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Productive and economic performance of endemic N'Dama cattle in southern Mali compared to Fulani Zebu and their crossbreds

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ABSTRACT

In recent decades, there has been a rapid shift in livestock breeds used in developing countries, leading to a loss of local genetic resources. The introduction of high-performing livestock breeds might, however, offer opportunities to improve the income of poor livestock keepers. In southern Mali, where cattle play an important role in farmers' livelihoods, the endemic trypanotolerant N'Dama cattle breed is increasingly being crossbred with the improved Fulani Zebu breed. Thus, the N'Dama cattle face serious threats of genetic erosion, despite their adaptive attributes. This study aims to evaluate and compare the productive and economic performance of endemic N'Dama, Fulani Zebu and their crossbreds in southern Mali in order to assess the comparative advantages of these breed groups for farmers. Data collection methods comprised of interviews with 34, 31, 34 and 61 households keeping N'Dama, crossbreds, Fulani Zebu and mixed herds respectively, and a cow progeny history and body condition scoring (BCS) (n = 770). Data were analyzed using linear mixed models and a non-parametric test. Results on cow individual performances showed a higher body condition for N'Dama compared to Fulani Zebu and crossbred cattle, while cow milk offtake was higher for Fulani Zebu herds. Calving and offtake rates were higher for the Fulani Zebu and crossbred herds. The gross margin/cattle and the benefit-cost ratio were highest in the Fulani Zebu herds, followed by the crossbred herds, whereas the net benefit/cattle, including non-market benefits, such as traction, manure, insurance and home consumption, was similar between the herd categories. The N'Dama cattle remain a valuable breed for subsistence-oriented crop-livestock farmers for whom non-market benefits from cattle play a considerable role. Fulani Zebu and crossbred cattle were the most favorable options for market-oriented local and settled transhumant farmers, given their higher price and increased profitability.

1. Introduction

Crossbreeding local tropical cattle with exotic western cattle, as well as between tropical breeds, is, today, a widely used strategy by farmers in developing countries to increase the milk and meat output of their herd, and, thereby, increase their income (Leroy et al., 2016; Roschinsky et al., 2015). Crossbreeding and breed replacement are mainly due to economic globalization and change in consumer preferences, as well as technological and environmental changes (Tisdell, 2003). An increased proportion of exotic breeds or crossbred groups in livestock populations might offer opportunities, but could also pose a risk to the livelihoods of poor livestock keepers through the loss of adaptive traits of their animals, such as disease resistance and hardiness (König et al., 2016; Rege et al., 2011), as well as possibly leading to the loss of farm animal genetic diversity. Similar impacts are to be expected when introducing an improved tropical breed for crossbreeding or replacement of the endemic breed. The loss of biodiversity by losing an endemic breed might be accompanied on the local level by either increased profitability of cattle production or by a threat to livelihoods that rely on endemic breeds in low input systems. Only a few studies have undertaken economic comparisons of different breed groups in developing countries, taking into account the complexity of the production system in which they are kept (Marshall, 2014), and the value of non-market benefits achievable from livestock, such as traction, manure or insurance (Leroy et al., 2016).

The local taurine N'Dama breed (*Bos taurus*), which is endemic to the southern region of Mali, the Fulani Zebu breed (*Bos indicus*), which originated from the northern part of the country, and their crosses are raised by farmers in southern Mali. The N'Dama cattle are well-known for their trypanotolerance and resilience to helminthes and tick-borne diseases (Dwinger et al., 1992; Murray et al., 1991). Additionally, the low nutritional and husbandry requirements of N'Dama cattle (Grace,

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2005) make it an interesting breed for extensive cattle production systems in western Africa. Many studies have indicated that trypanotolerant breeds possess a relatively good level of productivity when compared to the Fulani Zebu and, therefore, support the need to preserve them. Decades ago, the productivity of N'Dama cattle was shown to be only marginally lower than that of the Fulani Zebu (ILCA/FAO/UNEP, 1979) or even higher (Agyemang et al., 1991). Only ten years ago, Agyemang and Rege (2004) reported that output per head of cattle in tsetse-infested environments was on average 39% higher in trypanotolerant herds than in transhumant Fulani Zebu-dominated herds, and 26% higher than in sedentary mixed herds. The reported values referred to a range of production systems in different locations of West and Central Africa. In spite of these favorable results for N'Dama cattle, there has been an increasing trend of crossbreeding between N'Dama cattle and the larger trypano-susceptible Fulani Zebu breed (Agyemang, 2005), suggesting that farmers might gain from the introduction of the Fulani Zebu cattle.

A systematic comparison of the productive and economic performances of endemic N'Dama cattle, Fulani Zebu cattle and their crosses under the same farming conditions in western Africa may show whether farmers benefit from the introduction of the Fulani Zebu cattle or are negatively affected by the replacement of N'Dama purebreds. This study aims to evaluate and compare the productive and economic performances of N'Dama cattle, Fulani Zebu cattle and their crossbreds in southern Mali, and, through this, contribute to the on-going debate on the comparative advantages of endemic breeds for local farmers in western Africa and elsewhere.

2. Materials and methods

2.1. Study area and sampling

In southern Mali, like in other neighboring countries, cattle are kept in a traditionally extensive production system, with grazing on natural pasture. The feed availability depends on the season, with declining quantity and quality of pasture from the wet (May to October) to the end of the dry season (Umutoni et al., 2015). This study was conducted in the communes of Sibirila and Garalo, which are located within the district of Bougouni in the Sikasso region of southern Mali, from October 2012 to April 2013. Both communes and the four villages contained within each of them were purposively selected, based on the presence of N'Dama, Fulani Zebu and their crossbreds. Stratified random sampling within the villages in regard to cattle breed ownership was applied for the selection of the households. In total, 160 households were chosen and subsequently classified into four herd categories, according to the main breed group present in the herd. The first three categories comprised of herds with more than 75% of N'Dama, Fulani Zebu or crossbred cattle, respectively; herds with less than 75% cattle from a single breed were designated as mixed herds, forming the fourth category. The cattle herds of 160 households were visited to assess individual cows' performances. In each herd, up to 10 cows that had already calved at least once were randomly selected. In total, data on 770 cows were collected. The study area and household selection have been described in detail by Traoré et al. (2017).

2.2. Data collection

2.2.1. Household survey

Interviews with sets of semi-structured and structured questionnaires were used to collect socio-economic data on the households. This was followed by data collection on the herd inventory and cattle husbandry practices (feeding, herding, veterinary treatments), and herd productive performance (number of calves born and dead, average daily milk offtake per milked cow (DMO) for the dry and rainy season). The interviewee was also asked to recall all herd entries (births, purchases, gifts) and exits (sales, slaughters, deaths) of cattle that had occurred over the last 12 months. Data on inputs and outputs of animal and crop production, as well as marketing and use of animal products, were also collected for the previous 12 months.

2.2.2. Individual cow performances

Body condition scoring and a cow progeny history survey were applied to investigate the performance of randomly selected cows. Body condition was assessed based on a nine score scale in which each of the three main conditions (fat [F], medium [M] and lean [L]) were subdivided into three categories. The given scores ranged from 1 (L-) to 9 (F+) (Nicholson and Butterworth, 1986). Data on a cow progeny history comprised of the age at first calving (AFC), calving interval (CI) (the period between the date of birth of the last and previous calf), current age of the cow, number of lactations, number of calves born alive, number of stillbirths, number of abortions, number of calves dead before weaning, and cow lactation stage. The lactation stage was classified as not lactating, early stage (first 6 months) and late stage (after 6 months). The breed group of the cow (N'Dama, Fulani Zebu and crossbred) was recorded, based on the morphology, coat color and information on the pedigree of each animal.

2.2.3. Economic performances

The following parameters indicated the economic performance and efficiency of cattle production:

Gross margin (GM) = cash revenue – variable cash cost
Net benefit (NB) = (cash revenue + non-market benefit) – (variable cash cost + labor opportunity cost)
Benefit-cost ratio 1 (BCR1) = (cash revenue) / (variable cash cost)
Benefit-cost ratio 2 (BCR2) = (cash revenue + non-market benefit) / (variable cash cost + labor opportunity cost)
Return to herd capital (NB / herd capital) = net benefit / average value of the herd

GM and NB were calculated per farm and per head of cattle. Different revenue and cost components were calculated per head of cattle to account for differences in average herd sizes between herd categories. The currency used in this study was the Franc CFA. It has a fixed exchange rate to the Euro (1 Euro = 656 F CFA).

The cash revenue comprised of the sale of cattle, milk and renting oxen out. Since manure was not sold by anyone and only 8% of farmers gave manure away, it was considered as non-market benefit as specified below. The non-market value comprised of the meat and milk offtake for home consumption, cattle given away as a gift, value of draught power, and manure used on-farm, as well as the change in stock value. Cattle given away as a gift was valued based on the price of the cattle sold. The value of milk offtake was based on the average milk offtake for the rainy and dry season multiplied by a market price of 125 FCFA and 175 FCFA/liter milk for the respective season (years 2012–2013).

The value of the draught power was derived from the total working days/year multiplied by 2000 FCFA, which is the daily price charged to hire a pair of oxen without equipment and labor costs. The non-market benefit of manure was derived from the total cattle manure used for crops based on the fertilizer equivalent. A chemical equivalence of the manure was determined with respect to nitrogen and phosphorus and related to current unit prices of these key nutrients in two frequently applied inorganic fertilizers: urea and NPK (nitrogen-phosphorus-potassium). The nitrogen and phosphorus content were assumed to be 1.5% and 0.4% of manure dry matter, respectively (Amadou et al., 2015). Change in stock value was derived from the value of purchased cattle and animals born in the herd during the last year minus the value of the cattle that had been sold, given away or died in the same period. For all calves born in the herd within the last 12 months, a weight at 6 months of 64, 71 and 80 kg for N'Dama, crossbred and Fulani Zebu, respectively, was assumed (Ahamefule et al., 2007). This weight was multiplied by the price of 1 kg live weight of the respective adult