Cattle breed distributions across Borana Zone as determined from an analysis of phenotypic data collected in the Oromiya Regional State Livestock Breed Survey

A Report to Oromiya Agricultural Development Bureau

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Introduction

The Oromiya Regional State livestock breed survey not only resulted in over 60 breed names of cattle being recorded across the region but also a vast majority of cattle being reported as belonging to the local breed (see Chapter 9.4 of Workneh Ayalew and Rowlands, 2004). Furthermore, it is not known how many of the 60 breed names represent distinctive breed types. This means that it is difficult to characterise the breed distributions across the region. One solution proposed in Workneh and Rowlands (2004) is to apply the statistical method of 'cluster analysis' to use the phenotypic data collected to form different groups or clusters of animals that can then be summarised and mapped. Data on cattle raised in Borana Zone were used to illustrate the method. The survey was carried out in five woredas: Bore, Dire, Hagere Mariam, Liben and Teltele. The results of the analysis suggested three possible groupings representing three breed types. One small group, confined primarily to Bore Woreda, tended to be larger than cattle in the other two clusters with a large udder and hump sizes and with a concave shape of head. Cattle in the second cluster tended to have drooped ears and to have larger than average dewlaps and navel flaps that put them into the Borana type. However, many of the cattle in this cluster were raised in *dega* and *weina dega* as well as *kolla* agro-ecological zones suggesting possible interbreeding with other breeds. The third cluster was primarily associated with Bore and Hagere Mariam woredas with phenotypic characteristics indicative of the Guji breed.

One problem with the methods of cluster analysis used in this analysis was that they assumed that all the phenotypic descriptor variables were distributed according to a normal distribution. This may suitably be assumed for such variables as frame size, horn length etc. for, although the measurements are recorded as discrete categories (e.g. 1:small, 2:medium, 3:large), they are also 'ordinal' in the sense that the codes represent a monotonic change in magnitude. Other variables such as horn shape (i.e. 1:straight, 2:curved, 3:lyre-shaped, 4:spiral), however, do not share the same monotonic pattern and can be described as 'nominal' in the sense that they can be coded in any order. This may have had some influence on the results. A student from the Master of Science in Biostatistics programme at Limburgs Universitair Centrum, Belgium was, therefore,

recruited to explore alternative methodologies to accommodate the mix of variables characteristic of this data set (Nieves, 2004). Before applying cluster analysis it is necessary to calculate some measure of 'similarity' to describe the 'closeness' of each observation with one another. Most measures, as that applied in the previous analysis, assume the data to be normally distributed. There is one method, namely that known as 'Gower's similarity index', however, that provides a measure that can accommodate both nominal and ordinal variables. This method was therefore applied by Nieves (2004) to the mixed set of variable types found in this data set.

The results from this analysis indicated four clusters. The first cluster, as for the second cluster in the previous analysis, contained cattle that appeared to exhibit many of the characteristics of Ethiopian Boran. However, as found in the previous analysis, several of the animals grouped within this cluster were raised in different agro-ecological zones, again indicating possible degrees of interbreeding. The second cluster found in this second cluster analysis was found to be distributed across all five woredas and it was suggested that the characteristics displayed by animals within the cluster might be indicative of some Borana/Guji and Borana/Arsi interbreeding. A third group of animals found to occur primarily in Teltele Woreda, but also found in Hagere Mariam and Liben woredas, was thought to describe Konso cattle, characteristic of Teltele Woreda, and also admixtures involving Konso and Ethiopian Boran. The final group comprising smaller cattle, predominantly black in colour, assumed some of the characteristics of Guji cattle.

The methods applied by Workneh Ayalew and Rowlands (2004) and Nieves (2004) resulted in different cluster groupings, each interpreted to representing different breed types. This is a common problem that occurs in the application of cluster analysis, especially when there may be complex sources of variation amongst the data collected. Empirical judgements therefore need to be made as to whether the results make biological sense when considered in the light of other knowledge. One problem maybe that many of the different phenotypic characteristics recorded were too similar between breeds to allow much discrimination, and this would become an increasing problem if significant levels of interbreeding occur. Furthermore, observations recorded in a field survey situation by different enumerators working in different woredas may contain significant sources of observer error and bias. There may also be variations in the 'standard' type of animal chosen to represent the animals raised in a particular household. This adds to the imprecision with which different phenotypic characteristics may be described.

Both cluster methods that have been applied (Workneh Ayalew and Rowlands, 2004; Nieves, 2004) ignored the information supplied by farmers on breed type and assumed each animal to be of unknown breed type. This was intentional as it was planned to extend the methodology to other zones where only a 'local breed' description was given. However, breed types were recorded for all except two animals in Borana Zone and it seemed sensible to take account of this information, along with that of the woreda to which a household belonged, in a further statistical analysis to see how well the results from each of the previous analyses reflect the real picture. By ignoring this information

and treating the zone as a whole it is possible that the methods are too broad to allow sensible conclusions to be drawn.

The present report therefore uses information on the woreda to which a household belongs and the breed recorded by the farmer to guide the application of cluster analysis in a way that may better reflect the situation prevailing on the ground.

Methods

The phenotypic data collected on female cattle recorded in a total of 216 questionnaires were used. Data recorded for each phenotypic variable were checked for obvious inconsistencies and missing values (less than 1% of all the data collected) replaced by average values found by calculating frequency distributions across the whole data set and using the 'mode' or most frequently observed value. Codes 1, 2 and 3 were used to represent increasing levels for the 'size' variables such as frame size with 2 representing the 'medium' recorded value. The additional code 0 was used for variables such as such as hump size to indicate that the characteristic, e.g. hump, was not present. Phenotypic data collected on 10 ordinal 'size' variables and 15 nominal or categorical variables describing other characteristics such as horn shape and face profile were used together in the cluster analysis. Information on just the primary body colour was used to describe the colour of the animal.

Similarity measures using Gower's coefficient as define by Nieves (2004) were first calculated for each pair of variables. Clustering analysis was then applied using a method known as 'Agglomerative Hierarchical Clustering' with a 'strong linkage' approach. The analysis results in a dendogram graph or 'tree' that forms possible groupings of the individual records (See Figure 9.4.2 in Workneh Ayalew and Rowlands, 2004) and a cut-off line can be drawn across the dendogram to select by eye the number of clusters that appears to best discriminate between different groupings of animals. The statistical software XLSTAT was uses for the cluster analysis.

Results

Data description

Table 1 illustrates the distribution of the breed types recorded in the 216 households across the five woredas. Ethiopian Boran cattle were reported in Dire, Liben and Teltele woredas (with four animals also in Hagere Maria Woreda). Guji cattle were reported in Bore, Hagere Mariam and Liben woredas. Arsi cattle were also reported in Liben Woreda and Konso cattle in Teltele Woreda. In order to tease out differences in phenotypic characteristics both among and within breed types that might indicate influences of interbreeding, four separate cluster analyses each using a different subset of the data are suggested.

1. Ethiopian Boran – Dire, Liben and Teltele woredas (98 records)
2. Guji – Bore, Hagere Mariam and Liben woredas (90 records)
3. Liben Woreda – Arsi, Ethiopian Boran and Guji (44 records)
4. Teltele Woreda – Ethiopian Boran and Konso (41 records)

Table 1. Distribution of recorded breeds by woreda and agro-ecological zone

	Agro-ecological zones and woredas						
	Dega (highlands)	*Weina dega* (midlands)			*Kolla* (lowlands)		
Recorded breed type	Bore	Dire	Hagere Mariam	Dire	Hagere Mariam	Liben	Teltele
Arsi						7	
Ethiopian Boran		20		20	4	26	32
Guji	39		30		10	11	
Konso							9
Admixtures	1				2	4	1

Cluster analysis

1. Ethiopian Boran

The results of the cluster analysis for animals of this breed are shown in Tables 2, 3 and 4. Virtually all Cluster 1 (C1) animals are in Dire Woreda in contrast to the C2 animals that are mainly in Teltele Woreda. All except two of the animals in Liben Woreda fall within C3 and C4. However, these two clusters are distributed throughout all three woredas (Table 2).

Table 2. Distribution of 'Ethiopian Boran' cattle clusters by woreda

	Woreda		
Cluster	Dire	Liben	Teltele
1	20	1	0
2	2	1	21
3	13	13	5
4	5	11	6

Tables 3 and 4 present the mean phenotypic characteristics for all 98 animals and also highlight differences between clusters.
Except for teat size, C1 and C2 animals have similar 'size' traits (Table 3). Sixty four per cent of animals are uniform in body colour (Table 4). However there are marked differences in primary body colour. Cluster 2 animals (together with C4) are mostly

white whilst there are as many animals of red-brown primary colour in C1 (also C3). Cluster 2 animals generally have white tails and hoofs whereas those in other clusters have mostly black tails.

Animals have short hair but there are differences in the type of hair observed. Animals in C1 (and C3) were recorded to have straight hair whereas those in C2 and C4 are of mixed type (Table 4). The hump positions in animals in both C1 and C2 were recorded to be at the thoracic whereas those in C3 and C4 were recorded to be at either the thoracic or cervico-thoracic position.

Table 3. Mean scores for 'size' traits for 'Ethiopian Boran' (n=98)

Trait	Mean score[a]	S.D.	Significant differences among clusters
Frame size	2.24	0.57	C3 (2.00); mean C1,2,4 (2.34)
Dewlap size[b]	1.94	0.59	
Hump size[b]	1.56	0.54	C4 (1.91); mean C1,2,3 (1.46)
Ear size	1.60	0.48	
Tail length	2.58	0.59	
Horns length	1.83	0.63	
Space horns	1.64	0.48	
Udder size	2.07	0.67	C4 (2.41); mean C1,2,3 (1.90)
Teats size	1.91	0.63	Mean C2,3 (1.63); mean C1,4 (2.23)
Navel flap size[b]	1.54	0.78	

[a] 1 small, 2 medium, 3 large
[b] Recorded as 0 if not present

Ears are mostly rounded in C1 and straight edged in the other clusters. They were observed to be either lateral or dropping in C1 (and C4) but mainly lateral in C2 (and C4). Two thirds of animals have straight horns, the remaining curved, and there is a mixture of orientation (Table 4). This pattern is similar across all clusters.

Rump profiles are mainly sloping in C1, C2 and C3 animals but flat in C4 animals.

In summary, there appear to be some differences in phenotypic characteristics between C1 and C2 animals that indicate some difference between Dire and Teltele woredas. Cluster 2 animals are primarily white in colour with white tails and hoofs and can have either straight or curly hair. Ears are straight edged and mainly held laterally. In contrast C1 animals can be either white or brown-red and have straight hair. Their ears are mainly rounded and can be lateral or dropping.

Differences are also observed for C3 and C4 animals. Sometimes characteristics matched those of either C1 or C2. However, animals in these two clusters were found to have hump positions at either the thoracic or cervico-thoracic positions (in contrast to just the

thoracic position for C1 and C2 animals). Cluster 4 animals were observed to have flat rump profiles in contrast to the sloping profiles in the other clusters

Table 4. Mean percentage values for qualitative traits for Ethiopian Boran (n=98)

Trait	Characteristic	%	Significant differences among clusters
Primary body colour	Black	2	
	White	57	Mean C2,4 (80) Mean C1,3 (38)
	Grey or blue/grey	10	
	Brown -red	24	Mean C2,4 (9) Mean C1,3 (38)
	Yellow- brown or beige	3	
Colour pattern	Uniform	64	
	Shaded	17	
	Pied or spotty	18	
Tail colour	Black	58	C2 (17) Mean C1,3,4 (72)
	White	25	C2 (67) Mean C1,3,4 (12)
	Other	19	
Hoof colour	Black	55	C2 (17) Mean C1,3,4 (68)
	White	23	C2 (71) Mean C1,3,4 (8)
	Other	22	
Hair length	Short	98	
	Medium	2	
Hair type	Straight	71	Mean C1,3 (98) Mean C2,4 (41)
	Curly	29	Mean C1,3 (2) Mean C2,4 (59)
Hump shape	Erect	93	
	Dropping	7	
Hump position	Thoracic	66	Mean C1,2 (91) Mean C3,4 (45)
	Cervico-thoracic	34	Mean C1,2 (9) Mean C3,4 (55)
Ear shape	Rounded	30	C1 (81) Mean C2,3,4 (16)
	Straight edged	70	C1 (19) Mean C2,3,4 (84)
Ear orientation	Upright	3	
	Lateral	65	Mean C1,4 (42) Mean C2,3 (84)
	Dropping	32	Mean C1,4 (56) Mean C2,3 (13)
Shape of horns	Straight	64	
	Curved	34	
	Lyre-shaped	2	

Table 4 continued

Horn orientation	Forward	16
	Lateral	33
	Upright	51
Face profile	Flat	90
	Concave	6
	Convex	4
Back profile	Curved	16
	Straight	84
Rump profile	Flat	35 Mean C1,2,3 (20) C4 (86)
	Sloping	65 Mean C1,2,3 (80) C4 (14)

2. Guji

The results of the cluster analysis are to be found in Tables 5, 6 and 7. More marked differences in 'Guji' breed types were observed than for Ethiopian Boran. It can be seen that C5 and C6 animals are primarily confined to the Bore and Hagere Mariam (*weina dega*) woredas (Table 5). Cluster 8 animals are also found in Hagere Mariam Woreda, especially in the *kolla* agro-ecological zone. Nine of the 90 animals appear in Cluster 7, mostly associated with Liben Woreda. Tables 6 and 7 present the mean phenotypic characteristics for the animals in this cluster analysis and highlight the differences observed.

Table 5. Distribution of 'Guji' cattle clusters by woreda

	Woreda			
	Bore	Hagere Mariam		Liben
Cluster		*Weina dega*	*Kolla*	
5	23	13		2
6	15	8		1
7	1	1		7
8		8	10	1

Cluster 5 and 6 animals are larger than those in C7 and C8 (Table 6) and mainly have black as their primary colour compared with a greater variety of primary colours (black, white and brown-red) among animals in C7 and C8 (Table 7). Tail colour differs similarly between these pairs of clusters. Cluster 5 and 6 animals also have larger ears and longer tails and horns than those in C7 and C8 (Table 6). There are also some variations between C5 and C6 traits. Dewlap, hump and udder size are each larger for C5 than C, which in turn is similar to C7 and C8. In general, there would appear to be

differences in breed characteristics in between animals found in Bore and Hagere Mariam (*weina dega*)woredas than in Liben and Hagere Mariam (*kolla*) woredas (Table 5).

Table 6. Mean scores for 'size' traits for 'Guji' cattle (n=90)

Trait	Mean score[a]	S.D.	Significant differences among clusters
Frame size	1.66	0.77	Mean C5,6 (1.85); mean C7,8 (1.22)
Dewlap size[b]	1.52	0.62	C5 (1.89); mean C6,7,8 (1.25)
Hump size[b]	1.40	0.52	C5 (1.71); mean C6,7,8 (1.13)
Ear size	1.44	0.50	Mean C5,6 (1.60); mean C7,8 (1.10)
Tail length	2.49	0.67	Mean C5,6 (2.62); mean C7,8 (2.18)
Horns length	1.68	0.63	Mean C5,6 (1.82); C8 (1.26)
Space horns	1.56	0.50	C5 (1.96); C6 (1.63); mean C7,8 (1.22)
Udder size	1.56	0.60	C5 (1.84); mean C6,7,8 (1.34)
Teats size	1.68	0.58	Mean C5,8 (1.94); mean C6,7 (1.21)
Navel flap size[b]	1.06	0.77	C6 (0.42); mean C5,7,8 (1.29)

[a] 1 small, 2 medium, 3 large
[b] Recorded as 0 if not present

There are apparent differences in hair length and type among clusters. Animals in C6, C7 and C8 have short hair whereas half of those in C5 were reported to have hair of medium length (Table 7). Half the cattle were observed to have straight and half curly hair, but hair type varied significantly among clusters.

Ear shape is mainly straight edged but in C7 the reverse was observed with the majority of animals possessing rounded ears. Both straight and curved horns were observed but the distributions varied between C5/C8 and C6/C7 (Table 7).

Rump profile varied. Half the animals in C5 and C7 were observed with flat profiles in contrast to the majority of animals in C6 and C8 that have sloping profiles.

Compared with the phenotypic characteristics for Ethiopian Boran (Tables 3 and 4) the Guji cattle are smaller with smaller dewlaps, udders and navel flaps. The sizes of their humps and ears are also slightly smaller ($P<0.05$). Lengths of horns and tails, however, were observed not to be significantly different between the two breeds. White is the prominent primary colour among Ethiopian Boran compared with black among Guji cattle.

Ethiopian Boran cattle have short hair, more often straight than curly (Table 4). The Guji cattle, however, were found to have a greater variety of hair lengths and types (Table 7). The trend for ear orientation is from lateral to dropping in Ethiopian Boran compare with lateral to upright in Guji cattle. Horn orientation is lateral or upright in Ethiopian Boran

whereas a quarter of Guji cattle were reported to have horns pointing in a forward direction.

Table 7. Mean percentage values for qualitative traits for 'Guji' cattle (n=90)

Trait	Characteristic	%	Significant differences among clusters
Primary body colour	Black	66	Mean C5,6 (82); mean C7,8 (29)
	White	13	
	Brown-red	17	
	Other	4	
Colour pattern	Uniform	59	
	Pied	24	
	Shaded or spotty	17	
Tail colour	Black	66	Mean C5,6 (89); mean C7,8 (39)
	White	14	
	Brown-red	12	
	Other	8	
Hoof colour	Black	73	
	White	8	
	Brown-red	12	
	Other	6	
Hair length	Short	76	C5 (50); mean C6,7,8 (94)
	Medium	24	
Hair type	Straight	53	Mean C5,8 (42); C6 (96); C7 (11)
	Curly	47	
Hump shape	Erect	94	
	Dropping	6	
Hump position	Thoracic	79	
	Cervico- thoracic	21	
Ear shape	Rounded	18	Mean C5,6,8 (10); C7 (88)
	Straight edged	82	
Ear orientation	Upright	20	
	Lateral	79	
	Dropping	1	
Shape of horns	Straight	51	Mean C5,8 (68); mean C6,7 (21)
	Curved	48	
	Lyre-shaped	1	

Table 7 continued

Horn orientation	Forward	28	
	Lateral	27	
	Upright	44	
Face profile	Flat	74	
	Concave	8	
	Convex	18	
Back profile	Curved	11	
	Straight	89	
Rump profile	Flat	32	Mean C5,7 (55); mean C6,8 (8)
	Sloping	54	
	Roofy	13	

3. Liben Woreda

Ethiopian Boran cattle in Liben Woreda fall mainly in C3 and C4 (Table 2); Guji cattle in the same woreda fall mainly in C7 (Table 5). It is of interest, therefore, to cluster the 48 animals recorded in Liben Woreda to see whether the Ethiopian Boran and Guji cattle separate into different clusters. The 48 animals also include seven interbred Arsi and four interbred Boran animals (Table 1). Cluster analysis puts the majority of the Arsi cattle and those interbred with Boran together with approximately half the Ethiopian Boran into C9 (Table8). Cluster 10 primarily comprises the remaining Ethiopian Boran and C11the Guji cattle.

Table 8. Distribution of clusters by breed in Liben Woreda

	Breed				
Cluster	Arsi	BxA	Boran	BxG	Guji
9	6	3	15		1
10	1		11	1	2
11					8

Cluster 11 animals are smaller than those in C9 and C10 with smaller dewlaps and humps, udders and teats (Table 9). Cluster 10 animals in general have the largest ‘size’ traits. Cluster 9 animals are as large as C10 animals in terms of overall size but tend to have smaller dewlaps, humps and ears, shorter horns and smaller udders, teats and navel flaps.

The primary body colour for C9 and C10 is white compared with black for C11. Some brown-red animals also occur in C9 and C11 (Table 10).

The majority of animals in C10 and C11 have curly hair compared with straight hair for those in C9. Ear shape is primarily straight edged in C9 and C10 but rounded in C11 with an orientation tending towards dropping in both C9 and C10.

Table 9. Mean scores[a] for 'size' traits for cattle in Liben Woreda (n=48)

	Cluster		
Trait	9	10	11
Frame size	2.12	2.07	1.13
Dewlap size[b]	1.88	2.27	1.38
Hump size[b]	1.48	1.73	1.00
Ear size	1.44	1.80	1.25
Tail length	2.88	2.80	1.88
Horns length	1.32	1.80	1.50
Space horns	1.80	1.87	1.38
Udder size	2.08	2.47	1.25
Teats size	1.84	2.40	1.25
Navel flap size[b]	1.16	2.00	1.13

[a] 1 small, 2 medium, 3 large
[b] Recorded as 0 if not present

Horns are more frequently straight for cattle in C9 and C10 but usually curved for cattle in C11 which also have a greater tendency to be upright than lateral or forward (Table10).

Enumerators reported rumps to be sloping among C9 animals in contrast to the greater frequency of flat profiles found among animals in C10 and C11.

Table 10. Mean percentage values for qualitative traits in Liben Woreda (n=48)

		%		
Trait	Characteristic	C9	C10	C11
Primary body colour	Black	8	7	62
	White	64	80	0
	Grey or blue/grey	4	0	0
	Brown-red	16	7	38
	Yellow- brown or beige	4	7	0
Colour pattern	Uniform	76	93	38
	Shaded	16	7	50
	Pied or spotty	8	0	12
Tail colour	Black	96	93	100
	White	0	0	0
	Other	4	7	0

Table 10 continued

Hoof colour	Black	100	100	100
	White	0	0	0
	Other	0	0	0
Hair length	Short	100	93	100
	Medium	0	7	0
Hair type	Straight	100	20	0
	Curly	0	80	100
Hump shape	Erect	92	100	100
	Dropping	8	0	0
Hump position	Thoracic	52	100	75
	Cervico-thoracic	48	0	25
Ear shape	Rounded	0	13	88
	Straight edged	100	87	12
Ear orientation	Upright	20	0	0
	Lateral	48	33	100
	Dropping	32	67	0
Shape of horns	Straight	60	67	12
	Curved	40	20	88
	Lyre-shaped	0	13	0
Horn orientation	Forward	20	7	0
	Lateral	44	80	25
	Upright	36	13	75
Face profile	Flat	96	93	100
	Concave	0	7	0
	Convex	4	0	0
Back profile	Curved	36	7	25
	Straight	64	93	75
Rump profile	Flat	8	87	88
	Sloping	92	13	12

4. Teltele Woreda

The Ethiopian Boran cattle falling in Cluster 2 were primarily associated with Teltele Woreda (Table 2). Ten additional animals in this woreda were identified as Konso (9) or Konso x Ethiopian Boran (1). The Ethiopian Boran cattle here were shown to possess

some different phenotypic characteristics from those in other woredas (Table 4). It is therefore of interest to explore further differences between Ethiopian Boran and Konso cattle in this woreda. Two clusters were observed (Table 11).

Table 11. Distribution of clusters by breed in Teltele Woreda

	Breed		
Cluster	Boran	Konso	KxB
12	22		
13	10	9	1

Two-thirds of the Ethiopian Boran cattle fall in C12; the remainder fall with the Konso animals in C13 (Table 11). C13 animals were smaller than C12 animals and had smaller dewlaps, humps, ears and navel flaps (Table 12).

Both clusters show the same characteristic white body colour with approximately half the animals in each cluster having white tails (Table 13). Animals in C13, however, generally have black hooves compared with the higher proportion of white hooves in C12. Other phenotypic characteristics are similar between the two clusters.

Table 12. Mean scores[a] for 'size' traits in Teltele Woreda (n=42)

	Cluster	
Trait	12	13
Frame size	2.55	1.60
Dewlap size[b]	1.82	1.30
Hump size[b]	1.73	1.35
Ear size	1.77	1.15
Tail length	2.36	2.50
Horns length	1.91	1.90
Space horns	1.68	1.55
Udder size	1.77	1.75
Teats size	1.68	1.85
Navel flap size[b]	1.45	0.90

[a] 1 small, 2 medium, 3 large

[b] Recorded as 0 if not present

Table 13. Mean percentage values for qualitative traits for Teltele Woreda (n=42)

		%	
Trait	Characteristic	C12	C13
Primary body colour	Black	0	10
	White	82	60
	Grey or blue/grey	0	5
	Brown -red	18	20
	Yellow- brown or beige	0	5
Colour pattern	Uniform	64	80
	Shaded	14	0
	Pied or spotty	23	20
Tail colour	Black	9	40
	White	59	45
	Other	32	15
Hoof colour	Black	14	85
	White	64	10
	Other	23	5
Hair length	Short	100	100
	Medium	0	0
Hair type	Straight	50	50
	Curly	50	50
Hump shape	Erect	95	100
	Dropping	5	0
Hump position	Thoracic	68	80
	Cervico-thoracic	32	20
Ear shape	Rounded	18	20
	Straight edged	82	80
Ear orientation	Upright	5	0
	Lateral	86	90
	Dropping	9	10
Shape of horns	Straight	55	25
	Curved	45	75
	Lyre-shaped		
Horn orientation	Forward	5	5
	Lateral	32	15
	Upright	64	80

Table 13 continued

Face profile	Flat	86	90
	Concave	9	10
	Convex	5	0
Back profile	Curved	14	15
	Straight	86	85
Rump profile	Flat	27	20
	Sloping	73	80

Summary

The Ethiopian Boran breed type was the only one used to describe cattle in Dire Woreda (Table 1). The majority of these cattle fall into C1 and C3; all except one animal in C1 falls in this woreda (Table 2). Many of the phenotypic characteristics are similar between C1 and C3 (Tables 3 and 4), but with differences in ear shape and orientation. Animals in C1 primarily have rounded and with a tendency to dropping ears, whilst those in C3 tended to be straight edged and lateral (Table 4). Animals in C1 and C3 have various primary body colours in contrast to C2 and C4 where the primary body colour is white.

The majority of Ethiopian Boran cattle in Liben Woreda are represented by C3 and C4. Cluster 4 animals tended to have larger humps and udders than those in other clusters. Compared with C3 animals the animals in this cluster were found more frequently to have curly hair, to have dropping rather than lateral ears and a flat rump profile (Table 4). Otherwise phenotypic characteristics in C3 and C4 animals tended to be similar.

The existence of Arsi, Guji and Ethiopian Boran cattle was reported in Liben Woreda (Table 1). The differences between C1/C2 and C3/C4 clusters may thus to some extent reflect breed admixtures in Liben Woreda. When the animals in Liben Woreda were clustered, three clusters were observed: C9 associated with Arsi and Ethiopian Boran, perhaps reflecting interbreeding between these breeds, C10 with Ethiopian Boran and C11 with Guji. Although of similar overall size, animals in C 9 tend to have smaller 'size' traits than those in C10 (Table 9). Rumps tended to be flat among C10 animals and they mostly had curly hair. Otherwise phenotypic characteristics are similar. The majority of animals in both clusters are white. In contrast C11 animals have more striking differences. They are small, generally with black as their primary colour, ears rounded rather straight edged, lateral rather than dropping, horns curved rather than straight and upright rather than lateral or forward.

When Guji cattle were clustered four groups were found with C5 and C6 associated with Bore and Hagere Mariam woredas and C7 with Liben Woreda. A fourth cluster C8 comprised the remainder of animals in Hagere Mariam including all the animals in the *kolla* agro-ecological zone (Table 5). These cattle in these clusters were smaller than the

Ethiopian Boran cattle and many other phenotypic characteristics were also observed to be different.

Differences in phenotypic characteristics were observed among the Guji clusters suggesting differences in breed characteristics across Borana Zone. For example, animals in Bore and Liben woredas have different characteristics. Half the animals in Hagere Mariam Woreda have similar characteristics to those in Bore Woreda, but the other half (including all in the k*olla* zone) fall into C8. Cluster 8 animals tend to share the same small 'size' characteristics as C7 (Table 6) but have straight-edged rather than round ears, straight rather than curved horns, and sloping rather than flat rumps (Table 7). There are a greater variety of primary colours among animals in C7 and C8 than among those in C5 and C6 that are predominantly black.

Ethiopian Boran cattle found in Teltele Woreda have certain differences in characteristics from those found in other parts of Borana Zone. Compared with cattle in Dire Woreda and some of those in Liben Woreda (C1 and C3) a greater proportion of animals are white in colour and also have characteristic white tails and hooves. Konso animals were also reported in Teltele Woreda. Two groups of animals were observed when the animals in this woreda were clustered, one an Ethiopian Boran group and one a 'Konso x Ethiopian Boran'. These two clusters shared similar characteristics but with the latter group being of smaller general size.

Different enumerators participated in the survey in different woredas. It is possible therefore that some of the differences observed may reflect differences in 'enumerator assessment'. A degree of caution is needed, therefore, in relating some of the differences observed among clusters to real differences in 'breed type'. Nevertheless, by taking into account recorded breed information and the woredas within which different breeds were described, our method of analysis does appear to have been able to characterise and describe variations in breed types across Borana Zone and indicate the levels of interbreeding within different woredas.

Discussion

The analysis has provided information on the distribution of breed types and variations in their phenotypic characteristics across the sampled woredas. By taking into account the woredas from which the data were obtained and the breed types that were recorded by the farmers a more realistic interpretation of the results would appear to have been obtained from that achieved by either of the earlier broader analyses across the whole zone. A combination of cluster analysis with geographical and recorded breed type information appears therefore to provide some insight into the locations where different breeds are found and the extent to which interbreeding is taking place.

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Nieves (2004) also applied the broad cluster analysis approach used in Borana Zone to data collected in East Shewa and East Wellega zones. Three clusters were identified in East Shewa highlighting differences particularly in body colour and colour pattern, horn shape and tail length. The majority of animals in one cluster were also humpless and

without dewlaps. The Arsi, and to a much lesser extent, the Ethiopian Boran and Karanyuu, Chefe and Oboo breeds, were recorded by half the farmers in East Shewa Zone These data may thus lend themselves, therefore, to the same approach adopted for Borana Zone. The situation with East Wellega Zone, however, is different since only 'local breed' information was collected. Just two clusters were identified in the analysis, distinguished one from another only by slight differences in size of hump, dewlap and navel flap. With the knowledge that the Horro breed is the predominant breed in this zone it may be that both groups simply describe variations among animals found among this breed. One approach to investigate further the breed distribution patterns within East Wellega Zone might be to undertake a combined analysis with the data from East Wellega Zone put together with data for selected breed types identified from cluster analyses in Borana and East Shewa zones. The extent to which the clusters obtained from this analysis fall within the different zones and woredas would indicate the extent to which different breeds or admixtures other than pure Horro animals exist within East Wellega Zone.

We shall welcome the views of the Oromiya Agricultural Development Bureau on the validity and usefulness of the results described above for Borana Zone and to know whether further analysis of the data collected in East Shewa and East Wellega would be of value.

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