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Review Article

Pastoralism Beyond Ranching: A Farming System in Severe Stress in Semi-arid Tropics

ABSTRACT

Pastoralism is the most traditional of ruminant livestock production systems in which extensive movement of the animals in search of pastures and water is its salient feature. Whereas the system is adapted to exploit the dry, arid climatic zone, it often overlaps into wetter, agricultural land, occasionally ending up into violent conflicts. Ranching is practically the intensive form of pastoralism but it has a weakness of being seen antisocial and needing high initial capital. Whatever other improved system of exploiting the pastoral agro-ecosystem must be sedentarized and can seldom be less intensive than ranching. This paper argues that the mobility survival strategy of pastoralism does not solve the problem the system itself creates. The paper further argues that because it is a livelihood system pastoralism will continue to thrive but so long as it cannot contain the internal pressures within itself and in presence of various external pressures, the system is destined to disintegrate as well as is destined to self-destruction. With the urgency to satisfy ever increasing global food needs, extensive practices such as nomadic pastoralism will continue to diminish at least in the peripheries of crop cultivation

Keywords: Pastoralism, Ranching, Arid climatic zone, Agricultural land, Livelihood system, Mobility

1. INTRODUCTION

Pastoralism is a ruminant animal (cattle, sheep, goats, camels, horses, raindeer, water buffaloes) production system that involves people making their living by tending herds of those animals. It is essentially a subsistence system where the people involved obtain all or large part of their food and other living needs using the herds they tend. The livestock consume grass and herbage they come across as they are grazed. The system is distinct from other agricultural practice, which would generally involve cultivation of crops or intensive rearing of livestock. Pastoralism is an extensive system of essentially the wilderness.

There are at least [1] two theories describing the origin of pastoralism. One theory asserts that at the beginning pastoralism was seen as an evolutionary stage in human history, a phase following hunting and gathering and leading to sedentarization and agriculture. Another theory argues that pastoralism develops from surplus and originated from settled livelihood. As individuals accumulated too many animals it became difficult to graze around a settlement throughout the year. In addition, as herders learned more about the relations between particular types of ecology and the spread of debilitating diseases they gradually developed the practice of seasonally removing their animals from danger zones.

No matter how it evolved, pastoralism is a system that tends to exploit wild and semi-wild ecosystems to benefit domesticated animals. The most salient feature of pastoralism is movement of animals in search of pastures, and consecutively water after feeding. Based on the pattern of movement of the livestock, pastoralism is usually classified into nomadic, semi-nomadic, settled and semi-settled pastoralism [2], or nomadic, semi-nomadic, semi-sedentary and sedentary pastoralists [3]. Nomadic pastoralists migrate all the time with their livestock without any permanent settlement. Semi-nomadic pastoralists spend more than half their time annually herding animals away from home or cultivated settlements [4]. Further description [3] elaborates that semi-sedentary (semi-settled) pastoralism is a system where the

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pastoralists settle (live in houses) during part of the year while part of the household moves with livestock to pasture, distinct from semi-nomadism where during movement the whole household moves. In sedentary pastoralism, the pastoralists live in villages all year round while taking livestock out to pasture every day, sometimes hiring shepherds.

The pattern of movement for nomadic pastoralists is random, non-directional. Movement of semi-nomadic and especially semi-settled or semi-sedentary pastoralists can be transhumant. This is a directional or regular back and forth movements between fixed locations, for example from mountains to the warmer valleys in winter and back to the mountains when it becomes warmer and frost has ceased.

Another classification categorizes pastoralism based on enterprise system and degree of contact with cultivators [5] [6]. This distinguishes pure pastoralism and agro-pastoralism, whereby pure pastoralism encompasses full-time livestock keeping ranging from those keepers with no consistent association with a particular farming or land use system (nomads) to those who have more or less regular contact with cropping systems at their grazing sites. Agro-pastoralism, on the other hand, refers to livestock keeping while also practicing cropping. Accordingly [4], agro-pastoralists are those farmers with animals who spend less than half their time in herding and more time in cultivation. The system exists in two sub-categories: sedentary agro-pastoralism and those who are transhumant. Sedentary agro-pastoralism is a system where livestock are kept throughout the year near cropping activities of the pastoralists. Transhumance agro-pastoralism is the cultivation of crops at one site while moving all or most of the livestock possession to other areas during the non-cropping season [6]. Typically in transhumance [1], the herders would split the herd, taking most of the animals to search for grazing, but leave the resident community with a nucleus of lactating females. Older members of the community would also remain in permanent homesteads throughout the year.

2. SEMI-ARID TROPICS

Pastoralism is especially considered to be an adapted livelihood that can exploit arid areas where cultivation of crops may not be successfully practiced. These are areas where annual precipitation and length of growing season are not sufficient for completion of any crop life or production cycle. Arid, semi-arid, sub-humid, humid, temperate, and tropical highlands are important climatic zones of the world [7] that determine agricultural production potential of different areas in the globe. Generally, an area is said to be arid when its average annual rainfall ranges from 100 – 300 mm [8] or 200 – 400 mm [9] while if precipitation is at least 100 mm [8] or 100 – 200 mm [9] the area is hyper-arid. Rainfall between 400 – 800 mm (Ibid) categorizes an area as semi-arid (300 – 600 mm to 700 800 mm with summer rains and 200 – 250 to 450 – 500 mm with winter rains, according to [8]. Table 1 summarizes more the arid climatic zones with natural vegetation and potential land resource use activity indicated (*Ibid*).

Rangelands all over the world are more suitably situated in arid and semi-arid climatic areas. These dry areas are less infested with livestock diseases. As it becomes wetter, diseases such as trypanosomiasis (also foot and mouth disease) become prevalent. A lot of animal life can be claimed because of such diseases. This forces pastoralists to prefer drier parts, and for the nomads to move from place to place partly for the sake of escaping chances of disease incidences.

Aridity sets practical limits of agricultural activity. In hyper-arid areas even crop growth is much limited. When an area is categorized as being “arid” crop cultivation activities can be possible only if irrigation water can be imported from wetter parts. When an area becomes semi-arid from arid, the value of land begins to change from strictly pastoral to general agricultural land. As average annual rainfall rises above 400 mm [6], crop production becomes more important (comparable to grazing livestock). The more productive environment can support rainfed cultivation of crops and sedentary livestock production [8

Table 1. Arid climatic zones indicating natural vegetation limits and possible economic activity

Arid climatic Zone	Precipitation (mm) (Annual average)	Natural vegetation	Possible Economic activity	Source

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Super-arid	< 100			[9]
Hyper-arid	100 – 200			[9]
	> 100	None except few scattered shrubs	True nomadic pastoralism frequently practiced	[8]
Arid	200 – 400			[9]
	100 – 300	Sparse (grasses, shrubs and small trees)	Pastoralism, no farming except with irrigation	[8]
Semi-arid	400 – 800			[9]
	300-600 to 700-800 with summer rains	Variety of species: grasses and grass-like fortes, half-shrubs, shrubs and trees	Rain-fed agriculture, Sedentary livestock production also occur	[8]
	200-250 to 450-500 with winter rains			

4. RANCHING

Pastoralism is essentially a free range grazing without limits. A modern form of pastoralism has developed which establishes limits of mobility even in arid land. This modern form is known as ranching, which is [1] an enclosed (usually fenced) system of extensive livestock production. Under this system a piece of land, the ranch, is allocated and owned for livestock grazing, and the owner is granted individual rights of use of the land so allocated.

Ranching is a very significant change of the pastoralist farming system which changes the mobility nature of pastoralism where traditionally there are no limits of grazing of the available pastures. It also changes the common property character of the pastoralist land where all land is open for pastures without any individual ownership.

Ranching is now the dominant system of ruminant livestock production in North America, Australia and parts of South America [1]. Some European systems could also be described as ranching, though enclosures are often small and animals are frequently given supplements in the field (*Ibid*). In countries like United States, (*Ibid*), communal grazing pastoralism was prevalent in the 19th century, but now the grazing systems are fully enclosed (*Ibid*).

5. PASTORALISM BEYOND RANCHING

Scientific and modern economic intervention into pastoralism has generally targeted the mobility and communal grazing characteristics of the farming system which results into sedentarized and most likely the enclosed, ranching system. This intervention has implication that the pastoralist ecosystem is a limited and valuable resource contrary to the traditional pastoralist perception that pastoral land is essentially vast wilderness with no instituted limitation of use (no use limits except the availability of pastures).

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There has been extensive scholarly analysis of the livelihood and sustainability of pastoralism as a way of life of a significant proportion of the human population. Much criticism exists especially on the mobile nature of the system. Mobility of large herds of livestock is stressful to the environment as it would cause extensive removal of vegetation. Repeated uncontrolled grazing often ends up into bare land where vegetation is completely removed. Due to livestock trampling topsoil of an area usually becomes much pulverized while the immediate subsoil beneath becomes severely compacted. Pulverized soil is prone to extensive loss of soil through wind erosion while when it rains sheet erosion sweeps away very easily most of the pulverized soil. The surface run-off becomes much enhanced by the compacted soil condition. Therefore, while rainfall would be stimulant for vegetation re-growth, because of extensive vegetation removal and compaction the rainfall instead becomes an enhancer of bareness of the soil after washing away all the soil that would support vegetation re-growth. In the Sahel in Africa, it has been reported [10, 11, 12] that vegetation removal by livestock in the area is believed to have increased soil surface albedo to the extent of causing reduction of rainfall and rapid desertification. The worst thing about the unlimited mobility is that it can extend its impact beyond limits.

Another criticism on pastoralism is centered on the system's tendency against limited use rights of pasturelands. this context all pastureland is communal and open to limitless grazing. Since communal use of pasturelands prevents any sense of ownership of the land, no individual pastoralist can think of expansion of his activities within the locality in which he is existing at any particular time. At the same time the pastoralist cannot intuit any idea of intensification because under communal ownership there is no ground on which this intensification can be exercised. Under the communal setup, for example, a pastoralist cannot think of possibility of substituting some of the livestock for more pasture land. This is the dilemma of the communal land tenure system of traditional pastoralism. In his much referred "Tragedy of the commons", [13] criticizes very categorically the communal grazing characteristic of pastoralism and insists privatization as a way to correct imbalances of the pastoralist practice. In his article he described how common property resources shared by pastoralists eventually become over-used and ruined. He argued that the pastoralist land use strategy is unstable and a cause of environmental degradation. Earlier more than a century ago, [14] also criticized pastoralism and argued observing that as far as common grazing land is concerned there is everything against it. He asserted that where there is communal grazing, every peasant in the village would tend to maximize the opportunity within the same limited area, with the result that grazing lands become always overstocked, never given rest, and usually become little more than exercise grounds for cattle (*Ibid*).

The only adaptive strategy that pastoralism uses to counteract problems it creates with its uncontrolled communal grazing is its mobility. Essentially, however, this is spreading the same problem rather than solving it. No matter where the grazing moves to, it will tend to maximize the fresh pastures use, and since the pastures are communal and many different herders make use of the opportunity to exploit the limited resource, this eventually ends up with heavy overgrazing and definitely degradation. This appears very clearly in the description [10] of the "paradigm of pastoral ecosystem dynamics" which the authors say is based on perceptions that:-

1. Pastoralism is basically an in-efficient and environmentally destructive resource exploitation strategy
2. Ecosystems occupied by pastoralism have capacity to support stable equilibrial populations of herbivores but pastoral strategies necessarily lead to overstocking and tend to move the system away from the potential equilibrium conditions
3. Pastoralists have avoided large-scale extinction by moving to new areas after degrading previously occupied environments or by changing strategies to accommodate the new but somewhat degraded environmental state

Owing to what have been perceived to be problems posed by pastoralism, ranching has been considered as an economically viable and ecologically controllable way of essentially nurturing the pastoralist practice. This owes to the more generalized tendency of sedentarization, which reduces mobility in the pastoralist practice. Traditionally sedentarization takes the form of settled, semi-settled or semi-nomadic pastoralism. But ranching goes a step further to have control of grazing within enclosures and not from without. The ranching system therefore totally overhauls the pastoralist pillars of mobility and communal land tenure and institutes regulated practice.

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Little alternative innovation is known that can curb the problems of pastoralism the same way ranching has potential to do while retaining the same pastoral features of rangeland use. Beyond ranching science and system improvement mostly advocate more intensive systems which involve much use of livestock feed supplements. Other less known innovations close to the fully privatized ranching have been tried including group ranches, grazing co-operatives and grazing blocks [15, 16, 10]. All such innovations have not grown in popularity as much as ranching. This lack of a widely acceptable alternative poses a question whether pastoralism will ever find any other refuge beyond ranching. Whatever improved alternative of pastoralism can seldom be less intensive than ranching and still claim to be not pastoralism, and if more intensive it simply is no longer pastoralism.

Even though ranching is extensively advocated as solving pastoralism imbalances, however, it also has faced a lot of criticism. The first criticism lies in the economic objective, that ranchers are not subsistence pastoralists but businessmen [17]. Thus even though pastoralists can participate in market economy, their top priority is survival with livestock as a source of household nutrition. Another criticism [18] points out that the individual ownership of large tracts of land characteristic of ranching is seen as antisocial. This makes the communal land tenure system of traditional pastoralism look superior. It is argued, therefore, that the rationale of ranching is only technical, socio-economic descriptions tend to be uniformly hostile (*Ibid*). Sociology based analysis also argue that ranching is less efficient, for example, than nomadic pastoralism [4] in exploiting rangeland vegetation. This is because of necessarily reduced stocking rate in ranches as a result of enclosure thus limited mobility. The fact that ranching is simply also demanding in initial capital costs is another basis for criticism

6. PRESSURE FOR PASTORALISM TO CHANGE AND THE BALANCE OF FORCES

Pastoralism has most of time been under enormous stress due to various pressures that threaten its continuity. There are pressures exerted from the system itself, from the environment or ecosystem, pressures exerted from cultivation, from science, economics and policy; and even from climate change.

6.1. Internal pressure

Within any localized community pastoralism contradicts itself. It, for example, has very little chance for expansion (increasing number of stock) within the same locality, because of communal grazing. Having less number of stock in the locality does not mean anything in favor of pastures (having excess pastures) because the pastures will be utilized by herders with greater stock number. Eventually in the localized communal pastures overgrazing will occur and both the pastoralist with small and large stock numbers will have to survive as a farming system only by moving to other areas for the pastures. If an individual pastoralist in the communal pastureland could own a parcel of the land he could begin with a small size of stock and allow the stock to grow (while density of pasture vegetation may also be growing) until an optimum stocking rate is reached at the pasture land's carrying capacity. With this conception, however, a lot of problems then come to the surface. The first is how the individual subsistence pastoralist will obtain enough food for his household with a very small size of stock. There must be a minimum size of stock to begin with and this must correspond with a minimum size of pastureland that can allow stock expansion (growth in number). In this context the area of land must be considerably large. A question now arises how many such parcels of land may be available in a localized pastoralist community. Human population in the pastoralist community would be also growing year after year. In fact, pastoralists population growth rates could be one of very high rates owing to the fact that most of the pastoralists are likely to be polygamous (A study [19] of a pastoralist community evicted from a wetland in Tanzania found that 87% were polygamist). For the subsistence food production system to be a reliable livelihood there must be parallel increases in livestock numbers when human population increases (research has shown livestock population lagging behind human pastoralist higher population growth rates [20]. If mobility outside a localized community was not in existence subsistence pastoralism would rapidly become unbearable in any of such community.

The second array of problems in the conception of the individual communal pastoralist owning land arises as to what happens when an optimum stock size is reached. Two ensuing problems will also arise one being overstocking and the second destocking (of excess). The pastoralist will be very reluctant to

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241 destock as they have always been. Destocking is a very hard idea to sell to pastoralists [10]. Since
242 pastoralists also view their cattle as part of a ritual and prestige nexus [1], reducing herd numbers would
243 be equivalent to moving down the social ladder. Another reason for reluctance to destock is that (*Ibid*) it is
244 considered rational for each individual herder to keep a maximum (no longer optimum) number of animals
245 as insurance against epizoonotics or drought; with argument that the more animals there are the more will
246 be left after disaster.
247
248 To avoid both destocking and overstocking the individual pastoralist will therefore opt to move his/her
249 stock outside the localized community area, where of course the land must necessarily be communal.
250 Ideally, however, moving out of a localized area (or simply mobility) does not free the pastoralist system
251 from the problem of increasing stock size and growing population of pastoralists. This eventually will lead
252 to the same problem of overstocking, the need for destocking or instead degradation of pasturelands and
253 desertification elsewhere pastoralism moves to, for no matter how extensive the rangeland may be,
254 natural limits of mobility must exist at a certain geographical point somewhere. It can be concluded in this
255 argument, therefore, that pastoralism as a system is self-destructive owing to its inherent overstocking
256 and increasing pastoralist population. In other words, the system itself is a source of the stress it subjects
257 itself to. Relief from this stress cannot be sought outside the ecosystem the system is naturally destined
258 to alone, outside the rangelands.
259
260 **6.2. Pressure from the ecosystem**

261 Efficiency of the traditional pastoralist system lies in its mobility. Nomadic pastoralism is therefore,
262 according to Hunter (1997), considered to be often the most efficient means of resource extraction in
263 rangelands. In spite of this, however, rangelands cannot be extensive enough to unlimitedly
264 accommodate growing numbers of both livestock and the pastoralists. Though the ecosystem
265 vulnerability to over-grazing is reduced by the pastoralist system mobility, so long as there is ever-
266 increasing numbers of livestock, and human population under the livelihood system also increases,
267 carrying capacity of the ecosystem diminishes. It has already been pointed out, for example, that
268 pastoralism in the Sahel [10, 11, 12] is held responsible for rapid desertification. Diminishing ecosystem
269 carrying capacity therefore imposes stress to the pastoralist system, to which the system is ought to
270 respond properly. According to an Indian Government Task Force on Grassland and Deserts [21],
271 carrying capacity in semi-arid grasslands was found to be 1.0 Adult Cattle Unit (ACU) per hectare while
272 stocking rates were as high as 51 ACU ha^{-1}, whereas in the arid areas carrying capacity was 0.2 – 0.5
273 ACU ha^{-1} but stocking rates were 1 – 4 ACU ha^{-1}. Under such situation the ecosystem may not sustain
274 production for any future.
275
276 **6.3. Pressure from cultivation**

277 Very significant stress on pastoralism is imposed by cultivation activities where both livelihoods overlap.
278 Cultivation is a competitor of pastoralism for land resources, each system causing stress on the other.
279 Where such competition exists it becomes very difficult to resolve tension between the two groups
280 (herders and farmers) owing to opposing land resource use perceptions. Whereas as reported in
281 literature [22] to the traditional pastoralist property is cattle, land is no one's property open to herds, the
282 farmer perceives land to be property, which is divided between households. This makes it very difficult to
283 settle the pastoralist and farmer disputes on rights of use of land and always calls for righteous and
284 determined state intervention. Long unresolved conflicts and violence are therefore very usual in
285 pastoralist and farmer overlapping areas. Innumerable human lives have been lost because of such
286 violence, as for example reported from various parts of Africa (Table 2).
287
288 Most of the conflicts between pastoralists and farmers are in the form of livestock destroying crops in
289 farmers fields, restrictions on trespassing on such fields or livestock drinking water near the fields or from
290 domestic water sources, large scale invasions for grazing on agricultural land, un-negotiated grazing on
291 farmer fields' crop residues, and sometimes farmers claimed to invade for cultivation land belonging to
292 pastoralists for grazing. Sometimes raids are made simply for purposes of revenge on previous clashes.
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Violence sometimes become devastating burning houses, destroying property, destroying crops, looting of animals, causing injuries and sometimes disabilities in addition to casualties, causing crop fields to be abandoned for lengthy periods of time, and sometimes leading to massive evacuations.

Available literature expresses “the pastoralist’s dilemma” [23] which points out that while the amount of rangeland that is available is considered to be insufficient to support enough livestock to provide livelihoods for a fast growing population, the pastoral drylands are also confronted by loss of rangeland (especially valuable riverine pastures) to commercial farming and especially irrigated cropping. Development plans [24] and agricultural economic activity, for example in East and the Horn of Africa, are continuously valuing attention to irrigated cultivation [25, 26], much of it in the pastoral zone

Table 2. Human casualties in various incidents in record of violence between pastoralists and farmers in different parts of Africa

Country	Incident	Years	Casualties	Source
Nigeria	Clashes between farmers and pastoralists	2005 - 2010	280	[27]
	Clashes between farmers and pastoralists	2009	32	[28]
Mali	Dogan farmers clash with Fulani herders	2012	> 100	[29]
	Simbly village. Clashes between Farmers and pastoralists	2006	1 herder	[29]
	Dogan farmers clash with Fulani herders	2012	≥ 25	[30]
Bukina Faso	Clashes between farmers and pastoralists (4,000 incidents)	2007-2012	55	[31]
	Balere, East Region. Farmer-herder conflict	2003	10 herders	[31]
Ethiopia	Farmer-pastoralist violent conflicts	1994 - 2002	116	[32]
	Farmer attacks by pastoralists. Malo area in South- west	1976 - 1999	> 1,000 farmers	[33]
Kenya	Tana River clashes. Farmers and herders	2012	≥ 48	[34]
Tanzania (Pastoralist vs farmer violence)	Rudewa - Mbuyuni Village, Kilosa District	2000	38 farmers	[35]
	Kikenge Hamlet, Mabwegere, Kilosa District	2008	8	[35]
	Kilindi, Tanga Region and Kiteto (Manyara)	2008 - 2009	Several	[36]
	Ikwiriri, Rufiji, Coast Region	2012	1 farmer	[37]
	Dumila, Mvomero District	2013	≥ 1	[38]
	Loliondo, Ngorongoro District	Since 1880	About 5,000	[39]
	Hembeti, Mvomero District	2013	6	[40]
	Kiteto District, Manyara Region	2014	≥ 10	[41]
	Isakamaliwa Village, Igunga District, Tabora Region	2014	4	[42]
	Mabwegere and Mbigiri, Kilosa District	2015	3	[43]
	Kambala and Mkindo villages, Mvomero District	2015	2	[44]

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6.4. Pressure from science, economics and policy

Scientific study of pastoralism finds out that no matter how ecologically efficient pastoralism may be it has very low productivity per unit of land resource and is often too risky. This is partly because the system as a subsistence mode of production tends to be free from use of any inputs, such as fertilizers on improved pastures. Verterinary services usually and for convenience purposes require that pastoralists should settle in more permanent localities where the verterinary services such as tick control (dipping) and tending of sick animals can be provided. Strictly scientific and economically based land use planning would tend to set boundaries between arid areas where pastoralism can be exercised free from competition with crop cultivation and semi-arid areas where rain-fed agriculture can be practiced. Such boundaries often do not in reality exist and cannot be located, and pastoralism finds it not difficult to expand the rangeland territory. Judging between pastoralism and crop cultivation in the semi-arid areas needs a lot of seriousness. Based on resource use efficiency, for instance, it has been established that pastoralist animal production (meat) consumes comparatively more natural resources than vegetarian foods. Informed sources [45] report, for example, that to produce one kilogram of meat requires roughly 5 - 13 times the quantity of water to produce one kilogram of wheat, in addition to the fact that meat has comparatively lower nutritious value than cereals and pastoralist livestock production has the potential to transform agricultural land into unproductive, severely degraded land. Another authority [46], on Pastoral development policy argued that whatever pastoralists were doing was inappropriate and therefore range management programmes aimed at reducing presumed degradation should be applied universally and rapidly.

Since pastoralism is essentially a subsistence system, it cannot receive much support from modern economics whose central focus is the market and finance capital. Scientific and industrial livestock production systems cannot in any way advocate pastoralism as a system able to meet very urgent demand for livestock products. This is like what is reiterated [1], that even though seen antisocial, where urban demand for protein makes the lax supply systems of conventional pastoralism unacceptable and input supply can support higher throughputs that justify ranches, the ranching becomes inevitable. These very soundly science and economics based contentions are the bases of policy that most often is oriented towards more intensive rather than extensive systems such as pastoralism. No wonder, therefore, that livestock sedentarization programmes, assumed to lead to intensification of production thus more ability to supply meat and milk, are at the top of policy makers agenda [47]. The second policy goal influencing pastoralism has been measures to stop rangeland degradation [48], to which end policy makers most frequently [47] consider individualization and privatization [48, 49] of commons as a way to improve management of common rangeland. All these are tendencies towards either ranching or more intensive systems than ranching.

6.5. Pressure from climate change

Agriculture and all its sub-sets is dependent on weather parameters which are currently becoming very unpredictable due to climate change. While pastoralists are known to be able to exploit arid ecologies partly because of their knowledge of climatic patterns, it is claimed nowadays [50] that strategies they were using to track climate variability are now working less effectively. Negative patterns mean shortage of pastures and eventual loss of livestock if the patterns end in famine.

Due to climate change, researchers [51] summarize predicted climate changes for the East and Horn of Africa, for example, which include increases in temperature all year round, increased intensity of rainfall during rainy seasons, shifts in rainy seasons (changes in dates for initiation and cessations of rains), probable increases of frequency of extreme weather events and probable increases in inter-annual variation. The Intergovernmental Panel on Climate Change's climate models for East Africa [50] show an increase in temperature of up to 2 – 4^{o}C by 2080s, with more intense rain in the short rains (October – December) over much of Kenya, Uganda and northern Tanzania as early as 2020s and more pronounced in following decades. Temperatures will have already been higher by the tune of 1^{o}C by 2020. Throughout East Africa, increasing temperature is likely to increase heat stress to livestock (Ibid). High temperatures during rainy season enhance loss of moisture through evaporation, while intense downpours ensure that water is run off into floods [51]. Significant negative consequences will generally

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include loss of livestock through heat stress, increase in frequency of flooding, spread of human and livestock diseases that thrive during wet season, and loss of land to agriculture in arid areas. This means that there will also be positive consequences which will be essentially more rainfall resulting in more dry season pastures and longer access to wet season pasture, and perhaps less frequent drought (*Ibid*).

In Southern Tanzania, in the contrary, The Intergovernmental Panel's model (*Ibid*) predicts the area to become drier, with extreme dry years becoming increasingly common; and that the combination of increasing temperature, decreasing rainfall and more common extreme dry years in the area is likely to significantly increase water stress and drought for people and livestock.

6.7. Balance of forces

Owing to the multiplicity of pressures that are exerted on pastoralism including its own internal pressure threatening disintegration of the system, there may be slim future for such system and it may simply be approaching its extinction. As a livelihood for millions of people (pastoralism supports about 200 million households worldwide [52]) and an adapted means of resource extraction in economically difficult to exploit environments, however, the system will continue to attract advocates for a while longer until such time when economic, social and environmental conditions are ready to substitute the system with a more convenient adoptable alternative. Meanwhile, ranching is still a model that has not yet been defeated by seemingly any better option, except that it can seldom be recommended for the subsistence or even small scale commercial pastoralists because there may not be sufficient land to be conveniently demarcated for all existing households, and the pastoralists not only that they may not be likely to be culturally prepared for exercising ranching instead of pastoralism, but they may not have necessary initial capital.

7. CONCLUSION

The urgency to satisfy global needs for food towards the mid of the 21st century when human population will have increased by roughly 50% its current level sounds an alarm to current food production practices. Land use will long for ability even to utilize those areas not considered best for food production. General tendency will be necessarily in favour of more intensive rather than extensive production systems. With this challenge the vast wilderness idea of extensive practices such as nomadic pastoralism will continue to diminish, at least in the peripheries of crop cultivation. While in the free mobility pastoralism zone, the arid zone, pastoralism may continue to thrive parallel with or even more favorably as a livelihood than ranching, where there is overlapping between pastoralism as a farming system with crop cultivation farming systems, sustainability of such overlapping is seriously questioned.

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