Community-based performance indicators for monitoring and evaluating livestock interventions

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Abstract

The research aimed at identifying livestock performance indicators used by farmers in Malipati community, Zimbabwe and use them in developing a monitoring and evaluation framework for livestock interventions. Mixed methods research was used in the study. A questionnaire was administered to identify performance indicators of preference by farmers. Focus group discussions were done to rank performance indicators. Data analysis was done using SPSS version 25 and data were analysed using the ranking matrix. Scientific validity of performance indicators was determined through literature review. The study concluded that performance indicators of importance in poultry, cattle, goats/sheep and donkeys were egg production, milk yield, kidding/ lambing interval and animal power respectively. All performance indicators identified by farmers in Malipati are scientifically valid and were used in the development of the monitoring and evaluation framework.

Key words: ranking · scientific validity · monitoring and evaluation framework

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Declarations

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Compliance with ethical standards

Prior informed consent was obtained from all participants of the survey and focus group discussions. To secure the confidentiality and security, data were made available to the author team only after anonymization by the team member collecting the data and no identifiable personal data has been published.

Conflicts of interest

The authors declare that they have no conflict of interest.

Availability of data and material

All data needed to evaluate the conclusions in the paper are here in the paper. Additional data may be requested from the authors.

Code availability

Not applicable.

Author's contributions

V.G Performed research, analysed data and wrote the paper

S.N Supervised the research, contributed new methods and commented the manuscript

A.C Co-conceived the ProSuLi Project and contributed to the manuscript

P.H.M Conceived the study and contributed to the manuscript

Introduction

Participation by smallholders in the implementation of livestock development programmes is generally weak (Faustin *et al*., 2010) yet they are the target beneficiaries of most community based projects. Involvement of local people in the research process can help bring about development of sustainable livelihoods and contribute to the fight on poverty alleviation in rural areas (Ndegwa *et al*., 2014). Thus, participatory approaches are being promoted for designing community-based improvement programs (Onzima *et al*., 2017).

Monitoring and evaluation of any intervention is important for the following reasons: to determine whether it works, to help improve programme delivery, and to provide indication for continuing support of the programme (Macdonald, 2013). Weaknesses in monitoring and evaluation processes are associated with a lack of ownership and participation by the stakeholders (Muller-Praefcke *et al*., 2010). Also, externally imposed indicators cannot make "sense" locally and are impractical to measure with local knowledge and/or tools. Lack of ownership and participation stems from the fact that monitoring and evaluation has revolved around use of experts, with indicators that would have been determined externally or through rigid, imposed monitoring procedures (Guijt, 2009). Alternatively monitoring and evaluation can also be based on local knowledge so that indicators of performance are embedded in local institutions structures, values and beliefs. These are likely to have greater acceptance and weight in decision making for farming communities than scientific indicators (BRACED, 2018). Performance indicators valued by project participants are likely to incorporate user needs in the monitoring and evaluation framework, such that the basis of a project success is as close to the needs of the beneficiaries as possible.

Livestock production in Zimbabwe's communal areas is mainly in the semi-arid parts of the country (agro-ecological zones III, IV and V). This geographical set-up is a consequence of the colonial period during which the best land was put aside for white farmers and the black population, not working on farms, was constrained in native land in the remote and less productive areas of the country (Mavedzenge *et al*., 2006). In these same areas, protected areas were created during the 20th century. Where small-scale farmers live close to protected areas, livestock production is probably the most sustainable agricultural production in these semi-arid areas already impacted by climate change. However, in these contexts, wildlife/livestock interfaces expose farmers to human/wildlife conflicts (Le Bel *et al*.., 2011; Caron *et al*., 2013; Matseketsa *et al*., 2019) including elephant raiding of crops, predation by wild carnivores and the transmission of diseases between wildlife and domestic

stock (Gadaga *et al*., 2016). There, locally-meaningful support to livestock production takes an even bigger role to strengthen one of the pillar of local livelihoods and culture and at the same time ensure a sustainable coexistence between people, their livestock and wildlife.

This study was conducted in the Sengwe Malipati community in Chiredzi District, Zimbabwe, at the heart of the Great Limpopo Transfrontier Conservation Area (TFCA), where such coexistence issues are at stake. Within the context of the broader project: Promoting Sustainable Livelihoods in TFCAs – (ProSuLi) aimed at supporting local livelihoods in TFCAs, local farmers were invited to a participatory process during which they identified key interventions that could support their livelihoods and co-designed these interventions with the support of researchers and local stakeholders (e.g. governmental services, local NGOs). Improving livestock production was one of the four identified interventions as a driving force of local livelihoods and this research study aimed at identifying livestock performance indicators of preference by farmers in the Malipati community and use them in developing a monitoring and evaluation framework for livestock interventions.

Materials and methods

Study site

The research was done in ward 15 of Sengwe area in Chiredzi district in the south-east lowveld of Zimbabwe. The study area falls in agro-ecological regions IV and V. Sengwe area lies at <250m above sea level. Mean annual precipitation for Sengwe area is about 470mm whereas annual temperature range is 14-33°C. The climate, therefore, may be regarded as semi-arid. The major vegetation type is typical of semi-arid mopane (*Colophorspermum mopane*) woodland. The study area is adjacent to Gonarezhou National Park and falls within the Great Limpopo Transfrontier Conservation Area, which is one of the 18 Transfrontier Conservation Areas (TFCAs) in Southern Africa (Manjengwa *et al*., 2010). Human/wildlife conflicts do exist in the area (Le Bel *et al*., 2011; Chigwenhese *et al*., 2016; Matseketsa *et al*., 2019) and recent droughts (1992, 2002, 2008, 2012, 2018) (Frischen *et al*., 2020) have impacted livestock production raising concern about the capacity to adapt the production system to climate change.

Sampling procedure

Respondents for the survey were sampled from 9 villages of Sengwe's Ward 15. The ward and the villages were predetermined by the ProSuLi project as one of its four sites (the other sites being in Hwange, Zimbabwe,

Bostwana and Mozambique). Each village had around 25 households and for the 9 villages there were up to 225 households. Purposive sampling of farmer participants majoring in livestock production was done through key informant interviews with the village heads and the ProSuLi project focal person, a member of the community. The sample size was calculated using the Cochran's sample size formula (Cochran, 1977) and a sample size of 126 was recommended.

Data collection and analyses

A survey was done using semi-structured questionnaires to collect data on livestock performance indicators used by farmers. The questionnaire had thematic areas which included; socio-demographic information, livestock information and livestock performance indicators. Ranking was done in focus group discussions to identify the most widely used and preferred performance indicators. There were four focus group discussions based on gender and age, consisting on average of 8 members per group. A participatory scoring system was used for ranking the indicators where participants used small stones to rank their most preferred indicators. The number of stones for each indicator determined its preference by farmers.

Data from questionnaires were analysed using IBM Statistical Package for Social Science (SPSS) version 25 to obtain frequencies of the responses. Indexes were calculated to provide overall ranking of the livestock performance indicators according to the formula employed by (Zewdu *et al*., 2018):

Index = Rn × C1 + Rn-1 × C2 ... + R1 × Cn/ (Rn × C1 + Rn-1× C2 + ... + R1 × Cn)

Where; Rn = the last rank (example if the last rank is 8th, then Rn = 8, Rn-1 = 7, R1 = 1).

Cn = the % of respondents in the last rank

C1 = the % of respondents ranked first.

Identified indicators were scientifically validated through literature review. Core concepts of the study were identified and turned into search terms (which were mostly related to performance traits) and searched in Google Scholar. Previous studies were selected carefully whose hypothesis were comparable to the current study and analysed. Most of the previous research studies were choice experiments on preferred livestock traits.

The monitoring and evaluation framework was developed from the most preferred indicators after data analysis. The methods used by respondents to measure their community indicators were the sources of verification while the targets were the best levels that indicated performance of the used indicators. Since the ProSuLi project is participatory, during an initial phase, the monitoring of the indicators will be done by the farmers assisted by the

project's team; then, to move towards sustainability, the responsibility of monitoring and evaluation will be of the farmer.

Results

Socio-demographic information

In the study, 57.9% of respondents were female. The average household size was 7.21±3.54. 49.2% of the respondents had their education up to primary level while 20.6% did not attend school at all and 30.2% went up to secondary education. Most of the respondents (30.2%) were aged between 41 and 50 years while the least (5.6%) were aged between 21 and 30 years. The major source of income for households in Malipati is livestock production activities with a frequency of 27.8%, with other sources of income being salary (6.3%), pension (4.8%), crop production (9.5%) and horticulture (23.8%).

Livestock information

Chickens were the most common livestock species, with 91.2% of households owning a median flock size of 10.00 animals. 78.6% of the respondents had cattle owning a median herd size of 8.5 while 94.4% had goats and the median flock size was 10. Only 8% of the respondents owned sheep while 37.3% had donkeys. The respondents kept poultry mainly for meat, eggs and selling while cattle were kept for security reasons, draft power and milk. They kept goats for milk and security reasons while donkeys were kept only for draught power.

Identified performance indicators and how they are measured by Malipati households

Performance indicators indicated by farmers as well as the methods to measure them can be found for cattle, goat/sheep, poultry and donkey in Table 1, 2, 3 and 4 respectively. Milk yield mentioned by 73.8% of the respondents and calving interval (65.9%) were the most cited performance indicators for cattle production. The most mentioned performance indicator in goats and sheep was kidding/lambing interval with a frequency of 93.7%. Most indicators for chicken production targeted egg production with the most common performance indicator for poultry was egg production with a frequency of response of 96.8% followed by hatchability. Animal power had the greatest frequency of response (34.9%) for donkeys.

Table 1: Cattle performance indicators in use in Malipati

Performance indicator	Method of assessing	Frequency (%)
Milk yield	Amount of milk produced per cow per day	73.8
Calving interval	Observation of cow's calving frequency	65.9
Conception	Observation of cows in oestrus and being serviced by bulls	42.9
Growth rate/ weight gain	Observation of changes in body size	25.4
	Use weigh band to get animal weights	6.3
Drought tolerance	Observation of animal body condition	9.5
Animal power	Observation of animal speed and pull force when carrying load	42.9

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Table 2: Goat and sheep performance indicators used in Malipati

Goats/Sheep performance indicator	How it is measured	Frequency (%)
Milk yield	Amount of milk produced per doe per day	27.8
	Observation of kid liveliness	29.4
Kidding interval	Observation of frequency of kidding	93.7
Growth rate	Observation of increase in body size	27
	Use weigh band to get animal weights	0.8
Conception	Observation of oestrus and buck servicing	31.7

Table 3: Poultry performance indicators used in Malipati

Poultry performance indicator	How it is measured	Frequency (%)
Egg production	Counting number of eggs laid per clutch	96.8
Growth rate	Observation of increase in body size	23
Hatchability	Counting number of eggs hatched	94.4
Mothering ability	Observation of how hen rears chicks	78.6
Return to lay	Observation of how quickly a hen weans chicks and starts to lay again	25.4

Table 4: Donkey performance indicators and how they are measured

Donkey performance indicator	How it is measured	Frequency (%)
Animal power	Observation of animal speed and pull force when carrying load	34.9
Foaling interval	Observation of foaling frequency	5.6

Table 5 shows results for ranking exercises. For poultry, egg production was ranked first with time taken to return to lay post hatching being the least preferred. Milk production was ranked first in cattle with a ranking index of

171 0.33 followed by calving interval with a ranking index of 0.31. For goats and sheep, kidding/lambing was ranked
172 the highest. Animal power was the ranked first for donkeys with a ranking index of 0.89.

Table 5: Ranking of livestock performance indicators.

Livestock indicators	Weighting index	Ranking index
Cattle indicators		
Milk production	494	0.33
Calving interval	466	0.31
Conception	217	0.15
Growth rate	154	0.102
Animal power	145	0.097
Drought tolerance	21	0.01
Goat/ sheep indicators		
Kidding/lambing interval	436	0.53
Milk production	231	0.28
Growth rate	84	0.10
Conception	69	0.08
Poultry indicators		
Egg production	567	0.37
Hatchability	422	0.28
Mothering ability	334	0.22
Growth rate	101	0.07
Return to lay	91	0.06
Donkeys indicators		
Animal power	84	0.89
Foaling interval	10	0.11

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174 Validity in research is a measure of how correct the results of an experiment are. Table 6 shows which of the
175 community based performance indicators are valid according to scientific literature.

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Table 6: Scientifically valid livestock performance indicators

Community based indicators	Literature based performance indicator
Cattle	
Milk yield	Milk yield (Zewdu *et al*., 2018)
Conception	Conception rate (Penasa *et al*., 2016)
Calving interval	Calving interval (Ayalew *et al*., 2018)
Growth rate/ weight gain	Growth rate (Hulsen, 2011)
Drought tolerance	Adaptability (Khainga and Murage, 2015)
Animal power	Draught animal power (FAO, 2010)
-	Manure production (Pica-Ciamarra *et al*., 2011)
Poultry	
Hatchability	Hatchability (Tadesse, 2014; Abdurehman and Urge, 2016)
Egg production	Egg production per hen per clutch (Tadesse, 2014; Gebremariam et al, 2017)
Return to laying post hatch	Clutch number per year (Tadesse, 2014)
Mothering ability	Mothering ability and chick survivability (Mapiye *et al*., 2008; Tadesse, 2014)
Growth rate	Growth rate (Dana and Waaij, 2010)
Donkeys	
Animal power	Power proportion, traction capability, draught ability and force (Yilmaz *et al*., 2012)
Foaling interval	Foaling frequency (Pugh, 2002)
Goats	
Kidding interval	Kidding percentage (Sahare *et al*., 2009) Twinning ability (Warun *et al*., 2008; Sahare *et al.*, 2009)
Milk yield	Milk yield (Kaberia *et al*., 2003)
Growth rate/ weight gain	Growth rate (Meat & Livestock Australia, 2017)
Conception	Conception rate (Warun *et al*., 2008)

Table 7 shows a monitoring and evaluation framework designed using scientifically valid performance indicators as determined by the community.

Table 7: Monitoring and evaluation framework

Livestock species	Indicator	Definition	Target	Data source	Frequency	Responsibility	Reporting
Cattle	Milk yield	Amount of milk produced by a cow per day	≥4l per cow per day	Milking	Monthly	Farmer	6 monthly
	Growth rate/ weight gain	How the animal has grown or gained weight since inception of intervention	Shiny coat colour and increase in body size	-use of weigh bands -observation of changes in body size	Every 6 months	Farmer	Annual report
	Drought tolerance	The degree to which an animal is adapted to arid or drought conditions	Maintenance of animal's body condition even in drought	Observation	Monthly during dry season	Farmer	Annual report
	Conception	The number of days from calving to the service at which a cow actually gets pregnant	Cow conceives within 60-80 days after calving	Observation of changes in milk colour and coagulation properties	Annually	Farmer	Annual report
	Animal power	The time rate at which work is done by an animal	6 hours' work/ day (Netam, 2018)	Observing and recording number of hours of work	6 monthly	Farmer	Annual report
	Calving interval	The amount of time between birth of a calf and the birth of a subsequent calf of the same mother	A calf per cow per year	Review of records	Annually	Farmer	Annual report
Sheep and Goats	Kidding/ lambing interval	The amount of time between birth of a kid/lamb and the birth of a subsequent calf of the same mother	Kidding /lambing twice a year with twins or triplets	Review of records	Annually	Farmer	Annual report
	Milk yield	The amount of milk produced by a doe per day	2 kango cups milk per doe per day	Milking	6 months	Farmer	Annual report
	Growth rate	How the animal has grown or gained weight since inception of intervention	-60kg at maturity -significant increase in body size	-use a weigh band -observation of changes in animal body size	6 months	Farmer	Annual report
	Conception rate	The number of days from kidding to the service at which a doe actually gets pregnant	Takes a few days from kidding to conceive again	Observation of oestrus and buck servicing	6 months	Farmer	Bi-annual report
Donkeys	Animal power	The time rate at which work is done by an animal	-660 hours/ year for transport -450 hours/ year for tillage (Netam, 2018)	Observing and recording number of hours of work	Annually	Farmer	Annual report
	Foaling interval	The amount of time between birth of a foal and the birth of a subsequent foal of the same mother	A foal per jenny per year	Review of records	Annually	Farmer	Annual report
Poultry	Mothering ability	How well a hen looks after its chicks	Survivability of all chicks hatched	Observe how many chicks survive till weaning	All year round	Farmer	Quarterly report
	Hatchability	How many eggs are hatched out of those laid	Hen leaves no eggs unhatched	Count number of eggs hatched	All year round	Farmer	Quarterly report

	Return to lay	How quickly a hen returns to lay after hatching	4 clutches/hen/year	Count number of clutches per hen per year	All year round	Farmer	Quarterly report
	Egg production	How many eggs a hen lays per clutch	>10 eggs per hen per clutch	Count number of eggs laid by a hen per clutch	All year round	Farmer	Quarterly report
	Growth rate	How the animal has grown or gained weight since inception of intervention	Significant increase in body size	Observation of changes in body size	6 months	Farmer	Bi-annual report

Discussion

This study implemented a co-construction process of livestock production indicators in a small-scale and subsistence farming community adjacent to Gonarezhou national park in the South-East Zimbabwe, a region included in the Great Limpopo TFCA. The objective was to synthetize local knowledge on livestock production indicators and their measurement and confront them with academic knowledge on the topic. Our results indicated that there was a diversity of indicators for each domestic species, easily measurable locally and related to the local use of each species. These indicators were in agreement with indicators found in the academic literature.

There was a good participation of farmers to the process, both for the questionnaire and focus group discussion. This was to be expected given the involvement of the research team with local stakeholders in the area for the last 15 years (www.rp-pcp.org). More recently, this study was embedded in the ProSuLi project which unfold a participatory approach to let local stakeholders identify and co-construct management options relevant for their livelihoods and well-being. As livestock production was considered as a pillar of local livelihoods and culture, this study was designed to support this agricultural sector. One of the assumption of this study is that this participatory process would ensure the appropriation of the management of livestock production and the feedback given by farmers seems to support this assumption.

The various livestock production indicators reported by the farmers in Malipati can be found in the literature. A number of interventions by the International Livestock Research Institute (ILRI) used livestock production and productivity indicators in livestock development projects. They then use four calculated variables under these indicators which include: milk production per animal per lactation and per year, milk production per household per day, egg production per hen per clutch and egg production per household (Njuki et al., 2011). The Food and Agriculture Organisation (FAO), the World Bank and ILRI in joint projects used production and sale of livestock products and services as livestock indicators in monitoring and evaluating livestock interventions. They then use variables which include milk produced per year, meat production, egg production, manure produced per year and draft power as a service (Pica-ciamarra et al., 2013). The Livestock Production Program (UK Department for International Development Department for International Development, (DfID)) used egg and meat production in poultry and herd enlargement in cattle as indicators in monitoring and evaluating livestock programs (Rushton, 2004). For most livestock projects the indicators revolved around increased productivity which has also been the case in identified indicators in the study area indicating an adequate level of local knowledge around livestock production in the area. However, given the proximity of a national park and of an extended wildlife/livestock

interface leading to predation by wild carnivores (e.g. lions, hyenas) and a disease burden for livestock predation respectively, it was surprising not to see any indicator related to these issues (e.g. number of heads killed by wild carnivores; number of heads dying of disease). The focus on "livestock production indicators" of the study may have diverted local farmers from these other important issues impacting livestock production. Respondents of the study did not mention manure production as a performance indicator. This is most probably due to the reason that in Malipati they do not use manure in their fields. Manure is not used in arable fields; local people believe that their soils are rich in nutrients (because the soils are mostly deep-black loamy to clay eutric vertisols) (Murungweni *et al*., 2016).

As expected, there was a strong correlation between indicators enumerated by farmers and the uses of the different livestock species. Cattle rearing is used in the area for social status (size of the herd, number of calves), food production (milk, meat production), cash/capital (size of the herd, reproduction indicators, growth rate) and draught power for agriculture (animal power). The use of mechanisation in the ploughing of fields is not so common in the study area hence they use draft powered more as such they have animal power as a performance indicator. The study area is characterised by high frequency of drought (Frischen *et al*., 2020) and as such drought tolerance is one of the performance indicators indicated even if only a few times (10%) . This implies that if restocking interventions are planned in the area, farmers would probably favor breeds which tolerate drought situations. These findings are also in agreement with Zewdu et al., (2018) where they found that the major preferred cattle performance traits in their study area were milk yield, traction power, breeding ability, growth rate and adaptation.

A study by Misbah et al., (2010) had similar findings for goats as in the study area. There, a community in Ethiopia used milk yield, body size, twinning rate, kidding interval to measure goat's performance and for breeding. Preference ranking results indicated that the most preferred performance indicator in goats was kidding followed by milk yield, growth rate and conception rate respectively. Kidding was most preferred as it involved various levels including kidding interval, twinning and tripling ability. Goat production in the area is essentially for milk, food and rapid cash production for households' expenses (e.g., school fees) and therefore indicators targeted preferentially increasing numbers for profitability. Results from a study by Lorato et al., (2017) showed that

twining ability and short kidding interval were ranked as the most preferred goat traits and these were in agreement with results from the current study.

Poultry production in the area is mainly under "backyard" system and is aiming at producing eggs and poultry meat. This was reflected in the indicators chosen. Success of any poultry production is influenced by the fertility and hatchability of the eggs. Mothering ability implies that poultry can contribute to better survival of chicks. A discrete choice experiment by Terfa et al., (2019) came up with poultry performance traits which included number of eggs per clutch, body size, hatchability and mothering ability; these are in agreement with results of the current study. For donkeys, indicators mentioned reflected logically the use of donkey exclusively for animal power.

Respondents of the study use observation and counting methods as means of measurement. The choice can be attributed to costs and also the issue of knowledge. Farmers chose methods and tools (e.g. weigh bands) that they are used to and also that they afford. The reporting frequency was determined by the type of indicator with some indicators like milk production having a shorter reporting frequency since they are done almost daily. The targets for each indicator were the levels that they use to determine the best performance.

Conclusions and recommendations

This study confirmed that the local communities use livestock performance indicators that are logical and easy to use given the local context. The indicators are measured using observation of posture, behaviour and well-being. Since scientific validation of the performance indicators was only done through literature review, future research can focus on establishing the validity of the measurement and assessment of livestock performance indicators which could not be in literature. Monitoring the use, recording at the farmer level and reporting at the farmer community level of these livestock indicators would be useful to assess the level of appropriation and how this data is processed and used. These indicators could help the farmer community to test new management practices (e.g. feeding, reproduction practices), the introduction of different breeds and climate-smart adaptation in a framework in which they would choose the innovation they want for their livestock production.

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