Camel and Small Ruminant Based Pastoralism in Ethiopia: Recent Trends and Future Prospects

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Abstract

In Ethiopia, camel and small ruminant production are common pastoralism practices in three major pastoralist regions of Afar, Somali, and Borena. This review was aimed to indicate the recent trend and future prospect of camel and small ruminant production and the possible modifiers and the pros and cons of the practices in the pastoral area of Ethiopia. The data was collected from different researches conducted each year. The data was also organized in terms of the number of camel and small ruminant per household each year (2010-2020) and analyzed using trend and forecasting analysis model by SPSS software. There has been an increment of camel \textit{Tropical Livestock Unit} (TLU) per household from 2.78, 13 and 9 to 37, 28, and 28 between the years 2010-2020 in Borena, Afar and Somali respectively and will increase to 45, 45, and 35 by 2030, respectively. In the whole pastoralist regions, the number of camels TLU per household has increased from 2.8 to 31 between the years 2010-2020 and will increase to 50 TLU per household by 2030. Moreover, the number of goats and sheep has increased from 1.4 and 0.91 TLU per household to 2.45 and 2.46, respectively between the years 2010-2020 and the predicted model indicates that it will increase to 2 and 3.4 TLU per household by 2030. Climate change, drought and adaptation responses were the major drivers. Climate change coping and livelihood income improvements were the pros of the trend, while the reduction of cattle population and impact on the conservation of valuable indigenous cattle were the cons of the practice.

Introduction

Pastoralists in Africa are found in three natural zones; Mediterranean and Saharan zone, Sub-Saharan tropical and equatorial zone, and southern zone (FAO., 2018) and share 40% of the total continental landmass of Africa (Union, 2013). The way and extent of livestock rearing practice by pastoralists varied in this region mainly depending on the nature and characteristics of the environment (Lagat and Nyangena, 2018). In the drier parts of the regions, pastoralists majorly focus on the rearing of camels and goats, while in areas having a higher rainfall they focus on rearing of cattle, sheep, and goats (El-Hatmi \textit{et al}., 2015). Besides this, the type of livestock rearing is affected by social prestige (Alhaji and Isola, 2018). East African traditional substances pastoralists fully tends to keep large herds, milk cattle in preferences to eating them (Lombard and Parsons, 2015). In this decade, there is a dynamics and shifting of pastoralists livestock rearing practices in type and extent in Africa (McPeak \textit{et al}., 2011; Egeru, 2016; Hussein \textit{et al}., 2016).

The social and economic system on greater cattle production and the increase in environmental aridity through climate change hinder cattle-based pastoralism (Opiyo \textit{et al}., 2016), as a result of rangeland ecosystem services' degradation (Sala \textit{et al}., 2019). There is implication and evidence on pastoralists adjust their livestock composition and types in response to environmental extreme and unsuitability (Silvestri \textit{et al}., 2012; Kimani \textit{et al}., 2019 Bekele, 2013). Several studies indicate that pastoralists shift from cattle base pastoralism or from grazer to browser livestock rearing practices (Boru \textit{et al} 2014; Dirriba \textit{et al}., 2020). Cattle-based pastoralism is highly affected by environmental crises such as drought and different socioeconomic factors (Onono \textit{et al}., 2013; Kimaro \textit{et al}., 2018). Pastoralists involve adapting to
this environmental problem, especially by changing a livestock composition in type and extent (Opiyo et al., 2015) and by rearing browser and drought resistant livestock (Kagunyu and Wanjohi, 2014).

In Ethiopia, camels and small ruminant production considered as a strategy for coping and adapting drought-related hazards (Galma et al., 2017; Fano et al., 2018). The involvement of camels and small ruminant production in the whole pastoralist region of Ethiopia (Yosef et al., 2018; Aden and Kula, 2020) has increased average income and the risk for the pastoralist community has reduced (Belete and Shishay, 2019). Changing livestock complement through including more camels help the resiliency of community during drought due to several benefit length of lactating, consume some browse species and less frequency of watering and the ability to withstand harsh environmental conditions (Forrest et al., 2014). Studies recommend that boosting the capacity of the community on improving husbandry practices and product utilization as well as developing coordinated efforts for camel diseases, controlling and developing prevention schemes helps to strengthen the capacity of the pastoralists production system (Galma et al., 2017). Small ruminant production among pastoralists is largely undertaken along with large ruminants especially goats for the primary purpose of generating chase and full-filling basic needs. The feeding habit of various shrubs and tree level and acacia species, both during wet and dry season are preferable by pastoralists (Dirriba, 2020). Therefore, this review was focus on trend and future prospect of camels and small ruminant based pastoralism, the possible modifiers and the pros and cons of the practices in Ethiopia. The main objective of this review was to review the recent trend and future prospect of Ethiopian camels and small ruminant based pastoralism practices. More specifically, this review aims: 1) to review recent trends and future prospects of camels and small ruminant raring potentials’ in Ethiopia pastoralism. 2) To review the possible modifiers for the involvement of camel and small ruminant based pastoralism in Ethiopia. 3) To review the pros and cons of camels and small ruminant based pastoralism practice shift to other pastoralist practice.

**Method Of Review**

The data obtained from literature or research work was organized systematically. Several studies related to this topic were searched from google and google scholar using key terms or phrases and sentences. The number of camels and shoat per household was organized from different studies. The data was organized for each year (2010-2020) and estimated in terms of Tropical Livestock Units (TLU) per household; 0.7 for cattle 1 for camels and 0.7 for goats and sheep. The data was analyzed using trend and forecasting model analysis system.

**Recent Trend And Future Prospect Of Camel And Small Ruminants Based Pastoralism**

Camels and small ruminants based pastoralism practices are the common way of life in Ethiopia, especially in the drought-prone regions (Belete and Shishay, 20191; Yosef et al., 2014). It plays an immense contribution to the national economy of the country (Gezahegn et al., 2015), despite the challenge faced due to natural and socioeconomic factors (Zeraye, 2015; Fikru et al., 2017; Shishay and
Mulugeta, 2018). There is a large tendency from pastoralists currently, towards camel and small ruminant-based pastoralism practices (Bekele et al., 2011; Tesfaye, 2017). Individual's preference favor camels and small ruminant based practices relative to cattle (Wossene et al., 2020; Argaw et al 2016). It indicates a shift from cattle-based practices, compared to the past involvement. The perception of pastoralists about the importance of cattle-based and camels and small ruminant-based practices vary from individual to individual (Coppock et al., 2014), but averagely they prefer camels first, followed by goats and sheep as a second option (Minayahel et al., 2016). This may arise from the long-time experiences of pastoralists about the pros and cons of the practices (K. Marshall et al., 2016). Many studies indicate that pastoralists of Ethiopia prefer and involve in livestock production, which are viable and feasible for their uses (Angassa and Berhan, 2015; Dejene, 2015). The national livestock population trend also indicates a large increment of camels and small ruminants in pastoralist areas (Samson and Frehiwot, 2014; Getachew et al., 2015). Several scholars suggest and seen as a panacea for the current alarming environmental crises of drought or climate change (Yosef et al., 2013; Nega et al., 2019; Wassie and Fekadu, 2015; Dejene, 2015). Many studies in Ethiopia, indicates pastoralists shift from cattle-based system to camel and small ruminant based in this decade (Grum et al., 2012; Yohannes et al., 2015).

In three pastoralist regions of Ethiopia (Afar, Borena, and Somalia) there is a large percent of shift from cattle-based system to camel and small ruminant based, but there are a dynamics of up and down, especially in goat ruminants TLU per household (Fig-2), this may be due to the seasonal occurrences of many diseases (Mohammed et al., 2016). According to the trend analysis and forecasting model data from research works between the years 2010-2020, there has been an increment of camel TLU per household in the year 2010 from 2.78, 13, and 9 TLU per household to 37, 28, and 28 in Borena, Afar and Somali in the year 2020, respectively (Fig-1). There will be also an increment of camel TLU per household to 45, 45, and 35 in Borena, Afar and Somali, respectively by 2030 (Fig-1). There was and there will be an increment of goat TLU per household in the last and next 10 years, decade (Fig-1), but there was up and down of goat TLU per household in Afar and Somali pastoralist regions (Fig-1). Sheep TLU per household indicates an increment in the last 10 years and the next 10 years through the whole pastoralist regions (Fig-1).

Camel and small ruminant TLU per household in pastoralist areas of Ethiopia possessed an increasing trend. There has been a large gap between the years 2010-2020 with an increasing trend of the number of camel TLU per household that increases from 8.26 to 31 with large increment in the years 2019 and 2020. The number of goat and sheep TLU per household also has increased despite the dynamics of up and down in different years. The number of goats and sheep TLU per household has increased from 1.4 and 0.914 to 2.45 and 2.46 respectively between the years 2010-2020 (Fig-2).

Possible Modifiers

Climate Change Adaptation Potentials
Climate change has an impact on the livestock production of pastoralists in Ethiopia due to several reasons such as feed shortage, water shortage, reducing productivity, decreasing mature weight and lastly decline number of livestock or altering pastoralist livestock holding (Zelalem, et al., 2009). This brings livestock species composition variation because all species are not equally vulnerable to drought (Dejene, 2015 Asamenew et al., 2014). The number and type of species which are left and available during drought are not equally consumed by all livestock species and the extent and potential of adaptation by species vary (Hassanuur et al., 2020). This might be due to the number of TLU species death varies from species to species; cattle are the most victims and lag number of cattle per household mortality than camel and shoat (Fig-3). Because camel and sheep have the capacity to adjust their body temperature or elevated rectal temperature (Abdoun et al., 2012) and they browse species that are available during drought season (Treydte et al., 2017)

This indicates there is a variation on the level of susceptibility to climate change and camels and shoats have the least susceptibility potentials relative to cattle and cattle take the first rank (Fig-4). This brings the shift of pastoralist towards camel and small ruminant production rather herding a number of cattle.

High temperature resulted in heat stress and affects the metabolic performances of cattle and affects breeding practice, feed quality and reproductive managements (Collier et al., 2012). All animals have a range of ambient environmental temperatures termed the thermo-neutral zone, this is the range of temperatures that are conducive to health and performance and upper critical temperature is the point at which heat stress effects begin to affect the animal and this stress occurs when the temperature-humidity index (THI) > 72°C (Petzoldt and Seaman, 2006). Animal responses to their thermal environment are extremely varied, it is clear that the thermal environment influences the health, productivity, and welfare of cattle (Lees et al., 2019). In addition to this, it affects not only the availability of fodder but also the rangeland ecosystem services in general (Vrieling et al., 2016). The availability and composition of fodder in the rangeland ecosystem vary with season, the highest composition in rain season while low and poor in the dry season (Fig- 5).

The pastoral system in Ethiopia is not affected only by drought, but also affected by the occurrence of a flood. The occurrence of sediment on rangeland through excessive flood affects the availability of grazing resources and serves as an initiation for agricultural investment, due to the accumulation of fertile soils (Tilahun et al., 2020). The occurrence of high rain and flood affects and damages the landscape and settlements of pastoralists (Gumma et al., 2019). Flood affects pastoralist cattle production directly through mortality and indirectly by affecting grazing land and resources (Thornton and Gerber, 2010).

The Existence of Different Constraint for Cattle Production

Several factors, both social and environmental hinder cattle-based production of pastoralism practices than camels and shoat production (Hanover et al., 2016; Samson and Frehiowt, 2014). The existing rangeland degradation crisis affects the cattle-based pastoralism system in different places (Minyahel et
The decline of rangeland ecosystem services affect cattle production more than camel, goat and sheep production (Aster et al., 2012), beside, the emergences of diseases following rangeland degradation and drought affect the livelihood of pastoralist worthy that focus or more involve in cattle production more than pastoralist involved in camel and shoat or combined with cattle (Bekele, 2013; Temesgen et al., 2014). To cope up with this paradigm pastoralist involve camel and shoat production combined with cattle (Galma et al., 2017).

Pastoralist Preferences on Livestock Production

There is a change in preference of livestock production by pastoralists. Pastoralists prefer livestock production, which is complemented with the existing environmental problems (Galma et al., 2017; Fana and Asnake, 2012), they have their own criteria to prefer or involve in livestock production. The capacity to adapt and cope drought (Hussein et al., 2016; Amare., 2018), the labor requirement and difficulty to manage during drought, the market value and rate, the level and amount of loss during drought, disease susceptibility, accesses to fodder during drought time, and easy to sell and buy from market after and before drought as well as during starvation (Deresa et al., 2010; Zewdie et al., 2017; Dirriba, 2016). Under all these criteria, camel and shoat are preferable by pastoralists. Camel and shoat have a better adaptation capacity than cattle when drought happens (Boru et al., 2014), and it is easy to access fodder for those species than cattle during drought time (Aster et al., 2014; Treydte et al., 2017). The level of susceptibility to disease is low relative to cattle (Vordermeier et al., 2012; Haimanot et al., 2013), but it depends on the type of disease occurred some type of disease harm shoat and camel (Bekele et al., 2012; Sprague et al., 2012). The rate of the seal and market value of camel, goat and sheep are high relative to cattle, especially during drought times (Karanja Ng’ang’a et al., 2016; Hailemichael et al., 2015).

Better-off in Income Generation from Camel, Goat and Sheep Livestock

The potential to generate income from livestock vary from pastoralist to pastoralist and depends on the type of livestock they involve (Berhanu et al., 2013; Getachew et al., 2010). There is a gap in income generation from the seal of livestock between households and they engage in cattle production and camel and shoat production as well as combine the use of cattle, camel and shoat (Eyassu, 2009; Hussein, 2013). The frequency and percent of income from camel, goat and sheep is higher than cattle (Table- 2). Camel and goat take the first and second rank respectively in income-generating (Table- 2).

The income obtained from camel milk and cow milk variety in the amount and continuity (Belete and Shishaye, 2019; Sisay and Awoke, 2015). There is a variation in milk per household and per heads generating during wet and dry season compared to cow (Fig-6). This makes household focus towards camel rather cow to survive during a drought time. Mulugeta, 2018); the number of frequencies in a market seal from goat and sheep is higher in a year compared to cattle seal.

Pros And Cons Of Camel And Shoat Production On Pastoralist Livelihood
Pros

Pastoralist involvement in livestock diversification majorly by focusing on camel and shoat production, results in a range of benefits. Pastoralists are able to improve their livelihoods. The potential vulnerability as a result of climate change or drought is reduced (Wassie and Fkadu, 2015; Bekele, 2010; Allan, 2011). Many studies indicate that there is a variation between pastoralist households on the potential to adapt to climate change or drought, as a result of the type of focus or involvement on livestock production (Wassie and Fkadu, 2014; Boru et al., 2014; Asheber et al., 2018). Pastoralists involve camel and shoat production in separate or combined with cattle has better adaptation and coping capacity than pastoralist engage only cattle production (Samuel and Treydte, 2017; Ketema, 2015; Mohamed et al., 2020). Individuals involve in camel, goat, sheep and cattle production are more food, more secure than those individuals only involve in cattle production (Indris and Adam, 2013; Tsegaye et al., 2013). The different products of meat and milk obtained from the camel and shoat are higher in frequency and amount as well as continuity compared to the cattle (Shishay and

Cons

The production of camel and small ruminant affects cattle production (Zander and Mburu, 2013). It leads to the reduction of pastoralists’ to focus on cattle production (Zander, 2011). Those pastoralist having or involved in a higher number of camels and small ruminant has less number of cattle per household (Kagunyu and Wanjohi, 2014). In the three pastoralist regions (Borena, Somali and Afar), cattle population is decreasing from time to time, while camel population is in increasing trend in arid and semi-arid areas as a result of the combined effects of pastoralists’ need and the impact of climate change, which could position the indigenous cattle breed at risk in the near future (Yosef et al., 2013).

Conclusion And Recommendations

Camel and shoat production in Ethiopian pastoralists indicate a change in increasing trend. The trend and forecasting model from 2010 -2020 and in the next one decade indicates an increasing trend. There is an up and failing of the number of shoats per household in different regions of pastoralists areas. This might be due to vulnerability by pandemic diseases. Climate change and coping or adaptation strategies are the major drivers to focus pastoralists on camel and shoat production. Besides this; the amount, frequency and continuity of income from camel and shoat make pastoralists to shift to this practice. Climate change and drought coping and livelihood improvement are the major pros resulted from the practices, while reduction of cattle population and impact on the conservation of valuable indigenous cattle are the cons of the practices.

The primary focus on camel and shoat production by pastoralists may result fail, in the long future. Because:

- These three livestock species have more or less the same fodder preferences; this may bring niche shortage or competition in the long future, so it needs an investigation about the sustainability of the
practices in the long-lasting.

- This occurrence may global in the whole pastoralist regions and may bring global failure due to some catastrophic event or disease pandemic, so it will be better to investigate the possible consequences that emerged in the future.

- It may bring market failure, the major driver is climate change or drought and this paradigm has happened in the whole pastoralist regions, especially in Africa and may give the same responses by pastoralist users and result in cross border market failure in the future due to the livestock similarity between the regions in type and extent.

- It seems a shift from cattle-based, this also bring an impact on the cattle production sectors, so it needs to investigate the extent of the impact on the sectors.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

We have agreed to submit for Journal of Agroforestry Systems and approved the manuscript for submission.

Availability of data and materials

The dataset and materials used for this manuscript is available and can be shared whenever necessary. The data was generated by the authors from published articles, books, reports.

Competing interests

The authors declare that there are no competing interests.

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Authors’ contributions

Both authors downloaded the data from Google. They read and arranged the data and wrote the manuscript, both authors prepared and revised the manuscript critically. Finally, both authors read and approved the final manuscript.

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**Tables**

Table 1: Different constraint on cattle production perceived by pastoralist in drought season

| Constraints         | Percent of respondent |
|---------------------|-----------------------|
| Water scarcity      | 94.6%                 |
| Cattle diseases     | 92.9%                 |
| Range degradation   | 90.2%                 |
| Feed shortage       | 94.3%                 |
| Lack of market outlet| 76.4%                 |
| Predators           | 86.1%                 |

Table 2: Frequency, percent and rank of income from different livestock species

| District            | Frequency | Percent (%) | Rank1 | Rank2 | Rank3 | Rank 4 |
|---------------------|-----------|-------------|-------|-------|-------|--------|
| Gode                | 28        | 96.6%       | Camel | Goat  | Sheep | Cattle |
| Jijiga              | 22        | 68.8%       | Camel | Sheep | Cattle | Goat   |
| Shinille            | 26        | 89.7%       | Camel | Goat  | Cattle | Sheep  |
| Mille               | 22        | 73.3%       | Camel | Goat  | Sheep | Cattle |
| Amibara             | 29        | 100%        | Camel | Cattle| Goat  | Sheep  |
| Borena(Yabelo)      | 20        | 76.9%       | Camel | Goat  | Cattle | Sheep  |
| Borena(Moyale)      | 22        | 88%         | Camel | Goat  | Cattle | Sheep  |
Figure 1

Trend and prospect of mean number of camel and shoat per household in 3 pastoral areas TLU (2010-2030)
Figure 2

Trend and prospect of mean number of camel and sheep per household in TLU in pastoral household of Ethiopia (2010-2030).
Figure 3

Mean number of deaths per household in TLU by drought

Figure 4

Level of susceptibility to climate change (Rank)
Level of susceptibility by drought in different livestock species

Figure 5

Rangeland biodiversity composition and conditions under different climatic season (Ayana et al., 2006)
Figure 6

Mean value of milk per head and per household in different season from camel and cows