.8 [1–60]	874	10 (7.1%)

Table 3 shows the pathways used by the sampled farmers to acquire livestock for the different animal breeds. Pure-bred Brahman cattle were first introduced in the area by NGOs. Some farmers from nearby commercial farms exchanged them for indigenous breeds. Direct purchases from nearby farms were also frequently reported by informants. Pure and crossbred cattle were acquired by farmers between 1996 and 2018. Agritex officers and NGOs introduced Boschveld chicken quite recently (2019). The introduction projects involved teaching farmers about the potential of foreign breeds and their important traits. NGOs were largely reported to have influenced the adoption of Boer goats, by distributing animals to farmers in 'livestock pass-on schemes.' This was a pyramid type of arrangement, whereby the first receiver passes the doe to the next recipient after the doe has produced a kid. Farmers participated in pass-on schemes between 2001 and 2019 to improve the quality of their herd.

The Brahman cattle breed was preferred by 58% of the adopter farmers and 37% of the non-adopter farmers. Brahman and Mashona cattle were the favorite cattle breeds (95%). For both adopters and non-adopters, the preferred attributes in the Brahman were: higher sale price (43% of preferred Brahman traits); higher milk production (22%); quantity of meat (10%); draught power (8%) and social status (6.5%). The local Mashona breed was preferred by all farmers for its resistance to drought (52%), draught power (10%), disease resistance (8.5%), and high milk production (2%).

The Boer goat breed was preferred by 44% of the adopter farmers and 15.5% of the non-adopter farmers. The preferred traits mentioned for the Boer goat were: sale price, fast growth rate, easy to breed, higher carcass weight ('more meat'). Farmers also reported their high reproductive prolificacy. These traits were only mentioned between 1 and 6 times by the 100 interviewees. Non-adopters who expressed a preference for an indigenous breed largely did so because it was the only breed they knew (54.4%). Other traits were mentioned several times, including: high reproductive prolificacy (19.3%) and sale price; being easy to breed; and higher carcass weight ('more meat').

Given the small number of adopters of the Boschveld chicken breed (n=6), we summed up preferred traits across all farmers. The Boschveld was preferred because they produce more eggs. The indigenous breed was preferred for being easy to breed (35.2%), or because it was the only breed known (18.5%).

Focus group discussion & key informant experiences with foreign livestock breeds

The results from the FGDs and KIIs were aggregated to show the participants' perceptions of foreign livestock breeds (Table 4a, b and c).

Table 3: Methods of acquiring foreign livestock breeds. 'Bought' = bought from trader or other farmer; 'Exchange' = exchange with other farmers; 'NGOs' = acquired through NGO project; 'Mixing' = mixing with local breeds (Source: questionnaire survey) /// *Méthodes d'acquisition des races de bétail étrangères. "Achetées" = achetées à un commerçant ou à un autre agriculteur ; "Echangées" = échangées avec d'autres agriculteurs ; "ONG" = acquises dans le cadre d'un projet d'une ONG ; "Mélangées" = mélangées à des races locales (Source : enquête par questionnaire).*

Breeds	Bought	Exchange	NGOs	Mixing
Brahman	54.5%	36.4%	9.1%	-
Brahman cross	17.0%	8.5%	6.4%	68.1%
Boschveld	100%	-	-	-
Boschveld cross	-	-	-	100%
Boer	60%	-	40%	-
Boer cross	42.9%	-	7.1%	50.0%

KIIs (n=8) were conducted with Agritex officers (n=2), veterinary officers (n=2), traditional leaders (n=2), headmen (n=1) and a councillor (n=1). Six FDGs were organized as follows: one with men who did not have any foreign breeds; two with women; two with men and one with women who had adopted Boschvelds. The perceptions of foreign breeds were drawn from responses to questions asked during KIIs and FGDs, for example: 'What are the genetic characteristics of local breeds? Foreign breeds?'; 'What are your local perceptions of genetic characteristics or traits of foreign and local breeds?'; 'What challenges do you face in adopting animal breeds?'. For each livestock species, the advantages and disadvantages mentioned by participants were classified into different sectors: production, reproduction, social, management and health (Table 4a, b and c).

Brahman, Boschveld and Boer breeds were unanimously perceived as having better production and reproductive traits compared to local breeds. However, they were generally more labour intensive and more susceptible to environmental threats, such as climate, predation, diseases and theft.

From a management perspective, all FGDs reported that foreign breeds were more labour intensive than indigenous breeds. For example, respondents associated foreign breeds with high food and water requirements. Respondents from all the FGDs reported that Brahmans needed large volumes of water compared to indigenous breeds. As natural surface water is scarce in the area, farmers rely on wells dug in the riverbed to water their animals during the dry period. Watering livestock was reported to be a burden for women, tasked with carrying water when it was needed and with filling up the dip tank regularly. Foreign livestock breeds seem more susceptible to heat waves, particularly Brahmans. During the dry season, they have to walk long distances to access poor quality pasture and water sources. This not only exposes the Brahman to heat, but also causes tiredness due to their lack of stamina. In addition, distant pastures may be located inside the Gonarezhou NP, where livestock are exposed to diseases and predation (see below). Boschvelds are most affected by heat stress at a young age. Boschvelds do not brood and tend to lay their eggs all over the place, which means farmers spend extra time collecting eggs. These factors explain the poor adoption of Boschvelds. The higher food requirements of foreign breeds, notably due to their larger body size, placed an additional burden on farmers in the dry season (e.g., harvesting Mopani leaves, *Colosphospermum mopane,* to feed livestock*).*

Predation by wild animals, such as lions, hyenas and baboons affected cattle, goats and chickens. Lions were reported to attack cattle and goats, particularly. All foreign breeds were perceived to be more susceptible to predation.

Respondents also complained about the increasing theft, which largely targeted foreign breeds and crosses for their attractive physical appearance (body weight and coat colour) and higher market value, especially in neighbouring Mozambique. Pure Brahman cattle cost on average $2000-$4000 (USD) per head, compared to indigenous cattle, which are worth $150-$400 (USD). These figures were reported by farmers and confirmed by key-informants. This phenomenon was reported to be a major detractor for local communities adopting foreign breeds.

In terms of health, the main diseases affecting livestock were Lumpy Skin, Heart Water, Anthrax, Foot and Mouth (cattle) and New Castle Disease (NCD) (which affects chickens). An outbreak of NCD occurred during the course of the study, causing death among Boschveld chickens. According to agricultural extension officers, diseases affect both indigenous and foreign breeds. However, farmers argued that foreign breeds were more susceptible and die first. In addition, they need more drugs and vaccines (due to larger body size). Foreign breeds were reportedly very sensitive to ticks and required

Table 4a: Perceptions of the Brahman cattle breed expressed during FGDs & KIIs. Key: 'm' = men FGDs, 'w' = women FGDs, 'k' = key-informant interviews /// *Perceptions de la race bovine Brahman exprimées au cours des FGD et des KII. Légende : 'm' = FGD hommes, 'w' = FGD femmes, 'k' = entretiens avec des informateurs clés.*

Sector	Advantage	FGD	Disadvantage	FGD
Production	High milk yield	m, w	Lose weight fast	m
	Better sale price	m, k	No market	m
	Draught power	m	Need a lot of food	w, k
	Large body frame	m, w	Need supplements	k
	Faster growth	w, k	Shorter life span / Fragile	w, k
	More dung for burning bricks	k		
	Tender meat	w		
Reproduction	Annual calving	m, w		
	Larger calves	m		
	No birth complications	m		
	Easy calving	m		
	Earlier first calving	k		
Social	Beautiful coat colour	m	Conflicts with non-adopters	w
	Increase in social networking	m		
	Increase in social status	m		
Management	Easy to train	w	Heat stress	m, w, k
	Good temperament	k	Not drought resistant	m, k
	Good for crossbreeding	k	Increase in theft	m, w
	Easy to sell	k	Genetic pollution of local breeds	m, k
			Lack stamina	m, w
			Unable to walk long distances	w, k
			Needs a lot of water	w
			Affected by hunger	w
			Stubborn with women	w
			Predation	k
			Degrade the environment	k
Health			More drugs required	m
			Not resistant to diseases	m, k
			Affected by ticks	m, k

Table 4b: Perceptions of Boer goat breed expressed during FGDs & KIIs. Key: 'm' = mentioned during men focus group discussion (FGD), 'w' = women FGDs, 'k' = key-informant interviews /// *Perceptions de la race caprine Boer exprimées au cours des discussions de groupe et des entretiens avec les informateurs clés. Légende : « m » = mentionné lors des discussions de groupe des hommes, « w » = discussions de groupe des femmes, « k » = entretiens avec des informateurs clés.*

Parameter	Advantage	FGD	Disadvantage	FGD
Production	Faster growth	w, k	Expensive to buy	M
	High milk production	w, k	Need a lot of food	K
	Large body frame	w, k		
Reproduction	Produce triplets	w	Kidding once a year	m
	High prolificacy	k	Time before first birth	m
			Poor mothering ability	w
Management	Resistant to drought	m, k	Increase in theft	m, k
	Can be well trained	m	Predation	k
	Resistant to heat	k		
Health	Disease resistant	m		

Table 4c: Perceptions of the Boschveld chicken breed expressed during FGDs & KIIs. Key: 'm' = mentioned during men focus group discussion (FGD), 'w' = women FGDs, 'k' = key-informant interviews /// *Perceptions de la race de poulet Boschvelds exprimées au cours des groupes de discussion et des entretiens avec les informateurs clés. Légende : « m » = mentionné lors des discussions de groupe des hommes, « w » = discussions de groupe des femmes, « k » = entretiens avec des informateurs clés*

Sector	Advantage	FGD	Disadvantage	FGD
Production	Faster growth	m, k	Eggs lack taste	m
	Larger eggs	w, k	Need a lot of food	w
	Large body frame	m, k	Chicks not available for sale	w
Reproduction	High egg production	w, k	No brooding	m, k
Management	Strong	m	Predation	m, w, k
	Resistant to heat	m	Labour intensive (searching for eggs)	w, k
	Drought resistant	k	Need incubator for eggs	w
			Heat stress	k
Health			Poor disease resistance	m, w, k

systematic dipping, which is challenging given the shortage of water and dipping chemicals in the area. Some farmers failed to generate good economic returns with Boschveld chicken because of losses caused by diseases or wildlife predation.

From a social perspective, most FGDs reported that the adoption of foreign livestock breeds led to an increase in social networking within the community. They described the free flow of information and the sense of trust and safety that prevailed, when a non-adopter borrows a pure breed from a fellow adopter for breeding purposes. However, some negative social perceptions emerged in relation to the mixing of indigenous and foreign breeds and the potential genetic pollution of the indigenous gene pool. Farmers highlighted that foreign breeds are spoiling their indigenous breeds as a result of uncontrolled breeding, which arises with shared grazing and when livestock mix at the dip tank. Non-adopters expressed their desire to keep indigenous breeds for cultural reasons and because they are adapted to conditions in the lowveld (supported by key informants).

An increase in domestic conflicts between men and women was reported and linked to the money generated by the rise in egg production and the sale of eggs from Boschveld chickens. In general, men were reported to control the profits from the poultry farming, while women had the daily task of taking care of the chickens. The higher egg production associated with the foreign breed challenged the status quo and men's dominant position. In the three women FGDs, women stated that their husbands sometimes sold livestock and spent the money on alcohol or used it for other personal reasons.

■ DISCUSSION

This study explored the level of foreign breed adoption in farming communities in Zimbabwe's south-east lowveld, on the edge of the Gonarezhou National Park, in the Great Limpopo Transfrontier Conservation Area. The low level of adoption of goats and chickens was associated with the lack of knowledge among non-adopters with regard to foreign breeds. This is probably due to the failure of foreign breeding programmes to convince the first generation of adopters.

In Zimbabwe, livestock production was transformed by the Land Reform Program (Masama, 2014), in 2000. The reform involved the transfer of farmland from white commercial farmers to black smallholders. The extensive resettlement programme caused the widespread mixing of breeds (Mavedzenge et al. 2006, Bennett et al., 2019). As a consequence, indigenous livestock were diluted through crossbreeding with foreign breeds. Given the long drawn-out socio-economic crisis, the country's extension services have deteriorated substantially.

Foreign breeds of the three species were reported to be more productive than indigenous breeds. Imported breeds were introduced into the country in response to the low performance of indigenous breeds (Assan, 2013). Breeds with a larger body mass, which produce more meat and more offspring, can generate greater benefits for their owners in terms of food resources and sale value. In the case of Brahman cattle, their size and coat were an important indicator of the owner's social status. These factors explain why farmers initially wanted to buy animals or take part in NGO or government programmes that gave easy (or free) access to individual animals from exotic breeds. The different stakeholders argued that it made sense to adopt more productive foreign breeds, capable of outperforming the indigenous breeds, because it would improve livestock production and, therefore, local livelihoods. Yet, more than 20 years after the introduction of Brahman cattle and Boer goats in the study site, the level of adoption remains moderate for cattle and low for goats. This is despite the general consensus that these breeds outperform the local indigenous breeds. The recent introduction of Boschveld chickens in the area (2019), partly explains the very low adoption rate. According to farmers, the low adoption rate was due to the increased constraints associated with foreign breeds, given the harsh local conditions and the additional management burden linked to animal health issues.

The study area is characterized by long hot dry seasons (August to November), with low rainfall and regular heat waves. In the dry seasons, the quality, quantity and distribution of natural resources are limited. The average distance to the main water source (the nearby river) was 2.9 km and to pasture was above 7.4 km. The villages in the Sengwe area have an inadequate water supply all year round; 80% of the boreholes are dysfunctional (Tagutanazvo and Bowora, 2019). Given the water scarcity, households rely on boreholes for watering animals. Brahman cattle reportedly struggle to walk long distances, grow weaker as the dry season progresses and lose weight faster. Overall, they are less resistant to the prevailing dry conditions (Faye, 2008). Their larger body mass compared to indigenous breeds is an advantage for production, although it means that they require more resources, including water and food during the dry season. This increases the burden for farmers, who rely on boreholes for watering their animals. It is difficult for foreign breeds to satisfy their dietary requirements when good quality pasture diminishes and recedes. Heat waves were reported to affect foreign breeds disproportionally.

This observation is supported by Assan (2015), who states that heat stress increases water requirements for livestock. This scenario was reported to be a major driver for people in the area, who preferred heat tolerant indigenous breeds.

The challenge linked to diseases was also considered to have a greater impact on foreign livestock breeds than on indigenous breeds. The need to buy more drugs (larger body size requires a higher dose), and vaccines placed an additional burden on farmers. These findings are supported by Bwire (2008). Among the farmers interviewed, 75% stated that disease was the greatest challenge to the adoption of Boer goats. They suggested that the government should provide drugs at affordable prices and veterinary services should be readily available. Brahman and Sanga cattle (like Mashona) are considered to be more resistant to ticks than many other breeds (Burrow et al., 2019).

The presence of wildlife/livestock interfaces in the study site located in the GLTFCA, creates another layer of constraints for foreign breeds. Travelling long distances to pasture often meant approaching or entering protected areas, where wild predators can be attracted to domestic prey. For example, the Mwenezi River forms part of the boundary between the communal land and the Gonarezhou National Park. According to farmers, hyenas, wild cats, eagles and baboons have attacked their livestock. Janisch (2017) posits that hyenas and baboons are considered to represent the most serious risk to livestock, particularly goats. Reports suggest that foreign cattle and goat breeds are easy targets because they do not run as fast as indigenous breeds in rough terrain. They also appear to lack the ability to sense danger rapidly, unlike indigenous breeds. Gebremiam et al. (2017) have shown that exotic chickens are more vulnerable to predatory attacks. Farmers stated that Boschveld chickens were vulnerable to attacks by wild cats, eagles and baboons.

The coexistence between wild and domestic animals presents risks of pathogen transmission. This poses a threat to local livelihoods reliant on animal production (Caron et al., 2013). Foreign breeds appear to require more veterinary support when sick and are more susceptible to local diseases. Therefore, living at the interface with wildlife, where inter-species disease transmission is known to occur, may increase the burden for adopters.

Stock theft is quite prevalent given the transboundary location. Foreign cattle breeds are prized for their higher value, which is a further disincentive for adoption. Living in the TFCA, where predation, disease transmission and cross-border theft may occur, appears to affect the decision to adopt foreign breeds. Farmers do not consider that the potential benefits of foreign breeds will offset the added constraints.

Lastly, the introduction of foreign breeds was also perceived as having both positive and negative impacts on social dynamics. Foreign breed programmes introduced by NGOs or the government were thought to promote trust and networking between farmers involved in collective action. However, conflicts may arise between adopter and non-adopter farmers, over issues linked to maintaining the genetic stock of local breeds, for example, when uncontrolled mating occurs between foreign and indigenous breeds at grazing and dipping sites. Non-adopter farmers want to protect their indigenous breeds from 'genetic pollution'. The issue of gender-based conflicts, arising between husband and wife, was mentioned in relation to the use of the extra income generated by the introduction of Boschveld chickens. Therefore, the social impacts of livestock introduction programmes should be taken into account in future livestock improvement programmes.

In summary, farmers clearly expressed the mismatch regarding the productive potential of foreign breeds and their sensitivity to the harsh semi-arid local conditions and the wildlife/livestock interface due to the GLTFCA. The production potential of foreign breeds cannot be achieved without improved management practices and greater investment (i.e., better quality feed, water, medicine and security). In addition, foreign breeds are more susceptible to heat waves and drought. In the face of more frequent extreme events linked to climate change, it may not be worth farmers investing in foreign breeds. In fact, adopting foreign breeds may make them more vulnerable and food insecure (Freeman et al., 2008). Consequently, most farmers kept indigenous breeds because they are well adapted to local climatic conditions. They have the capacity to survive in an environment with limited resources; they are less vulnerable to predation by wildlife; and have better disease resistance. These traits are necessary for livestock production in a TFCA. Farmers clearly expressed the need to preserve their indigenous breeds, by protecting their local traits from genetic dilution brought in by foreign breeds. The practice of crossbreeding between Brahman and Mashona cattle seems to be more widely adopted. Crossbreeding Brahman with small indigenous breeds may help improve cattle production. Indeed, these crossbreds are well adapted to the local climatic and environmental conditions. They are also very fertile, early maturing, calve easily and have excellent carcass and meat qualities (Wilson, 2018).

However, breeding programmes are required with a double objective: to promote crossbreeding with a view to improving production; and to preserve the local breed diversity because of their locally-adapted traits. An innovative approach is needed, combined with support and expertise from extension services, which are currently lacking. As a result, farmers do not have access to the appropriate technologies that could help them improve productivity (Sebho, 2016). While crossbreeding can improve overall livestock performance, if it is indiscriminate and uncontrolled, it may result in poor production performance (Kahi,2002). Improving livestock breeds calls for a realistic approach, which takes into account environmental constraints, socio-economic demands and resource availability (Philipson, 2006). When farmers adopt crossbreeding technology, they need access to credit and support from extension services (Abdulai and Huffmann 2005). Extension services in the area have skills and knowledge (as shown in the result section), but lack transport (to access distant and remote areas), access to veterinary drugs and other essential materials. They lack the resources and are unable to provide funding and technical support to design long-term cattle breeding programmes to improve production and protect local breeds. NGO support is limited over time, which means it is inadequate for long-term breeding programmes.

■ CONCLUSION

Farmers' feedback highlights the need for a different approach to promote the adoption of foreign breeds in the semi-arid areas in the TFCAs. Ultimately, the farmers are the ones who decide whether or not to adopt. Building farmers' capacity helps them make well informed decisions: first, livestock production and management practices should be tailored to the context and correspond to farmers' knowledge and skills. Sharing experience with adopters from the same or similar areas is also important. Second, extension services are essential for providing support, access to inputs (e.g., drugs), field trials and if necessary, assistance during the transition process (MacLeod et al., 2008). Lastly, farmers need a political and administrative environment, which facilitates access to markets, inputs, and micro-financial systems (Scudiero et al., 2019). Our study reveals the importance of community involvement when it comes to successful and sustainable project development. Indeed, external stakeholders (e.g., NGOs, national or provincial government), should avoid implementing pre-designed projects or blueprints from other areas in a top-down manner. Interventions should be discussed and negotiated with local stakeholders to ensure that their needs are identified and their indigenous knowledge and experience are taken into account (Gobvu et al., 2021). Platforms of communication and exchange or

participatory processes should be the cradle for this type of innovation process (Bourgeois et al., 2023).

Lastly, more research is needed to investigate the social and ecological determinants of foreign breed adoption in semi-arid zones, especially given the impact of climate change in these areas. For example, more studies should investigate the relative advantages of crossbreds compared to pure breeds. The breeding strategies in semi-arid areas in the context of TFCAs should be co-designed. By drawing on local genetic diversity and local knowledge, it will be possible to optimize the use of foreign breeds in the challenging and changing environment of Southern Africa (Scholtz, 2011).

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Conflict of Interest

The authors declare that there is no conflict of interest.

Author contributions

CRM: Investigation, Formal Analysis, Writing – Original Draft; VIC: Software, Data Curation, Formal Analysis; BM: Project Administration, Supervision (field activities); PHM: Conceptualization; AC: Methodology, Supervision; All: Writing – Review & Editing

Ethical statement and animal rights

All human and animal studies were approved by the appropriate ethics committee and were, therefore, performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Data availability

The data were not deposited in an official repository. Data supporting the study findings are available from the authors on request.

Declaration of Generative AI in the writing process

The authors did not use any artificial intelligence-assisted technologies in the writing process.

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Résumé

Mudavanhu C.R, Mugabe P.H., Mukamuri B., Imbayarwo-Chikosi V.H., Caron A. Facteurs socio-économiques et écologiques associés à l'adoption de races de bétail exotiques par les petits exploitants agricoles zimbabwéens dans la zone de conservation transfrontalière du Grand Limpopo

Contexte : Dans les zones rurales africaines, la productivité des systèmes d'élevage est faible et les programmes de développement visent à accroître la productivité par l'innovation technique, y compris l'introduction et l'adoption de races exotiques. Le niveau d'adoption de ces races exotiques doit être étudié afin d'évaluer l'efficacité de ces programmes. ***Objectif*** : Cet article analyse les facteurs socio-économiques et écologiques associés à l'adoption de races de bétail étrangères, notamment les bovins Brahman, les chèvres Boer et les poulets Boschvelds dans les communautés rurales zimbabwéennes de la zone de conservation transfrontalière du Grand Limpopo. ***Méthodes*** : Une méthodologie mixte a été employée, combinant une analyse documentaire, des questionnaires à réponses fermées (n=100), des entretiens avec des informateurs clés, des entretiens individuels approfondis et des discussions de groupe. Un processus de triangulation et d'analyse thématique ont servi de base à la recherche et à l'analyse des données. ***Résultats*** : Les principales dynamiques socio-économiques influençant les perceptions et l'adoption de races de bétail spécifiques sont liées à la productivité, à la reproduction, à la gestion, aux aspects sociaux et à la santé. Les facteurs écologiques les plus importants sont la prédation du bétail, le stress thermique et les pénuries d'eau et de pâturages. Malgré le potentiel productif des races étrangères, le niveau d'adoption est faible en raison du contexte local, dans lequel les races étrangères ne peuvent pas exprimer tout leur potentiel génétique. La plupart des agriculteurs conservent des races indigènes parce qu'elles sont bien adaptées aux conditions climatiques locales et résistantes aux maladies du bétail. ***Conclusions*** : Pour améliorer l'efficacité des programmes axés sur la production animale, les services gouvernementaux et les acteurs du développement devraient adopter des processus plus participatifs et des stratégies de gestion adaptative, qui reflètent mieux les demandes des petits exploitants.

Mots-clés : Production animale, race animale, critère de sélection, zone protégée, Zimbabwe

Resumen

Mudavanhu C.R, Mugabe P.H., Mukamuri B., Imbayarwo-Chikosi V.H., Caron A. Factores socioeconómicos y ecológicos asociados a la adopción de razas de ganado exóticas por parte de los pequeños ganaderos zimbabuenses de la Zona de Conservación Transfronteriza del Gran Limpopo

Contexto: En las zonas rurales africanas, la productividad de los sistemas de cría de ganado es reducida y los programas de desarrollo tienen como objetivo aumentar la productividad mediante la innovación técnica, incluyendo la introducción y la adopción de razas exóticas. Debe estudiarse el nivel de adopción de estas razas exóticas para evaluar la eficacia de los programas. ***Objetivo***: El artículo analiza los factores socioeconómicos y ecológicos asociados a la adopción de razas de ganado foráneas, especialmente los bovinos Brahman, las cabras Boer y los pollos Boschvelds en las comunidades rurales zimbabuenses de la zona de conservación transfronteriza del Gran Limpopo. ***Métodos***: Se empleó una metodología mixta, que combina un análisis documental, cuestionarios con respuestas cerradas (n=100), entrevistas con informadores clave, entrevistas individuales en profundidad y debates de grupo. Un proceso de triangulación y de análisis temático sirvió de base en la investigación y el análisis de los datos. ***Resultados***: Las principales dinámicas socioeconómicas que influyen en la visión y la adopción de razas de ganado específicas están relacionadas con la productividad, la reproducción, la gestión, los aspectos sociales y la salud. Los factores ecológicos más importantes son la depredación del ganado, el estrés térmico y la escasez de agua y de pastos. A pesar del potencial productivo de las razas foráneas, el nivel de adopción es bajo a causa del contexto local, en el cual las razas foráneas no pueden expresar todo su potencial genético. La mayor parte de los agricultores conservan razas indígenas porque están bien adaptadas a las condiciones climáticas locales y son resistentes a las enfermedades del ganado. ***Conclusiones****:* Para mejorar la eficacia de los programas centrados en la producción animal, los servicios gubernamentales y los actores del desarrollo deberían adoptar procesos más participativos y estrategias de gestión adaptativa, que respondan mejor a las demandas de las pequeñas explotaciones.

Palabras clave: Producción animal, razas animales, criterios de selección, zona protegida, Zimbabwe