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Pastoralism, sustainability, and marketing. A review

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Hans C. M. van Trijp

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Abstract Pastoralism is a highly traditional production system for livestock and livestock products. Under the surface of a seeming stability a variety of pressures of the modern time all seem to accumulate to put the sustainability of the pastoralist production system to the test. Population growth and growing demand for meat, put pressure on the natural resources used by pastoralists because the grazing lands that are saved from encroachment or conversion into arable lands, may be overexploited. Changing climatic conditions, such as frequent droughts, put even more pressure on the system. With so many challenges coming together, it is important to analyze whether pastoralism in itself can be considered a sustainable production system that in principle can cope with these challenges and thus deserves support from policy, or whether the pastoralist production system has fundamental misfit with today's challenges, in the sense that it is detrimental to the world's scarce resources. The scientific literature on pastoralism provides an important entry point to such fact finding. This article therefore analyzes 125 recent research contributions to the literature on pastoralism on their inferences as to whether pastoralism is a sustainable production system for livestock-based products. The results show substantial consensus that pastoralism is seen as a sustainable production system for livestock and livestock products (78 of the 125 studies contain sustainability inferences, of which 58 infer that the pastoral system is sustainable, while only 2 come to a negative conclusion). A total of 18

studies point however at conditional factors. The main factors that can potentially explain differences in the conclusions on whether pastoralism is sustainable pertain among others to the domain of sustainability, including abiotic and biotic factors representing the planet dimension, mobility, adaptation, indigenous knowledge, institutions and population growth as people-related factors, and economic contribution as a profit-related factor. Other factors include the ecosystem and land use types, policy instruments, constant/flexible stocking, controlled/mobile grazing, and diversification policies, as well as academic discipline, research methods and geographic focus. A quantitative test shows that consideration of adaptation, institutions and mobility are most strongly related to the sustainability inference. Such studies suggest that pastoralists that can adapt to external conditions, that are supported by effective institutions and that can exercise mobility, are more likely to behave sustainably. We argue that marketing can help to meet these conditions. Because the role of marketing has received scant attention in the context of pastoralists and because it has often been narrowly interpreted as market integration, we further explain the potential role of marketing in sustainable pastoralism. The role of marketing comes down to a strategic competence that enables pastoralists to create value for target buyers with whom they may develop economic and social relationships that can be favorable for both parties. Because it is likely to stabilize prices and generate a long-term perspective on value creation, and therefore on resource use, marketing can contribute to a pastoral system that supports people, planet, and profit.

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1 Introduction

Pastoralism is a highly traditional production system that dates back to ancient times in which the lifestyle of Biblical patriarch Abraham has much resemblance with the lifestyle of pastoralists. Also today, a large community of pastoralists still lives with herds of livestock which they move to take advantage of water and natural pasture for grazing (Koocheki and Gliessman 2005). Yet, under that surface of seeming stability, a variety of pressures of the modern time, like human population growth, rapid urbanization, the growing demand for livestock products, land use changes, and climate change (Thornton et al. 2009), all seem to accumulate to put the sustainability of the pastoralist production system to a serious test. For example, globally about 70 % of the range lands in dry lands can be considered degraded, according to FAO (2006a) estimates. Pressure on the natural resources that are used by pastoralists will further increase because, as a result of population growth and changing lifestyle patterns, the demand for meat is projected to double from 229 million tons in 1999/2001 to 465 million tons in 2050 (FAO 2006b). Market imperfections, such as constrained market access provide pastoralists with limited means to flexibly cope with ecological challenges (FAO 2012; Rosegrant and Thornton 2008). Next to increased demand for meat, population growth also leads to a higher population to land ratio that intensifies encroachment and the conversion of grazing lands into arable lands further threatening the livestock production of pastoralists (Steinfeld et al. 2010; Narrod et al. 2010). It also sometimes leads to overexploitation of the remaining grazing lands (Easdale and Aguiar 2012; FAO 2012). On top of these developments, changing climatic conditions, such as droughts, bring shortages in pasture and water to the livestock production of pastoralists (Thornton et al. 2009; Ericksen et al. 2012). The pressures on land and frequent droughts bring formidable

challenge to the pastoralist cycle of herd building, destocking in times of drought, and a rebuilding of herds afterwards as a way to effectively sustain livestock production over time (Toulmin 1994).

With so many challenges coming together, it is important to analyze whether pastoralism in itself can be considered a sustainable production system that in principle can cope with these challenges and thus deserves support from policy, or whether the pastoralist production system has fundamental misfit with today's challenges, in the sense that it is detrimental to the world's scarce resources. The scientific literature on pastoralism provides an important entry point to such fact finding.

The debate on the sustainability of the livestock production by pastoralists has a history of several decades with important contributions from policy makers, academics, and development practitioners, especially in the aftermath of events such as the Sahelian droughts of the 1970s (Franke and Chasin 1980; Lesorogol 2005; Warren 1995). The discussion has heightened the attention of the donors such as the World Bank to fund projects that aimed to intervene on the pastoralist land use (Franke and Chasin 1980). Recently, the debate renewed in response to the continuing drought in the marginal lands of east Africa (Devereux and Scoones 2008; Scoones 2008; Sandford 2006). With the 2011 massive drought in the Horn of Africa affecting the lives of more than 12 million people (FAO 2011), the debate will probably continue in the years to come.

Opinions about the sustainability of pastoralism diverge, mainly reflecting the different ideas about the extent of overgrazing that will lead to degraded natural resources (Lamprey 1983). One position follows the Tragedy of Commons view introduced by Hardin (1968), arguing that pastoralists pursue their short-term survival at the expense of the long-term preservation of commonly shared natural resources. Building on the Tragedy of Commons thinking, extensive donor funded development projects has been invested on pastoralism to "modernize" it through private ownership of communal rangelands to avert the assumed environmental degradation (Fratkin 1997). Few of these projects however brought a positive impact on the way communal resources are used because most of them have failed to solicit the cooperation of the pastoralists (Behnke and Scoones 1993). Others have therefore called for a larger diversity of institutions to manage the commons and to explicitly incorporate the institutions of locals that have developed over many centuries (Ostrom 2000; Mwangi and Ostrom 2009). Following this view, pastoralism can be considered as an effective way of utilizing the sparse vegetation of dry lands which promises an optimal economic strategy in many areas of the world (Casimir and Rao 1998; Davies 2008). Pastoralist land use practices are then seen as an effective response to the highly variable natural environment

in which practices can slightly change in response to changing circumstances, but the system itself remains in place (Behnke and Scoones 1993).

Although Vetter (2005) observed a growing consensus that land use by pastoralists is in principle sustainable, the direction of the literature since then is unclear. With the increased pressure on pastoralism, research efforts have also increased, both in terms of amount and diversity. Research contributions now come from a larger variety of disciplines, not only including ecology and anthropology, but increasing also from others, like geography and economics (Hatfield and Davies 2006). A fresh review of the literature on the sustainability of pastoralism is therefore both timely and important.

This article has three objectives. The first objective is to review recent research contributions on their inferences as to whether pastoralism is a sustainable production system for livestock-based products. We find substantial consensus that pastoralism is seen as a sustainable production system, although some studies point at conditional factors. The second objective is to use the research database to test quantitatively the contribution of sustainability-related variables that underpin the (un-)conditional conclusion on the sustainability of pastoralism. We find that consideration of adaptation, institutions and mobility are most strongly related to the sustainability inference. We posit that marketing can contribute to the adaptation of pastoralists, but our results confirm early work by Bailey et al. (1999) that the role of marketing as a way to improve the adaptability of pastoralists is still largely unaddressed in the discussion on the sustainability of pastoralism. Hence, the third objective of this article is to discuss how marketing can contribute to the sustainability of pastoralists by helping them to adapt.

In the remainder of this article, we first present a brief background on pastoralism and its purported sustainability. Next we explain the methodology of our study, which organizes the recent contributions to the literature according to their inferences about sustainability and examines the explanatory power of study characteristics such as the studied ecosystem and land use types, the geographic focus, research method of the studies, and the disciplines in which they were published. We then elaborate on the concept of adaptation and the role that marketing could play therein. After giving directions on how future research may address the role of marketing, we formulate conclusions and implications.

2 Pastoralism

Historians argue that pastoralism emerged as agriculture developed (Spooner 1971). When crop production on lands suitable for agriculture intensified, stimulated by emerging urban areas and the development of irrigation systems, lands that were too marginal for agriculture were left to the cattle

(Spooner 1971). In this sense, pastoralism is an adaptation to natural conditions by which people exploit lands such as plains, deserts, steppes, tundra, and mountains (Barfield 1997; Galaty and Johnson 1990). As an illustration, Fig. 1 shows pastoralists that let their camels drink at a well during a dry period. Nowadays, pastoralism is practiced on 25 % of the world's land area (FAO 2001), and is common in Africa, Asia, the Americas, and Australia (Galaty and Johnson 1990), and a form of it based on the seasonal movement of herds still occurs in Europe (Chang and Tourtellotte 1993). Pastoralism supports about 200 million households and herds of nearly a billion head of livestock including camels, cattle, goats and sheep that account for about 10 % of the world's meat production (FAO 2001).

Cohen (1974, p. 261) describes pastoralism as “a system of production devoted to gaining a livelihood from the care of large herds of animals ... based on transhumance ... an adaptation to a particular habitat: semi-arid open country or grasslands, in which hoe or digging-stick cultivation apparently cannot be sustained.” Drawing on this description, we define pastoralism as a production system that involves livestock raising and uses mobility to adapt to a dry land ecology that is not suitable for sedentary crop cultivation. Other definitions sometimes restrict pastoralism to subsistence systems (Spooner 1971), but we acknowledge that pastoralists earn incomes by selling their livestock or livestock products such as milk. In addition, pastoralists may engage in crop cultivation, if the land and availability of water allow them to do so; and this makes them so called agro-pastoralists.

Unlike settled farmers, pastoralists (1) usually have access to communal grazing resources, (2) raise their livestock for direct consumption, and exchange through the market to generate cash that can provide security during droughts (Widstrand 1975), (3) locate their livestock in remote areas without advanced infrastructure or logistics systems, (4) use marginal lands where large-scale sedentary production is



Fig. 1 Pastoralists letting their camels drink at a well during a dry period

difficult and unsustainable (Bostedt 2005), and (5) use mobility to access pasture and water for their livestock (Niamir-Fuller 1999).

Because pastoralism must adapt to various physical and social conditions, it is highly diverse in terms of the type of livestock reared and strategies followed to exploit alternative livelihoods (Galaty and Johnson 1990). Dynamic social, economic, and ecological factors affect the pastoralists' daily lives, options, and decisions (Cousins et al. 2007). Temporary droughts and low market prices may induce pastoralists to pursue alternative income generating strategies that threaten their natural environment, such as producing charcoal from the scarce vegetation if they cannot sell or feed their livestock (Toulmin 1994; Devereux 2006). These events increase the ecological, socioeconomic, and political pressures on pastoralism in many parts of the world (Abule et al. 2005) and raise debates about its sustainability (Devereux and Scoones 2008; Sandford 2006).

3 Potential factors influencing the sustainability of pastoralism

Recent research on the sustainability of the pastoral production systems increasingly acknowledges that rangeland management in dry lands is complex and is influenced by physical, social and economic factors at different scales (Vetter 2005). The investigation of how pastoralists live with their natural ecological environment has therefore broadened so that it includes the complex dynamics of their entire environment (Sullivan 1999; Xiaogang 2005). To do justice to these conditions, the focal variable of our review, the sustainability inference that emerges from the studies on pastoralism, is operationalised at the levels: (1) pastoralism is sustainable, (2) pastoralism is not sustainable, and (3) it depends. To understand how the reviewed studies arrived at their inferences on the sustainability of pastoralism, we analyzed the studies in terms of relevant study characteristics, pertaining to the domain of sustainability, the ecosystem and land use types, the policy instruments, the academic discipline, the research method and the continent where the study was conducted (see Table 1). Although these factors may be related, their analysis will provide a deeper understanding of how important they are in guiding researchers to their sustainability inferences regarding pastoralism.

3.1 The domain of sustainability

Studies may arrive at different inferences on the sustainability of pastoralism, depending on how they conceptualize sustainability. Influential conceptualizations of sustainability include three themes: the planet, that is the ecological imperative to live within and maintain biodiversity, people, that is

a social imperative to ensure the development of healthy and functional societies, and profit, that is an economic imperative to meet basic needs of the pastoralist community and society (Dale 2001; Brundtland 1987; Serageldin 1996). To understand how sustainability is conceptualized in the context of pastoralism, we incorporate (a) abiotic and biotic factors, which are predominantly planet-related factors, (b) mobility, adaptation, indigenous knowledge, institutions and population growth, which are predominantly people-related factors, and (c) economic contribution, which is predominantly a profit-related factor.

The nature and level of *abiotic* such as rainfall and *biotic* factors such as grazing have been linked to the sustainable land use of pastoralists (Behnke et al. 1993). This research has demonstrated that abiotic factors such as rainfall play a more important role in limiting livestock populations of pastoralists (Ellis and Swift 1988). However, biotic factors, such as grazing regime and herd size management may combine and potentially interact to disturb the system to the extent of overgrazing (Sullivan and Rohde 2002; Steinfeld et al. 2006).

Mobility is a way to make sustainable use of rangelands by pastoralists, both economically and environmentally (IFAD 2009). Mobility as an ecological rationality is a response by pastoralists to variable range production and livestock nutritional needs (Oba 2011). The sustainability of pastoralists thus depends on the ability of pastoralists to exercise livestock mobility (Fratkin and Mearns 2003). If mobility is constrained it may also lead to overgrazing and thus to a lack of sustainability (Fernandez-Gimenez and Le Febre 2006; Ostrom et al. 1999).

Adaptation refers to “the decision-making process and the set of actions undertaken to maintain the capacity to deal with current or future predicted change” (Nelson et al. 2007, p. 396). Pastoralists have shown a wide variety of adaptations to respond to the environmental and socioeconomic changes (Fratkin 1997; Galvin 2009). Adaptation is thus the flexibility in coping with changes (Smit and Wandel 2006). For example, with the increase of sedentarization, pastoralists adapt by changing their herd structure from cattle to goats (Galvin 2009). The *indigenous knowledge* of pastoralists is reflected in pasture use norms and herding practices, leading to a mobile land use that persisted for centuries (Fernandez-Gimenez 2000). To this respect, the indigenous ecological knowledge of pastoralists is the foundation for their sustainable resource management (McGahey et al. 2008). *Population growth* potentially undermines sustainability (Lynn 2010), because it leads to fragmentation of the rangelands (IFAD 2009). In fragmented rangelands, pastoral management strategies may not be sufficient to sustain their production, potentially leading to a collapse of the system (Galvin 2009).

Formal and informal *institutions* can regulate sustainable grazing by organizing access to pasture and water (Fernandez-

Table 1 Potential factors influencing sustainability inferences and their coding

Categories	Variables	Coding scheme
Sustainability inference	Sustainable	Coded as 0 if a study considers the pastoral system sustainable
	Not sustainable	Not included in the multivariate analyses
	It depends	Coded as 1 if a study considers sustainability as conditioned on some, policy, measures
	Not indicated	Not coded for analysis if a study does not indicate a position on sustainability of the pastoral system
Domain of sustainability	Biotic factors	Coded as 1 if biotic factors such as grazing by livestock are considered as causes to the changes to pastoral system or vegetation, otherwise coded as 0
	Abiotic factors	Coded as 1 if abiotic factors such as climate and rainfall are considered as causes to the changes to pastoral system or vegetation, otherwise coded as 0.
	Adaptation	Coded as 1 if pastoralists are considered as flexible to coping with changes, otherwise coded as 0
	Indigenous knowledge	Coded as 1 if pastoralist indigenous knowledge is considered in range management, otherwise coded as 0
	Mobility	Coded as 1 if pastoralist mobility is considered in range management, otherwise coded as 0
	Institutions	Coded as 1 if pastoralist traditional institutions are considered in range management, otherwise coded as 0
	Population growth	Coded as 1 if the human population growth is emphasized, otherwise coded as 0
	Economic contribution	Coded as 1 if the pastoral system's economic importance to provide meat, milk, and/or income is indicated, otherwise coded as 0
Ecosystem type	Arid/semi-arid	Coded as 1 if the ecosystem type is characterized by a lower growing period of plants, otherwise coded as 0
	Humid/sub-humid	Coded as 1 if the ecosystem type is characterized by a longer growing period of plants, otherwise coded as 0
	Tropical highland/temperate	Coded as 1 if the ecosystem type is characterized by a higher daily mean temperature or by a lower daily mean temperature, otherwise coded as 0
Land use type	Pastoralism	Coded as 1 if the land use mainly focuses on mobile livestock production, coded as 0 if the land use combines livestock production with crop farming
Policy instruments	Constant stocking	Coded as 1 if constant stocking of livestock is indicated, otherwise coded as 0
	Controlled grazing	Coded as 1 if controlled grazing is indicated, otherwise coded as 0
	Flexible stocking	Coded as 1 if flexible stocking of livestock is indicated, otherwise coded as 0
	Mobile grazing	Coded as 1 if mobile based grazing is indicated, otherwise coded as 0
	Diversification	Coded as 1 if pastoralists are engaged in other income-generating activities in addition to livestock production, otherwise coded as 0
Discipline	Anthropology	Coded as 1 if the focus of the discipline in the study is on Anthropology, otherwise coded as 0
	Ecology	Coded as 1 if the focus of the discipline in the study is on Ecology, otherwise coded as 0
	Economics	Coded as 1 if the focus of the discipline in the study is on Economics, otherwise coded as 0
	Geography	Coded as 1 if the focus of the discipline in the study is on Geography, otherwise coded as 0
	Interdisciplinary	Coded as 1 if the focus of the discipline in the study is interdisciplinary, otherwise coded as 0
Research method	Quantitative	Coded as 1 if the research method used is based on quantitative techniques, otherwise coded as 0
	Qualitative	Coded as 1 if the research method used is based on qualitative techniques, otherwise coded as 0
	Quantitative and qualitative	Coded as 1 if the research method used is based on quantitative and qualitative techniques, otherwise coded as 0
	Conceptual/review	Coded as 1 if the research method used is based on conceptual or review techniques, otherwise coded as 0
Geographic focus	Africa	Coded as 1 if the focus of the study is in Africa, otherwise coded as 0
	Asia	Coded as 1 if the focus of the study is in Asia, otherwise coded as 0
	Global	Coded as 1 if the focus of the study is in a global context, otherwise coded as 0
	Australia/New Zealand	Coded as 1 if the focus of the study is in Australia/New Zealand, otherwise coded as 0
	Europe	Coded as 1 if the focus of the study is in Europe, otherwise coded as 0
	Latin America	Coded as 1 if the focus of the study is in Latin America, otherwise coded as 0

Gimenez 2000; Flintan 2011). To this respect, the reciprocal arrangements that are developed by pastoralists contribute to sustainable land use (Flintan 2011). Formal institutions such as governments can, for example, influence sustainability by protecting land tenure rights of pastoralists (WISP 2008). The *economic contribution* that pastoralists make through their land management practices is substantial (Nelson 2012). For example, pastoralists in northern Tanzania's savannah ecosystems provide an economically valuable ecological service by conserving wildlife on their lands, which in turn helps to sustain the ecology (Nelson 2012). Generation of economic benefits to pastoralists helps for the sustainable use of the range lands (Nelson 2012; Hausner et al. 2012). But decrease in the level of income from livestock production by pastoralists can lead to the negative impacts on the range lands such as cutting trees to make charcoal for sale (Riginos et al. 2012).

3.2 Ecosystem and land use types

Studies conducted in different ecosystems may arrive at different sustainability inferences. Arid and semi-arid rangelands are, for example, characterized by variable rainfall and high rate of vegetation dynamics. In such ecosystems light pastoral use is possible and rain fed agriculture is usually not possible (Goodin and Northington 1985). In contrast to the arid and semi-arid ecosystem, the temperate ecosystem is a relatively productive and predictable environment in terms of forage availability and livestock production (Coughenour 2004). In terms of sustainability, the pastoralist and agropastoralist *land use types* have both advantages and disadvantages. For example, integration of pastoral production and cropping permits more intensive use of land than cropping or livestock husbandry alone (Bayer 1986). This is because crop residues and fallow lands offer better forage than natural range (Powell and Waters-Bayer 1984). The main disadvantage of integrating pastoral production and cropping for the pastoralists is that livestock must be closely supervised to avoid crop damage (Bayer 1986). There is also a concern to sustainability with respect to agropastoral land use because as more land is used for crop farming, pastoral land use begins to be replaced by sedentary livestock raising (Neupert 1999).

3.3 Policy instruments

To promote sustainability, researchers have suggested different policy instruments in terms of stocking, grazing and diversification of income. *Constant* (conservative) stocking strategies maintain a relatively fixed stocking rate, while *flexible* (opportunistic) stocking strategies vary depending on forage supply (Campbell et al. 2006; Sandford 1983). Both methods attempt to sustain the livestock production

with the available forage in the range lands, but the latter give more decision authority to the pastoralists themselves. As for grazing, *controlled grazing* limits the number of livestock entering a grazing land, which, according to some researchers, is efficient, because it enhances productivity through fencing and better management (Iro 2009; Mueller and Green 1995). Others have stressed that *mobile grazing* enhances pastoralists' access to resources in climatically unpredictable environments (Nori et al. 2005; Niamir-Fuller 1999). Policies that stimulate *diversification* may help pastoralists to sustain their livelihood (Galvin 2009). Small-scale cropping can, for example, stabilize their income (Notenbaert et al. 2012), but it may also lead to a drop in dry season grazing areas because the most fertile lands are used to grow crops (Fratkin 2001; Notenbaert et al. 2012).

3.4 Discipline, methods, and geographic focus

In addition to the substantive factors discussed above, also the researchers' discipline, the research methods employed, and the geographic area of the study potentially influence the sustainability inferences from the study. As for *discipline*, it has been argued that anthropological studies tend to emphasize the land use strategies (Ruttan and Borgerhoff 1999), while ecologists focus more on grazing and stocking strategies (Galvin et al. 1994). In addition to these two disciplines that have contributed to research on pastoralism for a long time, we also include disciplines that have joined the debate later or have been less visible, namely economics, geography, as well as interdisciplinary studies. Different *research methods* can be related to the sustainable land use of pastoralists. Quantitative studies in ecology in semi-arid areas across Africa have demonstrated the key role that rainfall plays in the condition of above-ground vegetation (Behnke et al. 1993). On the other hand, the qualitative research that is based on in-depth case study analysis can show, among others, the impact of government policies such as land privatization on pastoralists (Dougill et al. 2010). We consider in our analysis categories of quantitative, qualitative, and combined quantitative and qualitative studies as well as conceptual or review studies. We categorize the *geographic focus* of the studies in terms of continent. Concerns about the sustainability of pastoralism have, for example, particularly been expressed pertaining to the African continent (Sandford 2006; Devereux and Scoones 2008). Because we found no studies on pastoralism in North America, we categorize the geographic focus therefore as Africa, Asia, Australia/New Zealand, Europe, Latin America, and worldwide.

In summary, the main factors that can potentially explain differences in the conclusions on whether pastoralism is sustainable pertain among others to the domain of sustainability, including abiotic and biotic factors representing the planet dimension, mobility, adaptation, indigenous knowledge,

institutions and population growth as people-related factors, and economic contribution as a profit-related factor. In addition to these sustainability characteristics, the analysis will include the ecosystem and land use types, policy instruments, constant/flexible stocking, controlled/mobile grazing, and diversification policies, as well as academic discipline, research methods and geographic focus.

4 Literature review

4.1 Methodology

A simple search in Google Scholar for publications with the words “pastoralism” or “pastoralist” yields more than 15,000 hits for the 2005–2009 period. To identify pertinent literature, we undertook a literature search using Scopus and the Web of Science with the search terms “pastoralism and development” and “sustainability and pastoralism.” Only studies published since Vetter’s (2005) review were considered for the search, conducted in February 2009. In reviewing the initial search result of 553 journal articles, we excluded papers not directly related to our research, according to their title, key words, or abstract or their introductions, which indicated a few articles that did not pertain to development. Therefore, our analysis focuses on 125 papers (Table 2). We coded these contributions according to the classification scheme in Table 1.

The first author coded all the papers, and a second rater coded 40 of them to ensure intercoder reliability. We developed an initial coding scheme on the basis of prior literature and discussions between the coders after a pilot study of 10 papers. When the two coders did not agree, they discussed their differences until they reached agreement and then refined the coding scheme accordingly. If they could not reach agreement, one of the coauthors intervened. At one instance, there was disagreement about the correct interpretation on sustainability inferences between the two coders. A third coder (the second author) was called in to make a final judgment. To validate the final coding scheme an additional 30 papers were coded by two coders, resulting in a reasonably high intercoder reliability of 0.907 (Bryant and Miron 2004).

4.2 Descriptive results

Table 4 (lower part) shows the distribution of studies across geographic settings, academic disciplines, and research methods. This distribution reveals two insights that are worth mentioning here. First, although still dominated by ecological/environmental approaches (59 out of 125 studies), research on pastoral systems appear in various academic areas. As compared to previous reviews, this indicates a growing interest of other disciplines in pastoralist production system. Second, Africa is the dominant research context accounting

for 90 out of 125 studies in the research database. This must be taken into account when interpreting the policy implications, because the pastoral area in Africa is mainly savanna which is often an arid and semi arid ecological system (Homewood 2008).

From the 125 selected studies (see Table 2), 78 contained sustainability inferences. The other 47 studies were dropped for further analyses. No less than 58, which is 74 % of 78 studies, infer that the pastoral system is sustainable. Only 2 of the 78 studies, both from ecology, reach a negative conclusion about the sustainability of the system (Abule et al. 2005; Mortimore and Turner 2005). Both studies emphasize the growing human population in the range lands that impacted the mobile livestock grazing on communal lands. We also find that a substantial number of studies (18) assert that sustainability of the pastoral system is conditional. The results therefore show an almost unanimous consensus that pastoralism is not by definition unsustainable, even though some scholars apparently argue that sustainability is only reached if certain conditions are met.

The conditions to sustainability mentioned in the group of studies that inferred that sustainability is conditional, are summarized in Table 3. Studies emphasize diverse conditions, that pertain to the ecological (Hill et al. 2006; Malley et al. 2008), economic (Thornton et al. 2006), and social (Solomon et al. 2007; Richardson et al. 2007; Sternberg 2008) domains. Other studies emphasize the combination or even integration of ecological, social, and economic conditions (Boone et al. 2006; Galvin et al. 2006; Hoffman et al. 2007; Kassahun et al. 2008) that make pastoralism sustainable. For example, based on Somali pastoralists of eastern Ethiopia, Kassahun et al. (2008) indicate that sustainability requires an integrated approach that includes among others participation of pastoralists in resource conservation, and income generation. Institutions are also brought forward as a help for pastoralists to adapt to changing environments, such as land tenure systems (Solomon et al. 2007), conflict management (Haro et al. 2005), access to technologies and markets (Malley et al. 2008), secured herding contracts (Turner and Hiernaux 2008), and adaptation, sometimes referred to in comparable terms such as flexibility (Sternberg 2008; Haro et al. 2005). Multivariate analyses of the reviewed studies will show whether these and other factors relate to the sustainability inferences of the studies.

4.3 Substantive results on sustainability inferences

This section analyzes the 76 studies that reach a non-negative conclusion on the sustainability of the pastoral system on the factors that discriminate between the conditional and the affirmative conclusions. Column 4 in Table 4 provides the descriptive results as to how the conditional conclusion is distributed across studies that have versus have not addressed

Table 2 Studies included in the analysis grouped by sustainability inferences

Sustainable (58)	Not sustainable (2)	It depends (18)	Not indicated (47)
Adriansen (2006); Adriansen (2008); Allsopp et al. (2007); Anderson and Hoffman (2007); Anderson and Centonze (2007); Angassa and Oba (2008); Berhanu et al. (2007); Berzborn (2007); Campbell et al. (2005); Cousins et al. (2007); Curtin and Western (2008); Davies (2008); Davies and Bennett (2007); Davis (2005); Dong et al. (2009); Hendricks et al. (2007); Hobbs et al. (2008); Homann et al. (2008a); Homann et al. (2008b); Homewood et al. (2006); Huang et al. (2007); Hunt (2008); Kiunsi and Meadows (2006); Kobayashi et al. (2007); Koocheki and Gliessman (2005); Lesorogol (2005); Little et al. (2008); McAllister et al. (2008); McPeak (2005); Moritz (2008); Muller et al. (2007a); Muller et al. (2007b); Mwangi (2007a); Mwangi and Dohrn (2008); Namgail et al. (2007a); Ngugi and Conant (2008); Pedersen and Benjaminsen (2008); Postigo et al. (2008); Quaas et al. (2007); Reeson et al. (2008); Richardson et al. (2005); Roba and Oba (2008); Rohde et al. (2006); Samuels et al. (2007); Scholte et al. (2006); Smith and McAllister (2008); Tyler et al. (2007); Verlinden and Kruger (2007); Vetter (2005); Vetter et al. (2006); Wangui (2008); Warren (2005); Wessels et al. (2007); Wurzinger et al. (2008); Xiaogang (2005); Yang et al. (2008); Yi et al. (2008); Zhang et al. (2007)	Abule et al. (2005); Mortimore and Turner (2005)	Angassa and Oba (2007); Boone et al. (2006); Borner et al. (2007); Fernandez-Gimenez and Le Febvre (2006); Galvin et al. (2006); Gemedo-Dalle et al. (2006); Haro et al. (2005); Higgins et al. (2007); Hill et al. (2006); Hoffman et al. (2007); Kassahun et al. (2008); Malley et al. (2008); Richardson et al. (2007); Solomon et al. (2007); Sternberg (2008); Thornton et al. (2006); Turner and Hiernaux (2008); Unruh (2005)	Abebe et al. (2008); Adriansen and Nielsen (2005); Barrett et al. (2005); Barrett et al. (2006a); Barrett et al. (2006b); Bellemare and Barrett (2006); Benjaminsen (2008); Blaikie (2006); Boone et al. (2007); Bostedt (2005); Briske et al. (2005); Britz and Ward (2007); Campbell et al. (2006); Doss et al. (2008); Gill (2005); Hoffman and Rohde (2007); Kabubo-Mariara (2005); King (2008); Kyeyamwa et al. (2008); La Rovere et al. (2005); Lebert and Rohde (2007); Lybbert et al. (2007); Madulu (2005); McAllister et al. (2006); McCarthy (2007); McPeak (2006a); McPeak and Doss (2006); Mieke et al. (2008); Milligan and Binns (2007); Morton (2007); Moyo et al. (2008); Muchiru et al. (2008); Mwangi (2007b); Namgail et al. (2007b); Niyogi et al. (2007); O'Connor and Kuyler (2009); Oba et al. (2008); Ogutu et al. (2005); Okayasu et al. (2007); Retzer (2006); Sandford and Scoones (2006); Slegers and Stroosnijder (2008); Smet and Ward (2005); Thornes (2007); Thornton et al. (2007); Turner et al. (2007); Upton (2008)

the particular issue (organized into sustainability domain, policy instrument, and ecosystem and land use type). The results indicate that variables on the *domain of sustainability* have relatively equal distributions across studies that have addressed the issue versus those that haven't. As such, this category allows potentially for strong statistical conclusions.

The table also shows that *policy instruments* have often been ignored in existing studies, with the exception of mobile grazing and, to a lesser extent, diversification. With regard to *ecosystems and land use types*, the available research is clearly dominated by (semi-) arid regions, with much less attention to tropical highland and (sub-) humid contexts. With regard to the *disciplines*, ecologists are clearly the main suppliers to the literature. Qualitative research is the most frequently applied *method*. Most studies had a *geographic focus* on Africa.

We next conducted multivariate analyses per block of independent variables, i.e. domain of sustainability, policy instruments, ecosystem and land use types, discipline, research

method, and geographic focus, relating to the sustainability inferences to examine any relations. We use the following logistic regression model for each block of variables.

$$\text{Logit}(p) = C + \beta_1 X_1 + \dots + \beta_n X_n$$

Where p is the probability that a study reaches a conditional rather than unconditional positive conclusion on sustainability of the pastoral system; C is a constant; β s are the parameter estimates (reported in column 2 of Table 4); and X_1 – X_n denote dummies for predictor variables pertaining to the specific group of variables relating to sustainability inferences. Because the highest Variance Inflation Factor in these models is 2.860 for ecology in the discipline variables category, multicollinearity is unlikely to have influenced the findings (Hair et al. 1995).

With the exception of the domain of sustainability, for none of the sets of variables we find statistical support that

Table 3 Overview of conditions indicated for sustainable pastoralism

Condition	Description	References
Adaptation	Flexibility to adjust to changes in social, market economic, and ecological such as rainfall factors.	Sternberg (2008); Kassahun et al. (2008); Angassa and Oba (2007)
Management strategies	Techniques followed in livestock production and use of natural resources such as flexible stocking and mobility	Thornton et al. (2006); Richardson et al. (2007); Borner et al. (2007); Higgins et al. (2007); Turner and Hiernaux (2008)
Indigenous knowledge	Traditional knowledge about rangeland, water management, and grazing reserves	Angassa and Oba (2007); Gemedo-Dalle et al. (2006); Solomon et al. (2007); Fernandez-Gimenez and Le Febre (2006)
Institutions	Customary and legal land tenure systems, conflict management, security of herding contracts, access to markets and technologies	Solomon et al. (2007); Fernandez-Gimenez and Le Febre (2006); Haro et al. (2005); Malley et al. (2008); Unruh (2005)
Integrated approach	Combining two or more activities together such as resource conservation and income generation, and land use for livestock production and cultivation	Kassahun et al. (2008); Boone et al. (2006); Galvin et al. (2006); Hill et al. (2006); Hoffman et al. (2007)

addressing these factors in the research significantly changes the odds of reaching a conditional conclusion. This is largely due to the unequal distribution of studies that have versus have not addressed the issue. The results show that studies that consider *adaptation* and the role of *institutions* are more likely to reach a positive rather than conditional conclusion to their inference to sustainability of pastoralism. Studies that pay research attention to *mobility* are more likely to reach a conditional conclusion on sustainability of the pastoral system. When we add control variables to the equation, such as the ecosystem and land use types, research methods, disciplines, and continents, the effects remain significant.

In summary, the quantitative analysis confirms the consensus among research contributions that the pastoral system is sustainable, but also hints towards three important factors on which this sustainability inference may depend: mobility, adaptation and institutions. We explored these studies in more detail for their more nuanced conclusions. The eight studies that include adaptation and arrive at a conditional conclusion indicate that pastoralist production practices are based on adaptive ways to secure their livelihood in unpredictable environment. They further argue that failure to incorporate the practices and strategies of the pastoralists in policy reduces their adaptation. Without pastoralists being able to adapt, pastoralism is not sustainable. Studies on mobility that arrive at a conditional conclusion ($n=12$) indicate that the mobility of pastoralists is increasingly restricted due to land tenure changes that favor ranching, sub-dividing and privatizing communal lands, sedentarization and crop farming. These studies see mobility as a necessary condition for pastoralism to be sustainable because it provides pastoralists with the freedom to adapt; thus roughly echoing the logic underlying the studies that focus on adaptation. Studies on institutions that arrive at a conditional conclusion ($n=8$) indicate that institutions that promote sedentarization are overshadowing

the customary pastoral institutions that support sustainable practices. In line with the studies on adaptation they therefore emphasize the indigenous ability of pastoralists to adapt to the changing conditions. The adaptation to changing resource inputs, in the case of pastoralists due to changing ecologic and climatic conditions; the active influence of output markets to facilitate such adaptation, including the role of institutions, are central to the marketing philosophy. As such, insights from marketing theory may contribute to a better understanding of when and why the pastoral system is sustainable and how marketing-based strategies can be implemented and facilitated to enhance sustainability. As marketing's contribution has largely gone unaddressed in this research domain (Charter et al. 2002), we reflect on this potential role in the next section.

5 Role of marketing

Marketing refers to “the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large” (American Marketing Association 2007). From this perspective, marketing is a competence that enables entities like companies or pastoralists to create value for target buyers with whom they may develop economic and social relationships that can be favorable for both parties. Central to the marketing concept is the strategic inclination; managing the market exchange process such that the right product is delivered at the right time in the right place, generating an appropriate price. Adaptation, mobility, and institutions are in that respect important determinants of strategic marketing of pastoralists.

Rather than marketing, prior research has studied the market behaviors of pastoralists along the lines of market integration. Market integration refers to the amount of agricultural

Table 4 Distribution of studies along the inferences “sustainable” and “it depends”

Variables	Multivariate B	# studies that addresses the variable (<i>n</i> =125)	# studies that (doesn't) address the variable from the studies that reach a conditional (<i>n</i> =76)		Proportion of the studies that reaches a conditional conclusion from the studies that address the variable	
			Variable not addressed	Variable addressed	Variable not addressed	Variable addressed
Domain of sustainability						
Biotic	0.142	58	8/35	10/41	0.23	0.24
Abiotic	0.177	68	6/30	12/46	0.20	0.26
Adaptation	-2.019 ^a	58	10/33	8/43	0.30	0.19
Indigenous knowledge	1.010	37	10/47	8/29	0.21	0.28
Mobility	1.447 ^b	60	6/30	12/46	0.20	0.26
Institutions	-1.161 ^b	64	10/34	8/42	0.29	0.19
Population growth	0.190	47	10/42	8/34	0.24	0.24
Economic contribution	0.472	52	8/36	10/40	0.22	0.25
Policy instruments						
Constant stocking	0.198	5	17/73	1/3	0.23	0.33
Flexible stocking	-0.771	18	16/62	2/14	0.26	0.14
Controlled grazing	-20.479	9	18/70	0/06	0.26	0.00
Mobile grazing	-0.528	74	6/23	12/53	0.26	0.23
Diversification	0.515	31	11/55	7/21	0.20	0.33
Ecosystem and land use types						
(semi-)arid	0.272	103	3/9	15/67	0.33	0.22
Tropical highland ^c		12	17/71	1/5	0.24	0.20
(sub-)humid	1.396	10	16/72	2/4	0.22	0.50
(agro-)pastoral	-1.065	125	4/9	14/67	0.44	0.21
Discipline						
Anthropology	-0.847	10	17/68	1/8	0.25	0.13
Ecology	-0.105	59	9/37	9/39	0.24	0.23
Economics	0.251	26	15/66	3/10	0.23	0.30
Geography	0.118	17	15/65	3/11	0.23	0.27
Interdisciplinary ^c		13	16/68	2/8	0.24	0.25
Research method						
Quantitative	-0.087	23	15/64	3/12	0.23	0.25
Qualitative	-0.205	55	10/41	8/35	0.24	0.23
Quantitative and qualitative	-0.288	18	15/62	3/14	0.24	0.21
Conceptual/review ^c		29	14/61	4/15	0.23	0.27
Geographic focus						
Africa ^c		90	4/21	14/55	0.19	0.25
Asia	-1.005	13	17/67	1/9	0.25	0.11
Global	0.669	10	16/71	2/5	0.23	0.40
Australia/New Zealand	-0.312	8	17/71	1/5	0.24	0.20
Europe	-20.128	3	18/75	0/1	0.24	0.00
Latin America	-20.128	1	18/75	0/1	0.24	0.00

^a $p < 0.05$, ^b $p < 0.1$, ^c Parameter is not estimated because the variables in the focal category are mutually exclusive

produce that is offered to the market versus the amount that is consumed by the household (Timmer 1997). Because livestock is the most important economic output of pastoralists as compared to livestock products like milk and leather (Davies

and Hatfield 2007), market integration of pastoralists can be seen as the number or volume of livestock sold and bought in the market (Tessema 2012). Grounded in the literature on transaction cost economics, market integration is likely to

increase with a decrease of transactions costs. Costs of information search and negotiation that are often mentioned as barriers to market integration (Hatfield and Davies 2006; Scoones 1994) are, for example, likely to decrease with the establishment of formal market places where pastoralists with their livestock are brought in contact with buyers (Barrett et al. 2006c; IFAD 2010). Because such interventions currently rank high on many policy agendas, several authors witness a trend towards increased market integration of pastoralists from the Horn of Africa (Mahamoud 2012; Catley et al. 2012; Desta et al. 2006).

Several positive consequences for sustainability have been ascribed to market integration. By producing for a market, pastoralists enter the cash economy which logically leads to more specialization and efficiency. Based on historical data on the livestock marketing of Gabra pastoralists in Kenya of 50 years, McPeak (2006b) finds, for example, that increased market integration has allowed pastoralists to meet their subsistence needs with smaller herds. Pastoralists may also increase their quality of life, for examples by buying cereal food and other consumer products like medicines for themselves and for their livestock, or by sending their children to school, and through financial investments (Adriansen 2006; Homewood 2008; Riseth and Vatn 2009). Also the ecology potentially benefits from market integration because pastoralists can destock livestock in times of drought and buy after the drought (Turner and Williams 2002; McPeak and Little 2006). This helps pastoralists to adjust their livestock population to available feed resources (Verbeke et al. 2009), making their production more sustainable against changes in climatic conditions (Adriansen 2008). The cash generated from selling a part of their herd further enables pastoralists to purchase fodder during dry period for their remaining livestock (Blench 2001).

Yet, market integration may also create a situation in which these positive consequences for sustainability turn negative. When an upcoming drought demands that more pastoralists bring a larger share of their herd to the market, prices are likely to drop (Holtzman and Kulibaba 1994). Pastoralists therefore have less money to buy cereal foods and other consumer products. Moreover, the prices for these goods will increase as a consequence of the suddenly increasing demand (Kerven 1992; Swift 2011; Lybbert et al. 2000). When pastoralists subsequently decide to refrain from selling, the ecology may be structurally damaged. Market integration is therefore a concept that provides at best only a part of the market-based solution to make pastoralism sustainable.

While market integration is a necessary condition for marketing, the two concepts are fundamentally different in that marketing emphasizes a strategic, anticipatory, approach. This strategic component is reflected in the market orientation concept, which captures a seller's understanding of what the market wants at what moment in time. In a behavioral sense,

market orientation refers to the generation and sharing of market information pertaining to current and future customers and competitors (Kohli and Jaworski 1990). Ingenbleek et al. (2013) apply the concept of market orientation to pastoralists in the Borana and Awash Valley regions of Ethiopia. They find that not market integration but an orientation towards customers is the strongest predictor of livelihood performance. Their study also implies that market orientation can not only be learnt from modern management books, but can also be learnt by experience (Kerven 1992; Homewood 2008).

When pastoralists manage to understand the specific wants and needs of their target buyers, they are likely to be rewarded by customers through willingness to pay and loyalty in terms of repeated purchases. Pastoralists can attain this, for example, by using specific breeds and raising the livestock in particular ways so that they meet certain quality criteria. Superior insights in customer wants enable pastoralists to increase the quality of their livestock as it is perceived by their target buyers, through for example feeding and fattening practices. Such practices differentiate the livestock that pastoralists offer and reduce the level of commodity competition, characterized by uniform quality and low prices, especially when the supply increases in times of drought. A study by Radeny et al. (2006) found that the type and quality of livestock that pastoralists supply to the market can influence the price that they receive. Davies et al. (2010) note that marketing has a growing influence on herd composition. Market-oriented pastoralists are therefore more likely to sell a larger share of their herd when climatic conditions demand them to do so. In a semi-experimental study, Tessema (2012) finds evidence that market-oriented pastoralists indeed intend to do so.

By offering livestock and livestock products that cater the needs of target customers, more durable relationships between buyers and sellers develop, that are characterized by both economic and social aspects. This in turn facilitates the integration between parties within marketing channels. More integrated chains can develop concerted efforts to solve a sudden increase in supply. Downstream players can stimulate demand by developing new market connections and promotion campaigns. Dissemination of communication technology, like mobile phones, can help pastoralists to become an integral part of such supply chains (Little 2012). Besides contributing to ecological sustainability, marketing therefore potentially decreases poverty among pastoralists and may help to improve the fair distribution of rents in the channel. The pastoralist literature has in that respect acknowledged that improving marketing skills may increase the competitiveness of pastoralists (Hatfield and Davies 2006; Kyeyamwa et al. 2008) and strengthen their position in the emerging livestock chains (Coppock et al. 2005; Catley et al. 2012; Aklilu 2008).

Because it can contribute to livelihoods as well as ecological sustainability, marketing favors an integrated approach

in pastoralist policy (Boone et al. 2006; Kassahun et al. 2008). Institutions can in that respect make the marketing efforts of pastoralists and other channel members more effective. Public policy is an important force to establish new institutions. According to Nori et al. (2005), marketing has, however, seldom been used in policy making for pastoralists. Musemwa et al. (2008) argue that most of the projects that involve collective action groups end up in removing production bottle necks in disregard of the marketing factors. As an exception, Desta et al. (2006) find that assistance in basic education, information, and market relationships, increases pastoralists' livestock sales for export.

In summary, because the role of marketing has received scant attention in the context of pastoralists and because it has often been narrowly interpreted as market integration, we further explained the potential role of marketing in sustainable pastoralism. This role of marketing comes down to a strategic competence that enables pastoralists to create value for target buyers with whom they may develop economic and social relationships that can be favorable for both parties. Because it is likely to stabilize prices and generate a long-term perspective on value creation; and therefore on resource use, marketing can contribute to a pastoral system that supports people, planet and profit. As explained in the next section, also policy makers may approach their policies from a marketing viewpoint.

6 Policy implications and future research

6.1 Policy implications

Supporting the development of a true market orientation competence should be an important policy objective. Developing a market orientation requires the support of clan members (in particular elders), as well as the sufficient availability of market information on customer wants. The adoption of market standards may further facilitate the transactions between pastoralists and their (potential) buyers. The formation of producer groups may help pastoralists to increase their level of market orientation and take advantage of market opportunities (Markelova and Mwangi 2010). Collective marketing can enable pastoralists to meet quality and safety standards and enable the supply of the quantities demanded by larger buyers (Thorp et al. 2005). Enhancing the market orientation of pastoralists may also require an increased awareness among the clan elders who may consider livestock selling as a possible threat to the security of their clan members. To this respect, clan elders need to understand the possible benefits of advance livestock destocking in order to restock after the drought. Younger generations, growing up with market opportunities may think more commercially about the value of their livestock than older generations, thus gradually changing traditional cultural values (Marin 2008) and gradually replacing

subsistence lifestyles by lifestyles in which consumer products are more prominent (Casciarri 2009).

Market orientation should however not be equated by setting short-term sales objectives. It is the strategic inclination of market orientation that may help to secure a sustainable use of natural resources. Increases in the market participation of pastoralists can lead to higher herd productivity (Zander 2011). At the same time pastoralists might be constrained from selecting productive breeds, such as those producing more milk, because they also take into account the ecological tolerance of the breed types. For example, pastoralists may be forced to take into account the hardness of the livestock type to tolerate forage shortages rather than their productivity (Desta et al. 2011). Policy may facilitate this trade-off through breeding programs, research and/or improving the forage conditions.

While supporting the market orientation of pastoralists, policy measures are required to minimize any undesired lifestyle changes, such as increased alcohol consumption, that may accompany increased market orientation of pastoralists. A higher market orientation could potentially ruin pastoralists' lifestyles as well as their livelihood level unless the benefits that pastoralists gain from a higher price are properly channeled for saving and further investments. In other words: long term value creation requires the appropriate institutions. Developing financial and insurance markets could therefore be a complementary endeavor that policy makers need to consider (von Braun 1995).

6.2 Implications for further research

While market orientation is an important concept to connect marketing thinking more strongly with the literature on pastoralism, the marketing literature than the market orientation concept only may have more to offer to the sustainability of pastoralists. Future research may explore, for example, the potential benefits of relationship marketing concepts (Berry 1983; Gronroos 1995; Sheth and Parvatiyar 1995), concepts from the knowledge-based view of the firm (Grant 1996), and customer satisfaction models (Szymanski and Henard 2001).

Research could also be directed on identifying the effects of market orientation on changes in the lifestyle of pastoralists. In this regard, sociological research might be conducted to investigate relationships between the higher market orientation of pastoralists and other market integration types with respect to the changes in lifestyle. The outcomes from this type of research could be helpful in designing policies that aim to enhance market orientation while being abreast to pastoralists' culture and lifestyles.

Finally, more in general, interdisciplinary research appears necessary to deal with the research challenges ahead. Input from the social sciences can reveal the adaptation

exercises of pastoralists, while ecologists test their actual impact on natural conditions. Economists then are needed to understand whether market conditions stimulate adaptation to sustainable pastoralism or promote unsustainable practices. As the environments that pastoralists face grow complex and dynamic, all elements of sustainability (ecological, social, and economic) should be addressed in their full breadth to help pastoralists function in a more sustainable manner. Addressing pastoralism from a perspective that covers all elements of sustainability, therefore, can enhance wise use of the natural resources, pastoralists' livelihood, and their contribution to the growing demand for animal protein. The marketing concept may be a continuous source of inspiration in these efforts as the strategic creation of customer value has proven to be a basis to strengthen sustainable development of pastoralist system.

7 Conclusion

Pastoralism is not necessarily unsustainable, but, according to the literature in recent years, its sustainability depends on adaptation, mobility and institutions. Marketing can help pastoralists to adapt through strategic selling and buying to strengthen their livelihood and to adapt to natural conditions that demand either destocking because of drought or allow restocking because of rain. In that respect, strategic marketing with a central view on the creation of customer value can contribute to economic, social and ecological sustainability at the same time.

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