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A REVIEW ON INDIGENOUS CATTLE GENETIC RESOURCES IN ETHIOPIA: ADAPTATION, STATUS AND SURVIVAL

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ABSTRACT: Ethiopia is endowed with different Indigenous cattle genetic resources with millions of people directly depending on them. However, despite the potentials of these diversified genetic resources, the huge loss of cattle genetic diversity is becoming a prominent challenge these days. The aim of this review is to show the current status and performance of some selected indigenous cattle breeds of Ethiopia for better understanding of the situation of these breeds for the collective efforts towards conserving and improving the breeds. Based on the review, there are persuasive evidences on the critical situation of the selected indigenous cattle breeds. The facts and figures of the past and current situation of the selected indigenous cattle of Ethiopia showed that the situation of these breeds is very critical. This situation therefore demands the need to devise strategies to conserve and improve the cattle breeds based on the challenges that threatens them. Use of new biological and information technologies is also imperative to facilitate the genetic restoration process. Besides, use of new biological and information technologies which can enhance the conservation and improvement program are crucial. Various ongoing development interventions like Artificial Insemination and introduction of genotypes into new environments that are exacerbating threat of the breeds should totally be avoided by revising and designing sound approaches for cattle Conservation and improvement programs. Strict regulations and by laws should also be in place for illegal movement of breeding cattle to the neighboring countries.

Keywords: Genetic Resources, Indigenous Cattle, Ethiopia

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INTRODUCTION

Indigenous animal genetic resources are believed to preserve much of the current global genetic diversity with millions of people directly depending on them for the livelihood of the people (Rege and Gibson, 2003). According to Bradley et al. (1998), the earliest cattle introduced in Africa is *B. taurus*. However, literatures indicated that later on the genetic landscape of African cattle had been profoundly changed by waves of immigration of humped *B. indicus* like the most recent immigrant Zebu cattle which was mainly being centered East Africa, around Ethiopia and neighboring countries (MacHugh et al., 1997; Clutton-Brock, 1989; Rege, 1999; Hanotte et al., 2000 and 2002). Subsequent interbreeding of the zebus with the local taurine longhorns produced the present-day sanga cattle and the second introduction of zebu led to the emergence of zenga breeds and their different strains adapted to the diverse ecological environments in the East African highlands (Rege, 1999).

Ethiopia in particular and horn of Africa at large own the highest concentration of domesticated and diversified cattle (*Bos indicus* and *Bos taurus*) in the continent (Rege, 1999). Hanotte et al. (2000) also concluded that east Africa is the cradle of the largest number of African zebu population. This might be because of the fact that Ethiopia is believed to have been a gateway for cattle immigrations into Africa (Hanotte et al., 2002). It is indicated that cattle may have penetrated to Ethiopia in the middle of second millennium B.C (Epstein, 1971). According to Li et al. (2007) the country, Ethiopia, is considered to be a putative migratory corridor for both Near-East Bos taurine and Arabian and Indian *B. indicus* cattle into East Africa. Therefore, in general, the country is considered as the home of most important cattle breeds for eastern and southern Africa (Hanotte et al., 2002; Ayalew et al., 2003) and enriched with 31 recognized indigenous cattle breeds (IBC, 2004; DAGRIS, 2007). The diverse agro-ecology, cultural and ethnic diversity, a long-lasting agricultural practice and farming systems in the country have contributed to be a centre of secondary diversification for livestock in the continent (IBCR, 2001; Takele et al., 2011).

Despite the potentials of diversified genetic resource, the huge loss of livestock genetic diversity in developing countries will seriously undermine the efforts towards achieving food security and poverty reduction (Zerabruk et al., 2007a) *viz avis* the long-term effect on global biodiversity. The intervention trials of the animal diversity, for instance in Ethiopia, has been poorly addressed in contrary to the efforts made on recognition of the importance of conserving plant biodiversity (Nigatu et al., 2002). In line with this, as the percentage of the total

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number of existing breeds that have population data (and therefore the risk status is known), the number of mammalian breeds recorded in the African region at risk of extinction has increased from 8% (of 179) to 19% (of 388) since 1995 (Garrine, 2007). Similarly, apart from the absence of documenting impact of the losses and the unquantified within breed diversity (FAO, 2007), 31% of cattle breeds found globally are currently at risk and already extinct (FAO, 2009a). Especially the situation is very serious in developing world where rapid changes in production systems are leading to replacement of the breeds or at best cross breeding (Zewdu, 2010). A total of 22 breeds (13%) of the previously recognized have become extinct in the last Century in Africa (Rege, 1999). This figure has grown up to 22 % of risk extinction in parallel with 47% of the 150 identified breeds which are getting threatened in Africa (FAO, 2007). Most breeds may even perish before they have been exclusively recognized and exploited (Okeyo et al., 2010; Hoda et al., 2012). In this regard, Pilling (2010) stated that knowledge regarding the threats facing particular breeds and production systems is yet patchy and often unavailable to relevant stakeholders. The absence of information on the level of genetic introgression of the indigenous Boran cattle (Nigatu et al., 2002) can be a very good example. The lack of knowledge about threats often goes hand in hand with a more general lack of knowledge about the characteristics, use, management and distribution of livestock breeds (Pilling, 2010). For instance, in the absence of conservation measures to be implemented, half of the current cattle diversity in Africa will be lost in the next 20-50 years (Reist-Marti et al., 2003). The situation in our country is becoming serious. Though most parts of the country have been assessed in-terms of identifying the livestock genetic resources, some of the livestock breeds identified are found at risk with unwise utilization of each breed consecrated.

Thus, in cognizant of these facts there is a need to sensitize various stakeholders (the scientific community, funding organizations, research institutes, government officials and others) to come together and internalize the problem first, to design conservation and utilization strategies, and to show their commitment for the implementation of sustainable breeding/conservation programs so as to alleviate the challenge our indigenous cattle genetic resources are facing. Therefore, this paper aims to review the current status and performance of some selected indigenous cattle breeds of Ethiopia for better understanding of the situation of these breeds for the collective efforts towards conserving and improving the breeds.

Description and distribution of the breeds

Sheko cattle Breed: Tatek and Abegaz (2013) mentioned that it was in 1929 from South-west Ethiopia at which the first report about Sheko cattle was made and later in 1982 (Albero and Haile-Mariam, 1982). However, it is not Sheko rather Gimira (Kuri-humpless long horn) cattle of Ethiopia which was mentioned in 1929 for the first time by *Encyclopedia britanica*. Despite discrepancy of these reports, currently, Sheko cattle is found only in the remote corner of southwestern Ethiopia specifically at the humid Sheko and Bench districts owned by small holder farmers who breed them for millennia of years for their natural resistance to disease, particularly tsetse-transmitted trypanosomosis (ILRI, 2007). This breed represents the last remnants of Africa's original *Bos taurus* (humpless shorthorn) cattle which were probably the first to be domesticated in eastern Africa (ILRI, 2007). The phylogenetic, genetic distance based, analysis of the breed indicated that Sheko cattle are distantly related to Sanga cattle breeds of Ethiopia (Dadi et al., 2008). They are smaller in body size, with narrower belly and hindquarters, and shorter or no horns which made them much easier to manage (Takele et al., 2009) (Figure 1). Sheko cattle have better feed conversion efficiency, longevity, fertility good mothering ability compared to other cattle breeds in adjacent areas. Fast growth rate and possession of larger teats than the comparators were also noted as useful traits to improve milk production of the Sheko breed (Takele et al., 2009). Rege (1999) had also emphasized that, from the view of their morphology, Sheko cattle appear to have been deliberately developed for milk production (Rege, 1999). However, these days some of the Sheko cattle manifest small humps that they inherited from zebu introgression (Tatek and Abegaz, 2013). On the other hand, their occasional aggressive temperament and voracious feeding habits, particularly during the dry season, were mentioned as undesirable traits which trigger its keepers to intentionally reinstate with smaller breeds of lower feed intake (Takele et al., 2009).

Figure 1. Sheko cattle (DAGRIS, 2007)

Boran cattle Breed: According to Mpofu (2002) the Boran is believed to have been originated from south-west Asia and developed by the Borana people, southern Ethiopia. This breed is also believed to be the ancestor of the other renowned indigenous Fogera cattle breed predominant in the Lake Tana Belt of Northwestern Ethiopia (Ibid). The Boran also then spread to Somalia (Ethiopian-Somalia border) and known as Somalia Boran or *Awai* and was further extended to South-eastern Ethiopia (Mpofu, 2002). Nigatu et al. (2002) had also reported that Boran cattle are being raised by both the Boran and Somali ethnic groups in Ethiopia. Rege and Tawah (1999) had also ascertained Ogaden cattle are an ecotype/strain of the Boran found in Ogaden and Eastern Hararghe. They were further distributed by the nomads of southern Ethiopia and Somalia who migrated to Kenya and in the late 1920s where by European ranchers in Kenya purchased these cattle and developed the Improved Boran or Kenya Boran through selective breeding. It was then introduced to Zambia in 1947 and to South Africa in the 1960s (Mpofu, 2002; BCBSSA, 2005).

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With regard to the phenotypic characteristics of the breed, Gillooly et al. (2001) described that a typical Boran cattle have white coat color, and large dewlap and hump. But mostly they have light grey or fawn with black or dark brown shading on the neck, head, shoulders and hindquarter and shorter, more pendulous sheath, well developed hump, well developed udder, long legs, wide ear and large dewlap and erect horn orientation with dominantly thick base (Getachew and Nigatu, 2001; Rege et al., 2001 and Nigatu et al., 2002; Getinet, 2005) (Figure 2 and 3). However, based on the survey report of Nigatu et al. (2002) it was revealed that the Ethiopian Boran cattle known by the community 50 years ago were not identical with the current Ethiopian Boran types, especially in terms of their body size and coat color. The body size decreased and the current color is becoming variegated as opposed to white and grey characteristic of the Boran due to the probable genetic admixture with small sized zebu.

These phenotypic characteristics are a result of adaptation mechanisms of the breed to the harsh environments. For instance, white color is helpful in thermo-regulation ability; long legs to trek long (60 km per day) and wide ear and large dewlap help to increase the surface area for metabolic heat dissipation. Those of Somali Boran cattle have white with black patches coat color (Rege et al., 2001 and Nigatu et al., 2002).

Begait Cattle breed: Begait cattle breed, alternatively called Barka, is believed to be originated from Sudan and low lands of Eritrea (Zerabruk et al., 2007b). They are currently, found in Humera area of Ethiopia. Begait cattle is phenotypically relatively large in size with a well developed udder, small and stumpy horns in both male and females, long teats, a higher milk yielder and aggressive nature (Ibid). The common coat colors are grey, brown, and black and white (Figure 4 and 5). In terms of susceptibility, they are very vulnerable to food shortage.

Figure 2. Boran bull (Source: Workneh and Rowlands, 2004)

Figure 3. Boran herds at South-west Borana plateau

Figure 4. Begait herd at Humera ranch

Figure 5. Begait bull at Humera res. Center

Fogera Cattle Breed: Fogera cattle breed are considered as a definite breed which inhabits the Fogera plains around Lake Tana, Ethiopia having its own defined phenotypic and genetic characteristics. Regarding its origin there are two schools of thoughts as stated by different scholars. According to Rege and Tewah (1999), Zewdu (2004) and Zerabruk et al. (2007b) it is believed that it is a Zebu x Sanga (called Zenga) breed. In other words it is believed that it is cross of various strains of Ethiopian highland zebu, Nilotic sanga and Abyssinian sanga (Rege and Tawah, 1999). In contrast, Mpofu (2002) suggested that the introduction of Boran cattle (low land zebu) around Lake Tana Belt by the Nomads from the south might have been the origin of Fogera cattle breed. According to the hypothesis of Mpofu (2002), the nomads from the south moved northwards and settled with their cattle in the areas of west and south of Lake Tana where the cattle became known as Tanaland Boran. In this connection, despite the low bootstrap estimates that indicate the sampling bias, the protein polymorphism as well as nuclear DNA reports ascertained the close relationships between Fogera cattle (the breed currently found around Lake Tana) with Boran or Ogaden cattle breeds (Sisay, 1996; Dadi et al., 2008) (Figures 6 and 7).

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Even though it is not supported by research, there are some people who link few places with names of Oromo tribes like Yilmana Denssia, Jawie and Mecha (which are proxy to the belt of Lake Tana) to the coming of the Oromo nomads (Habitamu, 2014). The same author stated that the tribes were allotted by the Central government to stay in those mentioned place following their arrival during the 15th and 16th century. This school of thought invites social anthropologist to investigate the concrete expansion events of the Borana people with their cattle up to Lake Tana area for scientific enquiry.

Needless to say both schools of thoughts might have true implications regarding the origin of Fogera cattle as both events might have occurred over years in the history of the breed. In this sense, it looks that the breed might have been introduced by the nomads as a Tana Land Boran and further crossed with other Sanga types which gave its current description. Fogera cattle are generally of relatively larger size and long legs. Their coat color varies, black-and-white or black – and –grey coat (Rege and Tawah, 1999; Zerabruk et al., 2007b). Most of their characteristics (small horns, very large dew-lap, pendulous naval flap and perpetual sheath, docile) indicate the characteristic of zebu cattle (Rege and Tawah, 1999; Zewdu, 2004; Fasil, 2006; Zerabruk et al., 2007b) (Figure 8 and 9). Only the hump, which in most of the cases is rather small and cervical or cervico-thoracic in position (Rege and Tawah, 1999) represent the sanga genetic influence. These cattle, therefore, have been classified by breeders as intermediate zebu-sanga type.

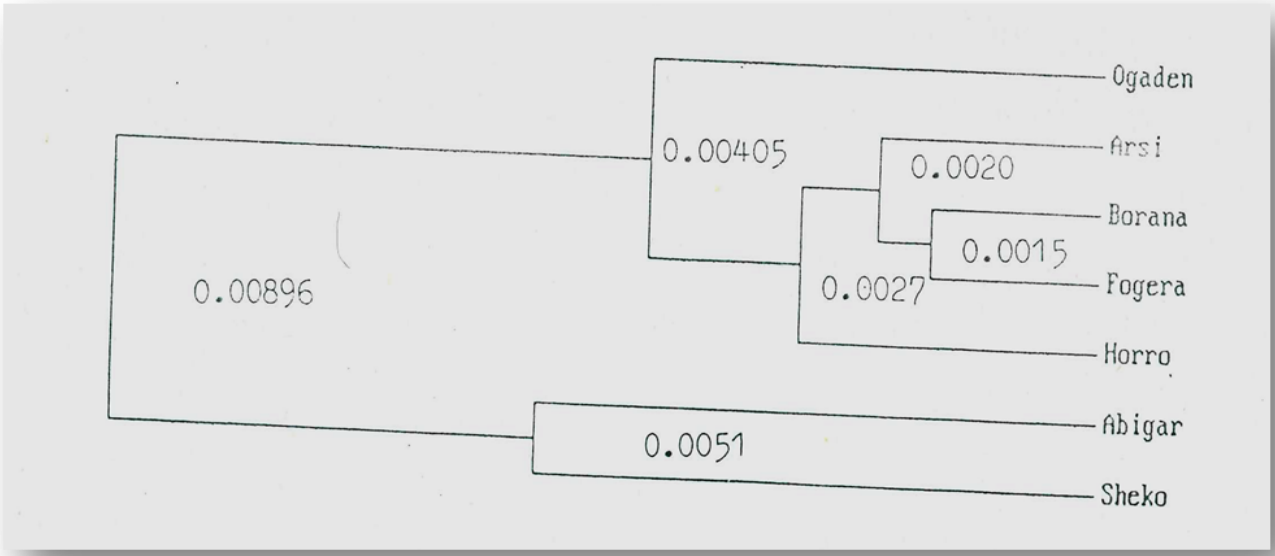

Figure 6. UPGMA tree summarizing genetic relationships using blood protein polymorphism (Sisay, 1996)

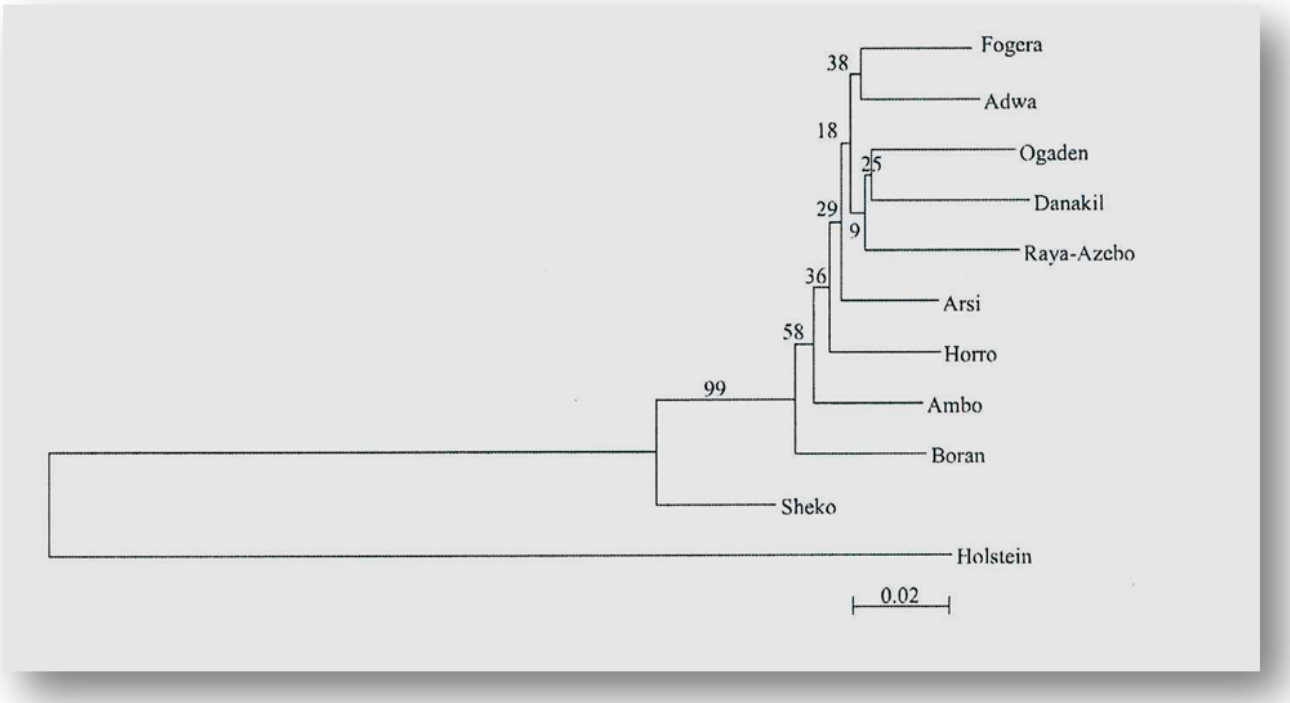

Figure 7. Neighbour-joining dendrogram summarizing genetic relationships using DA genetic distances based on 30 microsatellite loci (Dadi et al., 2008)

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Disease resistance and Adaptability

According to ILRI (2007) report, Sheko breed has been recognized as one of Africa's "Big Five" vintage cows having great potential to form the genetic backbone for future survival. Dadi et al. (2009) had also explained characters related to disease resistance and adaptation to extreme environments of the breed could prove fundamental to food security for the present and future human generations. Apart from N'dama cattle, Shecko cattle is one of the trypano-tolerant cattle strain in Africa which lets to thrive in a trypanosomiasis infested area of the country especially in wet areas of Ethiopia, South and South-west parts where trypanosomosis coverage exceeds 180,000 to 200,000 km^2 of agricultural suitable land. This breed which shares some genetic characters with the West African Shorthorn cattle (Alberro and Haile-Mariam, 1982) and N'dama cattle breed (having ARHGAP15 and TICAM1 functional polymorphic markers that could affect the response to infections) (Noyes et al., 2011) are recognized as trypanotolerant breeds which possess trypanotolerance character better than other indigenous cattle breeds in Africa (Lemecha et al., 2006; Dayo et al. 2009; Stein et al., 2011; Takele et al., 2012) and very important for sustainable agricultural development in tsetse infested area.

In this regard, according to the reports of MoA (1995), more than 20% of Ethiopia's landmass in the west and southwest was infested by trypanosomosis, which even could be higher when the north western and pocket areas of the south and southeast of Ethiopia are considered (Takele et al., 2012). Apart from importance of the breed for tsetse invaded areas because of its trypanotolerance nature, molecular characterization of the Sheko breed indicates that it has high genetic diversity with numerous unique alleles which may be vital for future breed conservation (Dadi et al., 2008). This fact really underlines essentiality of rearing of trypanotolerant Sheko cattle breed and designing conservation and improvement strategies for this peculiar adaptive breed.

The molecularly and clinically evidenced trypanotolerant nature of this breed should await either a transgenic technique or a breeding program to make use of such unique qualities of the breeds for increment of the productivity of arable as well as livestock-based farming systems by making draft power available to tsetse infested areas in addition to the direct benefits from their products like milk and meat.

Like Sheko cattle breed which is trypanotolerant, conserving local breeds which are adaptive to the local environment are critically important. It is strongly believed that to adapt the production systems to radically changing conditions, traditional/local breeds offer diversity which is the only base for future selection and adaptation as does plant genetic diversity (ILRI, 2007). For instance, both Boran and Begait are drought tolerant and withstand water thirst. Boran cattle can stay two to three days without thirst (Nigatu et al., 2002). The genes that Boran cattle carry are mainly the result of a long-term natural selection under harsh environmental conditions. They have developed adaptive traits of crucial importance for their survival (BCBSSA, 2005). Zerabruk et al. (2007b) indicated that Begait cattle breed is well adaptive to arid and semi-arid conditions where as Fogera cattle adapt to survive in flooded and swampy areas for several months.

Populations' status and their voice of survival

Population status: Africa, a continent which is believed to be home to diverse and genetically unique ruminant livestock and wildlife species, is missing its genetically diverse livestock genetic resources at an alarming rate (Okeyo et al., 2010). This on-going loss of the livestock genetic heritage is tantamount to losing a road map for survival - the key to food security, environmental stability and improving the human condition (ILRI, 2007). According to various scholars report, the situation in Ethiopia seems very critical and remarks to be keen in terms of internalizing the challenges, revising development intervention approaches which are threatening potential breeds and to redesign them, and bringing the fragmented hands together and act accordingly.

For instance, in the last 15 years, different literatures indicate that there is very high population reduction of Sheko breed. According to Rege (1999) who had identified Sheko cattle (the humpless shorthorn of East African cattle group) breed as endangered breed in Ethiopia, the population was estimated about 31,000 and later declined to 4040 which constitute only 2% of the total cattle population in the known breeding tract of Sheko (Takele, 2005; Takele et al., 2007), further declined to 2400 (ILRI, 2007; Dadi et al., 2009) and 1967 by the year 2011 (Tatek and Abegaz, 2013). The later report was based on secondary data collected from district agricultural office and in terms of population group 562, 231, 421, 651, and 102 of 1967 were heifers, bulls, oxen, cows and calves, respectively (Tatek and Abegaz, 2013). These all figures confirm and reverberate sparks of echo for survival, a widely held notion, Sheko breed is indeed endangered and the apprehensive declining trend. Figure 10 shows the highest probability of missing Sheko cattle soon like Gimira (Kuri cattle-the humpless long horn) of Ethiopia which has been already Extinct (Rege, 1999).

Figure 8. Fogera Bull at Andassa Livestock Research Center (ALRC)

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Similarly, this declining trend is also being observed in Boran and Fogera cattle breeds. The Boran breed is threatened not only by effect of genetic erosion due the introduction of small zebu cattle from Bale area, through uncontrolled mating and human purposive selective breeding for improvement towards the desired genetic traits (Nigatu, 2001; Sabine et al., 2004). Population size of Fogera cattle was also estimated to be more than 800,000 in the beginning of 1980s (Alberro and Haile-Mariam, 1982), 86,500 (Rege, 1999) and declined to 15,000 heads in the beginning of 2000s (Gebeyehu et al., 2004). This might be because of lack of indigenous animal genetic resource management by farmers and a shift in the production system of the area within the last 30 years (Adebabay, 2014) and indiscriminate cross breeding practice (Zerabruk et al., 2007b) in contrary to the Afar cattle breed which is protected by the traditional indigenous animal genetic resources management systems of the pastoralists.. The Figure 11 can clearly show the degree of genetic admixture in the main home tract and how much the breed is affected by indiscriminate cross breeding practice with highland zebu.

Figure 9. Fogera Cow at Blue Nile fall under farmers management

Similarly, even though, the population size of Begait (Barka) in Ethiopia has not been figured out, Rege (1999) had indicated Barka cattle in Eritrea were estimated to be 850,000. Later, Zerabruk et al. (2007b) estimated the extinction probability of Begait cattle in Ethiopia to be 67% within the coming 20-50 years that might be due famine and war, and next to the danger of cross breeding.

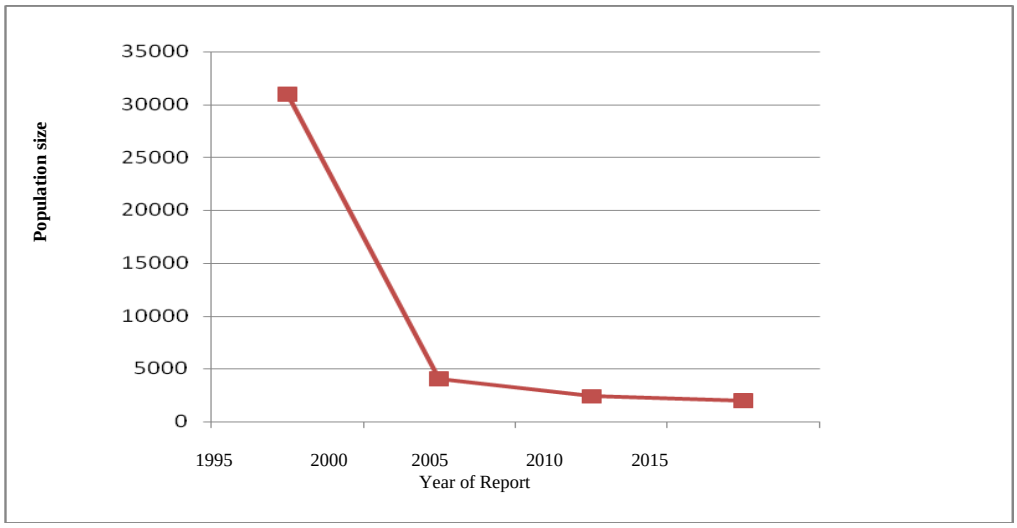

Figure 10. Sheko cattle population: a declined trend (Source: Tatek and Abegaz, 2013)

Figure 11. Are they really Fogera cattle? Cattle herd at Fogera cattle breed home tract, Fogera district

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Major causes of the threat

Among other things, Okeyo et al. (2010) had mentioned some of the reasons that aggravate threat of Africa's indigenous cattle as follows. These includes: unfair competition from vigorously promoted commercial European breeds, even where such genotypes are inappropriate, unplanned crossbreeding with commercial European breeds, globalization and the supermarket revolution where standards of livestock products are made to mirror the developed world's tastes and requirements, absent or poor breeding program design and implementation plans, lack of infrastructure (e.g. recording systems, breeders organizations etc.) and policy frameworks to support sustainable breed improvement programs. Few of these factors can be mentioned as the major contributing factors in threatening the indigenous cattle breeds in Ethiopia.

Presence of high gene flow and admixture among indigenous breeds: The presence of high gene flow and admixture between indigenous cattle breeds is one of the major contributing factors in threatening unique breeds (Zerabruk et al., 2007a; Hoda et al., 2012). In Borana area, pastoralists usually move to look for feed and water resources which leads the breed to be admixed with the surrounding small sized zebu in the watering and feeding points (Getachew and Nigatu, 2001; Nigatu et al., 2002). Similarly, there is indiscriminate crossbreeding and high affinity of reinstating Sheko cattle by other thoracic-humped zebu cattle which have good temperament (Rege, 1999; Takele, 2005; Takele et al., 2007; Dadi et al., 2009). With this respect, the molecular genetic evidence also showed that about 90% of the sampled Sheko bulls have had their specific taurine allele replaced by indicine allele confirming an alarming introgression of Zebu genes (Hanotte et al., 2000). In the pastoral area, like Borana plateau, the conflict between clans on control over resources has also contributed to genetic admixture due to raiding (the animals obtained through raiding are reared to increase animal number). In general, various molecular studies (Sisay, 1996; Fedlu et al., 2007; Zerabruk et al., 2007a; Dadi et al., 2008; Zewdu, 2010; Zewdu et al., 2012) conducted on indigenous cattle genetic resources in Ethiopia indicate that the genetic diversity among breeds is very minimal. This is just because of the fact that there is high pressure of breed admixture and uncontrolled breeding program.

The alarming increment farm land at the expense of grazing lands: Pasture and grazing lands are decreasing due to various reasons which are related to the biological and behavioral nature of the breeds, natural disaster and other development interventions priorities. For instance, apart from the aggressive nature of the breed which provides difficult to manage the animals in tethered feeding system Sheko breed is known with its high feed intake that contrasts to the high farm land expansion in the home track and consequently causes to shrinkage of grazing land (Rege, 1999; Takele 2005 and 2010; Dadi et al., 2009). On the other hand, pastoralists identified scarcity of pasture in Borana range land due to the increasing recurrence of droughts as the main cause shrinkage of the grazing land (Sabine et al. (2004). Due to this, cattle are losing their predominant position to small ruminants and camels (Nigatu, 2001; Sabine et al., 2004). Diress, et al. (2003) also stated that the change in the rangeland condition has infavoured cattle rearing compared to camel and goat production. The shift from livestock dominant mixed crop livestock production system to crop dominant mixed crop livestock system has also affected the indigenous Fogera cattle breed. In this regard, the expansion of dominantly rice and other crop farming at the expense of productive communal lands is interfering with the production and productivity potential of the breed.

Recurrent drought and war: Literatures indicate that recurrent drought and war were frequently affected various parts of the country. In Borena area drought was occurred during 1984/85 and 1995/1997 which caused to the decline of the cattle population by 60 and 78%, respectively (Sanford and Yohannes, 2000). Similarly, more than 70% reduction in population size was recorded between May 1999 and May 2000 in the southern Somali and Borena regions (Devereux, 2000). The large sized animals, the Boran cattle, which demand high metabolic maintenance requirement couldn't cope up the drought occurrence compared to small sized zebu. Therefore, sometime there is intentional shift to small sized zebu, like small Bale highland Zebu, *Ayuna* and other intermediate, by pastoralist (Getachew and Nigatu, 2001; Nigatu et al., 2002).

Similarly, the north Ethiopian region had been a centre of some of the longest civil wars in Africa and this has led, among other things, to the accelerated destruction of eco-systems and natural resource degradation resulting in recurrent drought and famine (Zerabruk et al., 2007b). The highest meat demand by the huge number of army stationed in the region, particularly between Ethiopia and Eritrea border since 1998 has been also mentioned as one of the potential concern in creating extreme pressure on the livestock populations found in the region (Zerabruk et al., 2007b). This pressure can also be considered as one of the causes of the livestock threat in the south-eastern region because of the huge military based in Somalia and Ethiopia to fire back *Al Shabaab* terrorist group since 2009.

Inappropriate and imbalanced development interventions and absence of institutionalized breed improvement intervention: Various studies indicated that in most of the indigenous breeds in Ethiopia, there is no any active research and development work targeted towards conservation, example, Sheko cattle (Tatek and Abegaz, 2013). Rather, mostly practiced breed improvement interventions are contributing for the loss of indigenous genetic resources. When one can see the interest of conserving the local livestock types has decreased over the last 25 years in response to the expansion of highly productive livestock breeds at the expense of local populations (Hall, 2004). For instance, there is provision of AI service (exotic blood) in the home land of Sheko breed and introduction of Boran breed for farmers with a subsidized cost in some selected districts of bench Maji

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zone (Tatek and Abegaz, 2013). Such treat of introduction of Boran cattle breed was practiced, still going on, in Metema area and other places. The restocking programs by Non Governmental Organizations (NGOs) was identified and considered potential influential factor in changing the genetic constitution of the native breed populations. In line with this Nigatu et al. (2002) reported that 50% of farmers' herds are composed of admixture in Borana area. The absence of institutionalized schemes for genetic improvement of the breeds have encouraged the practice of exchanging of superior bulls among closely related herdsmen apart from the massive admixture of herds of various origins (Zerabruk and Vange, 2005; Zerabruk et al., 2007b) which have unique and potential attributes. This practice is significantly observed among north Ethiopian indigenous cattle breeds including Fogera and Begait cattle.

Increasing demand of the indigenous gene pool: This point may not a big concern, at this time, particularly for the cattle breeds mentioned above. But this does not mean that the interest and demand for large animals by the local people in Ethiopia is still low. For instance, Fogera cattle breed is preferred for its relatively larger body size for domestic market and illegal foreign trade to Sudan border. Different literatures revealed that there is intentional cross breeding between indigenous cattle breeds in search of large size animals (Getachew and Nigatu, 2001; Nigatu et al., 2002). Due to this reason, many development agents pick better performing animals from their home tract and introduce to other environments with complete negligence on the fate of the breed and its effect on the genetic dilution with the native indigenous breeds. Apart from that, it is quite clear that Ethiopia is home and main gate of many of African cattle breeds, example, the Boran breed which is now widely distributed beyond Africa. Kenya is the major beneficiary in providing the improved Boran gene pool to the market. Many of the countries which introduced the Boran have developed their own Boran breed. The performance difference of Boran at its original home land and where it is improved is quite large. Conversely, the breed is becoming threatened at its homeland. It is proverbed that "*If you can't breed them buy 'em*" (BCBSSA, 2005). Yes indeed that genetic resource is a global property. One may use unwisely but others do it in a better way to make use of the genetic resource they obtained. As authors, we prefer to say that *"If we couldn't breed them buy 'em back and breed"*.

In general, these all points indicated above provide evidences how indigenous cattle populations are loosing their initial genetic architecture and landscape.

Possible options of interventions and points to be considered

Focusing on insuring infrastructures: According to FAO (2007) African countries are described with shortage of the technical, physical, institutional and financial resource capacity needed to enable sustainable utilization and genetic improvement of their livestock. Meticulously, Ojango et al. (2010 and 2011) commented inefficiency of the human resources who have got trained in the area of Animal genetic resource management.

Ethiopia as part of African countries, these gaps are significantly seen and caused for the reduction and poor utilization of the livestock genetic resources. Hence, apart from supporting policy which is the major infrastructure in breed conservation and utilization program, infrastructures like physical facilities, functioning recording and genetic evaluation systems, efficient and workable organizational and institutional frameworks and linkages, well trained personnel and long-term financial support are critically thought and be in place. The strong links between these mentioned components are also essential (FAO, 2009b, 2010, 2011).

Formation of breeders' society as an alternative tool for arresting genetic erosion: Formation of breeders' society can be one of the means to arrest the deterioration of the indigenous gene pool of the various cattle breeds. In line with this, Strydom (2008) indicated some of the successful breeder societies that have helped to make use different economic important traits of the breeds. Examples of the breeders' societies are the Drakensberger Breed Society which was formed in 1947 in South Africa, the Tuli Breed Society formed in 1961 in Zimbabwe, the Bonsmara (a composite indigenous breed originated in the 1940's) and Shorthorn/Hereford breed society established in 1964. Similarly, Mpofu (2002) has also indicated formation Boran breed societies in various countries like Kenya, Zambia and Australian. The Boran cattle breed breeders' society in South Africa is also one of the strongest bovine breed society established in the beginning of 1960s (BCBSSA, 2005). For the success of utilizing, for instance, from economic benefits of Boran cattle breed, the breeders' societies had contributed a lot in outlining and designing the conservation and improvement programs. Therefore, Ethiopia can learn from those countries and show efforts for the implementation. Kefena et al (2009) had also suggested the importance of formation of breeders' society in Ethiopia.

Production system tailored breed improvement program: Ethiopia is characterized in having various production systems ranging from intensive livestock production system, though this very limited share and coverage compared to others, to pastoral based livestock production system. The diverse agro-ecologies the country is endowed with had contributed to have such numerous production systems that demand to understand the genetic diversity of the animal genetic resources accordingly. Therefore, the breed conservation and improvement programs should be carefully tailored to the specific production systems.

Substantial reduction of cattle number as an intervention of breed improvement program: Apart from the genetic introgression of breed admixture, especially in countries like Ethiopia, the within population genetic diversity is incomparably higher than the between population genetic diversity. This is because of the fact that the practice of extensive random mating and absence of selection. This allows poorly performing individual animals to be reproduced. Therefore system based reduction of number of animals should be part of the breeding program to be implemented. Such strategies will have simultaneous advantages in taking the edge of environmental

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degradation due overstocking, reduce environmentally harmful methane emissions and helps to utilizes potential advantages of ecologically and environmentally friendly breeds.

Exercising informed conservation programs: Conservation and breeding programs should also be supported with information technology. In this era of information technology one can dig maximum information from the genomic data of a given population that can provide to design efficient and accurate conservation and improvement programs. In connection with this, Okeyo et al. (2010) indicated that integration of the advanced information technology with the genomics and bio-informatics allows collection and real-time remittance of the biological data for safe storage and management. This in turn provides opportunities for fast turnover and feedback potentially to a wide variety of stakeholders. Not only genomic information together with advanced information technology facilitates conservation and utilization of the animal genetic resources but also the advancement of reproductive technology highly helps for the breed conservation and improvement program implementation (Okeyo et al., 2010).

Capitalizing and scaling up indigenous resource management practices: Uncompromised development interventions are one of the bottle necks in affecting the sustained survival of indigenous cattle populations in their own natural habitat. For instance, the traditional natural resource management practice of the Borana pastoralists has been severely disturbed mainly by such inappropriate development interventions (Sabine et al., 2004). In this area numerous water ponds in the traditional wet season pastures were constructed which eventually discouraged seasonal mobility of herds and opportunistic resource exploitation. Besides, the indigenous institutional and social networks by which pastoralists governed access to pasture and water resources have been severely compromised (Sabine et al., 2004). The replacement trend of large-framed Ethiopian Boran (Qorti) by small size type of Boran (Ayuna) can be a very good indicative. According to Sabine et al. (2004) large framed Boran cattle are considered not competitive when the grazing resources are scarce and the pastoralists select small sized type of Boran cattle which have lower demands on forage. Side by side pastoralists are increasing the adoption of small ruminants and camels. One of the root causes of the species replacement is the development intervention introduced in the area that highly disturbed the indigenous and traditional practices accustomed by pastoralist in governing the natural pasture and water resources.

Since longtime ago, farmers especially pastoralists, used to have their own practices to manage and utilize the resources they have and had sustainably employed their practices and utilized the genetic resources. Therefore, new interventions should compromise the local context of indigenous practices which pastoralist or farmers have been acquainted with to meet the intended objectives in any of the development programs. This helps the pastoralists to efficiently utilize the resources they have and maintain their indigenous cattle breeds.

Maintaining and consolidating traditional social structures: In the local community, there are ample of traditional social structures which had been, perhaps have been, functioning since long time before. Those social structures contribute in resolving conflicts in between, predicting the upcoming natural as well as human intervened disasters and other advantages. The traditional social structure of the Borana people which have maintained for long in managing the livestock production and productivity issues can be a very good example (Sabine, 2004). Next to *Abba gadda* (the president) *Abba guya* (delegate for water use and maintenance), *Abba herrega* (delegate for water management), *Abba quaee* (Convener of *ad hoc* meeting) and *Aburro* (Range scouter for the assessment of current range conditions) are facilitators who are supposed to manage livestock and livestock related resource management issues. Therefore, appreciating the system, identifying the gaps in the system and contributing in the system by providing modern tools and inputs would be helpful for better conservation and utilization of the breeds. The breeding strategies to be designed should also look into such indigenous practices within the community and one can easily and successfully demonstrate to farmers and implement activities like livestock recording, evaluation of data and supporting the farmers with selection tools. According to FAO (2009b) most breeds have been developed based on traditional knowledge and improved through human interventions and natural selection. However, only structured and systematic breeding programs designed have resulted in the impressive genetic improvements starting in the 20th century (Zonabend et al., 2013).

Reviving back closed ranches and strengthening new ones: When one may have a look at the experience of other countries like Australia, South Africa and others, the key destinations for implementation of breed conservation and improvement programs are ranches, multiplication centers and farms. These farming areas have contributed a lot for their success of benefit from their cattle genetic resource. In Ethiopia, from the 1950s to 1970s there are indications that scholars and respective bodies exerted their efforts in establishing ranches, multiplications centers and farms. Some of them are Metekel Fogera cattle ranch, Wolaita cattle ranch, Jigjiga ogaden cattle ranch, Dida Tuyura Boran cattle and Abernossa Boran cattle ranch. However, most of them, including sheep ranches (Horro sheep ranch at Bako, Menz sheep ranch at Sheno and Amed-Guya menze sheep multiplication center) are unjustifiably demolished. Many thousands of animals from those ranches have been disappeared together with the ranches. This devastating action is a big treat in losing the diversity of indigenous livestock resources which was conserved for future use. Still there are indications to shift the remaining ranches, multiplication centers and farms. The only active ranches in this time are Dida Tuyura Boran cattle ranch at Borana, Metekel Fogera cattle ranch at Chagni, Begait cattle ranch (newly established) at Humera and Horro cattle ranch at Bako. These ranches would have contributed a lot if they were supported with soft as well as physical infrastructures and tools. Demolishing cannot be an alternative for success and better utilization of genetic resources rather unavertly failure. Keeping the existing ranches, reviving the lost ones is not a dead lock option rather there is still an opportunity to replace back.

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Use of genomic conservation and selection tools: The advent of cheaper, faster sequencing technologies and the realization of good draft sequences and development of SNP chip technologies for livestock species have contributed to our understanding on many ways to further improve our important food species (Rothschild and Graham, 2014). Genomic studies analyzing between and within breeds can be used as an effective and significant conservation tool in conservation programs as a basis for understanding geographical distribution of variation (Ryder, 2005). According to Allendorf et al., (2010), genomic tools may assist the management of *ex situ* populations and reintroductions by providing increased precision and accuracy of estimates of neutral population genetic parameters and by identifying specific loci of importance, which is essential for selecting founder individuals. Moreover, it provides exciting opportunities to assess differential rates of introgression across different genomic regions following hybridization. These days, in developed countries the uses of genomic tools have heightened practical implications for designing breeding programmes. It has the potential to radically alter the structure of livestock breeding programmes (Goddard and Hayes, 2007). Therefore, incorporation of genomic conservation and selection tools is indispensible to hasten in conservation and breed improvement of indigenous livestock genetic resources in Ethiopia.

Developing *in-situ* and *ex-situ* breed conservation and improvement programs: Indigenous cattle populations are declining and there is lack of breeding bulls and high genetic admixture in village herds. This calls for maintenance of breed based nucleus populations (e*x-situ*) as a source of pure genetic material to maintain and buildup purity of village herds and community based breeding programs (*in-situ*). Nucleus breeding programs entail a continuous supply of replacement bulls to villages, usually at no cost or highly subsidized prices. Yet community-based conservation may be uncertain, especially for highly threatened breeds, and thus complementary nucleus-village based programs are suggested (Heimstra et al., 2006). Thus a breed based breeding scheme that integrates the merits of station-based nucleus herd and village (community-based) breeding scheme should be designed and implemented.

Creating institutional frame work: Well coordinated institutions and organizations constitute important parts and roles for the development of the livestock sector (Philipsson et al., 2011; Zonabend et al., 2013). For better utilization and conservation of these indigenous cattle genetic resources, a well coordinated institutional arrangement is a key issue. Apart from the between institutional readability, the arrangement should include dissemination of information and networking at different levels. To implement this concerned regional, national and international institutions should take up the lead responsibility.

Context based dissemination of cattle genetic resources and development interventions: In Ethiopia, attempts have been made to improve indigenous cattle breeds mostly either by crossbreeding with exotic breeds or with themselves. However, in majority of the cases attempts have failed due to mainly indiscriminate dissemination of breeds to areas where the breed is not geographically and socio-culturally supported usually leading to wrong breeding objectives and neglect of the potentials of various indigenous breeds of livestock. Therefore, approaches better adapted to the potential of indigenous livestock breeds must be developed. In this regard, Philipson et al. (2011) suggested that realistic ways of improving these genetic resources must be chosen and applied in the context of environmental constraints and socio-economic demands and within the resources available. In a nut shell, for sustainable maintenance of indigenous cattle genetic resources, suitability mapping of physical and socio-cultural environments should be done before dissemination of any potential breeds.

Extensive implementations of utilization of reproductive technology tools: Since in last few years, there is an effort of providing indigenous cows for AI (out breed bull: either local or exotic) by bringing them into estrus cycle via synchronization. Despite the limitation in using, for instance, the Boran or exotic semen for Sheko cows, this technique is helpful to bring the threatened indigenous breeds back. However, it seems imperative to mention about consequences of the former approach in particular that needs due care so that the intervention would not embark back after sometime.

CONCLUSIONS AND RECOMMENDATIONS

The facts and figures of the past and current situation of some selected indigenous cattle of Ethiopia showed that the situation of these breeds is very critical. This review gave us persuasive evidences on the critical situation of the selected indigenous cattle breeds. Therefore, there is a need to devise strategies to conserve and improve these cattle breeds based on the challenges that threatens these potential breeds. Use of new biological and information technologies is imperative to facilitate the genetic restoration process. Various ongoing development interventions like Artificial Insemination and introduction of genotypes into new environments that are exacerbating threat of the breeds should be totally avoided by revising and designing sound approaches for cattle Conservation and improvement programs. Strict regulations and by laws should also be in place for illegal movement of breeding cattle to the neighboring countries. Our live animal export practice (legal) is also the most important point that needs to be seen critically. Live animals are exported without castrating them. No one seems aware about transporting the gene pool too to outside in contrary to the strict genetic resource transfer regulation we have.

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