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Preferred livestock interventions for small-scale farmers in the Great Limpopo Transfrontier Conservation Area: a demand-driven and participatory approach

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Abstract

In southern Africa, residents of Transfrontier Conservation Areas (TFCAs), devoted to biodiversity conservation and local development and well-being, practice small-scale farming in semi-arid environments constrained by the presence of protected areas and extensive wildlife/livestock/human interfaces that come with conflicts and opportunities. Under these contexts, livestock production aims at supporting local livelihoods despite the harsh semi-arid environment and conflicts with wildlife. In the context of an intervention aiming at promoting local development and the well-being of residents in the Great Limpopo TFCA, the objective of this study was to test a methodology to identify demand-driven interventions (i.e., based on local stakeholders' needs) for improving livestock production in a communal land in Zimbabwe. This study used the outputs of an anticipatory scenario-building workshop (e.g., a desired future scenario for the area) and individual questionnaires to establish possible and desired livestock interventions by local stakeholders. Results were largely similar and complementary between the co-elaborative scenario building workshops and the questionnaire survey. Preferred interventions were: restocking herds with breeds adapted to local production; training in livestock practices and production; support to marketing; feed development and value addition; loan schemes to invest in livestock housing and stockfeed; and finally, animal health interventions to reduce the heavy disease burden. The individual questionnaire data specified preferred interventions for each domestic species. These demand-driven interventions provide a basis for future development projects in the area and avoid top-down approaches by development agencies that fail to address local needs and lack appropriation by local stakeholders necessary for the sustainability of the interventions.

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Introduction

Mixed crop and livestock systems practiced by agropastoralists in southern Africa are the predominant form of agriculture and source of income and produce more than 80% of food in the region (Homann-Kee Tui et al., 2021). They represent integrated agricultural systems that cultivate crops and rears livestock on the same farm (Seré et al., 1996; Mkuhlani et al., 2020). Extensive livestock production systems (LPS) are characterised by a low productivity per animal and per surface, use small amounts of inputs, capital, and labour compared to more intensive production systems. LPS are often associated with rainfed agriculture to produce mixed crop and livestock systems. Extensive LPS in sub-Saharan Africa are challenged by decreasing rangeland sizes, poor-quality livestock feed (based mainly on crop residues), diseases and pests (Mupangwa & Thierfelder, 2014). Soil erosion, land degradation, and a reduction in soil fertility are caused by overgrazing, which frequently occurs on rangelands in addition to negative impacts of climate such as unpredictable and variable rainfall and worsening droughts. These LPS also suffer from constrained operational environment such as limited access to markets and veterinary services, and limited foreign investment are some of the reasons behind the poor adaptation of new equipment and infrastructure (Easter et al., 2018; Matope et al., 2020; Oduniyi et al., 2020; Mogomotsi et al., 2020).

Transfrontier Conservation Aeras (TFCAs) are complex matrices of land use that 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) (Bollmann, 2019). Agropastoralist communities in TFCAs practice livestock production in the most semi-arid environments of southern Africa, characterised by rainfall variability and unpredictability. TFCAs were founded on the realization that natural resources that straddle international boundaries are a shared asset with the potential to meaningfully contribute to the conservation of biodiversity, welfare and socio-economic development of rural communities (Hanks, 2003). In TFCAs, LPS farming communities live close to protected areas and experience additional constraints such as human-wildlife conflicts including livestock predation by wild carnivores, competition between livestock and wild ungulates for forage and water and infectious (potentially zoonotic) diseases that can be transmitted between wild and domestic animals (Cumming, 2011; Caron et al., 2013; Matseketsa et al., 2019). Information on vulnerability and adaptation of these production systems needs to be context specific, while accounting for the main farming system components (Homann-Kee Tui et al., 2021).

Despite this context, African agropastoralist LPS are required to address an important challenge. Projected demand for animal-derived proteins will increase by 30% in Africa, mainly driven by the growth of the human population on the continent (OECD & Food and Agriculture Organization of the United Nations, 2021). Successful transformation of the agropastoralist LPS with increased output and productivity to meet the increased demand for animal proteins, requires appropriate intervention modes. However, LPS interventions are often designed centrally and implemented in a top-down manner, leaving farmers outside the innovation process, as passive stakeholders. This results in low outputs or even failure of interventions that do not match local knowledge, experience and production conditions (Hauser et al., 2016). Agropastoralist communities have not always been consulted in social-change processes (Şandru, 2014; Gobvu et al., 2021) and as a result, development partners may not be appropriately informed of the community priorities.

To be more sustainable and locally relevant, LPS interventions must be informed by farmers' needs as well as prevailing state and conditions of livestock production (An et al., 2024). Community-based approaches have been suggested to identify and prioritize problems (Khashtabeh et al., 2019). Participatory approaches to solving livestock production build a strong base for the intervention in the

community (Mubita et al., 2017). In addition, they ensure that interventions are designed to respond to a demand-driven process and not parachuted in a top-down manner, that is not embraced by final beneficiaries. LPS interventions defined through a participatory approach should therefore produce interventions that are locally owned, context-relevant and adapted to local constraints but still match national objectives.

In Zimbabwe, agriculture contributes 15-18% of Gross Domestic Products (GDP) and provides livelihoods to approximately 70% of the rural population (Government of Zimbabwe (GoZ), 2018). As of 2017, the productivity of agropoastoralist cattle herds remains very low, with average calving rates of about 45% against a potential of 60%, and off-take rates of about 6% against a recommended 20% (GoZ, 2018). Changes in land use patterns following the land reform of the early 2000s have influenced LPS across Zimbabwe, whereby the national livestock herd sizes declined by about 20% for beef, over 83% for dairy, and 26 and 25% for pigs and small ruminants respectively (Ossome & Naidu, 2021). Livestock and livestock products still contribute significantly to the economy of Zimbabwe, with 35% to 38% of the GDP contributed by the agricultural sector (Mhaka & Runganga, 2023). The Zimbabwe National Agriculture Policy Framework calls for the formulation of interventions that directly respond to the local people's needs and enhance the flow of investments that are critical to sustaining the growth of the agricultural sector with a decided focus on increasing agricultural productivity and production (GoZ, 2018).

The Great Limpopo TFCA (GLTFCA), where this study was implemented, combine public and private protected areas and communal land from Mozambique, South Africa and Zimbabwe since its creation in 2001 after the signature of the 3 heads of state. In the Zimbabwean part of the GLTFCA, livelihoods are crop-based (41%), non-farm based (47%, e.g., cross border trading, employment) and cattle-based (12%, e.g., cattle trading) (Murungweni et al., 2016). Drought, poor management of rangelands, and rangeland fires limits the availability of fodder (Tavirimirwa et al., 2013). Masikati (2011) mentions that seasonal deficiency in feed quality and quantity particularly during the second half of the dry season is the major constraint to communal livestock production. The common cattle diseases in the area include Rift Valley Fever, Anthrax, Brucellosis, Theileriosis, Bovine Tuberculosis, Rabies. Foot-and-Mouth Disease, Babesiosis and Anaplasmosis (Caron et al., 2011; Gomo et al., 2012; de Garine-Wichatitsky et al., 2013; Gadaga et al., 2015; Ndengu et al., 2020).

In the agro-ecological, institutional and socioeconomic context of the GLTFCA, this study was part of the Promoting Sustainable Livelihoods in TFCAs (ProSuLi) development project and used an inclusive and participatory approach to identify demand-driven LPS interventions in a communal area in South-east Zimbabwe belonging to the Great Limpopo TFCA. The objective was to co-design with local stakeholders a prioritization of livestock interventions adapted to the local context. This study is rooted in post-normal sciences and action research, re-instating the scientist in the social field and promoting the concerns of people in the transition to action (Funtowicz & Ravetz, 1993). Our assumption was that by enabling local farmers to coproduce interventions and their outputs, those would: i) differ from top-down interventions promoted by the state or other external organisations; ii) result in more empowerment and appropriation by local stakeholders of the interventions; iii) result in more locally-relevant interventions. These assumptions were not tested in this article but it contributed to the co-design of an intervention and provides a methodology that is replicable and to the benefit of local stakeholders.

Methods

Study context and design

The Promoting Sustainable Livelihoods in TFCAs (ProSuLi) project recognised that the success of development programs is rooted in positive stakeholders' interactions, recognising the legitimacy and importance of their respective positions, needs and constraints and the need for negotiations in order

to achieve a shared common vision of a sustainable project (Caron et al., 2022). ProSuLi objective was to promote sustainable livelihoods in 4 local communities living in the periphery of protected areas in Zimbabwe, Mozambique and Botswana within the Great Limpopo TFCA and the Kavango-Zambezi (KAZA) TFCA.

Study Site

Sengwe Communal Area is located in the Great Limpopo TransFrontier Conservation Area (GLTFCA) in the Southeast Lowveld of Chiredzi District, Zimbabwe, which lies at 21o33'S and 31o30'E (Figure 1). The specific study site, Ward 15, lies at the southern edge of Gonarezhou National Park buffered by the Malipati Safari Area to the South and Malilangwe Conservancy Trust towards the North. The average altitude is 392 m. Chiredzi District is in Agroecological Region V and is characterised by erratic rainfall and low mean annual rainfall of around 450mm (Kupika et al., 2019; Nyarumbu et al., 2019) with high interannual rainfall variation (Poshiwa et al., 2013). Minimum temperatures range between 4.3 and 21.1 °C and maximum temperatures range between 27.8 and 37.3 °C. Major soils are eutric vertisols, chromic luvisols and eutric fluvisols. Colophospermum mopane trees dominate in the area.

In each village, diptanks are infrastructures that allow livestock to be immersed in a water pool in which an anti-tick chemical molecule has been diluted. This helps to fight against tick infestation and tick-borne diseases (e.g., theileriosis, babesiosis, anaplasmosis), the diseases with the most impact on cattle mortality in the area.

Different organisations have come up with livestock interventions in the study area before; Brahman restocking programs, Boer goats and Boschveld chickens restocking (Mudavanhu et al., 2024). However all of these have been top-down and failed to be sustainable due to lack of community involvement in project selection and design (Silvius & Schipper, 2014).

Co-elaborative scenario building towards action

Participatory prospective analysis and the Futures workshop

This study applied two approaches namely: a co-elaborative scenario-building workshop called Participatory Prospective Analysis (PPA) (Bourgeois et al., 2023) to support a group of local stakeholders/actors in producing plausible contrasted scenarios about the futures of livelihoods in the Sengwe site by 2038, followed by a planning workshop and a questionnaire-based survey. The year 2038 was selected as 20 years after the workshop, a period that was estimated to account for a generation locally (it was proposed and agreed by the participants). A questionnaire survey was conducted in September/October 2019 on sampled individual households to identify their preferred livestock interventions.

The PPA was used for engaging key stakeholders through participatory meetings. All expert stakeholders progressively identify and develop a range of scenarios and elaborate actions in response to the scenarios identified (Larson et al., 2023). The co-elaborative scenario-building workshop was conducted in October 2018 and was implemented through a three-day "Futures Workshop". Purposefully selected community representatives covering community livelihoods and support sectors were in attendance. They were selected because they were expected to be able to share and provide a range of different perspectives on livelihoods and to be "knowledge broker" about specific aspects (e.g., livestock production, education system) in the study areas, based on their knowledge and experience. The workshop gathered 31 participants, 80% of which were male who acquire most of the influential positions in existing community structures. Participants were community members (68%), some occupying committee positions (e.g., irrigation schemes, development trust), traditional leadership (n=3) or famer group positions, the remaining participants (32%) belonging to governmental and non-governmental institutions operating in Malipati (Table 1). The facilitating team included 10 members (including students).

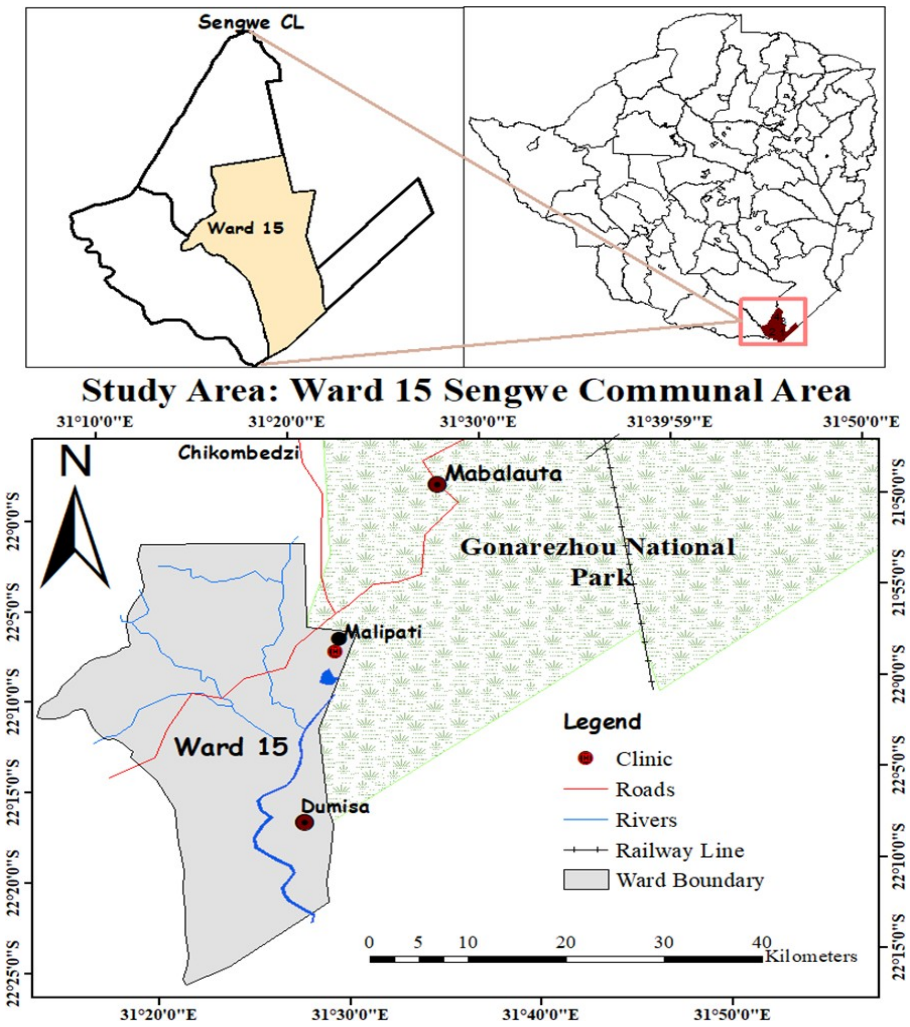

Figure 1 - Map of the area including the Ward 15 of the Sengwe communal land (yellow area) and Gonarezhou national park ("National Park"). The southern-eastern part of the map is Mozambique and the area South of the Limpopo River (bottom left) is Kruger National Park in South Africa. All the area shown on the map is part of the Great Limpopo TFCA.

The project team, including researchers and students from Zimbabwe, Mozambique and France facilitated the workshop. The workshop alternated plenary and group sessions taking the participants step-by-step from their perception of the future to the strategic tipping points connecting the future with the present. For detailed information about the methodological steps, see Bourgeois et al. (2017 and 2023). In summary, the objective of the Futures workshop is not to predict the future but to give the possibility to participants to use the future to make sense of, and to sense novelty in the present (Miller, 2015). The future does not exist, does not belong to anyone and therefore can be used by anyone. Using the future is thus a transitional step that allows participants to explore pathways beyond the current trends, to use future thinking to change the present. The resulting scenarios are not predictions and do not intend to become blueprints for action. Their role is to widen the perception the participants have of the present by engaging in a stimulating reflection about the evolution of their environment, and what could happen to their livelihoods beyond usual basic trend analysis. As such they serve to "benchmark" the future, opening horizons, enabling people to think differently and becoming pro-active in TFCA management (Bourgeois et al., 2023).

Table 1 - Institutions engaged in the co-elaborative scenario planning workshop

Institution	Mandate
Agritex	Agricultural extension services
Veterinary Services of Zimbabwe	Livestock health and management extension
Malipati Development Trust	Strategising and spearheading village level development projects
Communities Initiative for Sustainable Development (CifoSude)	Good governance of the community structures Advocacy of development Information
Communal Areas Management Programme for Indigenous Resources Committee (CAMPFIRE)	Communal natural resource management Advocating for wildlife management
Manjinji and Magogogwe Irrigation Schemes	Food security
Malipati and Samu Dip Tank Committees	Livestock health management
Gonarezhou Conservation Trust (GCT)	Ecotourism Community engagement
Southern Alliance for Indigenous Resources (SAFIRE)	Capacity to adapt to climate change Assist traditional leaders in resource governance
Malipati School Committees	Education support

Participants identified through group work and plenary sessions “factors of change” (i.e., factors that could impact the livelihoods of local communities in the study site). Factors of change were later distributed according to the STEEP classification (Bowman, 1998), namely social, technical, economic, environmental and policy dimensions. Amongst, the factors of change, participants selected five driving forces of local livelihoods in the area (i.e., the 5 factors of change identified as the most influential on other factors of change and local livelihoods). In order to identify the five driving forces to build the frame of the future scenarios, participants engaged in a reflection on the interconnections between the different factors. A voting process took place where each participant was allocated dots of different colours to indicate on a board the factors that were the most influenced by the others and the factors that were the most influential on the others. Based on this voting process, participants selected five driving forces of local livelihoods in the area.

Then, for each driving force, different future states were proposed and discussed in common. Future states in 2038 could be desired or not desired states. Compatible future states of driving force were grouped to form synopsis that were at the basis of scenario after integrating the remaining factors of change under the form of future states linked to the driving forces’ future states considered.

After the workshop, each factor of change was classified as directly, indirectly or not linked to LPS based on their definition and expert opinion (Table 2). Also, scenarios were printed on posters and presented to the larger community (non-workshop participants) for discussion and feedback.

From anticipation to action: a follow-up participatory workshop

A few months after the Futures workshop, a follow-up participatory workshop was organized with the participants from the first workshop. This workshop was held on the 12th and 13th of April 2019 in order to provide feedback on the outputs of the first workshop and from the larger community, validate them and organize the way forward towards the selection of activities for the project.

Participants included local development trusts, local NGOs, community-based natural resource programme; community childcare workers, teachers form primary and secondary schools, local irrigation schemes, veterinary services, seed multiplication farmers, animal health care centre, farmers, religious leaders, agriculture extension services and headmen.

Questionnaire survey

After the co-elaborative scenario building processes, a survey was designed by the authors and conducted to consolidate the outputs of the participatory workshops with participants who were not present in the scenario planning workshop. The questionnaire was implemented using semi-structured questionnaires to collect information on important livestock interventions for each livestock species

(i.e., “indigenous chicken”, “cattle”, “goat”, “pig”, “sheep” and “other speices”). The questionnaire thematic areas were: demographic information, livelihoods activities, livestock kept and preferred livestock interventions (Supplementary material 1). Structured interviews collected information on livestock species kept and preferred livestock interventions per species of livestock. Respondents were sampled from 9 villages of Sengwe ward 15, as initially selected by the ProSuLi project. This ward was chosen because of its past involvement in research and development projects with the team (such as the DREAM Project on Learning Platforms) and as a ward sharing a border with Gonarezhou National Park, the second largest park in Zimbabwe in the South-East corner of the country. Each village had around 25 households and for the 9 villages there were 225 households. By law, villages in a rural district should have up to 25 households, once they exceed such, another village is built. It was assumed that half of the households (0.5) had livestock (Zimbabwe Vulnerability Assessment Committee, 2024) . The confidence coefficient was assumed to be 95% giving a z-value of 1.645. A 0.05 acceptable sampling error was also assumed. The sample size was calculated using the following Cochran’s sample size formula (Cochran, 1977).

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

Where **p** is the population proportion (50%), **e** is the acceptable sampling error (5%), **z** is the z-value at reliability level of 0.95 (1.645) and **N** is the population size (225). The computation provided for a sample size of not less than 123 households. An additional three households were included from the outcome of the purposive sampling to create a final sample size of 126 households, with 14 households per village across the 9 villages in the ward. The survey purposely selected household heads for respondents. Interventions collected through the questionnaire survey were then compared to the interventions identified through participatory approach.

Statistical Analysis

Data from the household survey were analysed with the Statistical Package for Social Sciences (SPSS) Version 25 (IBM Corp, 2017). Data were described using frequencies and means procedures of SPSS. Exploration of livestock numbers per household was done through the median because the frequency distribution of the data was skewed.

Results

Co-elaborative scenario building toward action

The Futures workshop

Thirteen out of 35 (37,1%) factors of changes were directly linked to LPS and 15 (42,9%) were indirectly linked to LPS which together indicated that 28 factors of change (80%) for local livelihoods were directly or indirectly linked to LPS. The report of the futures workshop can be found in Supplementary material 2.

Participants performed a collective mapping process to determine the influence between factors of a given dimension. After displaying the collective results, they voted for the five most influential drivers (i.e., driving forces) ensuring the representation of at least three of the five dimensions (social, technical, economic, environmental and political) (Bourgeois et al., 2023). LPS was regrouped with farming production systems as one of the five driving forces because of the interdependency between both type of farming systems (i.e., mixed crop-livestock farming systems); others were “State of food security / poverty”; “Governance capacity of the local community”; “Capacity to adapt to climate change”; “State of local culture and tradition” (Table 1).

Table 2 - Factors of change (n=36) and driving forces (in bold) influencing directly or indirectly LPS. The LPS driving force has been shaded for clarity. The 6 driving forces (both "Types of farming systems" were merged by participants as one driving force) selected by participants are starting with "(*)"; the definition column presents the definition of factors of change as agreed amongst participants during a dedicated session of the workshop, some of them only completing the title of the factor of change (e.g., "state of animal health"; the "Dim." column indicates the related STEEP dimension as follows: S=Social, T=Technical, En=Environment, Ec=Economic, P=Political; the last column "Link to LPS" indicate the factors of change that are directly (D) or indirectly (I) linked to LPS; empty cells indicate absence of link.

Name	Definition	Dim.	Link to LPS
(*) Capacity to adapt to climate change	The capacity of local people to adapt to climate change through actions	En	D
Quality of air	The quality of air in the area	En	
State of natural resources	Vegetation cover, excluding water and water bodies	En	D
State of water and water bodies	The quality and availability of water	En	D
State of animal health	Including domestic and wildlife	En	D
Human wildlife interactions	The nature of interactions between local people and wildlife	En	D
(*) Governance capacity of the local community	The capacity of the local community to organize and influence decisions	P	I
Natural resources management	By whom and how are natural resources (excluding wildlife) managed	P	D
Wildlife management	By whom and how is wildlife managed	P	I
Land use policy	Who decides and how about land use at the local level	P	I
Land use allocation	By whom and what for is land use allocated	P	D
State of health infrastructure	Quality and distribution of hospitals, clinics and pharmacies	P	
Access to health services	Who has access to health services quality of the services	P	
Distribution of wealth	Who is wealthy and where are they located	Ec	I
Nature and type of investment locally	Nature and type of investment locally	Ec	I
Nature and type of development	Which economic sector is developed how, by whom	Ec	D
State of poverty	Who is poor and how is poverty distributed	Ec	D
Movement of people	Migration flows out and into the area (number of people, who move in and out of the area)	Ec	
State of transport infrastructure	Quality and distribution of transportation networks	Ec	I
Accessibility to and from the area	How easy it is to reach and leave which parts of the area	Ec	D
Access and type and quality of education	Who has access to what type of education including the quality of it	T	
State of Information, Communication and Technology (ICT)	Level of development and accessibility to information and communication technologies	T	I
State of farming knowledge and skills	Include crops and livestock	T	D
(*) Type of livestock farming system	How livestock is managed and by whom	T	
Livestock density	Number and distribution of cattle in the area	T	D
(*) Type of farming system	Who is farming and how (crops)	T	I
Type of energy and access	Who has access to energy and what type of energy	T	
Attitude/behaviour of people	Individual attitude and behaviour of people locally	S	I
(*) State of local culture and traditions	The place of the local culture and traditions in the local society	S	D
Place of men and women in the society	Place of men and women in the society	S	I
General level of education	The level of literacy of the people in the area (including who and also distribution)	S	I
Nature of people relationship	The nature of the local social links between people	S	I
Density and distribution of the population	Who and how many live where	S	I
State of health of people	Who is healthy, where, who is not healthy, why	S	
(*) State of food security / poverty	Who is food insecure, how many and where	S	I
Demographic policy	The public means used to regulate the number of people living in the area	S	I

In plenary and subsequent validation sessions, participants collated 5 plausible contrasted scenarios based on the future states of the 5 driving forces (in bold in Table 2, future states can be found in Supplementary material 3), and code-named them as : Selfish Pain, The Male Power, Laissez-faire Kills, Bye Poverty!, A Big One for a Few Ones (Box 1; English versions chosen by the participants based on vernacular expressions). Full narratives resulted from the inclusion of all the remaining 30 factors of change into the synopsis. The process was that the initial narratives were written by the project team and later validated by local stakeholders through participatory feedback and comment sessions.

Box 1: Five synopsis which are the basis of the 5 full narratives (see Supplementary material 4)

Chaitemura Chavakuseva – Bye poverty!: In 2038, there is a mix of local and foreign cultures with good governance, empowered local leaders and cross-cutting inclusiveness in land use allocation. Due to the adoption of solar energy, there is well-adapted irrigation which promotes mixed farming using adapted livestock breeds and crop varieties with high-value markets. As a result, the level of poverty has been reduced to 30%. The poor and vulnerable groups (women, orphans and elders) scattered around the park.

Mazvakemazvake - Laissez-faire kills: In 2038, an individual culture prevails and people do whatever they want, affecting the governance capacity of the local community and leading to infighting for leadership. The power struggle deviates people from adapting to climate change. As a consequence farming has collapsed. A very disturbing situation exists whereby ninety percent of the people are poor except for only 10% which is employed or owning business.

Matimba Avanuna - The male power: In 2038, local culture and traditions are central to the society, taught at school. The governance capacity of the local community is characterised by abuse of power by male-dominated leaders and corruption in land allocation. People are resisting to adapt to climate change. As a result there is no more farming activities and livestock! Therefore 90% of the population is living in poverty throughout the whole area, except for the 10% who are either employed or have their own business.

A big one for a few ones: In 2038, the local culture and traditions are central in the local society and people's lifestyles entice them to resist to adapt to climate change. A top down governance system has taken over the capacity of governance of the local community and land use allocation. It is supporting agricultural activities based on zero grazing at small scale with small livestock (rabbits, chicken…) and greenhouse/rooftop farming. 60 % of the population remain poor, particularly women, children, elder men and the unemployed. Poverty is spread across the villages.

Selfish pain: In 2038, the local culture and traditions have been erased, leading to chaotic fight for power and unclear land use allocation. Ninety percent of the population has first become poor due to no more farming and livestock products. This resulted in everyone abandoning the area, leaving it with no capacity to adapt to climate change.

After discussion and debate about the pros and cons for the different scenarios, the workshop participants finally agreed collectively that they preferred the Bye Poverty! narrative (Box 1; See Supplementary material 4 for the full narrative of the Bye Poverty! narrative) as an acceptable future for 2038 that the project could take as a vision. Subsequent intra-community workshops were organised by participants of the workshop to feedback the experience and outputs of the workshop and validate the narrative chosen.

Follow-up participatory workshop

After feedback on the Futures workshop during day 1, participants decided to create four thematic groups (i.e., Governance and advocacy, Livestock production, Crop production and Ecotourism) to identify activities to be implemented during the project. Each thematic group had to come up with

activities related to their thematic in order to initiate the path towards the desired state of each driving force in the Bye Poverty! narrative in 20 years. Group committees were created with a membership based on interests and also the need for equitable representation in the presence of the facilitatory team members.

As a focus for this study, in addition to a list of sub-theme and activities (Table 3), the LPS group listed also the material needed to complete activities for their thematic group.

Table 3 - Sub-themes and activities as identified by the members of the livestock production system thematic group, one of the four thematic groups created following the future workshop

Objective	Sub-theme	Activities
Desired state: Mixed farming prevails with local farmers practising the use of adapted breeds of livestock with higher market value	Production	Bringing in adapted breeds of cattle, goat and chicken Building of a small-scale abattoir in Malipati Setting-up revolving fund to increase farmers' capacity to invest in interventions
	Supplementary feeding	Silage making Planting of pasture grasses Hay cutting
	Animal husbandry	Create feedlots for direct slaughter Create paddock to control breeding
	Animal health	Organise regular dipping for tick control Vaccination Available treatment for common diseases Organise regular deworming
	Empowerment	Training farmers on Animal health and production Livestock marketing Value addition, e.g., animal skin tanning Running an enterprise

Questionnaire survey results

Socio-demographic information

The database can be found in Supplementary material 5. Females represented 57.9% of respondents. The average household size was 7.21±3.54. Respondents had an education up to primary level (49.2%) or secondary level (30.2%) while 20.6% did not attend school at all. Close to 60% of the respondents were aged between 41 and 60 years old, while 20% were older than 60 years and 20% younger than 31 years. The major source of income for households was livestock production (27.8%), followed by horticulture (23.8%) and minor sources of income being salary, pension or part-time work.

Livestock ownership (Table 4) across households was generally greater for small stock, with 91.2% of households owning a mean flock size of 15 chicken (and up to 36); 94.4% of households owning a mean of 15 goats (and up to 35). Cattle were owned by 78.6% of households with a mean herd size of 11 (up to 25). Only 8% of the respondents owned sheep while 37.3% had donkeys which they kept only for draught power. The main reasons for keeping cattle were social security (e.g., in case of an unexpected need of money for burial, health issues), milk production and to a lesser extent for draught power (Gobvu et al., 2021).

Table 4 - Livestock numbers per household in Malipati Community

Livestock type	Mean	Median	Skewness
Cattle	10.88 ± 13.45	8.50	3.001
Goats	14.94 ± 19.96	10.00	6.731
Chickens	15.17 ± 21.23	10.00	5.716
Sheep	1.06 ± 4.36	0.00	4.802

Donkeys	1.97 ± 3.18	0.00	2.232

Preferred livestock interventions

Most livestock interventions mentioned were for cattle (93.8%), poultry (98.1%) and goats (95.4%), with much less mentions for donkeys (21%) and sheep (10%). Even farmers who did not have a certain species would require interventions on the particular species especially restocking interventions as some would mention having previously owned the same or would want to rear certain species.

Figure 2 presents, for each species, the most cited interventions by species' owners. For cattle, the most cited interventions revolved around animal health in terms of access to drugs and vaccine as well as the capacity to organise dipping and dosing against important vectors (e.g., ticks) and parasites (e.g., gastro-intestinal parasites). The next important mentioned interventions were revolving around feeding and access to water, especially during the dry season during which both these natural resources are scarce.

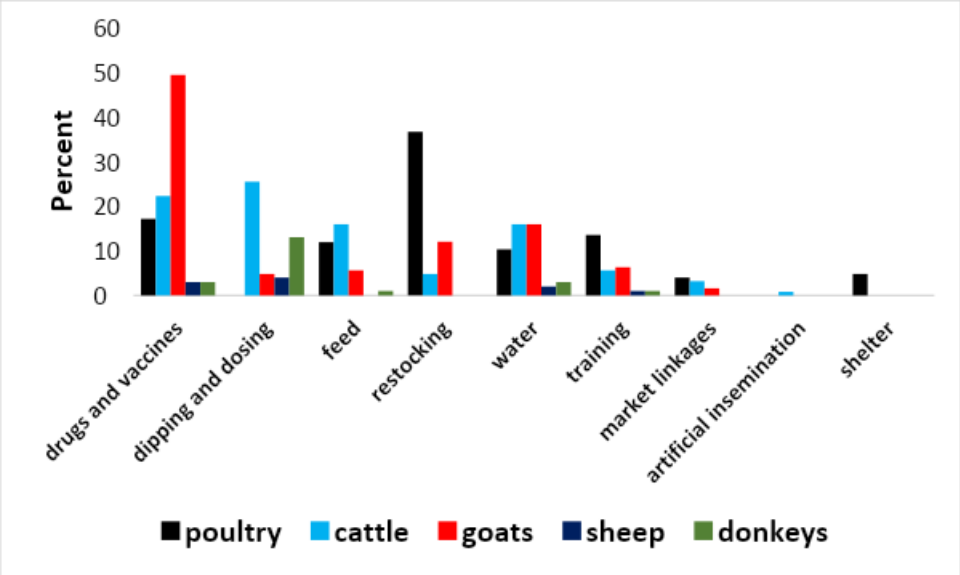

Figure 2 - Preferred livestock interventions per domestic species in Sengwe (species are always in the same order).

For goat production, health issues linked with access to drugs and vaccines were largely the most cited, with issues related to restocking (with locally adapted breeds) and access to water being less cited. For chicken, restocking was the most cited intervention, followed by access to drugs and vaccines and training on chicken production systems. The most preferred intervention for sheep was dipping and dosing (4%) followed by drugs and vaccines (3%). For donkeys, the most preferred intervention was dipping and dosing (13%) followed by water access and training.

Discussion

Advantages of participatory approaches

African agriculture faces the challenge to feed a human population that will double by 2050 (Losch et al., 2013). So-called top-down approaches from central government to district levels or from the northern hemisphere to the southern hemisphere have failed to raise lesser developed countries out of poverty until now (e.g., Van Damme et al., 2014). One of the reasons is that innovation or technology

transfer from science to practice or from one region to another is necessary but not sufficient to achieve effective agricultural development (An et al., 2024).

Different organisations working in the Sengwe Communal Area have previously come up with livestock interventions for cattle restocking programs, goats and chickens restocking using 'improved' exotic breeds (Mudavanhu et al., 2024). Most of these interventions have been imposed in a top-down manner and had sustainability challenges due to lack of community involvement and buy-in in project selection and design (Silvius & Schipper, 2014). For example, a Brahman restocking programmes through pass-on schemes (World Vision, Heifer International, and SEDAP) brought in Brahman breeds for restocking without much consulting local community about their preferred performance traits or interventions (Mudavanhu et al., 2024). The local community complained of the Brahman being less drought-tolerant than their local breeds. Today, the community has mostly Brahman crosses, and the loss of their hardy indigenous breeds is felt by part of the farmers. Innovation users, farmers in our case, are considered as passive stakeholders with no decision to make in the choice and way the innovation is used by them and without any recognition of their knowledge in the local agricultural context and its practices. As a result, introduced innovation do not match local needs and contexts and fail to bring adoption and a positive change (Duguma et al., 2010).

Participatory approaches have been developed and used to inverse top-down processes by giving to the final beneficiaries of the agricultural innovation, i.e., the farmers and their family, a role in the design, implementation and monitoring of the intervention (Chambers, 1994). Deployment of bottom-up studies across different types of production systems provides the evidence base needed making it possible to consider the perspectives of livestock farmers first in order to better inform interventions (Duckett et al., 2017). Any development endeavour needs to be aligned to the specific goals of the target communities and production environments. This gives them ownership of the project and there are better chances of sustainability of the intervention beyond the project life-time (Silvius & Schipper, 2014).

The co-elaborative scenario building process and the follow-up workshops that were used in this study promoted the involvement of local stakeholders in the design of intervention and collective discussions and consensus among the participants. To support the long-term sustainable management of GLTFCA, the co-elaborative scenario building process gave room for the community to build sustainable development pathways through desired pathways and futures. Through this process, not only did local stakeholders become empowered to think about the future of their own livelihoods but they were given the capacity to work on the linkages between the different factors of change, the main driving forces amongst them and how these driving forces could evolve in a generation time (i.e., 20 years). This provided an opportunity to contextualize LPS within the constraints and opportunities of local livelihoods and design interventions acknowledging these inter-relationships between livelihood components. The fact that LPS were directly or indirectly linked to 80% of factors of change demonstrated the importance of LPS in local livelihoods but also that some interventions could have multiple impact for local livelihoods beyond LPS: e.g., the state of food security and nutrition (Wordofa & Sassi, 2020), distribution of wealth, increased household level income through sale of livestock products (Muema et al., 2021) (Table 3).

Most of the scenarios developed could be perceived by external stakeholders as presenting a neutral (i.e., business as usual) or negative outlook for the future. This reflects the general perception of local stakeholders that the future does not offer much hope if current trends continue. Also, some scenarios could be negative for some stakeholders, but positive for others. The process helped local stakeholders to locate pockets of the future in the present that could have positive outcomes if supported, even if these positive outcomes were not the most likely. The relevance of the process was demonstrated by the identification of interventions by local stakeholders to move closer to the desired future, interventions that were implemented in the context of the project. One of the interventions that local stakeholders identified within the framework of the ProSuLi project and towards the achievement

of the selected narrative, *Bye Poverty !*, was the installation of a solar-panel borehole linked to a new irrigated garden. The location and use of the borehole was collectively decided, including members of the four thematic groups. The design and location of this infrastructure was linked to the location of the diptank and the primary school, which were directly connected to this water source in addition to the irrigated garden. This made it possible to alleviate the task reserved for the women of each family with livestock of filling the diptank with water before each dipping session. This task is a hard and time-consuming burden for women, requiring them to bring six buckets of 20 litres for each session over sometimes long distances, and may also be a financial burden when women are fined for failing to comply. This exemplifies how the participatory process and the empowerment of local stakeholders could lead to the appropriation of a demand-driven innovation (i.e., the borehole and the irrigated garden) and made it possible, based on local knowledge, experience and the inclusiveness of the process, to connect it to other aspects of local livelihoods directly linked to other thematic (e.g., LPS). A standard innovation transfer would have focused on the building of an irrigated garden with a borehole as per the project predefined activities and budget.

If the participatory process did not provide interventions detailed to the domestic species under consideration (i.e., cattle, goat, chicken, sheep and donkey), the questionnaire survey helped identifying interventions at species level. With a year between the two processes, they reflected similar views on livestock health and alimentation (i.e., pasture and water) as pillars to LPS, especially for cattle and goat production. The main difference between activities identified through the working group and through the questionnaire was on the value chain (e.g., building abattoir, create paddock) and marketing aspects (e.g., create feedlots for direct slaughter) and also more technical options for supplementary feeding (e.g., silage making) of LPS which were highlighted from the co-elaborative workshop. This could be explained because the attendance to participatory workshops provided participants with a better capacity to project themselves into the future and consider LPS in a more progressive way or because the co-elaborative working group was a more diverse group of stakeholders including governmental services (e.g., veterinary services), with higher levels of education and exposure to market-oriented interventions. There were more females in the questionnaire survey than males while there were more males than females during the scenario building workshops. The workshop participant membership reflected male-domination in the societal structures of the community (Gbaguidi, 2018; Gyan et al., 2022). The female dominance in the survey can be attributed to the male migration to neighbouring South Africa for employment and the fact that women are left as heads of households (Manamere, 2014).

The creation and subsequent discussion of ‘what if’ learning narratives during the workshops enabled participants to consider creative and novel alternative LPS interventions. The *Bye Poverty!* narrative indicated the importance of livelihood systems which integrate local cultures, good governance, empowered local leaders, mixed farming with integrated livestock and cropping production systems, high-value markets and poverty reduction. These are all illustrated across the various LPS interventions selected by the communities. It is hard to imagine farming without the tight integration of crops and livestock in smallholder agriculture (Melesse et al., 2021) and the livelihood systems are complex and coupled with human/natural systems (Senda et al., 2020). One of the driving force identified collectively by participants were the “capacity to adapt to climate change”. The region is known to be prone to more erratic rains and droughts, as already experienced several times in the last decade. Droughts in particular will exacerbate all identified interventions around health, feeding and reproduction for LPS. In all scenario, the capacity of LPS to cope with droughts is therefore embedded and should be reflected in all interventions. In addition, proposed interventions in our study focused on improving solidarity within the livestock sector through improved planning and formal communication networks between farmers, a way to increase the resilience of LPS.

The approach presented here has limitations. It is time-consuming compared to an intervention with pre-defined activities. Here the process lasted more than one year between the future workshop

and the questionnaire survey. In other sites of the ProSuLi project, some stakeholders expressed "workshop fatigue" and wanted more concrete outputs which only came later (pers. comm.). The approach is also resource consuming (human and material resources for workshops). This is a trade-off between the ratio of resource used and the probability of sustainability of the intervention that the authors decided to test in the long-term. Finally, we took into consideration the question of influence and power relations during the implementation of the participatory process but, as external stakeholders, the authors could never be sure that they were not manipulated and entangled within local hidden power relationships. This is a risk common to all participatory approaches undertaken by external stakeholders.

Relevance of identified interventions

The importance of animal health in this district is well-known and health-related interventions were ranked first for cattle, goats and donkey and second for poultry (Figure 2). The context of the wildlife/livestock interface due to the presence of protected areas and the risk of pathogen spill-over between wild and domestic populations and even to humans in the case of zoonoses puts a an additional burden on the sanitary status of livestock populations (Miguel, Grosbois, Caron, et al., 2013; de Garine-Wichatitsky et al., 2013; Caron et al., 2013; Gadaga et al., 2015). A highly listed intervention was dipping of livestock that contributes to controlling the impact of ticks and tick-borne diseases on livestock populations responsible for the highest morbidity and mortality in the LPS. In Zimbabwe, the Veterinary Services are in charge of distributing quality chemical (i.e., amitraz) to farmers and controlling for dipping frequency in order to optimize cattle dipping. However, since the land reform in the 2000s, Veterinary Services have struggled fulfilling this mandate (Mutibvu et al., 2012). A survey by Hanyani-Mlambo (2002) showed that most of the cattle farmers have poor access to veterinary extension services except for contact with the dip attendants during dipping days. This has resulted in farmers acquiring and administrating themselves the chemical at diptanks. These practices often include mis-use and under-dosing of the chemical that can result in resistance to acaricide and less efficiency of control measures (Makuvadze et al., 2020). For example, during the time of study, dipping frequency was irregular due to lack of dipping chemicals and there was an issue of water availability at dipping sites due to the difficulty to access water (especially during the dry season) and the quantity of water needed for each dipping (several thousand litres to counteract the evapotranspiration happening in the multiple thousand litres diptank) (Mhere D, personal communication, November 2019). Sungirai et al. (2017) mentions that interruptions to dipping in communal areas are usually due to long distances from homesteads to diptanks which makes it difficult for farmers to present cattle frequently for dipping and also issues of drought which cause diptanks to become non-functional due to lack of water. In the study area, there were no dipping systems for goats and sheep, but only dipping and vaccination programs for cattle. Hove et al. (2008) mentions that despite the prevalence of ticks on goats, as well as of the pathogens they transmit, their control by the state-run veterinary services is minimal and tick control mostly targets cattle. Other respondents would not mention the need for dipping and dosing goats and this may be due to the mistaken perception that goats are resistant to disease (Poku, 2009), despite the fact that they asked mainly for interventions around access to drugs and vaccines. Health-related interventions were therefore to compensate or re-activate the previously functioning dipping system and improve access to drug market in this remote area.

The access to food resources (i.e., pasture and water) was the second most cited intervention for cattle, goats and sheep (Figure 2). Competition for rangeland and access to water is prevalent as water is distributed along the main River (i.e., Mwenezi River) that delineates the border between the communal land and the Gonarezhou national park. During the dry season, a few pools of water remain in the riverbed to water wild and domestic ungulates and constrain livestock pasture to a few kilometres around those pools (Zengeya et al., 2014, 2015). A report by the Zimbabwe Resilience Building Fund (2017) showed that the trekking distance for water for livestock in Chiredzi district was above the

normal 2km. This distance-to-water constraint in the dry season has important implications for pasture access and disease spread (Guerrini et al., 2019). This limited access to pasture during the dry season is compounded by the lack of access to credits by smallholder farmers to purchase commercial feed for supplement provision. Livestock benefit from improved feed supply through larger quantities and improved quality of crop residues (Homann-Kee Tui et al., 2021). The different importance implied in the preference for feed intervention among cattle and goats could be due to the perception and observation that herbaceous grazing becomes more limited for cattle compared to goats, which can browse more efficiently on the predominant woody vegetation. Poultry, on the other hand rated higher in the feed intervention partly because this species needs feed to be brought to them. This supports the well documented LPS constraints in these contexts (van Rooyen & Homann-Kee Tui, 2009; Chatikobo et al., 2013; Homann-Kee Tui et al., 2021).

For poultry, the most preferred intervention was restocking. Boschveld chicken have been only introduced recently in the area (2019). This breed which requires more inputs (e.g., veterinary drugs) and labour is susceptible to the harsh environment and predation in the area (Mudavanhu et al., 2024) . Those constraints may explain the need for restocking chicken in the area. Women are usually in charge of the management of chicken locally and they play a major role in rural family poultry production and are generally the main owners and managers of poultry (Guèye, 2000; Njuki & Sanginga, 2013; Assan, 2014). After restocking, the most listed intervention for poultry was access to drugs and vaccines. Chicken diseases such as Newcastle disease induce high mortality in chicken in sub-Saharan Africa (Miguel, Grosbois, Berthouly-Salazar, et al., 2013). During the study, a suspicion of Newcastle disease outbreak killed many birds and left many homes with very few to no birds (Madzinga B., personal communication, November 2019). Respondents had no prior knowledge about vaccination for poultry diseases like Newcastle disease and requested interventions on training on health management of poultry. Only poultry interventions had mention of shelter, presumable due to their higher vulnerability to predation in the area. In implementing their project, “Strengthening resilience to enhance food security and nutrition of vulnerable rural communities to cope with recurrent shocks and stressors in Chiredzi district”, the Mwenezi Development Training Centre have implemented interventions on developing poultry shelter for the local communities (Mwenezi Development Training Centre, 2023).

The very low economic value of donkeys and their capability to withstanding poor treatment contributes to them receiving poor management (Muvirimi & Ellis-Jones, 1999). Donkeys are an important asset for traction power and transport, have high drought tolerance compared to cattle, play a critical role in providing draught power for smallholder farmers but their potential is not fully utilized (Hagmann & Prasad, 1995; Maburutse et al., 2012).

Conclusion

This study formed the first steps of a development project aiming at promoting local livelihoods in the context of TFCAs. Given the failure or lack of appropriation of previous LPS development programmes (i.e., as reported by local farmers), our anticipatory and participatory approach located farmers and members of the community at the centre of the co-production process, with the support of local governmental and non-governmental stakeholders. Being empowered, local stakeholders demonstrated a buy-in and a high level of appropriation of the project objectives and subsequent activities (Caron et al., 2022). This process has limitations in the sense that it requires time and resources to be developed in comparison to top-down implementation of interventions with or without consultation. However, it could ensure that LPS interventions are demand-driven and locally relevant. In addition, such participatory events will prepare local stakeholders to discuss with external interventions (development or state projects) about their priorities in terms of LPS interventions in the area.

Supplementary material

Supplementary material can be found in HAL (https://hal.science/hal-04060712, Gobvu et al., 2025).

Supplementary material 1: ProSuLi project's questionnaire used for the questionnaire survey

Supplementary material 2: Co-elaborative scenario building The futures of livelihoods in the Sengwe area Workshop Report

Supplementary material 3: Future states matrix of the 5 driving forces

Supplementary material 4: Full narrative of the Bye Poverty scenario selected by the community

Supplementary material 5: Database of questionnaire survey

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Data availability

Data (Supplementary material 5) can be found in HAL (https://hal.science/hal-04060712, Gobvu et al., 2025).

Conflict of interest disclosure

The authors declare that they have no conflict of interest.

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