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► To cite this version:

Vimbai Gobvu, Sharai Ncube, Venancio E. Imbayarwo-Chikosi, Robin Bourgeois, Prisca H. Mugabe, et al.. Preferred livestock interventions for small-scale farmers in the Great Limpopo Transfrontier Conservation Area: a demand-driven and systemic approach. 2023. hal-04060712v3

HAL Id: hal-04060712

<https://hal.science/hal-04060712v3>

Preprint submitted on 16 Jul 2024

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

3
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21
22
23 **Abstract**

24 In southern Africa, residents of Transfrontier Conservation Areas practice small-scale farming in semi-
25 arid environments constrained by the presence of protected areas and extensive wildlife/livestock/human
26 interfaces that come with conflicts and opportunities. Under these contexts, livestock production aims at
27 supporting local livelihoods despite the harsh semi-arid environment and conflicts with wildlife. In order
28 to promote local development and the well-being of TFCA residents, prioritization of livestock
29 interventions adapted to the local context is needed. The objective of this study was to test a methodology
30 to identify demand-driven interventions for livestock production (cattle, small ruminants and chicken) in a
31 communal land in Zimbabwe. This study used the outputs of an anticipatory scenario-building workshop
32 and individual questionnaires to establish possible and desired livestock interventions by local
33 stakeholders. Results were largely similar and complementary between the co-elaborative scenario
34 building workshops and the questionnaire survey. Preferred interventions were: restocking herds with
35 breeds adapted to local production; training in livestock practices and production; support to marketing;
36 feed development and value addition; loan schemes to invest in livestock housing and stockfeed; and
37 finally, animal health interventions to reduce the heavy disease burden. The individual questionnaire data
38 specified preferred interventions for each domestic species. These demand-driven interventions provide a
39 basis for future development projects in the area and avoid top-down approaches by development

40 agencies that fail to address local needs and lack appropriation by local stakeholders necessary for the
41 sustainability of the interventions.

42

43 **Keywords:** Livestock production, small-scale farming, scenario planning, participatory approach,
44 bottom-up approach, Transfrontier Conservation Area

45

46 **1. Introduction**

47 Mixed crop and livestock systems practiced by agropastoralists in southern Africa are the
48 predominant form of agriculture and source of income and produce more than 80% of food in the
49 region (Tui et al., 2021). Mixed farming or crop-livestock systems are an integrated agricultural
50 system that cultivates crops and rears livestock on the same farm (Sere & Steinfeld, 1996;
51 Mkuhlani et al., 2020). Extensive livestock production systems (LPS) characterised by a low
52 productivity per animal and per surface use small amounts of inputs, capital, and labour
53 compared to more intensive production systems. Extensive LPS in sub-Saharan Africa are
54 challenged by decreasing rangeland sizes, poor-quality livestock feed (based mainly on crop
55 residues), diseases and pests (Mupangwa & Thierfelder, 2014). These LPS are also characterized
56 by constrained operational environment such as limited access to markets and veterinary services
57 and negative impacts of climate such as unpredictable and variable rainfall and worsening
58 droughts (Easter et al. 2018; Oduniyi et al., 2020; Mogomotsi et al., 2020). Stocking capacity is
59 thus determined by pasture and feed availability. Soil erosion, land degradation, and a reduction
60 in soil fertility are caused by overgrazing, which frequently occurs on rangelands.
61 Socioeconomic constraints, limited extension services, and risky environment for foreign
62 investment are some of the reasons behind the poor adaptation of new equipment and
63 infrastructure (Matope et al., 2020).

64 Agropastoralist communities in Transfrontier Conservation Areas (TFCA) practice livestock
65 production in the most semi-arid environments of southern Africa, characterised by rainfall
66 variability and unpredictability. TFCAs were founded on the realization that natural resources
67 that straddle international boundaries are a shared asset with the potential to meaningfully
68 contribute to the conservation of biodiversity, welfare and socio-economic development of rural
69 communities (Hanks, 2003). In TFCAs, LPS farming communities live close to protected areas
70 and experience additional constraints such as human-wildlife conflicts including livestock

71 predation by wild carnivores, competition between livestock and wild ungulates for forage and
72 water and infectious (potentially zoonotic) diseases that can be transmitted between wild and
73 domestic animals (Matseketsa et al., 2019; Caron et al., 2013; Cumming, 2011). Information on
74 vulnerability and adaptation of these production systems is required that are context specific,
75 while accounting for the main farming system components (Tui et al., 2021).

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

87 To be more sustainable and locally relevant, LPS interventions must be informed by farmers'
88 needs as well as prevailing state and conditions of livestock production (An et al., 2024).
89 Community-based approaches have been suggested to identify and prioritize problems
90 (Khashtabeh et al., 2019). Participatory approaches to solving livestock production build a strong
91 base for the intervention in the community (Mubita et al., 2017). In addition, they ensure that
92 interventions are designed to respond to a demand-driven process and not parachuted in a top-
93 down manner, that is not embraced by final beneficiaries. LPS interventions defined through a
94 participatory approach should therefore produce interventions that are locally owned, context-
95 relevant and adapted to local constraints but still match national objectives.

96 In Zimbabwe, the productivity of agropastoralist cattle herds remains very low, with average
97 calving rates of about 45% against a potential of 60%, and off-take rates of about 6% against a
98 recommended 20% (GoZ, 2018). Changes in land use patterns following the land reform of the
99 early 2000s have influenced LPS across Zimbabwe, whereby the national livestock herd sizes
100 declined by about 20% for beef, over 83% for dairy, and 26 and 25% for pigs and small

101 ruminants respectively (Ossome and Naidu, 2021). Livestock and livestock products still
102 contribute significantly to the economy of Zimbabwe, with cattle accounting for 35% to 38% of
103 the GDP contributed by the agricultural sector (Runganga and Mhaka, 2021). The Zimbabwe
104 National Agriculture Policy Framework calls for the formulation of interventions that directly
105 respond to the local people's needs and enhance the flow of investments that are critical to
106 sustaining the growth of the agricultural sector with a decided focus on increasing agricultural
107 productivity and production (GoZ, 2018).

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

120

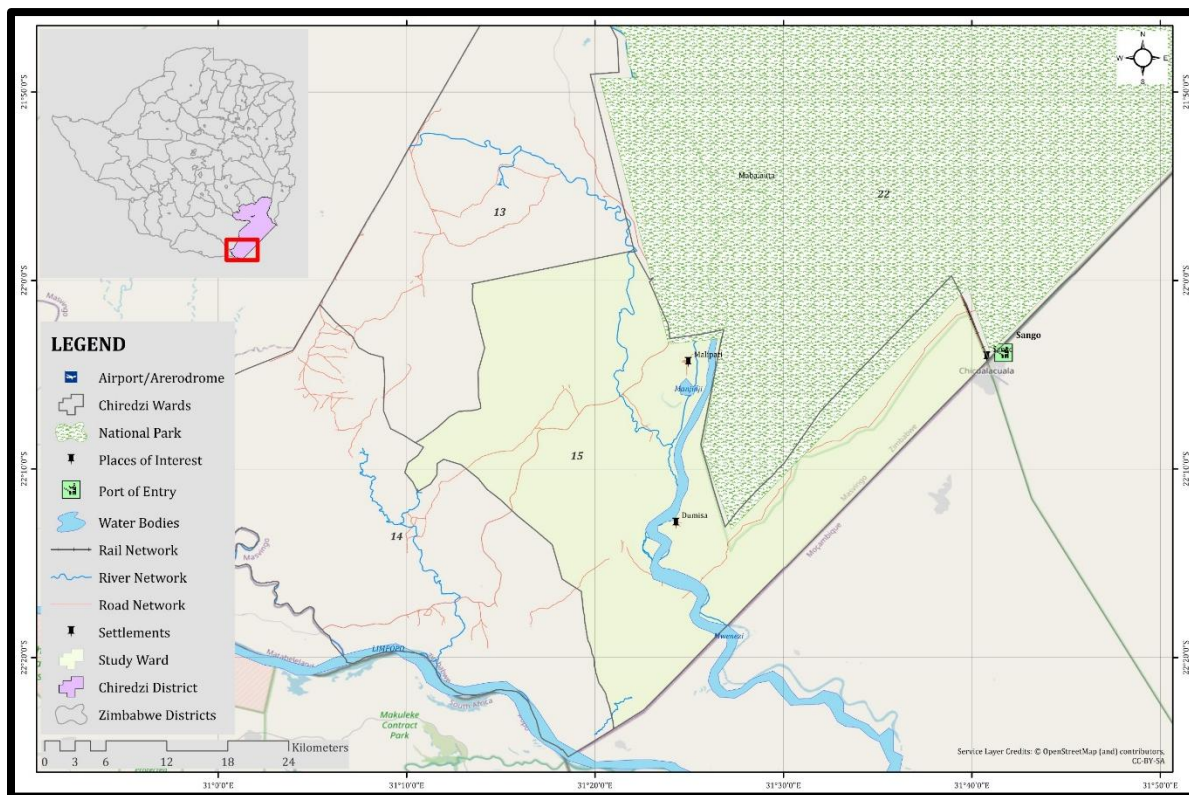
121 **2. Material and methods**

122 **2.1. Study context and design**

123 The Promoting Sustainable Livelihoods in TFCAs (ProSuLi) project recognised that the success
124 of development programs is rooted in positive stakeholders' interactions, recognising the
125 legitimacy and importance of their respective positions, needs and constraints and the need for
126 negotiations in order to achieve a shared common vision of a sustainable project (Caron et al.,
127 2022). ProSuLi objective was to promote sustainable livelihoods in 4 local communities living in
128 the periphery of protected areas in Zimbabwe, Mozambique and Botswana within the Great
129 Limpopo TFCA and the Kavango-Zambezi (KAZA) TFCA.

130

131 2.2. Study Site



132

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

137

138 Sengwe Communal Area is located in the Great Limpopo TransFrontier Conservation Area
139 (GLTFCA) in the Southeast Lowveld of Chiredzi District, Zimbabwe, which lies at $21^{\circ}33'S$ and
140 $31^{\circ}30'E$. The specific study site, Ward 15, lies at the southern edge of Gonarezhou National Park
141 buffered by the Malipati Safari Area to the South and Malilangwe Conservancy Trust towards
142 the North. The average altitude is 392 m. Chiredzi District is in Agroecological Region V and is
143 characterised by erratic rainfall and low mean annual rainfall of around 450mm (Kupika et al.,
144 2019, Nyarumbu et al., 2019) with high interannual rainfall variation (Poshiwa et al., 2013).
145 Minimum temperatures range between 4.3 and 21.1 °C and maximum temperatures range

146 between 27.8 and 37.3 °C. Major soils are eutric vertisols, chromic luvisols and eutric fluvisols.
147 *Colophospermum mopane* trees dominate in the area. Livelihoods are crop-based (41%), non-
148 farm based (47%, e.g., cross border trading, employment) and cattle-based (12%, e.g., cattle
149 trading) (Murungweni et al., 2016). Drought, poor management of rangelands, and rangeland
150 fires limits the availability of fodder (Tavirimirwa et al., 2013). Masikati, (2011) mentions that
151 seasonal deficiency in feed quality and quantity particularly during the second half of the dry
152 season is the major constraint to communal livestock production.

153 The common cattle diseases in the area include Rift Valley Fever, Anthrax, Brucellosis,
154 Theileriosis, Bovine Tuberculosis, Rabies. Foot-and-Mouth Disease, Babesiosis and
155 Anaplasmosis (Caron et al., 2011; Gomo et al., 2012; de Garine-Wichatitsky et al., 2013; Gadaga
156 et al., 2016; Pfukenyi et al., 2020). In each village, diptanks are infrastructures that allow
157 livestock to be immersed in a water pool in which an anti-tick chemical molecule has been
158 diluted. This helps to fight against tick infestation and tick-borne diseases (e.g., theileriosis,
159 babesiosis, anaplasmosis), the diseases with the most impact on cattle mortality in the area.

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

164

165 **2.3. Co-elaborative scenario building towards action**

166 **Participatory prospective analysis and the Futures workshop**

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

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

189

190 **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

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

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

218 Then, for each driving force, different future states were proposed and discussed in common.
219 Future states in 2038 could be desired or not desired states. Compatible future states of driving
220 force were grouped to form synopsis that were at the basis of scenario after integrating the

221 remaining factors of change under the form of future states linked to the driving forces' future
222 states considered.

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

227 **From anticipation to action: a follow-up participatory workshop**

228 A few months after the Futures workshop, a follow-up participatory workshop was organized
229 with the participants from the first workshop. This was done in order to provide feedback on the
230 outputs of the first workshop and from the larger community, validate them and organize the way
231 forward towards the selection of activities for the project.

232 A follow-up participatory workshop was held on the 12th and 13th of April 2019 to plan the way
233 forward following the co-elaborative scenario planning. Participants included local development
234 trusts, local NGOs, community-based natural resource programme; community childcare
235 workers, teachers from primary and secondary schools, local irrigation schemes, veterinary
236 services, seed multiplication farmers, animal health care centre, farmers, religious leaders,
237 agriculture extension services and headmen.

238 **2.4. Questionnaire survey**

239 After the co-elaborative scenario building processes, a survey was conducted on potential
240 livestock interventions in order to consolidate the outputs of the participatory workshops with
241 participants who were not present in the scenario planning workshop. A questionnaire survey
242 was implemented using semi-structured questionnaires to collect information on preferred
243 livestock interventions . The questionnaire thematic areas were: demographic information,
244 livelihoods activities, livestock kept and preferred livestock interventions (Supp Mat 1).
245 Structured interviews collected information on livestock species kept and preferred livestock
246 interventions per species of livestock. Respondents were sampled from 9 villages of Sengwe
247 ward 15, as initially selected by the ProSuLi project. This ward was chosen because of its past
248 involvement in research and development projects with the team (such as the DREAM Project on

249 Learning Platforms) and as a ward sharing a border with Gonarezhou National Park, the second
250 largest park in Zimbabwe in the South-East corner of the country. Each village had around 25
251 households and for the 9 villages there were 225 households. By law, villages in a rural district
252 should have up to 25 households, once they exceed such, another village is built. It was assumed
253 that half of the households (0.5) had livestock (ZimVac, 2017). The confidence coefficient was
254 assumed to be 95% giving a z-value of 1.645. A 0.05 acceptable sampling error was also
255 assumed. The sample size was calculated using the following Cochran's sample size formula
256 (Cochran, 1977).

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

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

263 **2.5. Statistical Analysis**

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

268

269 **3. Results**

270 **3.1. Co-elaborative scenario building toward action**

271 **3.1.1. The Futures workshop**

272 Thirteen out of 35 (37,1%) factors of changes were directly linked to LPS and 15 (42,9%) were
273 indirectly linked to LPS which together indicated that 28 factors of change (80%) for local

274 livelihoods were directly or indirectly linked to LPS. The report of the futures workshop can be
 275 found in Supp Mat 2.

276

277 **Table 2: Factors of change (n=36) and driving forces (in bold) influencing directly or indirectly**
 278 **LPS. The LPS driving force has been shaded for clarity.**

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

279 *Note: in bold the 6 driving forces (both “Types of farming systems” were merge by participants as one*
280 *driving force; the “Dim.” column indicates the related STEEP dimension as follows: S=Social,*
281 *T=Technical, En=Environment, Ec=Economic, P=Political; the last column “Link to LPS” indicate the*
282 *factors of change that are directly (D) or indirectly (I) linked to LPS.*

283
284 The participants selected five driving forces of local livelihoods in the area: LPS was regrouped
285 with farming production systems as one of the five driving forces because of the interdependency
286 between both type of farming systems (i.e., mixed crop-livestock farming systems); others were

287 “State of food security / poverty”; “Governance capacity of the local community”; “Capacity to
288 adapt to climate change”; “State of local culture and tradition” (Table 1).

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

297 **Box 1:** Five synopsis which hare the basis of the 5 full narratives (see Supp Mat 4)

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

303 *Mazvakemazvake - Laissez-faire kills:* In 2038, an individual culture prevails and people do whatever they
304 want, affecting the governance capacity of the local community and leading to infighting for leadership.
305 The power struggle deviates people from adapting to climate change. As a consequence farming has
306 collapsed. A very disturbing situation exists whereby ninety

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

313 *A big one for a few ones:* In 2038, the local culture and traditions are central in the local society and
314 people’s lifestyles entice them to resist to adapt to climate change. A top down governance system has
315 taken over the capacity of governance of the local community and land use allocation. It is supporting
316 agricultural activities based on zero grazing at small scale with small livestock (rabbits, chicken...) and

317 greenhouse/rooftop farming. 60 % of the population remain poor, particularly women, children, elder men
318 and the unemployed. Poverty is spread across the villages.

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

323
324 After discussion and debate about the pros and cons for the different scenarios, the workshop
325 participants finally agreed collectively that they preferred the *Bye Poverty!* narrative (Box 1; See
326 Supp Mat 4 for the full narrative of the *Bye Poverty!* narrative) as an acceptable future for 2038
327 that the project could take as a vision. Subsequent intra-community workshops were organised
328 by participants of the workshop to feedback the experience and outputs of the workshop and
329 validate the narrative chosen.

330 3.1.2. Follow-up participatory workshop

331 After feedback on the Futures workshop during day 1, participants decided to create four
332 thematic groups (i.e., Governance and advocacy, Livestock production, Crop production and
333 Ecotourism) to identify activities to be implemented during the project. Each thematic group had
334 to come up with activities to start the pathway towards the desired scenario in 20 years. Group
335 committees were created with a membership based on interests and also the need for equitable
336 representation in the presence of the facilitatory team members.

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

339 **Table 3:** Sub-themes and activities identified by the livestock production system thematic group

Objective	Sub-theme	Activities
Desired state: Mixed farming prevails with local farmers practising the use of adapted breeds of livestock with higher market	Production	<ul style="list-style-type: none">• Bringing in adapted breeds of cattle, goat and chicken• Building of a small-scale abattoir in Malipati• Setting-up revolving fund for farmer to

value	Supplementary feeding	<ul style="list-style-type: none"> • Silage making • Planting of pasture grasses • Hay cutting
	Animal husbandry	<ul style="list-style-type: none"> • Create feedlots for direct slaughter • Create paddock to control breeding
	Animal health	<ul style="list-style-type: none"> • Organise regular dipping for tick control • Vaccination • Available treatment for common diseases • Organise regular deworming
	Empowerment	Training farmers on <ul style="list-style-type: none"> • Animal health and production • Livestock marketing • Value addition, e.g., animal skin tanning • Running an enterprise

340

341 3.2. Questionnaire survey results

342 3.2.1. Socio-demographic information

343 The database can be found in Supp Mat 5.

344 Females represented 57.9% of respondents. The average household size was 7.21±3.54.
 345 Respondents had an education up to primary level (49.2%) or secondary level (30.2%) while
 346 20.6% did not attend school at all. Close to 60% of the respondents were aged between 41 and 60
 347 years old, while 20% were older than 60 years and 20% younger than 31 years. The major
 348 source of income for households was livestock production (27.8%), followed by horticulture
 349 (23.8%) and minor sources of income being salary, pension or part-time work.

350 **Table 4: Livestock numbers per household in Malipati Community**

351

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

352

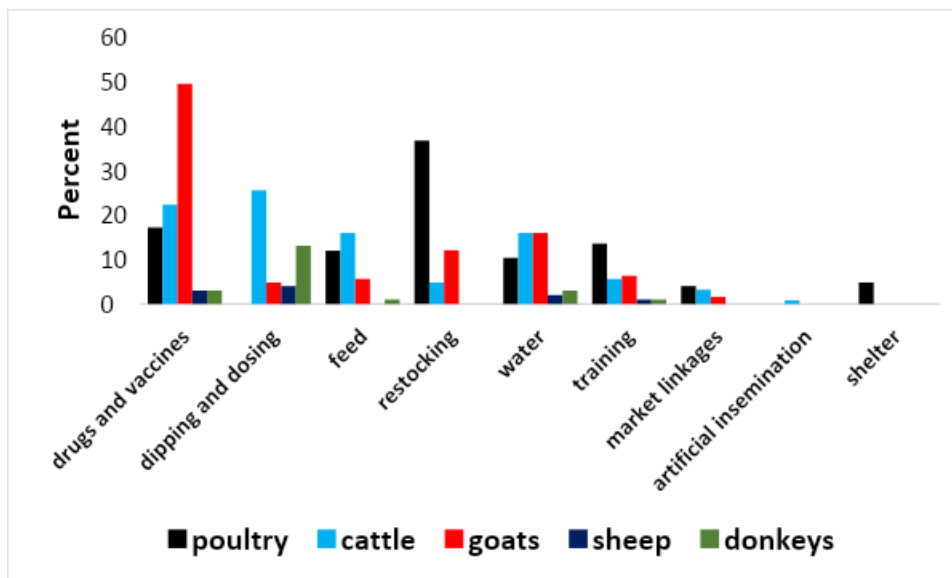
353 Livestock ownership across households was generally greater for small stock, with 91.2% of
354 households owning a mean flock size of 15 chicken (and up to 36); 94.4% of households owning
355 a mean of 15 goats (and up to 35). Cattle were owned by 78.6% of households with a mean herd
356 size of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

360

3.2.2. Preferred livestock interventions

361 Most livestock interventions mentioned were for cattle (93.8%), poultry (98.1%) and goats
362 (95.4%), with much less mentions for donkeys (21%) and sheep (10%). Even farmers who did
363 not have a certain species would require interventions on the particular species especially
364 restocking interventions as some would mention having previously owned the same or would
365 want to rear certain species.

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



372

373 **Figure 2:** Preferred livestock interventions per domestic species in Sengwe (species are always in the same order)

374

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

381

382 4. Discussion

383 4.1. Advantages of participatory approaches

384 African agriculture faces the challenge to feed a human population that will double by 2050
 385 (Losch et al. 2013). So-called top-down approaches from central government to district levels or
 386 from the northern hemisphere to the southern hemisphere have failed to raise lesser developed
 387 countries out of poverty until now (e.g., Van Damme et al., 2014). One of the reasons is that
 388 innovation or technology transfer from science to practice or from one region to another is
 389 necessary but not sufficient to achieve effective agricultural development (An et al., 2024).

390 Different organisations working in the Sengwe Communal Area have previously come up with
391 livestock interventions for cattle restocking programs, goats and chickens restocking using
392 ‘improved’ exotic breeds (Mudavanhu et al., 2024). Most of these interventions have been
393 imposed in a top-down manner and had sustainability challenges due to lack of community
394 involvement and buy-in in project selection and design (Silviu and Schipper, 2014). For
395 example, a Brahman restocking programmes through pass-on schemes (World Vision, Heifer
396 International, and SEDAP) brought in Brahman breeds for restocking without much consulting
397 local community about their preferred performance traits or interventions (Mudavanhu et al.,
398 2024). The local community complained of the Brahman being less drought-tolerant than their
399 local breeds. Today, the community has mostly Brahman crosses, and the loss of their hardy
400 indigenous breeds is felt by part of the farmers. Innovation users, farmers in our case, are
401 considered as passive stakeholders with no decision to make in the choice and way the
402 innovation is used by them and without any recognition of their knowledge in the local
403 agricultural context and its practices. As a result, introduced innovation do not match local needs
404 and contexts and fail to bring adoption and a positive change (Duguma et al., 2010).

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

414 The co-elaborative scenario building process and the follow-up workshops that were used in this
415 study promoted the involvement of local stakeholders in the design of intervention and collective
416 discussions and consensus among the participants. To support the long-term sustainable
417 management of GLTFCA, the co-elaborative scenario building process gave room for the
418 community to build sustainable development pathways through desired pathways and futures.
419 Through this process, not only did local stakeholders were empowered to think about the future

420 of their own livelihoods but they were given the capacity to work on the linkages between the
421 different factors of change, the main driving forces amongst them and how these driving forces
422 could evolve in a generation time (i.e., 20 years). This provided an opportunity to contextualize
423 LPS within the constraints and opportunities of local livelihoods and design interventions
424 acknowledging these inter-relationships between livelihood components. The fact that LPS were
425 directly or indirectly linked to 80% of factors of change demonstrated the importance of LPS in
426 local livelihoods but also that some interventions could have multiple impact for local
427 livelihoods beyond LPS: e.g., the state of food security and nutrition (Wordofa and Sassi, 2020),
428 distribution of wealth, increased household level income through sale of livestock products
429 (Muema et al., 2021) (Table 3).

430 If the participatory process did not provide interventions detailed to the domestic species under
431 consideration (i.e., cattle, goat, chicken, sheep and donkey), the questionnaire survey helped
432 identifying interventions at species level. With a year between the two processes, they reflected
433 similar views on livestock health and alimentation (i.e., pasture and water) as pillars to LPS,
434 especially for cattle and goat production. The main difference between activities identified
435 through the working group and through the questionnaire was on the value chain (e.g., building
436 abattoir, create paddock) and marketing aspects (e.g., create feedlots for direct slaughter) and
437 also more technical options for supplementary feeding (e.g., silage making) of LPS which were
438 highlighted from the co-elaborative workshop. This could be explained because the attendance to
439 participatory workshops provided participants with a better capacity to project themselves into
440 the future and consider LPS in a more progressive way or because the co-elaborative working
441 group was a more diverse group of stakeholders including governmental services (e.g.,
442 veterinary services), with higher levels of education and exposure to market-oriented
443 interventions. There were more females in the questionnaire survey than males while there were
444 more males than females during the scenario building workshops. The workshop participant
445 membership reflected male-domination in the societal structures of the community (Gbaguidi,
446 2018; Gyan et al., 2022). The dominance of female in the survey can be attributed to the male
447 migration to neighbouring South Africa for employment and the fact that women are left head of
448 households (Manamere, 2014).

449 The creation and subsequent discussion of ‘what if’ learning narratives during the workshops
450 enabled participants to consider creative and novel alternative LPS interventions. The *Bye*
451 *Poverty!* narrative indicated the importance of livelihood systems which integrate local cultures,
452 good governance, empowered local leaders, mixed farming with integrated livestock and
453 cropping production systems, high-value markets and poverty reduction. These are all illustrated
454 across the various LPS interventions selected by the communities. It is hard to imagine farming
455 without the tight integration of crops and livestock in smallholder agriculture (Melesse et al.,
456 2021) and the livelihood systems are complex and coupled with human/natural systems (Senda et
457 al., 2020). One of the driving force identified collectively by participants were the “capacity to
458 adapt to climate change”. The region is known to be prone to more erratic rains and droughts, as
459 already experienced several times in the last decade. Droughts in particular will exacerbate all
460 identified interventions around health, feeding and reproduction for LPS. In all scenario, the
461 capacity of LPS to cope with droughts is therefore embedded and should be reflected in all
462 interventions. In addition, proposed interventions in our study focused on improving solidarity
463 within the livestock sector through improved planning and formal communication networks
464 between farmers, a way to increase the resilience of LPS.

465 **4.2. Relevance of identified interventions**

466 The importance of animal health in this district is well-known and health-related interventions
467 were ranked first for cattle, goats and donkey and second for poultry (Figure 2). The context of
468 the wildlife/livestock interface due to the presence of protected areas and the risk of pathogen
469 spill-over between wild and domestic populations and even to humans in the case of zoonoses
470 puts a an additional burden on the sanitary status of livestock populations (Caron et al, 2013; de
471 Garine-Wichatitksy et al., 2013; Miguel et al., 2013; Gadaga et al., 2015). A highly listed
472 intervention was dipping of livestock that contributes to controlling the impact of ticks and tick-
473 borne diseases on livestock populations responsible for the highest morbidity and mortality in the
474 LPS. In Zimbabwe, the Veterinary Services are in charge of distributing quality chemical (i.e.,
475 amitraz) to farmers and controlling for dipping frequency in order to optimize cattle dipping.
476 However, since the land reform in the 2000s, Veterinary Services have struggled fulfilling this
477 mandate (Mutibvu et al., 2012). A survey by Mlambo, (2002) showed that most of the cattle
478 farmers have poor access to veterinary extension services except for contact with the dip

479 attendants during dipping days. As a result farmers have resulted in acquiring and administrating
480 themselves the chemical at diptanks. These practices often include mis-use and under-dosing of
481 the chemical that can result in resistance to acaricide and less efficiency of control measures
482 (Makuvadze et al., 2020). For example, during the time of study, dipping frequency was irregular
483 due to lack of dipping chemicals and there was an issue of water availability at dipping sites due
484 to the difficulty to access water (especially during the dry season) and the quantity of water
485 needed for each dipping (several thousand litres to counteract the evapotranspiration happening
486 in the multiple thousand litres diptank) (Mhere D, personal communication, November, 2019).
487 Sungirai et al., (2017) mentions that interruptions to dipping in communal areas are usually due
488 to long distances from homesteads to diptanks which makes it difficult for them to present cattle
489 frequently for dipping and also issues of drought which cause diptanks to become non-functional
490 due to lack of water. In the study area, there were no dipping systems for goats and sheep, but
491 only dipping and vaccination programs for cattle. Hove et al. (2008), mentions that despite the
492 prevalence of ticks on goats, as well as of the pathogens they transmit, their control by the state-
493 run veterinary services is minimal and tick control mostly targets cattle. Other respondents would
494 not mention the need for dipping and dosing goats and this may be due to the mistaken
495 perception that goats are resistant to disease (Poku, 2009), despite the fact that they asked mainly
496 for interventions around access to drugs and vaccines. Health-related interventions were
497 therefore to compensate or re-activate the previously functioning dipping system and improve
498 access to drug market in this remote area.

499 The access to food resources (i.e., pasture and water) was the second most cited intervention for
500 cattle and shoats (Figure 2). Competition for rangeland and access to water is prevalent as water
501 is distributed along the main River (i.e., Mwenezi River) that delineates the border between the
502 communal land and the Gonarezhou national park. During the dry season, a few pools of water
503 remain in the riverbed to water wild and domestic ungulates and constrain livestock pasture to a
504 few kilometres around those pools (Zengeya et al., 2014; 2015). A report by the Zimbabwe
505 Resilience Building Fund (2017) showed that the trekking distance for water for livestock in
506 Chiredzi district was above the normal 2km. This distance-to-water constraint in the dry season
507 has important implications for pasture access and disease spread (Guerrini et al. 2019). This
508 limited access to pasture during the dry season is compounded by the lack of access to credits by

509 smallholder farmers to purchase commercial feed for supplement provision (Gilbert et al., 2022).
510 Livestock benefit from improved feed supply through larger quantities and improved quality of
511 crop residues (Tui et al., 2021). The different importance implied in the preference for feed
512 intervention among cattle and goats could be due to the perception and observation that
513 herbaceous grazing becomes more limited for cattle compared to goats, which can forage more
514 efficiently on the predominant woody vegetation. Poultry, on the other hand rated higher in the
515 feed intervention partly because this species needs feed to be brought to them. This supports the
516 well documented LPS constraints in these contexts (Van Rooyen and Homann-Kee Tui, 2009;
517 Chatikobo et al., 2013; Tui et al., 2021).

518 For poultry, the most preferred intervention was restocking. Boschveld chicken have been only
519 introduced recently in the area (2019). This breed which requires more inputs (e.g., veterinary
520 drugs) and labour is susceptible to the harsh environment and predation in the area (Mudavanhu
521 et al., 2024). Those constraints may explain the need for restocking chicken in the area. Women
522 are usually in charge of the management of chicken locally and they play a major role in rural
523 family poultry production and are generally the main owners and managers of poultry (Assan,
524 2014; Gueye, 2000; Njuki and Sanginga, 2013). After restocking, the most listed intervention for
525 poultry was access to drugs and vaccines. Chicken diseases such as Newcastle disease induce
526 high mortality in chicken in sub-Saharan Africa (Miguel et al. 2013). During the study, a
527 suspicion of Newcastle disease outbreak killed many birds and left many homes with very few to
528 no birds (Madzinga B., personal communication, November 2019). Respondents had no prior
529 knowledge about vaccination for poultry diseases like Newcastle disease and requested
530 interventions on training on health management of poultry. Only poultry interventions had
531 mention of shelter, presumable due to their higher vulnerability to predation in the area. In
532 implementing their project, “Strengthening resilience to enhance food security and nutrition of
533 vulnerable rural communities to cope with recurrent shocks and stressors in Chiredzi district”,
534 the Mwenezi Development Training Centre have implemented interventions on developing
535 poultry shelter for the local communities (MDTC, 2022).

536 The very low economic value of donkeys and their capability to withstanding poor treatment
537 contributes to them receiving poor management (Muvirimi and Ellis-jones, 1999). Donkeys are

538 an important asset for traction power and transport, have high drought tolerance compared to
539 cattle, play a critical role in providing draught power for smallholder farmers but their potential
540 is not fully utilized (Maburutse et al., 2012; Hagmann et al., 1995).

541 **5. Conclusion**

542 This study formed the first steps of a development project aiming at promoting local livelihoods
543 in the context of TFCAs. Given the failure or lack of appropriation of previous LPS development
544 programmes (i.e., as reported by local farmers), our anticipatory and participatory approach
545 located farmers and members of the community at the centre of the co-production process, with
546 the support of local governmental and non-governmental stakeholders. Being empowered, local
547 stakeholders demonstrated a buy-in and a high level of appropriation of the project objectives
548 and subsequent activities (Caron et al., 2022). This process ensured that LPS interventions were
549 not repeating previous mistakes and were demand-driven and locally relevant. In addition, local
550 stakeholders are now prepared to discuss with external interventions (development or state
551 projects) about their priorities in terms of LPS interventions and negotiate with these
552 stakeholders the terms of any LPS intervention in the area.

553 **Acknowledgements**

554 This study was designed and implemented within the EU-ProSuLi project and conducted within
555 the framework of the Research Platform Production and Conservation in Partnership (www.rppcp.org). We appreciate the continued support from farmers in Sengwe communal land who
556 participated in the study. We would also like to extend our sincere gratitude to veterinary and
557 extension officers for their overwhelming support. This study would not be possible without their
558 cooperation. A special mention goes to Pastor Steven Chauke who was our local site coordinator
559 and interpreter.
560

561 **Conflict of interest disclosure**

562 The authors declare that they have no conflict of interest.

563 **Data accessibility**

564 In Supplementary Information 1, 2, 3, 4 & 5 attached to the publication, the questionnaire
565 template, the full narrative report of the futures workshop, the matrix of the future states of the
566 driving forces, the full narrative of the Bye Poverty scenario and the anonymized database can
567 respectively be found.

568

569 **Funding**

570 This study was funded by the European Commission under the EU-ProSuLi project,
571 FED/2017394-443.

572

573 **References**

574 An, Z., Yang, Y., Yang, X., Ma, W., Jiang, W., Li, Y., Chen, G. et al., 2024. Promoting
575 sustainable smallholder farming via multistakeholder collaboration. *Proceedings of the National*
576 *Academy of Sciences*, 121 (21), e2319519121. doi: 10.1073/pnas.2319519121

577 Assan, N., 2014. Gender disparities in livestock production and their implication for livestock
578 productivity in Africa. 126-138.

579 Bourgeois, R., Guerbois, C., Giva, N., Mugabe, P., Mukamuri, B., Fynn, R., Daré, W.S.,
580 Motsholapheko, M., Nare, L., Delay, E. and Ducrot, R., 2023. Using anticipation to unveil
581 drivers of local livelihoods in Transfrontier Conservation Areas: A call for more environmental
582 justice. *People and Nature* 5, pp. 726-741.

583 Bourgeois, R., Penunia, E., Bisht, S. and Boruk, D., 2017. Foresight for all: Co-elaborative
584 scenario building and empowerment. *Technological Forecasting and Social Change*, 124,
585 pp.178-188.

586 Bowman, C., 1998. *Strategy in practice* (p. 201). London, UK: Prentice Hall Europe.

587 Caron, A., Miguel, E., Jori, F., Hofmeyr, M., Pfukenyi, D., Foggin, C and de Garine-Wichatitsky
588 M. 2011. Prevalence of diseases at different wildlife/livestock interfaces in the Great Limpopo
589 Transfrontier Conservation Area. Research Platform Production & Conservation in Partnership
590 (RP-PCP) AHEAD Conference, Mopane Camp KNP.

591 Caron, A., Miguel, E., Gomo, C., Makaya, P., Pfukenyi, D.M., Foggin, C., Hove, T. and de
592 Garine-Wichatitsky, M., 2013. Relationship between burden of infection in ungulate populations
593 and wildlife/livestock interfaces. *Epidemiology & Infection*, 141 (7), pp.1522-1535.

594 Caron, A., Mugabe, P., Bourgeois, R., Delay, E., Bitu, F., Ducrot, R., Fafetine, J., Fynn, R.,
595 Guerbois, C., Motsholapheko, M. and Daré, W., 2022. Social-ecological System Health in
596 Transfrontier Conservation Areas to Promote the Coexistence Between People and Nature. One
597 Health Cases. doi: 10.1079/onehealthcases.2022.0005.

598 Chambers, R., 1994. The origins and practice of participatory rural appraisal. *World*
599 *development*, 22 (7): 953-969

600 Chatikobo, P., Choga, T., Ncube, C. and Mutambara, J., 2013. Participatory diagnosis and
601 prioritization of constraints to cattle production in some smallholder farming areas of
602 Zimbabwe. *Preventive veterinary medicine*, 109 (3-4), pp.327-333.

603 Cochran, W.G., 1977. *Sampling techniques*. John Wiley & Sons.

604 Cumming, D. H. M. 2011. *Constraints to conservation and development success at the wildlife-*
605 *livestock-human interface in southern African transfrontier conservation areas: a preliminary*
606 *review*. Wildlife Conservation Society, New York.

607 de Garine-Wichatitsky, M., Miguel, E., Mukamuri, B., Garine-Wichatitsky, E., Wencelius, J.,
608 Pfukenyi, D.M. and Caron, A., 2013. Coexisting with wildlife in transfrontier conservation areas
609 in Zimbabwe: Cattle owners' awareness of disease risks and perceptions of the role played by
610 wildlife. *Comparative Immunology, Microbiology and Infectious Diseases*, 36 (3), pp.321-332.

611 Duckett, D.G., McKee, A.J., Sutherland, L.A., Kyle, C., Boden, L.A., Auty, H., Bessell, P.R. and
612 McKendrick, I.J., 2017. Scenario planning as communicative action: Lessons from participatory
613 exercises conducted for the Scottish livestock industry. *Technological Forecasting and Social*
614 *Change*, 114, pp.138-151.

615 Duguma, G., Mirkena, T., Haile, A., Iñiguez, L., Okeyo, A.M., Tibbo, M., Rischkowsky, B.,
616 Sölkner, J. and Wurzinger, M., 2010. Participatory approaches to investigate breeding objectives

617 of livestock keepers. *Participatory definition of breeding objectives and implementation of*
618 *community-based sheep breeding programs in Ethiopia*, 7.

619 Easter, T.S., Killion, A.K., Carter, N.H., 2018. Climate change, cattle, and the challenge of
620 sustainability in a telecoupled system in Africa. *Ecology and Society*, 23 (1), doi: 10.5751/es-
621 09872-230110

622 Funtowicz, S.O., Ravetz, J.R., 1993. Science for the Post-Normal Age. *Futures*: 739-755

623 Gadaga, B.M., Etter, E.M.C., Mukamuri, B., Makwangudze, K.J., Pfukenyi, D.M. and Matope,
624 G., 2015. Living at the edge of an interface area in Zimbabwe: cattle owners, commodity chain
625 and health workers' awareness, perceptions and practices on zoonoses. *BMC public health*, 16,
626 pp.1-10.

627 Gbaguidi, C., 2018. The representation of the African woman in male-dominated society: A
628 study of Chinua Achebe's *Things fall apart* and Amma Darko's *Beyond the horizon*. *AFRREV*
629 *IJAH: An International Journal of Arts and Humanities*, 7 (2), pp.40-48.

630 Gobvu, V., Ncube, S., Caron, A. and Mugabe, P.H., 2021. Community-based performance
631 indicators for monitoring and evaluating livestock interventions. *Tropical Animal Health and*
632 *Production*, 53, pp.1-9.

633 Gomo, C., de Garine-Wichatitsky, M., Caron, A. and Pfukenyi, D.M., 2012. Survey of
634 brucellosis at the wildlife–livestock interface on the Zimbabwean side of the Great Limpopo
635 Transfrontier Conservation Area. *Tropical animal health and production*, 44, pp.77-85.

636 Government of Zimbabwe (GoZ). 2018. *National Agriculture Policy Framework*, Ministry of
637 Lands, Agriculture and Rural Resettlement, Harare

638 Guerrini, L., Pfukenyi, D.M., Etter, E., Bouyer, J., Njagu, C., Ndhlovu, F., Bourgarel, M. et al.,
639 2019. Spatial and seasonal patterns of FMD primary outbreaks in cattle in Zimbabwe between
640 1931 and 2016. *Veterinary Research*, 50: 73.

641 Gyan, C., Malik, M. and Siddique, A., 2022. Barriers to the participation of women in
642 community development process in rural Ghana: a regression analysis. *Development in*
643 *Practice*, 32 (4), pp.448-459.

644 Hagmann, J. and Prasad, V.L., 1995. Use of donkeys and their draught performance in
645 smallholder farming in Zimbabwe. *Tropical Animal Health and Production*, 27 (4), pp.231-239.

646 Hanks, J., 2003. Transfrontier Conservation Areas (TFCAs) in Southern Africa. *Journal of*
647 *Sustainable Forestry*, 17 (1-2): 127-148, doi: 10.1300/J091v17n01_08

648 Hauser, M., Lindtner, M., Prehsler, S., Probst, L., 2016. Farmer participatory research: Why
649 extension workers should understand and facilitate farmers' role transitions. *Journal of Rural*
650 *Studies*, 47, pp. 52-61.

651 Hove, T., Mukandi, R., Bere, M., Horak, I.G. and Latif, A.A., 2008. Ixodid ticks infesting
652 domestic goats in communal land areas of Zimbabwe. *Journal of the South African Veterinary*
653 *Association*, 79 (3), pp.116-120.

654 Khashtabeh, R., Akbari, M., Kolahi, M., Talebanfard, A. and Khashtabeh, R., 2019.
655 Investigation of participatory needs assessment to prioritize sustainable development indicators
656 of rural communities using hierarchical analysis process. In *International Conference on*
657 *Researches in Science & Engineering & International Congress on Civil, Architecture, and*
658 *Urbanism in Asia. Bangkok Thailand* (Vol. 7, p. 18).

659 Kupika, O.L., Nhamo, G., Gandiwa, E. and Kativu, S., 2019. Local ecological knowledge on
660 climate prediction and adaptation: agriculture-wildlife interface perspectives from Africa.
661 In *Traditional and Indigenous Knowledge for the Modern Era* (pp. 227-260). CRC Press.

662 Larson, A.M., Monterroso, I., Liswanti, N. and Tamara, A., 2023. What is forest tenure (in)
663 security? Insights from participatory perspective analysis. *Forest Policy and Economics*, 147,
664 p.102880.

665 Losch, B., Magrin, G., Imbernon, J., 2013. *Une nouvelle ruralité émergente: regards croisés sur*
666 *les transformations rurales africaines*. Cirad, Montpellier, France.

667 Maburutse, B.E., Mutibvu, T., Mbiriri, D.T. and Kashangura, M.T., 2012. Communal livestock
668 production in Simbe, Gokwe south district of Zimbabwe. *Online Journal of Animal and Feed*
669 *Research*, 2 (4), pp.351-360.

670 Masikati, P., 2011. *Improving the water productivity of integrated crop-livestock systems in the*
671 *semi-arid tropics of Zimbabwe: an ex-ante analysis using simulation modeling*. ZEF.

672 Matope, A., Zindove, T.J., Dhliwayo, M. and Chimonyo, M., 2020. Mitigating the effects of
673 drought on cattle production in communal rangelands of Zimbabwe. *Tropical animal health and*
674 *production*, 52, pp.321-330.

675 Matseketsa, G., Muboko, N., Gandiwa, E., Kombora, D.M. and Chibememe, G., 2019. An
676 assessment of human-wildlife conflicts in local communities bordering the western part of Save
677 Valley Conservancy, Zimbabwe. *Global Ecology and Conservation*, 20, p.e00737.

678 Makuvadze, F.T., Hove, T., Makaya, P., Waniwa, E., Nemaungwe, T., 2020. Resistance of ticks
679 on cattle to amitraz in Zimbabwe. *Trop Anim Health Prod*, 52 (6): 3323-3330.

680 Miguel, E., Grosbois, V., Berthouly-Salazar, C., Caron, A., Cappelle, J., Roger, F., 2013. A
681 meta-analysis of observational epidemiological studies of Newcastle disease in African agro-
682 systems, 1980-2009. *Epidemiol Infect*, 141 (6), pp. 1117-33.

683 MDTC. 2022. Retrieved at [Programmes — Mwenezi Development Training Centre \(MDTC\)](https://www.mdctco.org.zw)
684 [\(\[mdtco.org.zw\]\(https://www.mdctco.org.zw\)\)](https://www.mdctco.org.zw) on 13 February 2023

685 Melesse, M.B., Tirra, A.N., Ojiewo, C.O. and Hauser, M., 2021. Understanding Farmers' Trait
686 Preferences for Dual-Purpose Crops to Improve Mixed Crop–Livestock Systems in
687 Zimbabwe. *Sustainability*, 13 (10), pp.5678.

688 Miguel, E., Grosbois, V., Caron, A., Boulinier, T., Fritz, H., Cornélis, D., Foggin, C., Makaya,
689 P.V., Tshabalala, P.T. and de Garine-Wichatitsky, M., 2013. Contacts and foot and mouth
690 disease transmission from wild to domestic bovines in Africa. *Ecosphere*, 4 (4), pp.1-32.

691 Miller, R. 2015. Learning, the future, and complexity. An essay on the emergence of futures
692 literacy. *European Journal of Education*, 50, pp. 513–523.

693 Mkuhlani, S., Mupangwa, W., MacLeod, N., Gwiriri, L., Nyagumbo, I., Manyawu, G. and
694 Chigede, N., 2020. Crop–livestock integration in smallholder farming systems of Goromonzi and
695 Murehwa, Zimbabwe. *Renewable Agriculture and Food Systems*, 35 (3), pp.249-260.

696 Mlambo, B.T.H. 2002. ‘Strengthening the pluralistic agricultural extension system: a
697 Zimbabwean case study’, *Agricultural Research Council*, pp. 1–48.

698 Mogomotsi, P.K., Sekelemani, A. and Mogomotsi, G.E., 2020. Climate change adaptation
699 strategies of small-scale farmers in Ngamiland East, Botswana. *Climatic Change*, 159 (3),
700 pp.441-460.

701 Mubita, A., Libati, M. and Mulonda, M., 2017. The importance and limitations of participation
702 in development projects and programmes. *European scientific journal*, 13 (5), pp.238-251.

703 Mudavanhu, C.R., Mugabe, P.H., Mukamuri, B., Imbayarwo-Chikosi, V.H., Caron, A., 2024.
704 Socio-economic and ecological dynamics associated with adopting foreign livestock breeds by
705 Zimbabwean small-scale communities in the Great Limpopo Transfrontier Conservation area. .
706 *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, Minor revisions.

707 Muema, J., Oyugi, J., Bukania, Z., Nyamai, M., Jost, C., Daniel, T., Njuguna, J. and Thumbi,
708 S.M., 2021. Impact of livestock interventions on maternal and child nutrition outcomes in Africa:
709 A systematic review and meta-analysis protocol. *AAS Open Research*, 4.

710 Mupangwa, W. and Thierfelder, C., 2014. Intensification of conservation agriculture systems for
711 increased livestock feed and maize production in Zimbabwe. *International Journal of*
712 *Agricultural Sustainability*, 12 (4), pp.425-439.

713 Murungweni, C., Van Wijk, M.T., Smaling, E.M.A. and Giller, K.E., 2016. Climate-smart crop
714 production in semi-arid areas through increased knowledge of varieties, environment and
715 management factors. *Nutrient Cycling in Agroecosystems*, 105, pp.183-197.

716 Mutibvu, T., Maburutse, B.E., Mbiriri, D.T. and Kashangura, M.T., 2012. Constraints and
717 opportunities for increased livestock production in communal areas: A case study of Simbe,
718 Zimbabwe. *Livestock Research for Rural Development*, 24 (9), p.165.

719 Muvirimi, F. and Ellis-Jones, J., 1999. A farming systems approach to improving draft animal
720 power in sub-Saharan Africa. In *Meeting the Challenges of Animal Traction: A resource book of*
721 *the Animal Traction Network for Eastern and Southern Africa (ATNESA)*. *Intermediate*
722 *Technology Publications, London* (pp. 10-19).

723 Njuki, J. and Sanginga, P.C., 2013. Women, livestock ownership and markets. *Bridging the*
724 *gender gap in Eastern and Southern Africa. Londres-Nueva York: Earthscan Routledge.*

725 Nyarumbu, T., Kaseke, T., Gobvu, V., Murungweni, C., Mashingaidze, A. and Chikwambi, Z.,
726 2019. Phenotypic and genetic characterisation revealed the existence of several biotypes within
727 the *Neorautanenia brachypus* (Harms) CA wild accessions in South East Lowveld,
728 Zimbabwe. *BMC ecology*, *19* (1), pp.1-14.

729 Oduniyi, O.S., Rubhara, T.T. and Antwi, M.A., 2020. Sustainability of livestock farming in
730 south africa. outlook on production constraints, climate-related events, and upshot on adaptive
731 capacity. *Sustainability*, *12* (7), p.2582.

732 OECD, FAO, 2021. *OECD-FAO Agricultural Outlook 2021-2030*. doi:
733 <https://doi.org/10.1787/19428846-en>

734 Oosome, L. and Naidu, S.C., 2021. Does land still matter? Gender and land reforms in
735 Zimbabwe. *Agrarian South: Journal of Political Economy*, *10* (2), pp.344-370.

736 Pfukenyi, D.M., Tivapasi, M., Matope, G., Ndengu, M., De Garine-Wichatitsky, M. and Cetre-
737 Sossah, C., 2020. Seroprevalence and associated risk factors of Rift Valley fever in cattle and
738 selected wildlife species at the livestock/wildlife interface areas of Gonarezhou National Park,
739 Zimbabwe. *Onderstepoort Journal of Veterinary Research*, *87* (1), pp.1-7.

740 Poku, S.O., 2009. Analysis of the current status of small-scale sheep and goat production by
741 farmers of different age groups in the Jirapa and Lambussie districts, Ghana. *Journal of*
742 *developments in sustainable agriculture*, *4* (2), pp.149-159.

743 Poshiwa, X., Groeneveld, R.A., Heitkönig, I.M.A., Prins, H.H.T. and van Ierland, E.C., 2013.
744 Wildlife as insurance against rainfall fluctuations in a semi-arid savanna setting of southeastern
745 Zimbabwe. *Tropical conservation science*, *6* (1), pp.108-125.

746 Runganga, R. and Mhaka, S., 2021. Impact of agricultural production on economic growth in
747 Zimbabwe. *Munich Personal RePEc Archive*

748 Şandru, C., 2014. Participatory needs assessment in local communities. methodological
749 aspects. *Bulletin of the Transilvania University of Braşov, Series VII: Social Sciences and Law*,
750 (2), pp.97-104.

751 Senda, T.S., Kiker, G.A., Masikati, P., Chirima, A. and van Niekerk, J., 2020. Modeling climate
752 change impacts on rangeland productivity and livestock population dynamics in Nkayi District,
753 Zimbabwe. *Applied Sciences*, 10 (7), p.2330.

754 Sere, C., Steinfeld, H., 1996. *World livestock production systems: current status, issues and*
755 *trends*. In FAO Animal Production and Health Paper. Rome: FAO, vol. 127, 58

756 Silvius, A.J. and Schipper, R.P., 2014. Sustainability in project management: A literature review
757 and impact analysis. *Social Business*, 4 (1), pp.63-96.

758 Sungirai, M., Abatih, E.N., Moyo, D.Z., Clercq, P.D. and Madder, M., 2017. Shifts in the
759 distribution of ixodid ticks parasitizing cattle in Zimbabwe. *Medical and veterinary*
760 *entomology*, 31 (1), pp.78-87.

761 Tavirimirwa, B., Mwembe, R., Ngulube, B., Banana, N.Y.D., Nyamushamba, G.B., Ncube, S.
762 and Nkomboni, D., 2013. Communal cattle production in Zimbabwe: A review.

763 Tswegye, G., Ssemakula, E. and David, B.B., 2022. Adoption of Supplementary Feeding in
764 Smallholder Dairy Cattle Production in Mbarara District. *American Journal of Agriculture*, 4 (1),
765 pp. 58 – 88.

766 Tui, S.H.K., Descheemaeker, K., Valdivia, R.O., Masikati, P., Sisito, G., Moyo, E.N., Crespo,
767 O., Ruane, A.C. and Rosenzweig, C., 2021. Climate change impacts and adaptation for dryland
768 farming systems in Zimbabwe: a stakeholder-driven integrated multi-model assessment. *Climatic*
769 *Change*, 168 (1-2), p.10.

770 Van Damme ,J., Ansoms, A., Baret, P.V., 2014. Agricultural innovation from above and from
771 below: confrontation and integration on Rwanda's hills. *African Affairs*, 113 (450): 108-127

772 Van Rooyen A. and Homann-Kee Tui, 2009. Promoting goat markets and technology
773 development in semi-arid Zimbabwe. *Tropical and subtropical agroecosystems*, 11 (1): 1-5.

774 Wordofa, M.G. and Sassi, M., 2020. Impact of agricultural interventions on food and nutrition
775 security in Ethiopia: uncovering pathways linking agriculture to improved nutrition. *Cogent food*
776 *& agriculture*, 6 (1), p.1724386.

777 Zengeya, F.M., Murwira, A. and De Garine- Wichtitsky, M., 2014. Seasonal habitat selection
778 and space use by a semi- free-range herbivore in a heterogeneous savanna landscape. *Austral*
779 *ecology*, 39 (6), pp.722-731.

780 Zengeya, F.M., Murwira, A., Caron, A., Cornélis, D., Gandiwa, P. and de Garine-Wichtitsky,
781 M., 2015. Spatial overlap between sympatric wild and domestic herbivores links to resource
782 gradients. *Remote Sensing Applications: Society and Environment*, 2, pp.56-65.

783 Zimbabwe Resilience Building Fund. 2017. *ECRAS Annual Report*.

784 Zimbabwe Vulnerability Assessment Committee (ZimVAC) 2017 Rural Livelihoods Assessment
785 Report.