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Sustainability assessment of cattle herding in the North West Region of Cameroon, Central Africa

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Cattle herding in the North West Region of Cameroon is not sustainable in its present form. Although the role played by the cattle herding enterprise in the region is fundamental to the livelihood of cattle herders, consumers, the region, and others who depend on its products and services for survival; its sustainability unfortunately is not guaranteed due to several challenges. The repercussions of a breakdown of the enterprise on its dependents now and in the future can be very undesirable. This study was conducted to determine the sustainability of cattle herding in the region, in terms of its economic, social, and environmental components, and to develop strategies to assist stakeholders that were to reverse the trend of the impact.

Key words: Cattle herding, sustainability assessment, Cameroon.

INTRODUCTION

Cattle herding generated about 96.1 million USD for the North West Region (NWR) of Cameroon (Atanga, 2013) and serves as the main source of livelihood for about 5,041 families (Manu et al., 2014). Although the cattle herding enterprise is very important, the future of its continuity in the NWR of Cameroon is uncertain because of a series of economic, social and environmental challenges (Manu et al., 2014). This study assesses the situation of cattle herding in the NWR of Cameroon by identifying factors that affect sustainable cattle herding in the region with the intention of building on them to develop strategies to ensure the continuity of the trade.

The long term survival of emerging national economies of African countries depend on their ability to provide cattle products in their quantities and quality and at prices that satisfy subsistence and income needs of cattle herders (Konandreas and Anderson, 1982; FAO, 2011, 2014). Tah (2009), noted that poor road infrastructure to transport cattle and cattle products to the market, low productivity of cattle and its products as a result of depleted pastoral resources, and low capacities of cattle herders to conceive and adopt modern production techniques are some of the major setbacks to the economic sustainability of cattle herding in the NWR of

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Cameroon.

Social factors play key role in the success of cattle herding. Existing literature informs that the social status of the NWR of Cameroon in relation to cattle herding is not encouraging. For instance, none of the seven State divisional veterinary clinics in the Region is functional due to lack of equipment hence resulting in poor health coverage of cattle (Atanga, 2013).

The state of the environment plays a crucial role on the sustainability of cattle herding. While sustainable cattle herding demands adaptation to a stressful environment and the conservation of the ecosystem's diversity and mobility (IFAD, 2009), the situation is the reverse in the North West Region of Cameroon. Atanga (2013) noted that the soils of the region are progressively degrading because of overgrazing, progressive invasion of pastoral land by introduced and noxious plants (bracken fern and Bokassa), and others. Consequently, the environment is progressively becoming unsuitable for cattle herding.

The study aims to assess the sustainability of cattle herding and to identify strategies for sustainable cattle herding in the NWR of Cameroon as an alternative to current cattle herding practice in the region. Firstly, the study generates and documents information on the prevailing situation of cattle herding in the NWR in terms of environmental pressure (cattle activities), the state (aspects of the quality and quantity of natural grazing resources) and the various responses taken to overcome challenges to sustainable cattle herding. Secondly, it proposes appropriate strategies for sustainable cattle herding.

METHODOLOGY

This descriptive study was carried out from August 2014 to December 2014. In continuation, the sustainability framework used for the study is the "Driving force State Response" (DSR) developed by the Organization of Economic Cooperation and Development (OECD, 1991). According to OECD (1993), driving force indicators refer to factors that cause changes due to management practices and inputs. State indicators on their part show the effect of human actions on the environment. Meanwhile, response indicators refer to actions taken to the changing state of the environment. The DSR model analysis of 10 pastoral case studies conducted by Dong et al. (2011) in major pastoral regions in six continents confirm the model to be important in mitigating negative impacts of global changes on sustainable pastoralism. Yet, Hayati et al. (2010) after reviewing several studies carried out on sustainability indicators remarked that the indicators generally fall under three important dimensions; economic, social, and environmental.

Study area

The study area is the North West Region of Cameroon in Central Africa also situated within the Sub-Saharan belt (Figure 1). It is one of the 10 administrative regions of Cameroon and lies between latitudes 5° 45' and 9° 9' N and longitudes 11° 13' and 11° 13' E (CIA World Factbook, 2013; Atanga 2013). The population comprises about 1,728,953 people, of which about 80% are involved in agriculture; it has a surface area of about 17,400 km^2; it is the third most populated region and is also the second highest densely populated amongst all the ten administrative regions of the Cameroon. The region is made up of seven administrative divisions with each further divided into subdivisions (Yengoh et al., 2011; Atanga, 2013).

Sample size and sampling

A sample size of 100 cattle herders was used for the study from the NWR. However, a response rate of 97% brought the number to 97, comprising 98% males and 2% female. It should be noted that, women hardly independently practice cattle herding in the region though they may keep their cattle amongst those of husbands or other relatives. Meanwhile, the 2% of women consulted are widows that are household heads.

The general population for the study is the cattle herding population of Cameroon's NWR and stratified sampling method was used. Hence, four out of the seven administrative divisions in the region were selected based on access to information which reflects the situation of the entire region. The divisions selected include Mezam, Momo, Dunga and Mantung, and Ngoketunjia. Within each of the divisions, two subdivisions were randomly selected. Hence, for Mezam, Santa and Tubah were selected; for Momo, Mbengwi central and Njikwa were selected; for Ndonga Mantung, Ndu and Nkambe were selected; and for Ngo-Ketunjia, Ndop and Babessi were selected. In all, 26 cattle herders were contacted from Mezam, 24 each from Momo, Donga and Mantung and 23 from Ngoketungia division.

Data collection and analyses

Two types of data were used for this study; primary and secondary data. Primary data were collected through the administration of semi-structured questionnaires to cattle herders, focus group discussions, and observations while on the field. Focus group discussions were held with cattle herders in Donga Mantung and Momo divisions, respectively, to obtain information on the daily and annual calendar of cattle herding activities. Secondary data were collected from annual reports of the Regional Delegation of Livestock, Fisheries and Animal Husbandry in the NWR, and the Mbororo Social and Cultural Development Organization (MBOSCUDA) that works specifically with cattle herders in the region. Also, other secondary sources used included scholarly articles, research articles and other relevant works. Secondary data were obtained on cattle population, grazing surface area, human population, standard work hours, recommended minimum wages, fire regimes, and greenhouse emission factor.

The main inclusion criteria for selecting a cattle herder was the number of years of experience in cattle herding (which was fixed at 10 years minimum) and domicile in the region. On the other hand, a division was selected on the basis of fulfilling one or more of the following criteria: the highest number of cattle, highest number of herding related conflicts, least number of cattle, least number of cattle markets, and the highest human population density.

Parameters for analysis were classed under the three pillars of sustainability: economic, social, and environment. Meanwhile, some parameters were cross-cutting to the three aforementioned pillars, hence, they were investigated under generic parameters. Three types of analyses were used to demonstrate the validity of the indicators: chi-square, time series and ratio analyses. Hence, a given analysis was used for a given indicator depending on how it could better express the situation at hand.

Two benchmark information types were used in this study: standard and nonstandard. Standard benchmark consists of

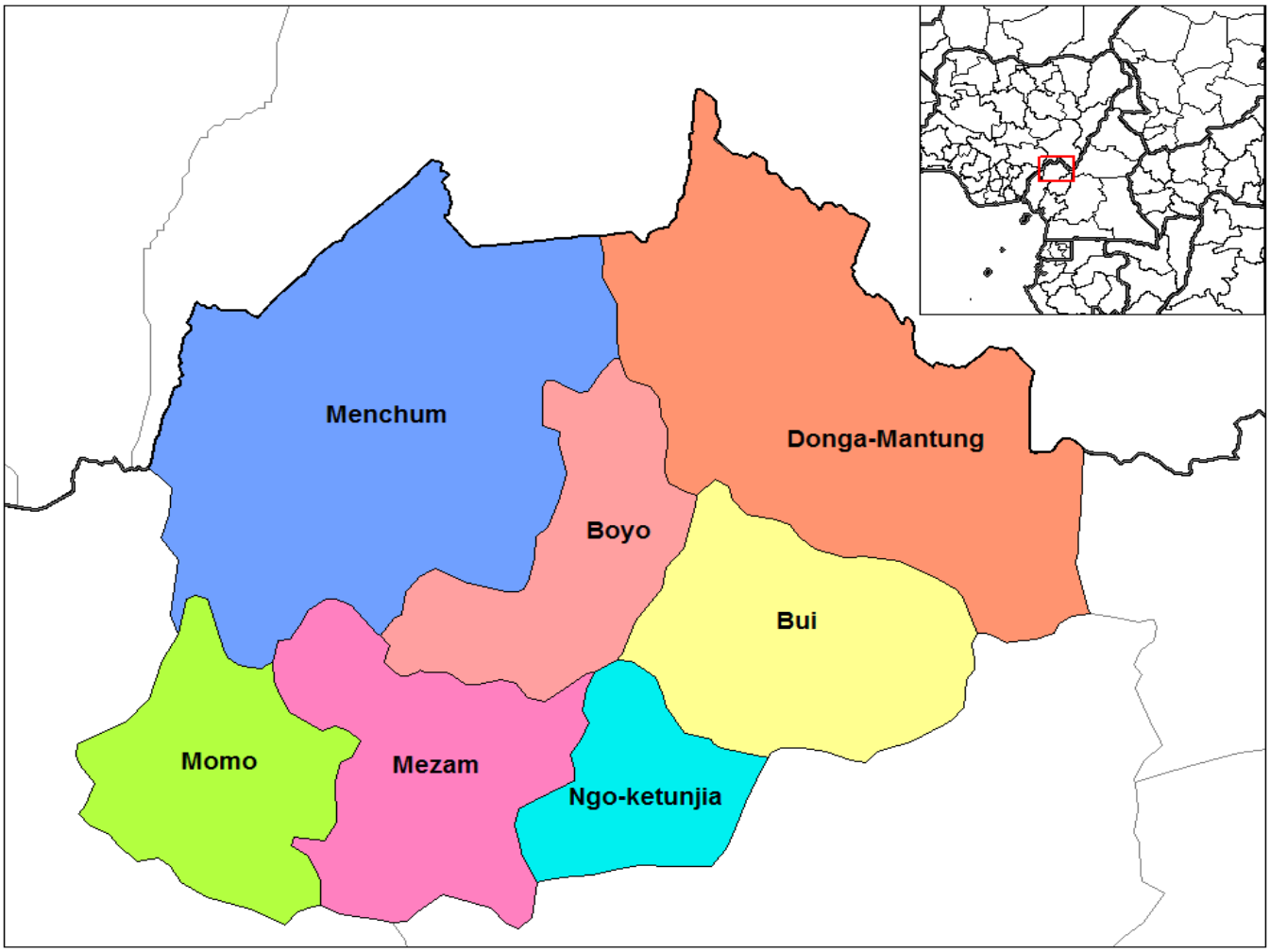

Figure 1. Location of NWR on Cameroon map.

information developed by the government of Cameroon while non-standard benchmark is the reference information or figures agreed upon by respondents in this study. Such figures (non-standard) were obtained by calculating the mean value of estimates expressed by cattle herders for a given variable. In this study, standard benchmarks were obtained for work hours, remunerations, Chi-square value, and for fire regime indicators.

Nonstandard benchmarks were obtained for the savings deficit, the input self-sufficiency, and cost effectiveness indicators in the economic dimension of sustainability. The values used were those considered by respondents to be the most appropriate to enable them achieve their economic goal of production.

Indicator selection

The selection of indicators for this study was guided by the "Driving Force State Response" framework (OECD, 1991). It was further interpreted under the social, economic, and the environment pillars of sustainability. According to Konandreas and Anderson (1982), OECD (1993), Kavana et al. (2005), and others, several indicators exist to highlight sustainability challenges. However, this study based its choice of indicators on the following arguments:

(1) Their ability to highlight important sustainability challenges at stake in the area of study
(2) They were scientifically verifiable
(3) The availability of data at less cost, the time frame of the study, and the resources available at the time of the study
(4) The indicators were simple and easy to understand by all stakeholders, cattle herders, local population, government technical services, researchers, scholars, civil society organizations, local governments, and others.
(5) The gravity of each indicator such that it could pave way for monitoring and evaluation of activities and their effects.
(6) In addition, its ability to trigger further studies on the subject in the area.

The time series variable on its part was used to show the evolution of a given variable over a stipulated time period; thus it was self-explicit on the trend of a situation. Table 1 summarizes a list of indicators investigated and the type of analysis used for each indicator explored in this study. Several indicators exists that could have been investigated as highlighted by Konandreas and Anderson (1982), OECD (1993), Kavana et al. (2005), Atanga

Table 1. List of indicators and type of analysis used**.**

Sustainability pillar	Main issue	Indicator	Method of analysis
Economic	Expansion of cattle trade	Job creation	Time series
		Savings deficit	Ratio
	Cattle productivity	Input self-sufficiency	Ratio
		Calving rate	Time series
		Cost effectiveness	Ratio
Social	Population growth	Human population density	Time series
		Cattle population density	Time series
	Social welfare index	Work hours	Percentage
		Remunerations	Ratio
Environment	Biodiversity threats	Weed invasion of grazing land	Time series
		Greenhouse gas emission	Time series
		Fire regimes	Ratio
Generic	Cattle security	Cattle loss	Time series
	Land tenure system	Satisfaction	Chi-square test

(2013) and others.

CHALLENGES TO SUSTAINABLE CATTLE HERDING IN CAMEROON'S NORTH WEST REGION (NWR)

Challenges to sustainable cattle herding in the Cameroon's NWR were investigated from the triple bottom line viewpoint. Hence, sustainability analysis has been conducted from economic, social, and environmental perspectives.

Economic sustainability challenges of cattle herding in the NWR of Cameroon

Expansion of cattle trade

The inability of the cattle herding trade to expand as any normal profitable business venture is explained with the help of the job creation and savings deficit pointers. The average number of jobs created per year by cattle herders who could create jobs remains approximately the same throughout the years (Table 2). Yet, the study found out that from 2009 to 2014, about 8% of cattle herders did not offer a single job. Meanwhile, this time series tracking revealed that on average, of the 92% cattle herders who were able to offer jobs, each of them provided about two jobs per year for six years with seemingly no possibility of increasing employment in the future with the present herding conditions. However, cattle herders argue that the prevailing situation is caused by a series of factors; firstly, they claim that the trade is labour intensive and tends to scare job seekers. Secondly, it is very costly to hire the required labour force, and also, the young labour force does not want to identify with cattle herding jobs as they are considered inferior and are therefore willing to switch jobs if given the opportunity. Consequently, the economic growth of the cattle industry translated through job creation is not evident as demonstrated by the study and that with these setbacks, cattle production is at risk.

The savings deficit indicator was also used to explain how the cattle herding trade was not expanding by showing how cattle herders were unable to save what they expected from the trade by using data for 2014 (Table 2). A savings deficit of 69% was recorded on average per cattle herder. Besides, a vast majority of 75% of cattle herders in the region declared that they were not satisfied with their savings from the trade and blamed the deficiency to cattle loss, shortage of pasture resulting from the progressive invasion by weeds and that cattle herding generally became expensive. Cattle loss was reported in the form of theft, predators, accidents, natural disasters like thunder strikes and floods, stress and diseases incurred during transhumance, and others. Obviously, a savings deficit of this magnitude is likely to discourage cattle herders from devoting their resources (time, money, and labour) to cattle herding and the resulting impact could be the collapse of the industry with

Table 2. Implications of the expansion of cattle herding.

Progress in job creation by the cattle herding industry	Number of jobs created per year by cattle herders	Average no. of jobs created per cattle herder
2009	188	2.11
2010	197	2.21
2011	193	2.16
2012	207	2.32
2013	216	2.42
2014	202	2.26

	Actual savings for 2014 ($)	Expected savings for 2014 ($)
Total estimates	46,539	120,340
No. of respondents	97	97
Mean	480	1,240

SD = (1-As/Es) × 100
Where SD = Savings Deficit
SR = Savings ratio = As/Ae
SR = 480/1,240 = 0.39
SR < 1
As = Actual savings
Es = Expected savings
SD = (1-480/1240) × 100 = (1-0.39) × 100
SD = 69%

alarming repercussions on the entire cattle herding production enterprise comprising cattle herders who depend on it for livelihood, consumers who depend on it for food, and other stakeholders who depend on it for services. Therefore, the economic sustainability of cattle herding in the region from the standpoint of savings can be judged as threatened and unsustainable given the current gap of cattle herders desire to save and what they actually save.

Cattle productivity

Cattle productivity as an issue demonstrated that cattle herding was not sustainable with the help of input self-sufficiency, calving rate and cost effective indicators. The input self-sufficiency indicator shows how much money was spent on local inputs compared to external inputs by a cattle herder while raising cattle as at the year of study. Table 3 shows a list of external and internal inputs and corresponding estimates.

In this study, it is assumed that a cattle herding industry is more sustainable if it uses more local resources than external resources in its production processes. Hence, the study compared the amount of money spent on local resources per cattle herder with that spent on external resources while raising cattle. A ratio analysis of input self-sufficiency ratio comparing local input and external input gave a figure of less than one. Consequently, more external resources which are also costly were used than local cheap resources; yet, the use of local input may not have been a priority to cattle herders. However, cattle herding is not sustainable economically as demonstrated with the input self-sufficiency indicator.

The study collected information as to the rate at which cattle of reproductive age calf per year and to conclude if the cattle population is increasing to meet demand from the ever increasing human population. This study, examined the average calving rate of cattle in the NWR from 2009 to 2014 as shown Table 3.

As shown in Table 3, calving rate was fairly steady ranging between 13 and 14 females calving per herd annually from 2009 to 2014. The calving rate is static and without increase is unlikely to meet the financial and food demands of producers and the ever growing population in the future. This indicates that further effort needs to be given to improving herd management, nutrition and breeding in the NWR. Thus, the economic sustainability of cattle herding as translated through calving rate is not commendable.

In Cameroon, the period from December to April coincides with poor forage quality in the pastures and a decrease in the average monthly calving rate of 2.31% against 5.21% in the rainy season (Deffo et al., 2011). Hence, improved livestock nutrition is necessary, particularly during critical periods of forage shortage to

Table 3. Implications of the expansion of cattle productivity.

Cost estimates of local and external inputs	Input	Total Estimated cost for all cattle herders interviewed in USD	Average estimated cost per cattle herder in USD
Local	Labour, local bricks, fencing material, ethno-medicines	37,684	388.5
External	Conventional medicines, barb wire, zinc, nails, cement	68,614	707.4
Total	Local and external	106,298	1,095.90

Calving rate

Year	Mean of female cattle of reproductive age (Months)	Mean value of females that calved per year
2009	28	14
2010	29	14
2011	29	13
2012	29	13
2013	29	13
2014	29	13

Value of expenditure to raise a cow

Subject	Actual amount spent (US $)	Expected amount (US $)
Total amount expressed by all the respondents	10,664	6,060
No. of respondents	97	97
Mean	110	63

Mean value of actual expenditure per cow (Ae) = 110 US $
Mean value of expected expenditure per cow (Ee) = 63 US $
Cost effectiveness (C_{eff}) = Ae / Ee
C_{eff} = 110 / 63 = 1.75
Ceff > 1

Input self-sufficiency was calculated as ratio of local expenditure compared to ratio of expenditure on external input as follows:
Local input/External input = Input self - Sufficiency ratio
388.5 / 707.4 = 0.55<1.

further improve animal performance.

This study compared the amount of money spent in raising a cow by a cattle herder with the amount they would prefer based on the cost effective indicator. The cost effectiveness of raising a cow becomes less effective as the ratio exceeds one and the higher the ratio, the more unsustainable it becomes. The actual value spent per cattle herder was obtained by summing and finding the mean of the actual amount spent by respondents to raise a cow until mature for the market. Meanwhile, the expected value of cost expected to be incurred to raise a cow was also obtained by finding the mean of the sum total of what all the respondents estimated would have been the appropriate amount to raise a cow. Thereafter, the mean actual value was then compared to the mean value of expected expenditure expressed by all the cattle herders.

The ratio of actual to expected expenditure is 1.75: 1 meaning that the cattle herders spend about 75% more money than expected to raise cattle for a desired purpose. Judging from this, it is clear that 75% of their expected profit was invested in raising a cow. Such a scenario will only impoverish a cattle herder and make the enterprise economically unreliable. So far, cattle herders blame the expense on the lack of equipped and functional health services in the area, absence of demarcated transhumance tracks which most often result in conflicts and extra expenditures that they pay to crop farmers due to damages caused by cattle, and the progressive decrease of pastoral resources (forage and water) especially during the dry season.

Economic challenges to sustainable cattle herding have been reported for other areas in the world by different authors. While cattle production has increased in the developed world to meet demands, it is growing at a slow rate that cannot meet the demands of the growing

Table 4. Social implications of human population density and cattle growth in the NWR Cameroon from 2009-2014.

Year	2009	2010	2011	2012	2013	2014
Human population density in the NWR from 2009-2014						
No. of people	1728953	1746743	1764716	1782874	1801219	1819753
Surface area (km^2)	17400	17400	17400	17400	17400	17400
Population density (no. of people/km^2)	99.37	100.40	101.42	102.46	103.52	104.58
Cattle population in the NWR of Cameroon from 2009-2014						
No. of cattle	311295	320678	359260	378980	391518	403115
Surface area (km^2)	17400	17400	17400	17400	17400	17400
Population density (no. of cattle/km^2)	17.89	18.43	20.65	21.78	22.50	23.17

population in sub-Saharan Africa (Biasca, 2012). This observation also ties with what the study noted for the NWR of Cameroon. In addition, it has been recorded that these challenges also cut across areas that practice extensive cattle rearing, characterized by little or no improved cattle herding input (Apostopoulos and Mergos, 1997; McDermott et al., 1999; Tavirimirwa et al., 2012). For instance, in Southern Europe, economic challenges to sustainable cattle herding were seen to reside in management deficiency, underdeveloped infrastructures, and grazing related factors (Apostolopoulos and Mergos, 1997). In Zimbabwe where two cattle herding systems exist; intensive (11%) and extensive (89%), challenges to economic sustainability of cattle herding were found to be related to prevalence of pests and diseases, low level of management in issues like use of improved technology such as vaccinations, poor nutrition, poor calf house facilities, use of uninformed ethno-veterinary medicines and others (Tamirvirma et al., 2014). Yet, cattle herders in the NWR of Cameroon, especially the Mbororo Fulani majority (an ethnic group who are traditionally a nomadic, pastoralist, trading people, herding cattle, goats and sheep across the vast dry hinterlands in Cameroon) who see moving after cattle as a culture and less of an economic venture were reluctant to adopt improved grazing systems (Hoot, 2006).

In summary, the economic sustainability of cattle productivity in the NWR of Cameroon is at risk as demonstrated through its inability to create more jobs with time, assist cattle herders to save the desired amounts of money, produce more cattle to sustain the growing population, raise cattle at reduced cost, and its inability to harness and make use of more internal resources.

Social sustainability challenges of cattle herding in the NWR of Cameroon

This study selected two indicators to unfold how social aspects constrain the sustainability of cattle herding in the region. The indicators included increasing human population density and increasing cattle population density with no improvement in the grazing system.

Increasing human population density

Table 4 shows the population and surface area of the region from 2009 to 2014. It appears that the population density will continue to rise and the need for more land to satisfy the needs of each new born also increases. The advent of the ever increasing population in Cameroon is progressively interpreted through the conversion of grazing land into construction of schools, roads, residents, administrative facilities, farm land and others (Pingpoh et al., 2007). The resulting impact of this scenario in the NWR region has been highlighted in the form of conflicts over grazing resources between crop farmers and grazers, grazers and grazers, administration and individuals over land (Pingpoh et al., 2007; Manu et al., 2014; Nchinda et al., 2014). The non-existence of population control obligations in the country as a whole and the region in particular amplifies population growth. Yet the demand for cattle for consumption keeps increasing. This phenomenon led to the conclusion that the growing population density is a likely social threat to the sustainability of cattle herding in the region.

Increasing cattle population

Cattle population figures from the Regional Delegation of Animal Husbandry and Fisheries were used to calculate the cattle population density shown in Table 4.

The Cameroon government in general and the NWR in particular have not demarcated grazing land from crop land. Hence, it was difficult to estimate the surface area reserved for grazing. However, for the purpose of demonstrating the trend of the impact of the increasing cattle population density on cattle herding itself and the environment without a corresponding improvement in cattle herding techniques, the surface area used to calculate human population density was equally used for

cattle. This calculation shows the gradual increase in cattle population in NWR during 2009 to 2014. Yet, the grazing system remains extensive with little or no improved input to support the increasing cattle population on the same surface area. Beside, assuming a constant grazing surface area might undermine the true negative impact of cattle population density for two reasons; firstly, the surface area actually used by cattle for grazing is far below the assumed surface area if it were actually given, and also, the surface area for grazing keeps reducing as more land is converted for other development purposes. The resulting consequences are as mentioned with human population density increase; conflicts between grazers and grazers, crop farmers and grazers, administration and grazers and others (Pingpoh et al., 2007; Atanga, 2014; Manu et al., 2014; Nchinda et al., 2014). Basically, an increase in both human population density and cattle population density without improved grazing systems is a serious social threat to sustainable cattle herding in the NWR of Cameroon.

Social welfare index

To judge social sustainability through the social welfare index, two indicators were considered; the amount of time put on cattle herding per day and per week and remuneration to an employed cattle herd guard.

The amount of time spent per day by a cattle herder was reported during group discussions with some pastoralists working 10 h minimum for 7 days per week. These hours were then compared with the standard number of working hours recommended by the Cameroon government, which are 8 h per day and 5 workdays per week (ILO, 2012). Finally, the work hour deviation was then expressed in terms of percentage.

The percentage of work hour deviation was calculated as follows:

Work hour deviation (DH) = Actual work hours per day (AWHD) - Standard work hours day (SWHD).

Otherwise expressed as DH = AWHD - SWHD

Work hour deviation expressed in percentage becomes:

DH (%) = (AWHD - SWHD) × 100 / 40

AWHD = 10; SWHD = 8

DH (%) = (10-8) / 8 × 100 = 25%

Hence, cattle herd guards put in extra 25% or 2 h of extra time per day at work.

Similarly, the weekly work hour deviation is also calculated as follows while bearing in mind standard work hours per week at 40 as stipulated by the government and the actual number of hours per week explained by cattle herders is 70.

Considering that:

Weekly Work Hour Deviation = WWHD
Actual Weekly Work Hours = AWWH
Standard Weekly Work Hours = SWWH
Then, WWHD = AWWH - SWWH
WWHD = 70 - 40 = 30, when expressed in percentage becomes (70 - 40) × 100 / 40 = 75%.

Based on these calculations, cattle herders spent more time on cattle herding than recommended. In addition, the situation becomes more tedious when compared with the number of hours per week. The average number of hours recommended for a full-time worker per week by the Cameroon government is 40 h. Yet, cattle herding requires an average of 70 h per week. Compared to the weekly work hour ratio (WWHR), this indicates that WWHR = 1.75, implying that WWHR > 1 (by 0.75) which is even more deplorable than WHR of 0.25. In addition, the study further verified the impact on the cattle herders and workers and found that the herders spend most of their time working and have little time to interact and participate in other societal needs like recreation, and development. Besides, herding is labour intensive compelling youths to move to towns for better paid and less labour intensive jobs. This finding concurs with Apostolopoulos and Mergos' (1997) that factors such as long working hours and harsh working conditions in cattle herding in Southern Europe tend to discourage youths, thereby reducing the certainty and supply of labour in the future. Thus, long working hours on cattle herding can be summarized as a potential threat to the continuity of the trade if these conditions are not addressed, there might be insufficient interest by the younger workforce to support cattle herding in the NWR.

The remuneration ratio of cattle herd guards has been considered as another indicator for the social welfare index. During the organized group discussions with cattle herders the maximum amount paid to a cattle herd guard in the region was said to be USD48 per month. Compared with the minimum recommended wage of USD57 per month by the Cameroon government (ILO, 1992) the remuneration paid to cattle herd guards is less. Besides, a cattle herd guard who earns as much as 48 USD per month is one who is known to have a good experience, committed, and is controlling a large cattle herd of at least 100. The maximum wage paid for guarding cattle was used in this rather than the mean wage and is not representative of the majority guarding cattle in the NWR for a paid salary.

The remuneration ratio (Rr) is calculated by dividing Maximum Remuneration (AR) by the Standard Minimum Remuneration (SR).

AR = 48, SR = 57, Rr = AR/SR = 48/57, Rr = 0.84.

Table 5. Environmental implications of cattle herding.

Weed invasion of grazing land per farmer	Year		
	2004	2009	2014
Average area invaded by weed (ha per farmer)	3	6	8
Evolution of greenhouse gas emission (methane)	-	-	-

Year	No. of cattle	kilo tonne of CH_4 per year*
2009	311295	13.7
2010	320678	14.1
2011	359260	15.8
2012	378980	16.7
2013	391518	17.2
2014	403115	17.7

*Total enteric CH_4 emissions = No. of cattle × Enteric emission factor. Enteric emission factor = 34 kg CH4/head/year.

where Rr<1, the remuneration is not sustainable.

Based on calculations, Rr<1 shows that remuneration to cattle herd guards is below standard; indicating that remuneration is less than expected. The situation is far more deplorable than this because the values compared here are those of the highest paid guard and the least acceptable payments by the Cameroon government. This alternate way of comparing the highest and lowest values was basically to show how poor remuneration is, even at optimum pay levels. Yet, some of these guards have families who depend on the meager remuneration for survival. With this kind of remuneration, we question if such individuals can save for retirement, children's education, health needs, and others? This is obviously no assurance to retain labour or a profession to recommend and so is not a sustainable venture for the society.

Environmental sustainability challenges to cattle herding in the NWR of Cameroon

To investigate the environmental impact of cattle herding activities, three indicators were used; weed invasion, fire regimes or frequency of bush burning and evolution of greenhouse gas emission from cattle wastes.

Weed invasion of grazing land and loss of biodiversity

Overgrazing contributes to weed invasion of pasture land and loss of biodiversity (Forcella and Harvey, 1983; Bowns and Bagley, 1986; Callihan and Evans, 1991). This study investigated if pasture land was being invaded by weeds from 2004 through 2009 to 2014. Table 5 shows the trend of weed invasion of grazing land of a cattle herder in the NWR. The surface area invaded by weeds for each herder was obtained by calculating the mean of all the surface area claimed to have been consumed by weeds by all the cattle herders after each 5 years' time lapse starting from 2004.

Basically, each cattle herder is progressively running short of pasture land with time (Table 5). This means that palatable grass species were disappearing at the expense of un-wanted plants. The implications as highlighted by herders included continuous decrease in pasture, conflicts between herders and herders, and herders against crop farmers over grazing land to satisfy pasture demands. Also, they noted a decrease in productivity due to shortage of pasture with cattle gaining less weight as was the case 10 years ago within a stipulated time period. In addition, cattle have to move to more distant areas and complex landscapes in quest for pasture and thus recording many losses through accidents, disease attacks resulting from stress and others. Hence, the deplorable scenario caused 45% of cattle herders to pay people to manually dig some portions of invaded weed, but this eventually increased the cost of managing pasture and is practically difficult for herders with very large invaded grazing areas. Meanwhile, 14% claim that they are trying to make up the loss by introducing improved pasture. Yet, 36% of the cattle herders are not sure of any action to take. Prominent weeds in the NWR include bracken fern and Bokassa (*Chromolaena odorata* (L.)) (Atanga, 2013). Weed invasion has been noted as a common problem in areas that practice extensive grazing. For instance, in the Burdekin range region of Australia, over-grazing, resulted in weed invasion, reduced cattle productivity, and increased soil erosion (Bartley et al., 2007). In Bhutan, particularly in the case of the Haa and Merak areas, over-grazing resulted in weed invasion, limited forage availability, vulnerability of cattle to diseases and others (Morktan et al., 2008). Basically, overgrazing contributes

to weed invasion of grazing land as well as extinction of biodiversity.

Fire regimes/frequency of bush burning is also one of the many cattle herding practices that affects the ecosystem. This study explored the gravity of the practice by comparing the actual frequency of bush burning with the prescribed frequency by the Cameroon Ministry of Environment and Nature Protection to show the damage caused to the environment. Findings show that a cattle herder in the region sets their grazing land on fire once a year. Yet, the Ministry of Environment and Nature Protection prohibits bush burning of any form in the country for various reasons; to reduce the emission of greenhouse gases to the atmosphere; to prevent material damages incurred on houses, crops and others; to prevent soil destruction emanating from bush burning; and also to prevent the extinction of biodiversity and others (World Bank, 2012). Hence, any bush burning practice in the NWR of Cameroon is against the law and is punishable as determined by each divisional administration (SIBADEF, 2012). Amazingly, this study found out that though this ban exists, the practice persists and the administration has hardly taken any action against it. In addition, 75% of cattle herders willfully practice bush burning while 25% claim that their grazing land is mostly set on fire by hunters, crop farmers and other accidents but not by themselves. Notwithstanding, 43% of cattle herders acknowledge that bush burning is detrimental to the environment, 54% are not sure of any effect caused by bush burning. However, cattle herders claim that they practice burning as a means of clearing old dry grass to create room for the growth of fresh grass for their cattle and that, it is a means to destroy and or reduce the prevalence of the tick parasite that feeds on the blood of cattle. In a similar study carried out in the arid and semi-arid regions of West Africa, Uwizeye (2013) reported that cattle herders practice bush burning to encourage the growth of fresh grass and destroy pests of cattle. Contrary to the practice of prescribed bush burning in Burdekin (McIvor, 2012), this study found out that bush burning in the region is completely prohibited, yet almost all grazing land is set on fire once a year. Generally, bush burning affects the environment and forage in particular. For instance, in Zimbabwe, bush burning reduced forage protein content by 5% (Tavirimirwa et al., 2012). In addition, Tavirimirwa et al. (2012) also said that burning destroys soil composition, kills important soil microbes, emits greenhouse gases into the atmosphere, and others; hence, it is not a sustainable cattle herding practice to the ecosystem.

Evolution of greenhouse gas emission from cattle herding in the NWR

Greenhouse gas emission was investigated as an indicator of environmental challenge by tracking the contribution of greenhouse gas from cattle waste from 2009 to 2014, with a particular focus on enteric methane (CH_4) (Table 5). This study limits its greenhouse gas investigation to enteric methane gas to show the trend of the increasing threat of cattle herding to the environment via greenhouse gas emissions. Nonetheless, other greenhouse gases are equally emitted by cattle and include CO_2 and N_2O (FAO, 2006; Uwizeye, 2013).

Table 5 shows that methane gas emission into the atmosphere increased at a rate of 5% during 2009 to 2014 as the number of cattle increases. Estimates for CH_4 gas emission were made using the revised 1996 IPCC guidelines for the National Greenhouse Gas inventories. Emission factors reflecting the conditions of the NWR for enteric methane was obtained from the guidelines and multiplied by the cattle population for each year to calculate the annual emissions. The emissions from manure management were ignored as the manure has multiple usages requiring information of a detailed breakdown of its prior use to obtain a reasonable estimate of CH_4. Although, data collected from the field did not differentiate dairy cattle from non-dairy cattle, the average of the two emissions factors provided in the guideline was then used combining both dairy and non-dairy cattle. IPCC (2015) stated that CH_4 gas impacts 28 times more than CO_2 on the effect of greenhouse gases emitted. Therefore, the increasing emission of CH_4 gas into the atmosphere is a potential threat to the stability of the environment. Changing of dietary habit of cattle may reduce the CH_4 emissions, but this may further increase the cattle herding cost.

GENERIC CHALLENGES TO CATTLE HERDING IN THE NWR OF CAMEROON

In the course of examining indicators under the three pillars of sustainability: Economic, social and environment, some other indicators were noted to fit in more than one of the three pillars at the same time. Hence, were classed under generic parameters.

Cattle security

To show that the security of cattle in the region is at stake, the loss of cattle was tracked to show how cattle herders lost cattle over time from 2009 until 2014. Table 6 shows the average number of cattle a herder lost per year from 2009 to 2014. Results from this study show that 94% of the respondents have lost cattle through at least one of the following ways: theft, predators, accidents in the course of moving into difficult terrain in search of pasture, thunder storms, floods and others. From 2009 to 2014, each cattle herder had lost about 17 cattle.

This loss is enormous and unsustainable to the cattle

Table 6. Implication of cattle security.

Cattle loss overtime	Year					
	2009	2010	2011	2012	2013	2014
Average no. of cattle lost per cattle herder	2.5	2.5	3.0	3.1	3.5	2.7
Cumulative no. of cattle loss per cattle herder	2.5	5.0	8.0	11.1	14.6	17.3

Cattle herders' approval of the existing land tenure system			
Approval	**No. of respondents**	**Approval (%)**	**Chi-square test**
Yes	13	13.4	
No	84	86.6	P=0.0001; hence P<0.05
Total	97	100	

herding profession in the region. The impact of cattle loss has ejected some cattle herders out of their profession, whereas in other cases, it reduced the livelihood capacity of households that strongly depend on cattle herding (Manu et al., 2014). Amazingly, 40% of cattle herders do not know of any measure to combat cattle theft whereas, 52% of them try to check the situation by intensifying monitoring mechanisms. Yet, 5% embark on recruiting committed herd guards. Still, at the time of the study, cattle loss was more than was recorded in 2010 and continues. Cattle security threats have been noted in other grazing communities and have been highlighted as an aspect that hinders the sustainability of cattle herding. For instance, 631 livestock were killed in Massai homestead within one year by predators (Karani, 1994), similarly, a total of 1205 of livestock were killed in the same area in Kenya within 8 months by predators (Mwangi, 1997). However, the major causes of cattle loss may differ in different areas. In the NWR of Cameroon, cattle loss is mostly through theft (Manu et al., 2014; Nchinda et al., 2014). Yet, in the Kajiado and Laikipia districts of Kenya, it is mostly linked to predators (Mwebi, 2007). Notwithstanding, cattle loss is a serious hindrance to the sustainability of cattle herding.

Satisfaction of cattle herders with the land tenure system in NWR

It is believed that as more people are unhappy with the system, the more difficult it is to access and manage grazing land sustainably. Table 6 shows the proportion of cattle herders who are either happy or unsatisfied with the land tenure system in place.

To conclude on the validity of opinions, a Chi-square test was conducted to see if there was a significant difference between people who agree or do not agree with the current land tenure system. From the study, P~0.0001, but P<0.05 implies that there is a significant difference. Otherwise, the land tenure system is a hindrance to sustainable cattle herding in the NWR of Cameroon. However, cattle herders who are not satisfied blame it on varied reasons; the process of obtaining land is too long, the cost incurred in obtaining grazing land is too expensive as it involves a lot of corruption, it creates a lot of confusion amongst herders especially as there are no clear demarcations of grazing land, and also, the process denies herders the right to own permanent grazing land. Consequently, herders are unable to develop grazing land that does not belong to them and are forced to pay unjustified sums to have even temporary grazing land. Besides, it discourages the cattle herding trade. In addition, field results show that about 70% grazers obtained their grazing land directly from the public administration, 8% from village Fons or leaders, 3% from individuals, and 18% from other undisclosed sources. These challenges confirm Pamo's (2008) findings that, grazing land in Cameroon is state owned has often discouraged herders from investing to protect such land. According to USAID (2011), pastoralists, small holder occupants and other informal settlers in urban and peri urban areas in Cameroon lack secure land rights that causes enormous constraints on their ability to invest, produce and prosper. Hence, the grazing land tenure system in Cameroon is a challenge to sustainable cattle herding.

STRATEGIES TO OVERCOME CHALLENGES

Strategies to overcome economic challenges are based on the field results as discussed in this paper. In order to ensure the economic sustainability of cattle herding in the region through the expansion of the cattle trade and improvement in cattle productivity, the following strategies can be considered by stakeholders operating in the region:

(1) Identify and construct the necessary infrastructures to boost the cattle herding industry. Such infrastructure may

include veterinary centers, drinking water points, markets and others. In situations where some of these facilities already exist such as veterinary health centers, they should be equipped, staffed and put in use.
(2) Upgrade training of cattle herders on management techniques to improve their effective use of resources as well as a sense of direction in making better gain from their ventures.
(3) Introduce improved cattle herding systems such as adoption of low cost feed supplement to reduce the cost of production and to secure family income, as well as introduce intensive grazing systems that will require less grazing land. Such systems may include the introduction of improved pasture, silvo-pastoral practices, zero grazing and others. Otherwise, in areas where improved pasture is already being practiced, such herders should be used as role models to share their experiences and benefits with those who are resisting improved grazing systems.
(4) Provide cattle herders with improved nutrition and economic breeds adapted to the environment and that are capable of increasing cattle production at a faster rate while using less land.

Strategies to overcome social challenges

For the two major social challenges investigated in this study, human population growth and cattle population growth, the following strategies are envisaged:

(1) Adopt improved grazing systems to contain the increasing cattle population by using a participatory approach with relevant stakeholders including cattle herders to identify improved and affordable cattle herding systems that are accepted by cattle herders.
(2) Although Cameroon is a developing countries that does not have concern about the increasing human population at the moment, its impact as per this study is already obvious. Hence, human birth rate control should be encouraged by family planning programs.
(3) Consideration should be given to fencing or hedging at least some portions of grazing land to contain cattle to reduce labour by herders.
(4) Mechanize some aspects of cattle herding such as milking by using simple affordable devices to reduce the intensive labour demand and long working hours.

Strategies to overcome environmental challenges

In order to check cattle herding impact on the environment, the following strategies are earmarked:

(1) Introduction of improved grazing by planting high quality and vigorous growing forage especially in areas that have been eroded.
(2) Determine soil constraints that may be affecting plant productivity and introduce appropriate amendments.
(3) Conduct a study to determine the most suitable stocking rate for cattle for a given area with consideration given to the available forage and its nutritive content. The absence of a prescribed stocking rate is likely to contribute to overstocking that accounts for the deterioration of land in terms of grass species, soil structure, water quality and others.
(4) Relevant stake holders including non-governmental organizations, the local governments, government technical services and others should assist farmers by subsidizing the purchase of mechanical slashers that can help reduce quality of the grass to avoid clearing with bush fires. In addition, training in the use of selective herbicides to control invasive weed species and manipulate pasture forage to encourage desirable grazing plant species. Actualize the ban on bush burning which seemingly existed only on paper by taking appropriate disciplinary actions against perpetuators, although it may be difficult to regulate.
(5) Promote the construction and use of biogas plants in individual homes of cattle herders in order to abate the quantity of greenhouse gas emissions from cattle waste. Changing animal feed to reduce enteric CH_4 emission in an economically feasible way.

Strategies to overcome generic challenges to cattle herding

These strategies by virtue of their generic nature are likely to impact across the entire sustainability pillar. They consist of:

(1) Scale out the farmer herder committee experience that already exists in some divisions of the NWR to other parts for amicable settlement of farmer herder conflicts. These committees were initiated by the Mbororo Social and Cultural Association (MBOSCUDA) NWR and consist of farmers and herders who always try to resolve uprising conflicts between the two parties without necessarily involving the administration since experience proves that conflicts have reduced greatly in such areas (Manu et al., 2014)
(2) The government should demarcate grazing land from other lands to reduce conflicts between farmers-herders over land and also to be able to determine the quantity of forage and cattle carrying capacity of the grazing lands.
(3) The government should impose on cattle herders to develop land on which they graze cattle and a sanction should follow suit that failure to develop such land may lead to withdrawal of their grazing permit. Land development could be any measure to protect grazing land and pasture growth. For instance, planting forage, protecting water catchments and developing water points are some of such land development endeavors.

(4) The government should improve on the land tenure system by allowing only the land commission to allocate land to herders. Circumstances where higher authorities surpass the land commission to give land have always reduced the rights of the commission and brought about conflicts because people tend to undermine the decisions of the land committee. In Cameroon, land allocation for grazing is done by a land commission that consist of representatives of the Delegation of Agriculture, Animal Husbandry and Livestock, the Fon of a given village, the Ardos and the Divisional Officer (Nchinda et al., 2014).

CONCLUSIONS AND SUGGESTIONS

In conclusion, this study determined that cattle herding in the North West Region of Cameroon does not appear to be sustainable in its present form based on economic, social, and environmental pillars of sustainability. Economically, the cattle herding enterprise was unable to improve on job creation and the savings situation of its cattle herders. Also, the trade depends more on external inputs for production even though there are possibilities of exploiting internal inputs, the calving rate is below expectation, and the cost of raising a cow is more than expected. Socially, cattle herding in the region is challenging as the human population is constantly growing and competing with the animal population that is equally growing over grazing resources. Yet, the grazing system remains unimproved and is unable to support the growing demand for cattle. Cattle herding is labour demanding and does not attract young people thus, the possibility of having a reliable labour force in the future is questionable. Besides, the remunerations to cattle workers are very low to support their needs. Environmentally, cattle herding poses several challenges and having marked effects on the biodiversity of the savannah system. For instance over grazing is progressively accounting for the replacement of pasture by weeds to the detriment of feed for cattle. Meanwhile, the amount of greenhouse gases emitted by cattle wastes keeps growing with a corresponding increase in cattle population. Yet, practices like burning are affecting the environment as they destroy the soil composition and texture, reduce biodiversity and are equally contributing to the pollution of the environment with the emission of greenhouse gases and others. Cattle herding in the region is also threatened by the current insecurity where cattle are constantly being lost to thieves, accidents, natural disasters, and others. Viewing these challenges as demonstrated through the three dimensions of sustainability, cattle herding in the North West Region of Cameroon is unsustainable in its present form.

It is expected that stakeholders like civil societies, local governments (councils), and government technical services and NGOs will be able to use the information to provide relevant assistance to cattle herders that can reverse the current deteriorating trend of cattle herding in the region. This will enable cattle herders to use the information generated to practice more sustainable cattle herding practices. Based on findings from the study, further research is required in many of the these key areas such as cattle husbandry, improved forage plants and plant agronomy. Finally, reducing cattle theft may help to better address the current challenges.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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