*Figure 2. Afar cow (Igahiboda type) Mayshiguala river, Abala, Afar, Ethiopia.*

*Figure 3. Afar bull (Igahiboda type) Abala, Afar, Ethiopia.*

the Oromo migration of the 16th to 17th century and indigenous to the area respectively (Figure 4).

### *Begait*

In the case of the Begait breed, 91 and 9% of respondents indicated the place of origin of this breed to be the Sudan and the lowlands of Eritrea, respectively. Two distinct types of the breed have been identified according to the group discussions.

The Dohin, is a tall and slender type with short ears, a straight nose, a narrow long neck and long thin legs, a long tail, a less developed dewlap and a smaller udder (Figure 5). Milk production is lower than in the other type. Both males and females have thin and medium horns, with black or brown coat colour. The most important traits of this type are its aggressive behaviour towards intruders which is an advantage in areas where cattle rustling is a big problem, and the capacity to travel long distances and graze in the vast range lands.

The Begait type is the largest and most docile with a well developed udder, long teats and a higher milk yield. Small and stumpy horns are common in both males and females of this type. The Begait is very vulnerable to food shortage. Grey, brown and black and white coat colours are most common (Figure 5, 6 and 7).

### *Medenes*

The Medenes is a crossbred of the Begait and Arado breeds (almost always a cross between Arado cow with Begait bull). They are medium sized with large ears, and are mostly black and white in varying patterns, other colours being rare (Figure 8). This type is tolerant to food shortage but milk production is lower than the Begait and is comparable with the Dohin type.

### *Arado*

The origin of this breed is less well known. Sixty seven percent of interviewed farmers do not know the origin of this breed, 12 and 21 % of the respondents indicated that the breed is indigenous and as a result of introduction from the lowlands respectively. The breed is characterised as small and hardy with red and black coat colours in abundance. Females have medium, thin horns while males have thicker and shorter horns and a cervicothoracic hump (Figure 9 and 10). This breed

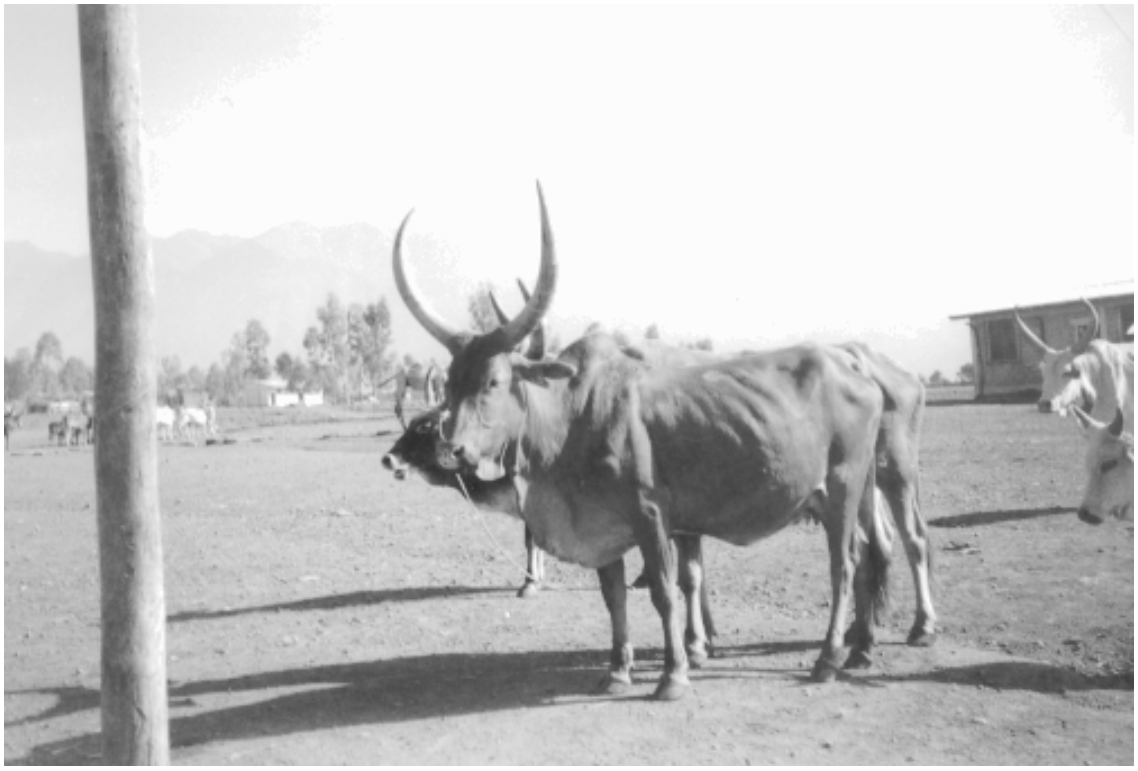

*Figure 4. Raya cow, Alamata, Tigray, Ethiopia.*

*Figure 5. Begait cow (Dohin type), Adiremets, Tigray, Ethiopia.*

*Figure 6. Begait cow (Begait type), Tekeze river, Adiremets, Tigray, Ethiopia.*

*Figure 7. Begait bull (Begait type), Sheraro, Tigray, Ethiopia*

is the most abundant and heterogeneous breed of cattle in the highlands and most influenced by such factors as introduction of bulls from the lowland breeds, and bull and AI services introduced by different projects.

*Fogera*

All interviewed farmers believe that this breed is indigenous to the area. The breed is characterised as medium to large in size with short or stumpy horns, a well developed dewlap, a navel flap and udder in females and a small to medium thoracic hump in males and females. Black with small spots of white is the most dominant coat colour (Figure 11 and 12).

## Production and Reproduction

The production and reproduction performance information from the questionnaire and group discussions, and body weight and height measurements are summarised in table 4. Males and females of the Begait breed were heavier and taller than the other breeds. Body weights and heights for Begait and Afar in the present study were smaller and marked differences between the sexes in the Afar breed were observed compared to earlier reports (FAODAD-IS). The average daily milk production for Begait was higher than all breeds, while the lactation length was shorter than the Arado, Afar and Raya breeds. The age at first calving for the Afar and Begait were 10, 26, 12 and 16% shorter than the Raya, Arado, Medenes and Fogera respectively; the calving interval for the Afar was 7, 36, 26, 14 and 30% shorter than Raya, Arado, Begait, Medenes and Fogera breeds respectively. Overall productivity of breeds from the pastoral production system (Afar and Begait) seems to be higher than the breeds from the agro-pastoral system (Raya and Medenes) and the crop/livestock production system (Arado and Fogera).

According to results from the group discussions, two outstanding factors - relative abundance of feed in the range lands and the knowledge and practice of selective and controlled breeding in pastoral communities - were identified to have contributed to the differences in the performance of the breeds with respect to the production system.

### Breeding and genetic resource management

Except for the initiative taken to improve and conserve the Fogera breed, there are no known

*Figure 8. Medenes cow, Aditseser, Tigray, Ethiopia.*

institutionalised activities for the benefit of the other breeds. The farmers and pastoralist are doing their best to manage their resources albeit under extremely difficult circumstances with no technical or other forms of support.

There was a marked difference in the general awareness of genetic resources management and utilization of inter and intra breed genetic variation between the pastoral and agro-pastoral communities in the lowlands, and the farmers in the highlands.

One hundred, 78 and 91 percent of the interviewed farmers/ pastoralists indicated that they use traditional methods of animal identification, controlled breeding and culling unwanted males before sexual maturity based on family information for the Afar, Raya and Begait breeds respectively. Only 7, 38 and 21% of interviewed farmers indicated the use of traditional methods to improve their animals for the Arado, Medenes and Fogera breeds respectively. Intra-breed selection and controlled breeding are favoured as methods for genetic improvement by Afar, Raya and Begait breeders, while crossbreeding is considered to be the best method in the case of Arado, Medenes and Fogera breeders.

It was further observed in the group discussions that there is the presence of a collective sense of breed ownership and awareness in the Afar, Begait and (to a lesser extent) Raya breeders, whereby traditional mechanisms are used to protect and maintain their genetic resource from the effects of migration from adjacent breed populations. Such traditional systems were generally absent in the case of Arado and Fogera breeders.

## Traits of adaptive and economic importance

According to interviewed farmers/pastoralists, the cattle breeds studied have traits of adaptive importance for their respective production systems. A very important observation in this study is pastoralists' and farmers' utilization of intra-breed genetic variation in their breeding systems to develop distinct types (the Bedaeru and Igahiboda types of the Afar breed, and the Dohin and Begait types of the Begit breed) within a breed that are suitable for a range of environmental conditions.

This practice, however, in addition to the effects of natural selection for fitness, tend to favour the intermediate types that can adapt well to broader environmental and farming system conditions as opposed to types with specific merits or high performers in a given niche.

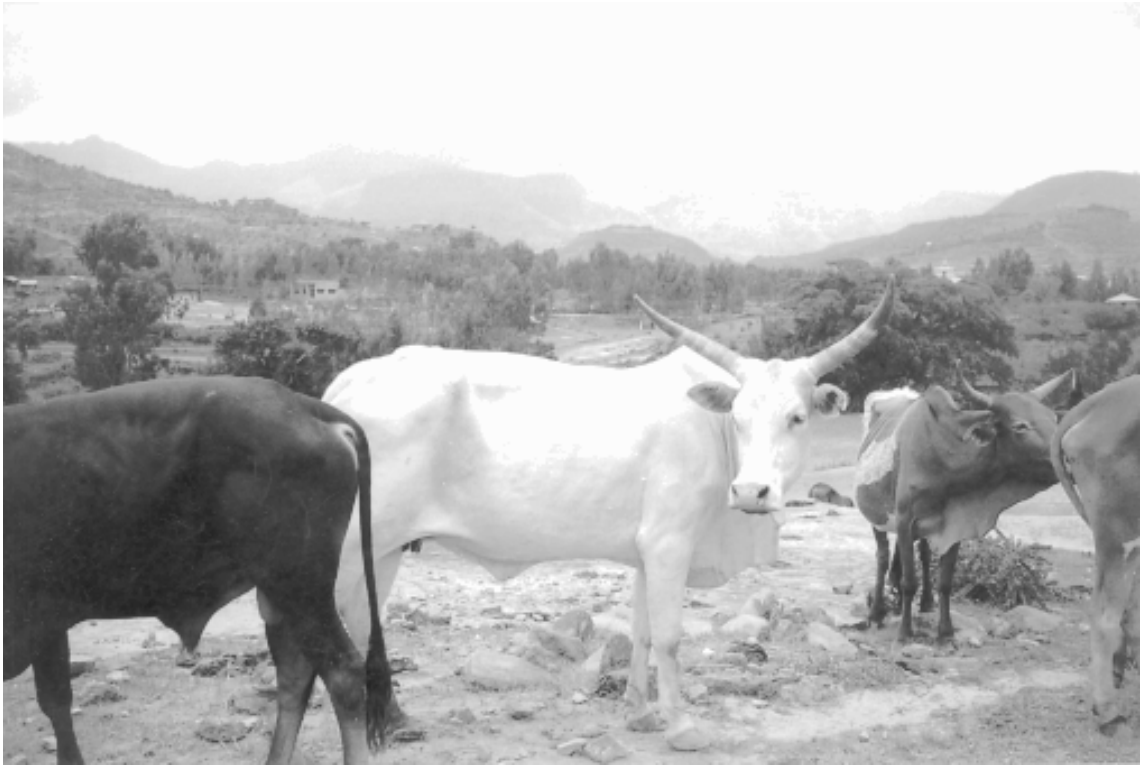

*Figure 9. Arado cow, Enticho, Tigray, Ethiopia.*

*Figure 10. Arado bull, Gerhusernay, Tigray, Ethiopia.*

*Table 5. Variables and criteria for the estimation of the extinction probability of African cattle breeds. (Reist-Marti et al. 2003).*

| Variable (abbreviation) | Criterion and value |
|---|---|
| Total population size (POS) | 0.3 < 1 000 |
| | 0.2 = 1 001-10 000 |
| | 0.1 = 10 001-100 000 |
| | 0.0 > 100 000 |
| | 0.1 = missing value |
| Change of total population size over the last 10 years (CHA) | 0.1 = decreasing (>20%) |
| | 0.0 = increasing or stable |
| Distribution of the breeds (DIS) | 0.1 = localized (in 1 or more countries) |
| | 0.05 = spread within 1 country |
| | 0.0 = widespread over several countries |
| | 0.0 5 = missing value |
| Degree or risk of indiscriminate crossing (CRO) | 0.1 = high |
| | 0.0 = marginal |
| | 0.1 = missing value |
| Organization of farmers (ORG) | 0.1 = no |
| | 0.0 = yes (e.g., herd book) |
| | 0.1 = missing value |
| Established conservation scheme (CON) | 0.1 = none |
| | 0.05 = partial |
| | 0.0 = yes |
| Political situation of the country(-ies) (POL)[1] | 0.1 = general advice against travel (war) |
| | 0.05 = some objections (conflict) |
| | 0.0 = no objection (no conflict) |
| Special traits (SPE) | 0.1 = none |
| | 0.0 = yes (e.g., trypanotolerance, adaptation to the environment) |
| | 0.1 = missing value |
| Social importance (CUL) | 0.1 = none or can easily be replaced by other breeds |
| | 0.05 = some sociocultural value |
| | 0.0 = yes (e.g., religion, traditional custom) |
| | 0.05 = missing value |
| Reliability of the information (REL) | 0.1 = not reliable |
| | 0.0 = reliable |
| | 0.1 = missing value |

[1]For the present study, the variable political situation of the country/ies (POL) is modified to reflect direct threats such as war and conflicts in the immediate vicinity of the breeds instead of "security information for travellers". The criteria and value were: war =0.1, conflict= 0.05 and no conflict= 0.0.

The creation of the Medenes breed in the last 50 or so years is an indication that farmers and agro-pastoralists are changing their breeding goals from high yielding to more adaptive types by exploiting inter-breed genetic diversity. As such animals have adaptive advantages they are replacing the pure breeds.

The adaptation of the Fogara breed to survive several months in flooded areas, adaptation of the Arado and Medenes breeds to extreme feed shortage in the dry season and the adaptation of the Afar and Begait to arid and semi-arid conditions are particularly important and unique.

## Threats of extinction and genetic conservation

The overall average extinction probabilities within the next 20-50 years for all breeds in the present study was 0.49±0.09, slightly higher than earlier reports (0.48±0.11) for 49 African breeds including some of the breeds in this study (Reist-Marti *et al.*,

*Table 6. Estimated extinction probabilities (z) of eight indigenous cattle breeds of north Ethiopia.*

| | | Variable[1] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Breed | Breed group[2] | POS | CHA | DIS | CRO | ORG | CON | POL | SPE | CUL | REL | z |
| Afar | Sanga[a] | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 | 0.05 | 0.10 | 0.47 |
| Raya | Sanga[a] | 0.00 | 0.10 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.10 | 0.05 | 0.00 | 0.47 |
| Fogera | Zenga[a] | 0.00 | 0.10 | 0.05 | 0.00 | 0.10 | 0.00 | 0.00 | 0.10 | 0.05 | 0.10 | 0.43 |
| Abergelle | Zenga[b] | 0.10 | 0.10 | 0.10 | 0.00 | 0.10 | 0.10 | 0.00 | 0.10 | 0.05 | 0.00 | 0.53 |
| Arado | Zenga[a] | 0.00 | 0.00 | 0.00 | 0.10 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.00 | 0.37 |
| Irob | Zenga[b] | 0.10 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.05 | 0.10 | 0.05 | 0.00 | 0.57 |
| Medenes | Zenga[c] | 0.10 | 0.00 | 0.10 | 0.00 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.00 | 0.43 |
| Begait | Zebu[a] | 0.10 | 0.10 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 | 0.05 | 0.10 | 0.67 |
| | | | Sanga | | | Zenga | | | Zebu | | All | |
| | Average z | | 0.47 | | | 0.47 | | | 0.67 | | 0.49 ± 0.09 | |

[1]Variables and criteria for the estimation of the extinction probability of African cattle breeds (Reist *et al.* 2003), refer table 5 for detailed description.

[2]Breed group classification according to [a] (Rege, 1999); [b] (Zerabruk & Vangen, 2005); [c](Tekleab, 2000).

*Figure 11. Fogera cow, Andasa cattle breeding centre, Amhara region, Ethiopia.*

*Figure 12. Fogera bull, Kidisthana, Amhara region, Ethiopia.*

2003). Extinction probabilities ranged from 0.37 for the Arado to 0.67 for the Begait breed (Table 6).

On the other hand, according to the information in the FAO DAD-IS and the global criteria for determining domestic animals at risk, none of the breeds studied is considered to be at risk (Scherf, 2000).

While the overall approach of estimating extinction probabilities by this method can be relatively effective, as it includes more variables in studying threat levels of breeds, its accuracy depends mainly on the availability of current population data and deriving variables and values that directly influence the threat level of each of the breeds studied in their respective production environment (Table 5).

Population size has dramatically changed in the last 20-30 years for most of the breeds studied and in many cases the same population data was used to estimate extinction probability and risk of extinction. Although the average overall extinction probability for all breeds in the present study is very close to earlier estimates (Table 6), the extinction probability of the Raya breed was higher and that of Arado was lower than reported (Reist-Marti *et al.*, 2003). Hence, extinction probability and expected loss of diversity should be updated based on the most recent information and using relevant variables to ensure successful monitoring of animal genetic resources.

However, the more than threefold increase in the population size of the Arado, while most of the other breeds had marked reductions during the same period, indicates more productive breeds such as the Begait and Raya and more productive types within breeds such as the Igahiboda type of the Afar breed are declining in numbers and being replaced by less productive breeds and types.

The high overall extinction probability for most of the breeds in this study indicates the need for urgent intervention in terms of breed conservation efforts. The only effort so far is the in-situ conservation program for the Fogera breed at the Andassa and Metekel cattle breeding ranches. Upgrading the recording system and the use of cryopreservation of semen and/or embryos could be an alternative method of conservation for the long term.

On the other hand, the fate of the rest of the breeds is in the hands of their owners. The Afar, Begait and to a lesser extent the Raya are protected by the traditional indigenous animal genetic resources management systems of the pastoralists. As a result, the biggest threat to these breeds is not cross breeding or replacement, but natural and man made disasters such as famine and war. The Arado and to a lesser extent the Fogera are threatened by natural and man made factors, a lack of indigenous animal genetic resource management by farmers and indiscriminate cross breeding projects.

Lack of resources for farmers and government institutions forced both to focus on averting pressing short term food shortages rather than a long term effort on conservation and utilization of genetic resources.

## Conclusions

Overall production and reproduction performances of cattle breeds in the pastoral and agro-pastoral production systems (Afar, Raya, Begait) were higher compared to breeds from the mixed crop/livestock production system. The six cattle breeds evaluated in the present study were found to have adaptive advantages and unique traits suited to their respective production systems. While traditional animal genetic resources management practices are part of the pastoral and agro-pastoral cattle owners approach to farming and continue to play considerable role, farmers in the mixed crop/livestock production system are less aware of similar practices. Traditional animal breeding in the form of sire and dam selection, culling and animal identification are used in genetic improvement in the pastoral and agro pastoral communities. Such practices in general are absent in the mixed crop/livestock production system and the preferred method of improvement there is cross breeding. This can partly be explained by the fact that fewer numbers of cattle are owned by farmers as compared to pastoralists, with which to undertake any meaningful selection.

Except for the Arado breed, all the breeds have gone through significant population size reductions as a result of famine and man made problems in the past 20-30 years. Famine, conflict, poverty and uncontrolled breeding (especially in the mixed crop/livestock production system) were identified as the most important threats to the cattle breeds studied.

The higher risk of extinction of the breeds especially the Begait breed (the only breed in the zebu group) calls for immediate action to save the breed.

Even though farming communities in northern Ethiopia have been the guardians for a number of plant and animal genetic resources with their indigenous knowledge, they are currently faced with problems that are complex and demand an

urgent intervention that combines modern approaches (*in-situ /ex-situ* conservation) and the utilisation of the traditional knowledge of farmers and pastoralists. Educating farmers and pastoral communities and other stake holders as well as learning from them about the challenges and opportunities of animal genetic resources should be a vital part of the battle against the extinction or loss of these valuable breeds.

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