

THE ONE-HUMPED CAMEL IN ERITREA AND ETHIOPIA: A CRITICAL REVIEW OF THE LITERATURE AND A BIBLIOGRAPHY

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ABSTRACT

Eritrea and Ethiopia, among the poorest in the world, are independent nations in north east Africa. Ethiopia's land area is ten times that of Eritrea and its population outnumbers that of Eritrea by a factor of eighteen. Ethiopia has the greatest number of livestock in Africa at an estimated 120 million ruminant animals of which 1.1 million are camels. In contrast Eritrea's livestock population is under 10 million in which camels may number 320 000. The one-humped camel possibly arrived in the area of study about 1900 years ago. The main areas of distribution are the arid lowlands below 1000 metres altitude although in recent years there has been some range expansion to higher elevations. In Eritrea camels are owned by Beja tribes near the border with Sudan, by Tigre clans in the north and by Afar and some Somali in the east along the Red Sea littoral. Ownership in Ethiopia is mainly by the Somali people and by the Afar in their respective Regional States in eastern Ethiopia and by the Boran in the south. Overall herd structure shows 40 per cent male and 60 per cent female. The genetic resource is generally referred to by the name of the ethnic group owning it but there are also classifications based on colour. The camel value chain includes milk, meat, hides, transport and medicines with milk for home consumption being the principal product. Welfare is poor by many standards. Camels suffer from many diseases including zoonoses. Trypanosomosis is a major problem as are respiratory diseases and bacterial infections. Ethnoveterinary knowledge is not well documented but is widely understood. Nutrition mainly derives from browse species but a wide range of feed resources is consumed. There is some supplementary feeding for commercial milk production. In the overall national and livestock economies the camel is of minor importance but is a major contributor to household wealth, welfare and food security to the many pastoral families inhabiting the driest and most impoverished areas of the two countries. The paper is complemented by an Annex (Bibliography) with more than 360 references.

Key words: Arid zones, camel trypanosomosis, *Camelus dromedarius*, disease, genetic resources

Background

The State of Eritrea and the Federal Democratic Republic of Ethiopia are independent nations in northeast Africa (Fig 1). "Eritrea" was formed in the late nineteenth century when Italy invaded the area and forcefully incorporated several independent and distinct kingdoms and sultanates into the Italian East Africa Colony or Italian Eritrea. Following defeat of the Italian colonial army in 1942 by Allied forces the country was administered by a British Military Administration until 1952. In that year the UN General Assembly decided that Eritrea would become an autonomous region of Ethiopia with a local Eritrean parliament: foreign affairs and defence would be federal in nature together with Ethiopia. In 1962, Ethiopia annulled the Eritrean parliament and annexed Eritrea. In 1991, after 30 years of continuous armed struggle for independence, the Eritrean Liberation Front achieved victory over the

Ethiopian forces. The State of Eritrea came into being in 1993 after a referendum overwhelmingly voted for complete independence. Ethiopia, unique among African countries, was an independent country for many centuries except for a short period from 1939 to 1942 when it was invaded and colonised by Italy. The Ethiopian monarchy was overthrown in 1974 by a military coup and became a Marxist republic. The Marxists themselves were toppled in 1991 when the country became known as the Federal Democratic Republic of Ethiopia.

Both countries are among the poorest in the world and subject to frequent drought due to erratic and generally low rainfall. Famine is a consequence of these droughts coupled to poor agricultural practices. Eritrea is much smaller than Ethiopia with an area of about 117 600 square kilometres compared to the 1 104 300 square kilometres of Ethiopia. Eritrea is divided administratively into

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six Regions each with a number of Subregions. Its 2017 population was estimated at 5.9 million people. Gross Domestic Product (GDP) per caput in 2017 was estimated at the equivalent of USD 1600 at Purchasing Power Parity rate (PPP) (CIA, 2018a). Ethiopia's area is almost tenfold that of Eritrea. The country operates as a federal state with nine ethnically based Regional States (Addis Ababa and Dire Dawa being Chartered Cities) each comprising Zones (total 68), Districts ('woreda') and Neighbourhoods ('kebele'). Ethiopia's population of over 105.3 million inhabitants outnumbers that of Eritrea by a factor of eighteen. GDP per caput was USD 2200 at PPP in 2017 (CIA, 2018b).

Agriculture remains a major component of the economy in both countries and employs the greater proportion of the population. Crop production is important in the moister highland area above 1300 metres altitude whereas livestock dominate the economies of the arid lowlands. Cattle, sheep, goats and equines are all significant in the highlands with cattle and equines providing much of the energy needed to drive crop production. In the lowlands camels are a major species along with goats, sheep and cattle.

This paper expands on and updates an earlier one (57 references) written by the author more than 30 years ago that covered the then Ethiopia (including Eritrea) (Wilson, 1989). Many of the early papers related to Eritrea and were written by Italian veterinarians during their occupation of the country. A goodly proportion of the remainder were about Ethiopian camels and produced by French veterinarians of the Institut d'Élevage et de Médecine Vétérinaire des Pays Tropicaux. Only five papers, all university dissertations, were written by Ethiopian nationals. In 2012 a book entitled "Camel in Ethiopia" was published because "camel production and health has, for the past last three decades, featured in the curricula of Ethiopian Veterinary and Agriculture colleges [but] there has been no textbook on Ethiopian camels [and] this book is intended for undergraduate veterinary and animal science students, policy makers and researchers". Further, the authors "tried to distill the scattered and scanty literature on Ethiopian camel, the pastoralist, the environment, the market and camel health and welfare [and] relied heavily on [their] experience of the past 25 years of on and off teaching and research on camels, blended with results and experience from other countries" (Melaku and Getachew, 2012). This last book lists 154 references of which only 55 (35.7 per cent) are directly related to

Ethiopia and of which 52 of these last (94.5 per cent) have at least one Ethiopian among the listed authors.

Since the early 1990s more than 230 articles or theses on camels have been produced. Only six (2.5 per cent) of these do not have an Eritrean/Ethiopian among the listed authors. Only five (2.1 per cent) of all these articles relate to Eritrea and two (40.0 per cent) of these were contributed by non-Eritrean authors. This paper provides a detailed analysis of camels and camel production in the two countries. It does not attempt to cite all the more than 360 references listed in the Bibliography but presents a representative selection of papers related to the various section headings.

Methodology

The methodology for this paper comprises two distinct parts. The first is based on the author's own knowledge and observations garnered over 45 years of (residential and intermittent consultancy) work in both Eritrea and Ethiopia starting in 1974. This part also benefits from the vast repository of knowledge of camel keepers throughout Eritrea and Ethiopia who shared their experiences with the author. Discussions with veterinarians, administrators and development workers also contributed to this paper.

The second part was a very detailed review of the literature which is provided as an Annex ("Bibliography") to the main text. Search terms for the literature review were: "camel", or "one-humped camel", or "dromedary", or "Eritrea", or "Ethiopia". It needs to be noted here that the search terms did not include "North East Africa", "Horn of Africa" nor "ruminants". It is known that many papers including these terms do contain information on the camel in the two countries under review but it is unlikely that they would add much, if any, knowledge additional to that already included in the analysis.

It also needs to be noted that Eritreans and Ethiopians have a system of naming that differs from the conventional "family" name system used in most western countries. In the area under study a child is given a personal name at birth, to which is added the father's given name and sometimes the paternal grandfather's given name. All people are addressed throughout life, even in official situations, by their given name as 'Ato' (Mr), 'Wezeiro' (Mrs) or 'Wezeirat' (Miss) and females do not change their patronym on marriage. This system is particularly problematic for citations as some journals will name the author by his Ethiopian form of address, others will treat the patronym as a "surname" and list the

author by this followed by his or her “initials”, yet others will provide only initials for the first (given) name and add the patronym after it. It is thus no easy task to use a name search to identify items published by one person and, indeed, in some data bases and reference lists the same paper is cited twice (or more times) because of this confusion. There are additional problems with variable spellings of both given names and patronyms due in part to the way the geez alphabet has been transliterated. In this paper, the author has attempted to standardise the presentation in the text citations and in the reference list using the Eritrean/Ethiopian system of given name plus patronym even when the original publication or references to it used a “western” system (thus, Mohammed YK, Kurtu MY and YK Mohammed have all been rendered as Mohammed Yusuf Kurtu). It is certain that the reference list, as presented, has not been completely successful in achieving this but citations by one person as the first author now appear together in the alphabetical reference list and most duplications have been removed. Searching on a given name or a patronym will in most cases lead to the author and the reference being found.

History and introductions

Palaeontological research in Ethiopia in the lower Omo valley discovered a molar tooth and a metatarsal bone dated at 2.6 million years ago (Arambourg, 1947). These seem to be of a Bactrian camel and are the first camel remains recognised from eastern Africa (Howell *et al*, 1969). The one humped camel appears to have been present in Ethiopia at least as early as 100 AD. This is evident from rock paintings in a cave at Laga Oda (Fig 2), some 30 km south-west of Dire Dawa in southeastern Ethiopia at about 9° 15' N and 41° 18' (Cervicek, 1971). A camel tooth found in Axum is dated at about 500 AD (Phillipson, 1995).

It is possible that modern camels arrived in Eritrea/Ethiopia from both the north and the east. The former route from Mesopotamia, across the Sinai and down the western side of the Red Sea and the latter from the same origin through the Arabian Peninsula and across the Red Sea north of its entry into the Gulf of Aden (Melaku and Getachew, 2012). There is, however, no DNA analysis to corroborate this hypothesis.

Numbers

Foreview and international sources

Some early attempts at enumerating livestock were made by the Italian administrations in Eritrea

and during its short hegemony in Ethiopia (Marchi, 1929; Pirani, 1938; Roetti, 1938; Girardon, 1939; Salerno, 1939; Bonomo, 1940). These were, however, very partial and probably far from accurate.

Since then estimates of numbers over time have varied widely among years, sources of data or information and method of computation. A livestock census was taken in 1978, followed by sample surveys in most years since. Neither the census nor the subsequent surveys, carried out by the Central Statistical Authority (CSA) have covered the entire country. Eritrea and Tigray were not included in much of the 1980s, mainly because of the disturbances of the peace in those areas. The “pastoral” areas of the Afar and Somali Regions – whose human populations of the eponymous ethnic groups have been traditionally suspicious of and hostile to a central government and who have strong antipathy to having their wealth counted and where most camels are to be found – were also not included in the enumerations until the early years of the twenty-first century. The Food and Agriculture Organisation of the United Nations (FAO) produces statistics on an annual basis with data provided by official sources of the country or arrives at numbers based on an estimate from many years ago that are updated by a formula peculiar to that organisation.

In general terms, based on FAO data, Eritrea and Ethiopia are home to about 6.4 per cent of the world’s one-humped camel population. Using three other criteria to determine the importance of camels in the livestock economy of a country, the contribution to total domestic herbivore biomass of Ethiopian camels is about 3.7 per cent (26th in a league table of 36 countries with one-humped camel populations), the number of camels per person is 0.03 (12th of 36) and the number of camels per square kilometre of land area is 0.87 (5th of 36). By any of these criteria, therefore, camels are a valuable resource in the region. Their true value to particular sections of the population is nonetheless masked by these very crude estimates.

FAO sources provide time series data for camel numbers from 1961 to 1993 for the former Ethiopia. Since 1993 data have been provided separately for Eritrea and Ethiopia. From 1961 to 1976 FAO reported numbers from official data but from 1977 to 1992 numbers were FAO estimates. From 1993 to 2016 all numbers for Eritrea were FAO estimates whereas for Ethiopia numbers were FAO estimates from 1993 to 2004 since when it is claimed they were from official data (FAO, 2016). According to FAO camel

numbers in Ethiopia (prior to 1993 thus including Eritrea) rose from 930 000 animals in 1961 to 1 070 000 in 1992 with a marked fall in numbers between 1974 and 1975 followed again by an increase (Fig 3). In the 1994 edition of the FAO Production Yearbook the number of camels for the former Ethiopia for 1992 was 1.07 million (FAO, 1995). In 1993 and 1994 the data for Ethiopia showed 1.0 million and 0.069 million for Eritrea (FAO, 1995): i.e the previous Ethiopia camel population had been partitioned between the two new states. In the most recent FAO publication, however, camel numbers for Eritrea are shown as 312 000 in 1993, rising to 373 572 in 2016 (FAO, 2016). The FAO 2016 publication shows the “new” Ethiopia of 1993 having 320 000 (meaning that camel numbers for Eritrea plus Ethiopia had fallen from 1.07 million in 1992 to 0.69 million in 1993), a total that increased to 445 000 in 2004 (FAO, 2016). CSA data for the year 2000 indicate 262 000 camels for Ethiopia (CSA, 2000) whereas the FAO Yearbook for 1999 still uses the old estimate of 1.03 million (FAO, 1999). From 2005 to 2016 FAO claims it uses Ethiopian official data but in that first year it indicates 458 576 camels (Fig 3) whereas the CSA is already reporting 2 100 000 (CSA, 2006a).

Eritrea

The Eritrean Ministry of Information admits to a lack of reliable statistics on livestock populations as there has been no census since 1978 and numbers are based on estimates. In 2007 one secondary source estimated 9.4 million ruminants of which about 320 000 were camels (Bissrat and Woldeselassie, 2007). In 2012 the camel population was estimated at 318 914 (Fig 3). This may be a completely spurious value as is the official estimate of cattle numbers where annual vaccinations are often double the official estimate (MOI, 2012). An estimate of 75 000 camels appears in a slightly earlier paper but does not indicate its source (Dioli, 2006). An otherwise quite detailed paper by an Eritrean author working in the Ministry of Agriculture does not give any indication of numbers (Gebrehiwet, 1998). Another estimate indicates camel numbers at 373 952 (Banerjee, 2006).

Ethiopia

The regular Agricultural Sample Surveys carried out by the CSA (e.g. CSA, 2000; 2006b; 2008; 2010; 2017) have suffered from only partial coverage, being restricted to the settled agricultural areas. In the year 2000 the “agricultural” areas of the country had 242 410 camels, in 2006 the population was 437 606 camels, in 2008 the number was 1 009 040,

in 2010 there was a fall in numbers to 807 581 but by 2017 the number had again risen to 1 418 457.

National estimates of livestock numbers for 2005 indicated that the country was home to 43.8 million cattle, 23.2 million sheep, 22.8 million goats, 1.5 million horses, almost 4.1 million donkeys, 356 thousand mules, 2.1 million camels and probably in excess of 50.0 million poultry (CSA, 2006a). These data include results of surveys in the two “pastoral” areas of Afar Regional State and Somali Regional State (CSA, 2004a; 2004b) which had not been included in earlier population data. The surveys, carried out on the ground in Afar and from the air and on the ground in Somali arrived at a total of 759 750 camels in the former State and 1 041 870 camels in the aerial survey plus 64 510 additional animals from the ground survey in the latter State. Consequent on the censuses in the Afar pastoral areas and the aerial surveys of the Somali ones the estimated camel population of Ethiopia is now considered to be well in excess of two million head.

Hindview

It needs to be noted that inclusion of the pastoral areas into the general census puts a considerable new light on Ethiopia’s livestock populations with moderate increases in cattle numbers, large increases in sheep and goat populations and very large increases in the camel population. It is clear from the available data that no firm conclusions can be provided for actual numbers in Eritrea and Ethiopia. Over time there has been considerable “redaction” of previously published data especially by FAO. In addition the actual area covered, the methodology employed and the analyses of any results are often confusing. Camels are the least numerous of all the domestic herbivorous mammals in both Eritrea and Ethiopia except for mules and possibly horses. On the assumption, however, that the Ethiopian camel population is in excess of 2.0 million claims that it has the third largest population of this domestic animal on the African continent, after Somalia and Sudan, may be valid but it is possible that numbers in Kenya exceed those in the two countries under review. The enumeration of camels in Eritrea and Ethiopia is best considered as a “work in progress”.

Distribution

Eritrea

Eritrean camels occupy the lowland northern arc of the country (Dioli, 2006). They thus are found

from the Southern Red Sea via the Northern Red Sea through Anseba and into the Gash Barca Regions (Fig 1).

Ethiopia

According to official data 42 per cent of the Ethiopian national camel herd is found in the Somali Region of eastern Ethiopia, 34 per cent in the Afar Region of northeastern Ethiopia and 24 per cent in the Oromia Region in the Borana and Kereyeu Zones in southern and southeastern Ethiopia (CSA, 2006) (Fig 1). Almost all Ethiopian camels are thus found in the northern, eastern and south-eastern lowlands at altitudes below the 1000 m contour except in the south where Boran camels are commonly found at 1500-1600 m altitude (Fig 4). In recent years under the pressure of drought and probable overstocking of the lowlands, Afar camels have been brought to feed in the dry season west of Dukam at 2000 m and only 30 km from Addis Ababa. In other highland areas some camels are used by sedentary farmers and traders for miscellaneous transport operations. Transport camels along with mules and donkeys also regularly traverse the 3200 m ridge of the west wall of the Rift Valley near Wukro in Tigray carrying salt from Dallol to the market in Mekelle (Fig 5) (Wilson, 1976). There are no camels in the southwestern or western areas and a very few in the northwest of the country.

The camel is traditionally an animal of the wide open spaces, constantly moving with its owners from place to place in search of feed and water and avoiding urban areas. Some Ethiopian pastoralists, due to demographic, socio-economic and political factors, are beginning to settle and in the process triggering an unprecedented growth of small towns and the creation of urban centres across the pastoral lands. Pastoralists have thus had to adapt to new situations or be left without sustainable incomes. An initiative of "town pastoralists" is camel dairy production in and around these new and expanding urban centres (Abdi Abdullahi Hussien *et al*, 2011)

Ownership

Eritrea

The main ethnic groups owning camels are the Beja tribes – Beni Hamer and Rashaida – in the north west and part of the north, the Tigre clans in the west, the north and the northeast, the Afar in the east and southeast and the Somali in the southeast (Dioli, 2006). Livestock production is the main economic activity for all these groups with camels generally being the most important species (Assefaw *et al*, 1999).

Most camels are owned by Muslim lowlanders in Eritrea but the Kunama people in the southwest close to the border with Ethiopia are mainly Christian. Camels were introduced into the highlands during the war of independence for carrying trade goods and for transporting military materials. This has led to some camels being owned by Christian highlanders who keep them for transport but, except for the Saho tribe, do not drink their milk or eat their meat (Gebrehiwet, 1998).

Eritrean camels are always considered as clan property although individuals and families "own" their own animals. Camels are branded with a clan mark and a subsidiary symbol that represents the individual or family. It is the clan that decides on the distribution of animals and this unit also arranges their distribution to deprived families or individuals, thus ensuring that members who have lost their animals can recover from the disaster. An individual possessor has no absolute right to give or refuse to give his or her animals (Gebrehiwet, 1998).

A male child is given a young or neonate female animal on its birth. Gifts of animals are also made to the child by close relatives. As he grows thus his herd increases. On marriage he is given a further allocation from the family holding and a bride price of two to seven camels is paid to the father of his new wife (Gebrehiwet, 1998).

Ethiopia

Ethiopian camels are mainly owned by the Somali people of the eponymous Regional State, then by the Afar in Afar Regional State and parts of Tigray Regional State. These are followed by the Borana people of the south of Oromia State. In the far northwest of the country some camels are owned by a small population of Kunama people, who are of Nilotic descent and whose main numbers are in southwest Eritrea. These last are mainly Ethiopian Orthodox Christians whereas in all other areas camel owners nominally follow the Islamic faith.

In much of Ethiopia camels are clan property with families and individuals benefiting from them in trust in a manner analogous to the system described for Eritrea.

Herd sizes vary over a wide range from as little as one animal to as many as 150 head. Many of these larger "herds" are, however, most likely to be agglomerations of camels belonging to several families. In one study of 73 families in eastern Ethiopia the average herding unit comprised 25 camels but there was a very large standard deviation

that was greater than the mean (Eyassu Seifu, 2009). All 73 (100 per cent) of these families owned camels whereas 67.1 per cent owned cattle, 37.0 per cent owned goats and 13.7 per cent owned sheep¹.

Herd structure

Camels are used less in Ethiopia for transport and draught purposes than they are in some other countries. Their main purpose for the Somali and Afar as well as the Boran is for the production of milk. The national herd structure reflects these functions with 39.4 per cent males and 60.6 per cent females. In Somali Regional State the ratio of males to females was 36:64 in the herd as a whole but in older animals over 4 years is about 1:2 indicating some offtake for meat or sale to other uses for transport and perhaps draught. The Afar herd once again shows the dairy vocation of all species of livestock with only 22.7 per cent males and 77.3 per cent females. About one third of camels under four years old in Afar are males and in the age group of over four years the ratio of males to females falls to about one to four. In one study in Somali Regional State 19.0 per cent of the camel herd was lactating females, 20.2 was male and 19.0 per cent was calves (Eyassu Seifu, 2009).

In the agricultural areas three quarters (76.6 per cent) of camels are in the age group of 4 years and older. About two fifths (39.4 per cent) of camels are in the age group of 4 years and older in the pastoral areas. Camels are multipurpose animals as indicated by the census return that shows 48 per cent kept for milk production and about 37 per cent for transport and draught. What the census does not show – only 3.3 per cent of animals are recorded as being kept for meat – but that can be inferred from the 40/60 per cent male/ female population structure is that camels are also meat animals either being slaughtered locally or sold to the international market. Almost all camels are found in the lowland areas (Fig 4).

Genetic resources

Early attempts to classify Ethiopian camels no longer seem entirely satisfactory and are certainly incomplete. Some merely named camels according to the tribes owning them (Droandi, 1921; 1932) and others are based on colour (Marchi, 1929). In the first of these sources subtypes were ascribed to racing or trotting ('il cammelli corridori') and to pack types. Taxonomy on this basis was confined to Eritrea in line with the needs of the Italian military colonial power. Among the qualities of trotting camels were

1. It was a study of camel-owning families!

regularity of pace, endurance for a whole day and a steady speed of 8-10 km/hr. Tribal types are almost all referable to Sudanese ones. The Bisari ('Bisciari') were preferred for riding and both females and males were used. Another Sudanese breed, the Anafi, was not subject to as intense selection in northern Ethiopia as in Sudan and it became more a general purpose type than a pure fast riding camel. Additional tribal types described were Cabbaci, Beni Amer (said to be very strong with reasonable speed) and Sceraf. Colour descriptions overlap tribal types. The Anafi thus become the Tzedi (white) and the Beni Amer the Cajeh (red). One type identified along the Red Sea coast was called the Grain (sandy).

Ethnic groups owning camels are rarely confined by the national boundaries of Eritrea or Ethiopia. The nomadic way of life and family ties have led to considerable continuity of camel types across the various national frontiers (Wilson, 1984). The camels of the northern lowlands of Gonder and Eritrea thus have much in common with those over the border in Sudan; Afar camels are found also in Djibouti and northern Somalia; Somali camels cross the whole length of the frontier with Somalia and with Kenya in the southeast and Borana camels extend into northern Kenya in the south-central area.

The most common camel types in Eritrea are the Bisharri, Arrir and Afar. There are also unidentified camels in the Gash-Barka and Anseba regions. The Arrir is the preferred type in the southwestern lowlands due to its high milk yield, good market price and high transport value (Gebrehiwet, 1998).

In Ethiopia several camel populations have been identified although there is inconsistency in terminology even within the same group of authors (Table 1, Table 2).

Products

The camel value chain includes milk, meat, hides, transport and medicines. The traditional pastoralist mode of production is not, however, one of commodities and is not primarily aimed at producing for the market. There is, nonetheless, limited – but probably rapidly increasing – commercial trade in milk and meat as well as in live animals. The standard outputs of milk and meat are mainly for home consumption. Herd accumulation is a vital economic function not only for cash but for traditional values in the context of the extended family (being able to loan out animals), as bride price and for prestige within the community. Camel owners therefore tend to be asset rich whilst remaining cash poor.

Table 1. A succinct classification of Ethiopian camel types

Camel type	Location	Colour	Height (cm)		Function
			Male	Female	
Afar	Northern lowlands	Fawn, red	160	150	Milk, (transport)
Ogaden (Somali)	Southeastern lowlands	Fawn	210	190	Milk
Borana	Souther lowlands	Fawn	185	170	Milk, pack, draught
Anafi	Northwestern lowlands	Very pale	190	170	Fast riding

Source: Yosef Tadesse *et al*, 2014.

Table 2. Morphological features of some Ethiopian camel groups.

Group	Morphological features
Hoor	Wide belly, long legs, long body, narrow hip width
Gelleb and Liben	Prominent hump, broad chest and hip, long neck and tail
Jijiga	Short body, medium body size and barrel girth
Shinille	Long ears, light weight, small heart girth, short stature
Amibara and Mille (Afar)	Small size small heart girth, light weight, long tail

Source: Yosef Tadesse *et al*, 2015.

Camels are raised mainly for milk by the Afar in Eritrea and the Afar and Somali in eastern Ethiopia, for milk, transport and riding by the Beja in the western lowlands of Eritrea and for milk and transport by the Borana in the south of Ethiopia.

Milk and dairy products

Milking is done by hand direct into containers (most often plastic) by both men and women who, because of the size of the camel, are able to stand during the process (Fig 6). Camel calves are given access to their dams to start the let-down process. Some milk is sold outside the immediate and extended family. Camel milk, which is rich in Vitamin C, partially offsets the deficit in cow and small ruminant milk supplies in many areas of lowland Ethiopia and makes a major contribution to the protein and calorie intakes of nomadic populations. In Eritrea in the early 2000s total camel milk production was estimated at 5385 tonnes, equivalent to 1.5 per cent of all milk and providing an availability of 0.85 litres per person per year (Banerjee, 2006). Total milk production from the Ethiopian national camel herd was estimated at 23 500 tonnes in 2005 (CSA, 2006b) although other sources indicate much higher amounts of up to 75 000 tonnes (Felleke, 2003). Formal export of camel milk ranges from 1600 to 2500 litres per day at a price of USD 0.08 per litre although a large amount is informally exported for Somali consumption through the Jijiga/Togochalle border land route (Abebe Bereda *et al*, 2016).

In the Shinile and Jijiga Zones of Somali Regional State the daily milk yield of a camel varied

from 1 to 10 litres with an average of 5.2±.2.2 litres: lactation length varied from 180 to 720 days and averaged 382.7±96.0 days (Eyassu Seifu, 2009).

In Gode township in Somali Region it has been found that average milk production in the traditional system is 2.43 litres per day in the dry season and 3.38 litres per day in the rains. Under a periurban/urban system dry season yield was raised to 3.9 litres of which 0.98 litres was consumed at home and the remainder sold in the market. In the wet season the yield was 6.25 litres of which 1.27 litres was used by the household and 4.52 litres was available for sale (Hussien *et al*, 2011).

Fresh and fermented camel milk products are often credited with therapeutic properties. These include prophylaxis or cures for gastritis, asthma, stomach discomforts, HIV, hamot (kar), tuberculosis, fever, urinary problems, hepatitis, jaundice, common cold, dearbeh (“diarrhoea”), daarta (“nausea”) and diabetes (Asresie and Kurtu, 2014).

Fermented camel milk, known as ‘dhanaan’ is said to have a shelf life of about five months (Asresie and Kurtu, 2014). Butter and cheese are potentially important value-added products of camel milk but in Ethiopia, as elsewhere, it has been found difficult to process and when successful the yield is lower than cow milk due to the lower butterfat content and the distribution of milk proteins (Asresie *et al*, 2013; Eyassu Seifu, 2007; Adugna *et al*, 2013; Tesfamariam *et al*, 2013; 2017; s2018). In one trial a now naturalized but invasive weed (*Parthenium hysterphorus*, congress grass) was used to help turn

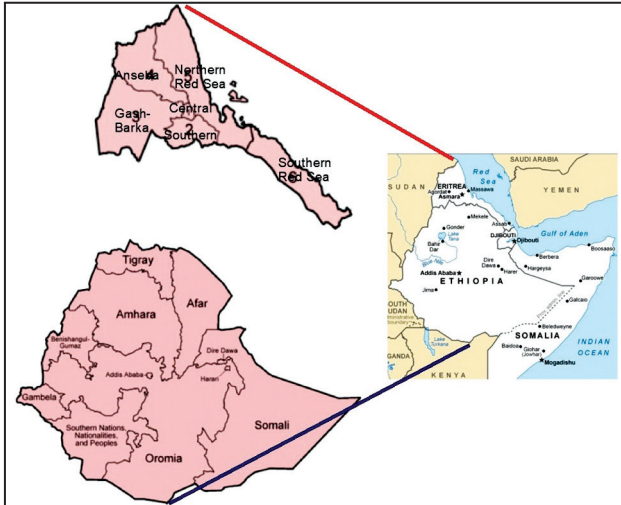
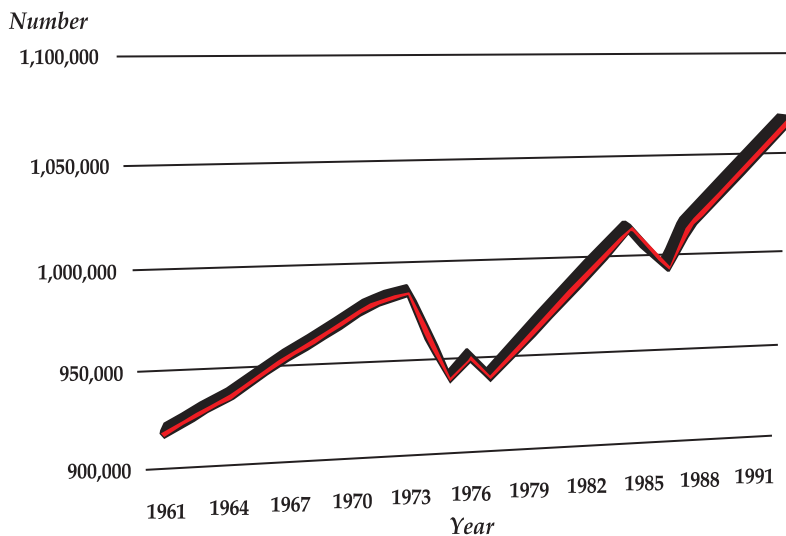


Fig 1. Location of Eritrea and Ethiopia in the Horn of Africa and country maps showing major administrative divisions (Source: compiled by the author from maps in the public domain).

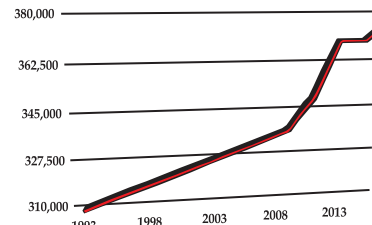


Fig 2. Rock paintings of camels in Laga Oda cave, southeast Ethiopia (Source: Cervicek, 1971).

Eritrea + Ethiopia, 1961-1962



Eritrea, 1993-2016



Ethiopia 1993-2016

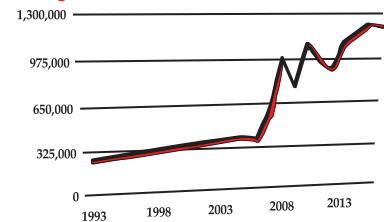


Fig 3. Camel numbers in Eritrea + Ethiopia 1961-1992, Eritrea 1993-2016 and Ethiopia 1993-2016: note different scales (Source: constructed from data in FAO, 2016).

the cream and produced a butter yield of 70 g from 3 litres of fresh milk.

Meat

In Eritrea in the early 2000s it was estimated that 48 614 slaughtered camels yielded 9722.8 tonnes, of meat and offal (i.e. a carcass weight of 200 kg) and that consumption of camel meat was 1.54 kg per person per year (Banerjee, 2006). In Ethiopia, camels will continue to serve a mainly niche as well as an emergency market for meat primarily in the lowlands but camel meat is not a preferred commodity among the Afar and Somali (Ayele Gebremariam, 1999).

Total camel meat production in Ethiopia in 2005 was estimated at 4560 tonnes (CSA, 2006b). In 2010 camel meat was equivalent to 9 per cent of all meat produced whereas sheep and goats contributed 70 per cent and cattle 21 per cent (Abebe Bereda *et al*, 2016). In 2017-2018 some 6742 camels were slaughtered of which 4749 were males (CSA, 2018). Most camels are in poor condition (low body condition scores) at slaughter. Slaughter practices are often less than humane and even violate 'halal' (permitted) conditions including cutting the Achilles tendon of the hind legs, severing the neck with more than one stroke and sharpening knives and killing animals in

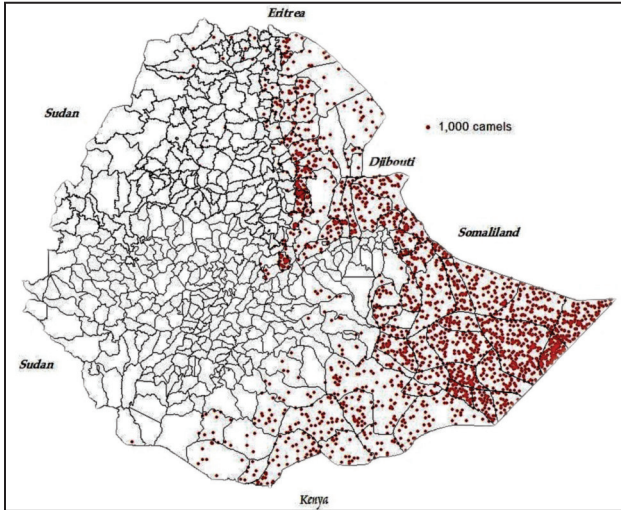


Fig 4. Gross distribution of camels in Ethiopia, 2004 (Source: generated from data in CSA 2006).

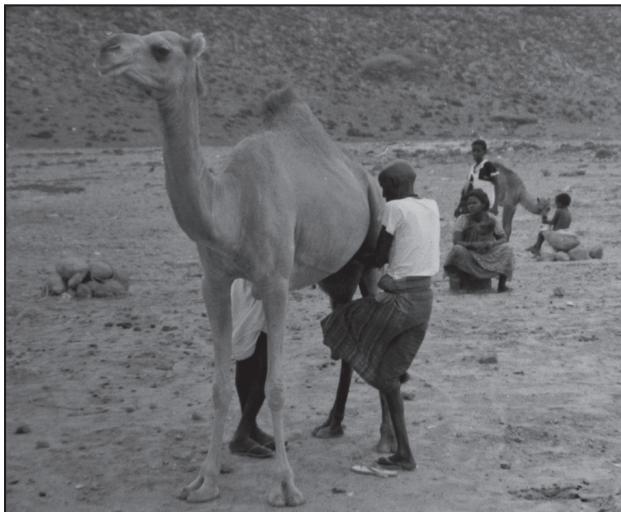


Fig 6. An Afar man milking a camel near Dire Dawa, 6 April 1986 (Source: photo by the Author).



Fig 8. Headquarters of the British Expeditionary force near Senafe (now in Eritrea) showing horses, mules and camels (Source: Engraving from the Illustrated London News, 8 February 1868).



Fig 5. Camels and mules loaded with salt from the Danakil at Wukro (3200 m altitude), 25 June 1974 (Source: photo by the Author).



Fig 7. Preservation of camel meat ('muremure') for longer storage life (Source: photos from Mitiku Eshetu Guya and Getachew Neme Tolesa, 2015).

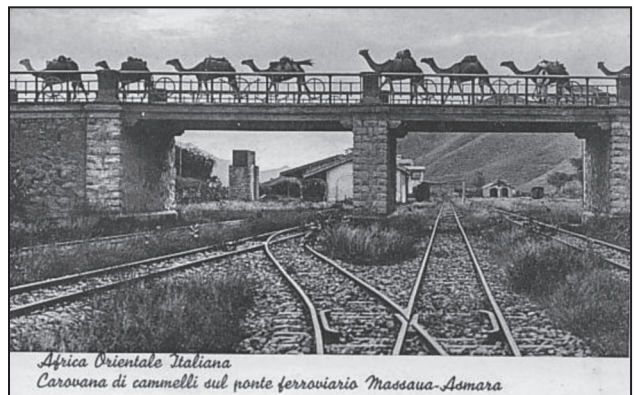


Fig 9. Camels competing with rail transport in Italian Eritrea in the 1890s (Source: Gagliardi, 2016).



Fig 10. The Eritrean Camel Corps on parade in Asmara, 1920 (Source: Italian National Archives).



Fig 11. The Emblem of Eritrea honouring the camel for its transport role in the country's war of independence (Source: Public Domain).



Fig 12. A family of the Bilen clan of central Eritrea on a seasonal move of their dry season camp, 25 November 1993 (Source: photo by the Author).



Fig 13. Camels ploughing near Yabelo in Borana Zone, southern Ethiopia at 1800 metres altitude, 28 February 1987 (Source: photo by the Author).



Fig 14. Private small camel transport train carrying sacks of locally produced grain at Agula Pass (Tigray) at an altitude of 2000 metres, 6 November 2018 (Source: photo by the Author).



Fig 15. Pack camel in extremely poor condition and with severe (healed) saddle sores near Addy Abby, Tigray, 6 November 2018 (Source: photo by the Author).



Fig 16. Camel feed resources: desert conditions in Somali Regional state; lush vegetation on banks of River Awash in Oromia Regional State (Photos by the Author).

the presence of other camels awaiting slaughter (Seid *et al*, 2017).

In Jijiga and Harar towns in Somali Regional State in 1999 almost all slaughtered camels were adults and were predominantly male. Average live and carcass weights were 400 kg and 211 kg with males being significantly heavier and having higher dressing percentages than females. Carcasses comprised 76 per cent meat, 12 per cent fat and 20 per cent bone in both sexes (Mohammed Yusuf Kurtu, 2004). Issa camels at Dire Dawa slaughterhouse averaged 233.4 kg carcass weight and had a dressing

percentage of 52.7 per cent: dressing percentage was higher in camels of heavier live weight and there was more weight in the forequarters than the hindquarters (Abebe Wossene *et al*, 2002). Similar results were obtained in another study of Issa (Somali) camels (Seid *et al*, 2016).

In Somali Regional State camel meat is preserved by boiling to reduce the water content and to reduce water activity of the meat. Butter is added during boiling to enhance the flavour and eating quality of the product. The meat is then hung to dry and finally pelleted (Fig 7), The final product is known as 'mukmud' or 'muremure' and is said to have up to six months shelf life (Mitiku Eshetu Guya and Getachew Neme Tolesa, 2015).

It is claimed that camel meat is healthier than beef as it is high in protein (19 per cent), low in fat (1.17 per cent), contains most essential amino acids, has low cholesterol (59.2 mg/100g) and low saturated fatty acids and is a rich source of vitamins and unsaturated fatty acids. Low levels of saturated fat in camel meat are important for avoiding atherosclerosis, for the control of obesity and hypercholesterolaemia and decrease the risk of cancer because of their effect on plasma cholesterol levels. Camel meat, as for camel milk and perhaps equally as precious, is believed by Somalis to have remedial effects for as many as 13 diseases, including hyperacidity, hypertension, pneumonia and respiratory diseases and also to be an aphrodisiac. Camel meat in general is considered a functional food as a remedy for ailments that include seasonal fever, sciatica, shoulder pain, asthma, removing freckles and for improved performance. It is used as a cure for exhaustion and fatigue because it contains energy derived from sugar and not fat and also glycogen, a carbohydrate which is easily absorbed and metabolised in the body and converted to glucose which activates nerve as well as other cells (Hussein, 2018).

Transport and Draught

An early record of camels being used for transport relates to the British Expedition to "Abyssinia" in 1867-1868. During this exercise, undertaken to force the release of British hostages being held by Emperor Theodros II, up to 40 000 animals (elephants, mules, horses, donkeys, oxen and camels) were used to support the invading army (Fig 8). At various times throughout the expedition up to 10 000 camels were at work in the baggage trains (Holland and Hozier, 1870) although it is not known

whence they came. Camels were not used only as baggagers, however, as they served to evacuate wounded personnel, either one each side on stretchers or in 2-person saddles on their backs for the less seriously wounded and generally sick or exhausted combatants.

Eritrea

The camel continued to be an important means of transport in Italian Eritrea at the end of the nineteenth century even after the advent of the railway with which in some respects it was in competition (Fig 9). The Italian administration of Eritrea as a colony wanted to be considered as a serious contender in the game of empire and as one expression of this – and like other colonial powers (Britain in Sudan and Somaliland, France in West Africa and Germany in Southwest Africa) – set up its very own Camel Corps (Fig 10). Camels were much used in the Eritrean war of liberation in the 1970s to early 1990s for transporting military equipment and weapons, a role for which they have been honoured by appearing on the Eritrean National Emblem (Fig 11). The Bilen people who are mostly located around Keren in central Eritrea use camels fitted with 'howdah' – possibly a relic of their historical links with the related Beja tribes and their origins in Sudan – when moving their temporary or seasonal camps for transporting family members and household goods (Fig 12).

Ethiopia

Before the establishment of Eritrea as an independent state estimates of camels used for draught were in the region of 130 000, of which two thirds were females (MOA, 1984): these were mostly found in Gonder in the northwest and Bale and Sidamo (Fig 13) in the south but the figures excluded any data for Eritrea and Tigray. Official estimates for Ethiopia for 2017-2018 were that 286 040 camels (about 20 per cent of the total camel population) were used for transport purposes of which 244 412 were males and 41 629 were females: draught camels numbered 26 584 all of which were males (CSA, 2018). About 330 000 households (1.85 per cent) of all households in Ethiopia) owned transport and draught camels. In the past camels were not normally hired out to other parties by the owners for transport or agricultural purposes. Years of drought have resulted in the deaths of many oxen, donkeys and mules and these are being replaced in the mid altitude areas by camels being kept by nonpastoral tribes who are more willing to rent out animals for both pack (Fig 14) and

draught to obtain income (Yacob Aklilu and Catley, 2011).

Hides and skins

Hides and skins and their value-added products are important items of internal commerce and international trade in Ethiopia. None of the numerous projects, reports and learned papers indicate, however, that camel skins are important in this respect. When flaying the hide is taken off by first making an incision along the back line (rather than the more common cut along the underline for other domestic animals) and then taken off in small pieces rather than as a whole ((Hussein, 2018).

Foreign exchange earnings

Livestock and their products are among the highest earners of foreign exchange for Ethiopia. Camels – whether legally or illegally exported – make a considerable contribution to the generation of foreign currency in support of Ethiopia's economy. In 2007-2010 some 62 per cent of an estimated illegal export of 6.8 million animals valued at USD 1.04 billion were camels (Abebe Bereda *et al*, 2016). Legal camel exports are mainly by sea through Djibouti and the Republic of Somaliland or by trekking overland.

In 2006 one company alone exported 20 000 camels to Egypt at a value of USD 6 million (Nazret. com, 2008). Some 79 000 camels were exported in 2010/2011 of which 15 000, valued at USD 6 124 800, crossed the border into Sudan through Humera on foot (Yakub Aklilu and Catley, 2011) with many having trekked 1500 km from Borana in southern Ethiopia: the other 64 000 were exported to or through Djibouti. During 2010/2011 Ethiopia exported 472 041 live animals of which 61 365 were camels. Camels thus contributed 13 per cent to the number of animals exported but their contribution to export revenue was 25 per cent (Sanitary & Phytosanitary Standards and Livestock & Meat Marketing Program, 2011). In the nine months prior to June 2017 a total of 11 527 camels valued at USD 6.57 million were exported (Ethiopian Herald, 2017).

Welfare and health

The Five Freedoms

Very few, if any, of the pastoralists or other groups who own and manage camels will have heard of the Five Freedoms (Brambell, 1965). If they are aware of them they are rarely put into practice.

Freedom from hunger occurs sporadically but for much of the year in many years the feed supply is

less than the demand in terms of quantity and often inadequate in quality. Thirst is less of a problem for camels than for other domestic stock but even these water-efficient beasts have to contend with restricted water supplies at times.

Discomfort is ever present often in terms of searing heat, lack of shade, rough underfoot conditions and heavy and unstable loads.

Pain is often inflicted by owners in ignorance of what does not cause it rather than a desire to do harm. Animals are frequently injured through overloading and inappropriate harnessing (Fig 15). The nose peg is the preferred method of control rather than a halter: its insertion causes injury and it is painful in use. Disease might be considered the norm in camels including pathogens, parasites and skin ailments.

Camels are seen to express fear and be distressed when ill-treated by their handlers.

Perhaps the least noxious of the freedoms is the ability to express normal behaviour. Most camels are kept in herds and are able to associate with and interact with their fellow beings. Removal of the calf in order to provide milk for the family is, however, an intrusion on normal behaviour.

Diseases

Ethiopian camels suffer from a plethora of diseases caused by pathogens over a wide range of classes including viruses, bacteria, fungi and protozoa. In addition they are beset by internal and external parasites and an embarrassing array of mechanical injuries. Several diseases are zoonoses: of the five (rabies, anthrax, brucellosis, leptospirosis, and echinococcosis) given priority for a One Health approach in Ethiopia (Pieracci *et al*, 2016) brucellosis – mostly due *Brucella melitensis* – with 29 references in the bibliography and echinococcosis or hydatid disease with seven are common in camels. It is certain that the other three are present but have gone unreported. Among other major diseases reported as of concern by herd owners are trypanosomosis (20 references) and a complex of respiratory diseases (six references). Mastitis is also of concern (12 references in both traditional and “modernizing” herds. Skin problems include sarcoptic mange (Bekele Megersa *et al*, 2012; Nesibu *et al*, 2014), contagious ecthyma and tick infestations (Zelege Mekuriaw and Tafesse Bekele, 2004).

Most of the early work on camel diseases was done by the Italian administration in Eritrea. A main interest was in the identification and control

of trypanosomiasis (Pricolo and Ferraro, 1914; 1918; 1920; di Domizio, 1918; Frullini, 1938; Grassi, 1947; which is usually caused in camels by *Trypanosoma evansi* which is transmitted to them mechanically by biting flies of the Tabanidae family. There was also considerable interest in filarial worms (Pricolo, 1913a; 1913b; 1913c). At a later period the larval stages of *Taenia* species were causing concern (Angelotti, 1947; Pellegrini, 1947a; 1947 b; 1947c; 1947d; Batelli, 1949).

During the 1970s and 1980s the French Government financed a team of veterinarians from the Institut d'Élevage et de Médecine Vétérinaire des Pays Tropicaux (IEMVT) to assist the Ethiopians in disease identification and control. This team was also interested in trypanosomiasis and carried out several trials to control it (Balis, 1977; Balis and Richard, 1977a; 1977b), helminths (Daynes and Richard, 1974) and bacterial diseases (Domenech, 1977; 1980; Domenech *et al*, 1977). The assistance was not wholly altruistic, however, as IEMVT personnel also benefited in doing research for doctoral degrees (Didier, 1975; Richard, 1975; 1979).

From the 1990s onwards most research on camel diseases has been undertaken by Ethiopian nationals. The French team can take some credit for this as they provided support to the Veterinary Faculty of Addis Ababa University – although veterinary education has also been supported by FAO and the British Government as early as 1969 (RTW, personal knowledge). In 2020 at least six Ethiopian universities provide courses in veterinary science and have awarded at least 44 postgraduate degrees (Addis Ababa Faculty at Debre Zeit, 33; Alemaya, 8; Haramaya and Hawassa, 1 each) on a variety of camel disease topics (see Annexe: Bibliography for full details).

Ethnoveterinary medicine

Only one direct study of the use of ethnoveterinary medicine in the treatment of camel ailments has been made (Tafesse Mesfin, 2000). In the Republic of Somaliland, bordering on Ethiopia's Somali and Afar Regional States and whose pastoralists are intimately related to their neighbours in Ethiopia ethnoveterinary practices have been documented since at least 1895 (Swayne, 1895). Camels showing stiffness were “fired”, either by raising small blisters with a red-hot ramrod or spear or by striping with hoops of red-hot iron. Open sores had glowing stones strapped over them which was followed by an application of moist camel dung. When off feed a dose of melted sheep's tail was given.

Thorns were removed from the foot with the ‘biláwa’ or dagger and camel dung was then applied. Sore backs caused by the chafing of a load was often bitten by the camel until it festered and became invaded by maggots, the treatment for which was a strip of calico, steeped in carbolic solution, tied over the wound to protect it from attack by omnivorous birds (Swayne, 1895). Some 30 years later a treatise on the camel provided additional information on ethnoveterinary medicine (Leese, 1927). Later work (Hunt, 1951; Mares, 1951; 1954a; 1954b; Peck, 1939; 1940) included descriptions of plant remedies, traditional vaccination, cautery, use of broths and use of salt in the form of salt bushes, salty wells and salt-rich soils. Mares (1954a; 1954b) also provided an extensive list of Somali names for livestock diseases and parasites. In the 1990s participatory techniques were used to elicit information on indigenous practices (Catley, 1996; Catley and Ahmed Aden, 1996). More recent accounts of Somali ethnoveterinary practice show considerable agreement with the earlier work and even 40 years after the publication of Mares' work, herders in northern Somalia were still using soups, cautery and medicinal plants (Catley and Mohammed, 1995; 1996). A brief review of the literature indicates common terminology for some livestock diseases throughout Somali-occupied areas. For example, the words ‘gendhi’, ‘dhukaan’, ‘caal’, ‘cadho’ and ‘cambaar’ are very widely used by Somali herders from north-west Somalia through Ethiopia to northern Kenya.

There are other studies on ethnoveterinary medicine. Although not specifically targeted at the camel this animal has been part of the overall study. In one such study in a district with a camel population of only 244 head some 20 per cent of 51 plants identified as of ethnoveterinary value were used on camels. The most common ailments treated were diarrhoea, mange, ringworm, black quarter and bloat. *Allium sativum* was used against eight ailment types and *Croton macrostachyus* against seven (Ermiyas Lulekal *et al*, 2014). In Afar Regional State 12 species of plants were used in the treatment of camel ailments (Tafesse Mefin, 2000; Mirutse Giday and Tilahun Teklehaymanot, 2013).

Feeds and feeding

Feed is obtained from a wide range of habitats ranging from hyperarid deserts to succulent bushland (Fig 16) and such other resources as fallows and stubbles on agricultural land. Camels are predominantly browsers and because of their size are able to procure feed from heights of up to four

metres above the ground on resources that are not available to other domestic stock. They are eclectic in their tastes and feed on a broad spectrum of fodder plants that includes thorny trees and shrubs, halophytes and aromatic species that may be avoided by other domestic herbivores. At times, nonetheless, they compete with these latter for other types of feed including grasses and herbaceous legumes. Camels employ various feeding strategies depending on the season and the available resources, using the herbaceous layer of mainly annual species in the shorter rainy season and the browse layer of perennial plants in the longer dry season.

In Jijiga District camels mainly fed on browse species with all parts of the plants (leaves, twigs, seeds and pods) except the roots being eaten. More than 100 species of plants were identified of which 20 were commonly eaten. These species included *Acacia brevespica*, *Acacia bussei*, *Acacia etbaica*, *Acacia nilotica*, *Acacia senegal*, *Acacia seyal*, *Acacia tortilis*, *Dichrostachys cinerea*, *Opuntia ficus-indica*, *Lantana camara*, *Blepharis persica*, *Grewia villosa*, *Ziziphus mauritiana*, *Euphorbia tirucalli*, *Heliotropium cinerascens*, *Commicarpus africanus*, *Rhus natalensis*, *Balanites glabra*, *Grewia ferruginea* and *Cadaba heterotricha*. Mean concentrations of Ca, Mg, K, Fe, Mn, Zn and Cu in forages were higher than the lower recommended levels in both the wet and dry seasons. The mean concentration of Na and P, however, were lower than the recommended levels for ruminants meaning that in the study district camels should be provided supplementary sodium and phosphorus from other sources (Tezera Getahun, 1998; Desalegn and Kurtu, 2012). This is well understood by pastoralists hence the frequent visits to salt pans or saline water sources.

In the Southern rangelands in Borana country the most important browse plants have been reported as *Acacia brevispica*, *Commiphora africana*, *Rhus natalensis*, *Grewia* spp., *Balanites* spp., *Boscia minimifolia*, *Cadaba glandulosa*, *Euphorbia* spp. and *Solanum tembensis* (Dessalegn, 1984).

Woody plants comprised 79 per cent of the diet in the dry season and 83 per cent in the wet season in the Errer Valley in eastern Ethiopia. The ten most preferred species were browsed for 87 per cent of the feeding time in the dry season whereas 80 per cent were browsed in the wet season. The highest ranked plant in the dry season was *Opuntia ficus-indica* in contrast to *Acacia brevispica* in the wet season. The range in composition of the ten most preferred species 88-228 g/kg dry matter for crude protein 1.3-3.3 for phosphorus, Ca 12- 48 for calcium, 29-216 for soluble tannins 9.4-129 for condensed tannins. *In vitro* dry matter digestibility (IVDMD) varied between 0.41 and 0.65 (Moges Dereje and Udén, 2005)

Attempts to improve nutritional status have not emphasized the natural feeding environment but have concentrated on niche feeding, mainly for dairy production. Milk yields were significantly increased, for example, from 7.6 kg per day to 12.9 kg when camels on natural grazing were provided with ground maize and a protein supplement: the percentage of butterfat also increased slightly (Moges Dereje and Udén, 2003). In another series of experiments lactating camels were studied in a cross-over trial in which they were watered once daily, every fourth day, every eighth day or every 16 days with a 5-day interval between treatments. When offered water every fourth or eighth day the camels drank enough to cover their needs for subsequent days but after 16

Table 3. SWOT analysis matrix.

Strengths	Weaknesses
Complement other domestic livestock species Multipurpose milk, meat, transport and draught animal Water conservation abilities resulting in long interval need for water Flexible management by owners (seasonal and long term) in search for and use of feed and water Adaptation to climate change	Extremely susceptible to respiratory infections and trypanosomosis Broad spectrum of other diseases constrain output Long reproductive intervals
Opportunities	Threats
Organisation into producer groups Better market information Improved market access Integration with agro-pastoral communities to provide draught power and transport Improve general management Improve disease control Improve nutrition	Inability to comply with World Trade Organisation Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) Politically motivated bans on imports from Ethiopia National administration does not empathise with pastoralists Inadequate market infrastructure internally and for export Migration of owners (NOT camels) to urban environment Increasing numbers risk causing greater environmental damage

days of dehydration they did not drink enough to compensate the body weight loss. Rectal temperature fell at night and the camels searched shade during daytime minimising evaporative fluid losses. Contrary to general belief camels did not dilute their milk in response to water restriction ((Tafesse Bekele *et al*, 2011; 2013).

Discussion

Constraints

Ethiopia's pastoral communities have battled for centuries with adverse weather conditions, to say nothing of an often hostile political environment. In these circumstances they have been more successful in adapting to change than sedentary populations as they can be much more flexible in their daily, seasonal and annual cycles. There has, however, been widespread environmental damage from overgrazing in recent times. Some of this damage results from increases in both human and animal populations that themselves derive from better medical care and reduced mortality.

Over the years the main constraints to increased and more efficient production have been cited as disease, feed shortage, predators, water shortage, labour shortage and inadequate marketing channels and opportunities (Ayele, 2002).

Opportunities

Camels are better adapted to survival in areas with harsh climatic conditions than "conventional" domestic livestock species. As such the species supports the livelihoods and improves the resilience of the pastoral communities of the Ethiopian lowlands and are an extremely important source of food and of improved welfare for local pastoralists.

The camel is a major animal species in the lowland pastoral system but is assuming some importance in the mid-altitude mixed farming and agro-pastoral systems. This is due to its multipurpose role and the variety of products, both direct such as milk, meat and transport and indirect in its social and cultural importance. The camel is able to adapt to many aspects of climate change and continues to do just more than survive when confronted by shortages of feed and water. Demand for the camel and its products is increasing and will continue to do so at an accelerated rate that is in excess of the conventional domestic animal species (Seyoum Bediye *et al*, 2018). In view of the close relationship between feed and water, the latter should be used to direct access to the former with a reduction in environmental

degradation being a principal aim of this (Wilson, 2007).

Lucrative export opportunities exist for both live animals and meat for transfers to, for example, Egypt, Libya, Saudi Arabia and the Gulf States (Tadele Mirkena *et al*, 2018). To capitalise on these, however, the value chain needs to become much better organised and potential problems with health and disease will need to be overcome.

The SWOT analysis (Table 3) provides a summary of the current situation with regard to strengths, weaknesses, opportunities and threats.

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ANNEX

A BIBLIOGRAPHY OF THE ONE-HUMPED CAMEL IN ERITREA AND ETHIOPIA

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