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Better dairy cattle breeds and better management can improve the livelihoods of the rural poor in Senegal

Karen Marshall, Stanly Tebug, Jarmo Juga, Miika Tapio, and Ayao Missohou

Summary

Research on dairy cattle breeds in Senegal shows that combining best livestock genetics with improved animal management practices can result in significantly increased household benefit. For non-transhumant dairy cattle keepers in two study sites, keeping indigenous Zebu by Bos Taurus crossbreed animals, under better management, resulted in the highest profit of the scenarios considered. This is because the breed-type is both well-adapted to local environmental conditions and productive (the contribution of its indigenous Zebu and Bos Taurus genes, respectively). Improved management also allowed its genetic potential to be expressed. The results, from one of only a few studies of this type in developing countries (Marshall et al. 2015), will allow different stakeholders to make evidence-based decisions on which breed or crossbreed of dairy cattle to promote or keep.

Introduction

In Senegal, dairy production—mainly from cattle kept in low-input systems—is unable to meet domestic demand and large amounts of milk and milk products are imported (FAOSTAT 2011). Improving the productivity and profitability of dairy cattle should have positive effects on the livelihoods of dairy cattle keepers and others involved in dairy value chains. Increasing the low levels of per capita milk consumption may also contribute to nutritional security.

The low milk yield of dairy cattle in Senegal is generally attributed to the low genetic potential of the indigenous Zebu breeds. It is also due to harsh environmental conditions and generally poor levels of animal management.

To increase the productivity of dairy cattle, the Senegalese government has promoted exotic cattle breeds through a public artificial insemination (AI) program at no cost to cattle keepers. In addition, AI to exotic breeds is available through private service providers. This has led to an increase in the uptake of indigenous by exotic breed crosses, as well as the use of pure exotic breeds.

Despite this, there is very little performance information for Senegalese cattle keepers to make informed decisions on which dairy breed of crossbreed to use. To address this, the Finnish Ministry of Foreign Affairs via the FoodAfrica program, and the CGIAR Research Program on Livestock and Fish, funded a project to identify and promote use of the most appropriate dairy cattle breeds or crossbreeds in selected production systems in Senegal. Initial results of this project are presented here.

Study area and data collection

The project worked in two sites in the Thiès and Diourbel regions of Senegal (see Figure 1). The sites can be described as semi-arid, with a short wet season from about July to October and annual average rainfall of 300 to 500 mm. The main livestock system is agro-pastoral, and cattle are generally kept for both milk and meat.

Figure 1. Location of the study sites in the Thiès and Diourbel regions (dots represent approximate locations of participating households)

Data on cattle performance, as well as household-level economic data on keeping them, was collected from 220 dairy cattle-keeping households, with collectively more than 3200 cattle, over a two year period. These households were located in both rural and peri-urban areas. The monitoring was done through 14 rounds of farm visits between May 2013 and April 2015.

Cattle breed-groups

Each animal was assigned to a breed-group (see Table 1 and Figure 2) based on either genomic information (628 female animals) or farmer recall. These breed-groups represented the main breeds and crossbreeds of cattle kept by the project households (with many project households keeping a mix of breed-types).

Table 1. Breed-group of cattle[1]

Breed-group	Description
Indigenous Zebu	Zebu Gobra; Zebu Maure
Indigenous Zebu by Guzerat	Indigenous Zebu cross with Guzerat; typically 25% to 50% Guzerat
Indigeous Zebu by Bos Taurus	Indigenous Zebu cross with Bos Taurus; mainly Montbeliarde and Holstein-Friesian; typically 25% to 50% Bos Taurus
High Bos Taurus	Indigenous Zebu cross with Bos Taurus, mainly Montbeliarde and Holstein-Friesian; typically 75% to 100% Bos Taurus

[1] Animals which did not belong to these breed groups were classified as 'other' and not used for parameter estimates.

Household management levels

All households were classified as 'poorer' or 'better' in relation to the level of animal management they applied. For this purpose milk yield was used as a proxy test-day milk yields (expressed in standard deviation units from the breed-group mean) were averaged across all animals in a household, and the top 50% of households classified as 'better management' and the bottom 50% as 'poorer management'. Note that this means that poorer / better management for one breed-group is not necessarily the same level of management as poorer / better for another breed-group.

Parameter estimates

Animal level parameters—such as reproductive parameters, mortality rates, sale rates etc.—were calculated for each breed-group by management level combinations for different age-classes of animals. These age-classes were: calf, less than 12 months of age; young, 12 to less than 36 months of age; and mature, more than 36 months old.

Economic parameters—including all costs and benefits —were calculated either for (a) each breed-group by household management level combinations, when the parameter was at animal level (such as animal sale price or cost of feed), or (b) for household keeping a majority of that breed-group, when the parameter was at household level (such as milk sale price or cost of animal housing).

Figure 2. Examples of mature cattle from the different breed-groups

Indigenous Zebu

Indigenous Zebu by Guzerat

Indigenous Zebu by Bos Taurus

High Bos Taurus

Parameters were calculated as means when the data was relatively normally distributed, and modes in other cases. The data used was for herds outside of the transhumant period, and thus results presented here do not apply to transhumant herds.

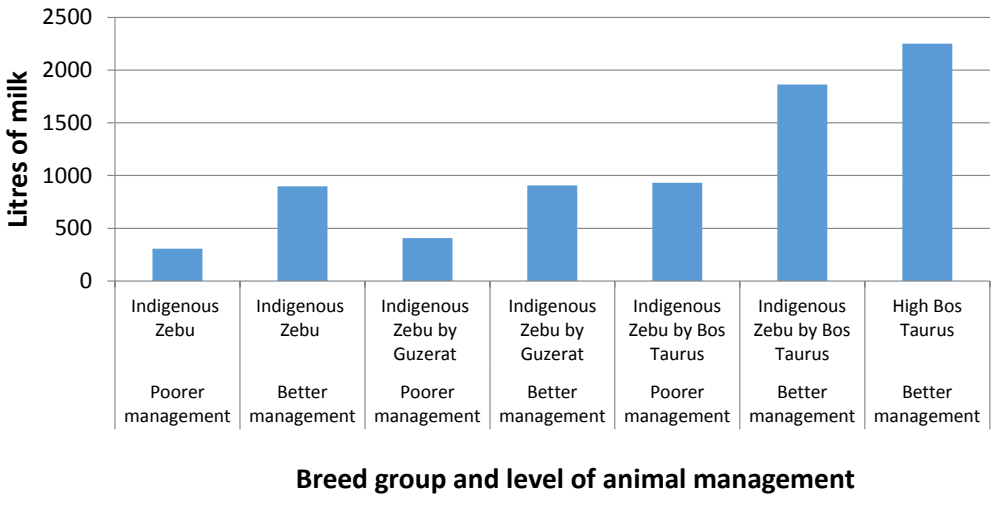
Table 2 lists selected key parameters and their values; Figure 3 shows lactation milk-offtake. Note that parameters were not estimated for the High Bos Taurus— poorer management combination—as there were too few households /animals in this category.

Table 2. Selected key parameters for the different breed-group by management level combinations: "-" for poorer management, "+" for better management

Parameter (unit)	Indigenous Zebu		Indigenous Zebu by Guzerat		Zebu by Bos Taurus		High Bos Taurus
	-	+	-	+	-	+	+
Lactation milk-offtake (litres)[1,2]	307	899	408	907	931	1863	2251
Annual milk-offtake (litres)[2]	175	568	223	640	508	1,315	1,422
Age at first calving (years)	4.25	3.75	3.67	3.67	3.50	3.50	3.33
Calving interval (years)	1.79	1.50	1.79	1.50	1.79	1.50	1.50
Age at culling (years)	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Annual mortality rate males (rate)[3]	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Annual mortality rate females (rate)[3]	0.02	0.02	0.02	0.02	0.03	0.03	0.07
Milk sale price (XOF per litre)[4]	500	500	500	500	500	500	500
Calf sale price (XOF per animal)	160,500	160,500	160,500	160,500	212,000	212,000	627,000
Young male sale price (XOF per animal)	176,000	176,000	205,500	205,500	536,000	536,000	933,000
Mature male sale price (XOF per animal)	261,500	261,500	385,500	385,500	434,000	434,000	800,000
Young female sale price (XOF per animal)	251,000	251,000	262,500	262,500	551,500	551,500	1,100,000
Cull for age female sale price (XOF per animal)	216,500	216,500	251,000	251,000	625,000	625,000	625,000
Annual mature female health cost (XOF per animal)	210	425	345	500	775	800	1,790
Annual mature female feed cost[5] (XOF per animal)	72,500	193,000	105,500	215,000	198,500	394,500	736,000
Annual labour cost (XOF per herd)[6]	350,000	350,000	350,000	350,000	350,000	350,000	350,000
Annual animal housing cost (XOF per herd)[7]	2000	2000	2000	2000	61,000	112,500	112,500
Artificial insemination (AI) cost (XOF per AI)	40,000	40,000	40,000	40,000	40,000	40,000	40,000

[1] For 365 day lactation, averaged over parities. ; [2] Does not include milk suckled by calves; [3]Annual mortality rates did not differ across calf, young or adult; [4] Milk consumed in the home was also valued at this price; [5]Assumes no cost associated with grazing of pasture; [6] Household labour was valued at the same cost as hired labour; [7] Taking into account initial building costs, maintenance costs, the percentage of structure space for dairy animals, and assuming a 15 year life-span.

Figure 3. Lactation milk off-take per cow, in litres, for a 365 day lactation



Cost: benefit model

To account for the specifics of the production system, a customized cost: benefit model was used. Revenue and costs (specified in Figure 4) were calculated per cow per year, where a cow is considered a breeding female attached to followers (her progeny). Economies of scale (on labour, animal housing, and water) were taken into account by setting a herd size as the number of breeding cows in the herd, to eight. Annual household profit (per cow per year) is given as total revenue less total costs.

Figure 4. Overview of revenue and costs included in the cost:benefit analysis

Revenue	Costs
•Milk: including that sold, consumed in the house, and suckled by calves •Male animal sale: calves, young, mature •Female animal sale: young, and cull for age cows	•Feed •Milk suckled by calves •Health-care •Animal-housing •Labour •Female reproduction •Water •Marketing and transport

The model assumed that all animals were born in the herd, and that the herd comprised animals of a single breed-group. Male animals were sold as either calves (10% of all male animals sold), young (40%), or mature (50%), and mortality of male animals could occur across all age-classes. Female animals not required as replacement breeders were sold at the end of the young period (at 35 months of age), whilst female animals kept as breeders were sold at the end of their productive life as cull-for-age cows. Female mortalities occurred during the calf and young period; female animals retained as breeders were assumed to survive until culling age.

Two reproductive scenarios were considered: (1) breeding bulls used for free as either they were born in the herd or accessed via the public AI program; (2) breeding bulls accessed via paid AI.

Household profit from keeping breeds and crossbreeds under different management levels

The household profit of keeping different breeds or crossbreeds of cattle is given in Figure 5 for the reproductive scenario of breeding bulls used for free. The highest household profit was for indigenous Zebu by Bos Taurus crossbred animals under better management (479,525 XOF per cow per year). The lowest household profit was for indigenous Zebu under poorer management (60,235 CFA per cow per year)—a nearly eight-fold difference. See Table 3 for other comparisons.

Table 3. Fold increase in profit per cow per annum for indigenous Zebu by Bos Taurus under better management, compared to the other scenarios.

Breed-group	Poorer management	Better management
Indigenous Zebu	7.96	3.38
Indigenous Zebu by Guzerat	7.33	2.57
Indigenous Zebu by Bos Taurus	2.03	NA
High Bos Taurus	NA	1.18

The division of revenue and costs to their various sub-components are shown in Figures 6 and 7. Revenue from milk, inclusive of milk offtake and (predicated) milk suckled by the calves, accounted for 61–77% of the total revenue (dependent on the scenario). The main cost was animal feed and milk suckled by the calves, which jointly accounted for 80–92% of the total costs. Better management households were seen to invest at least twice the amount in feed in comparison to poorer management households. Feed costs markedly increased when keeping indigenous Zebu by Bos Taurus or high Bos Taurus, in comparison to keeping indigenous Zebu or indigenous Zebu by Guzerat. The cost of animal housing was higher for breed-types involving Bos Taurus as they need shade.

Within a breed-group, moving from poorer to better management resulted in a 2.85–2.03 fold increase in profit per cow per year, depending on the breed-group. As discussed above, this can mainly be attributed to the provision of better feed.

This study could not precisely partition the effects of better genetics from the effects of better management, as management levels were not consistent across the breed-groups (the result of using field data based on current practices, rather than a designed experiment). However, it can be observed that the feed cost is approximately the same for indigenous Zebu and indigenous Zebu by Guzerat under better management, compared to indigenous Zebu by Bos Taurus under poorer management, and that the latter still resulted in the highest household profit of these three scenarios.

The benefit to cost ratio of the different scenarios is given in Table 4. The highest ratio, of 1.75:1, was for the indigenous Zebu by Bos Taurus crossbred animals under better management.

Table 4. Benefit to cost ratios for the different breed-group by management level combinations.

Breed-group	Poorer management	Better management
Indigenous Zebu	1.22:1	1.32:1
Indigenous Zebu by Guzerat	1.23:1	1.44:1
Indigenous Zebu by Bos Taurus	1.58:1	1.75:1
High Bos Taurus	NA	1.47:1

Figure 5. Profit, in XOF, per cow per annum, for breeding bulls used for free (born in the herd or fully subsidized AI).

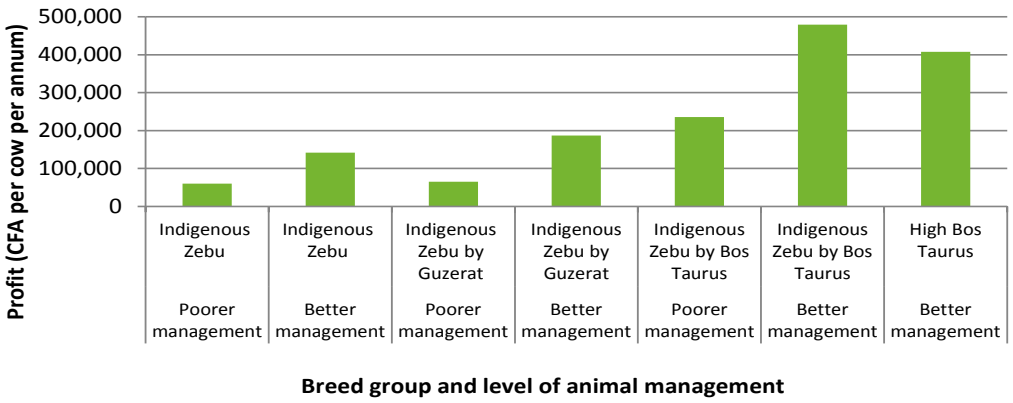


Figure 6. Revenue components, in XOF, per cow per annum, for breeding bulls used for free (born in herd or fully subsidized A

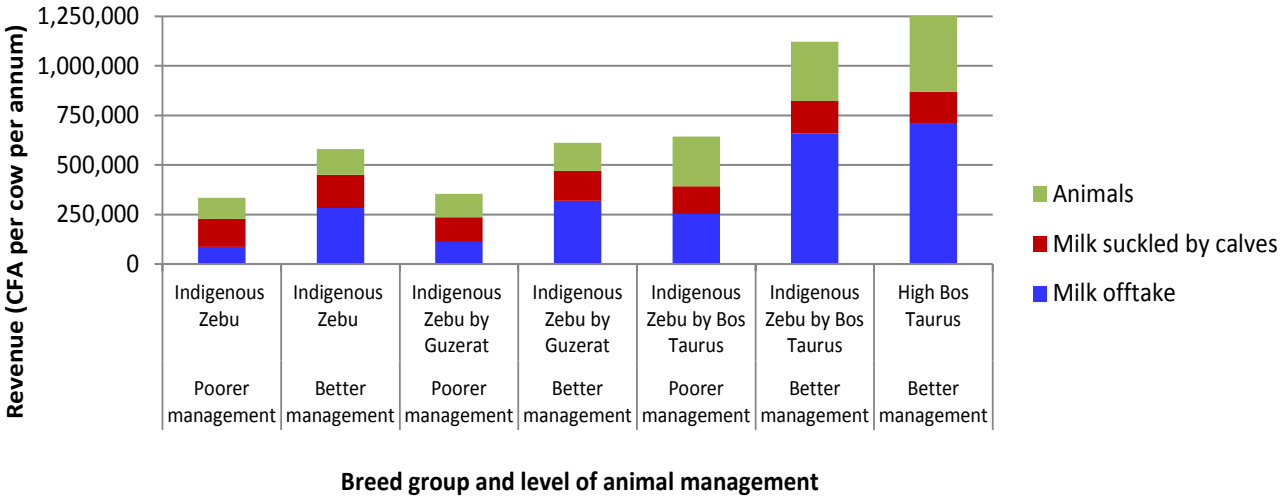
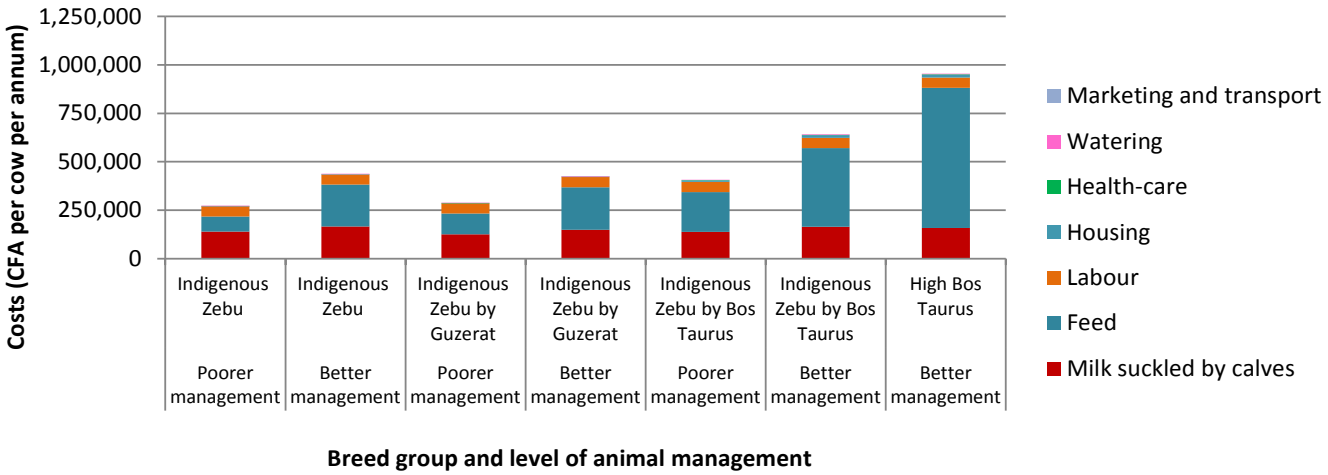


Figure 7. Cost components, in XOF, per cow per annum, for breeding bulls used for free (born in herd or fully subsidized AI).



If artificial insemination costs are applied to the use of Bos Taurus males, household profit is slightly reduced (by an average of 9% of the values shown in Figure 5), but Zebu by Bos Taurus crossbred animals under better management remain the most profitable (at XOF 445,585 per cow per year).

Recommendations

1. Public and private AI program should provide crossbreed indigenous Zebu by Bos Taurus semen to cattle keepers who desire this genotype, to improve accessibility and to avoid repetitive backcrossing to either the indigenous Zebu or Bos Taurus breeds.
2. Cattle keepers investing in indigenous Zebu by Bos Taurus crossbreed cattle should be trained on appropriate animal management practices—particularly in relation to feed, animal housing, and preparing animals for artificial insemination—so they can maximize household profits from this genotype.
3. The high costs of keeping indigenous Zebu by Bos Taurus crossbred animals—including the initial investment in animal housing and continual investment in feed—may prevent cattle keepers from lower wealth groups adopting this technology. This should be addressed, for example by access to credit.

Photo credit:
Page 1: ILRI/Karen Marshall and Stanly Tebug

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Karen Marshall and Stanly Tebug work for the International Livestock Research Institute. Jarmo Juga works for Helsinki University, Miika Tapio for the Natural Resources Institute Finland, Ayao Missohou for the Interstate School of Veterinary Science and Medicine, University of Dakar.

Contact
Karen Marshall
ILRI, Kenya
k.marshall@cgiar.org

Patron: Professor Peter C Doherty AC, FAA, FRS
Animal scientist, Nobel Prize Laureate for Physiology or Medicine–1996

Box 30709, Nairobi 00100 Kenya
Phone +254 20 422 3000
Fax +254 20 422 3001
Email ilri-kenya@cgiar.org

ilri.org
better lives through livestock

ILRI is a member of the CGIAR Consortium

Box 5689, Addis Ababa, Ethiopia
Phone +251 11 617 2000
Fax +251 11 667 6923
Email ilri-ethiopia@cgiar.org

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