Presentation G 3.10
(Management of Genetic Variation)

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ECONOMICS OF BREEDING PROGRAMS WITH INDIGENOUS AND ADAPTED CATTLE IN AFRICA AND THE EFFECT ON CONSERVATION

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INTRODUCTION

The convention on biological diversity (CBD) launched in 1992 bounds the signing countries to assess and conserve their biological diversity. For livestock, the Food and Agriculture Organization of the United Nations (FAO) started an inventory of rare breeds published as World Watch List for Domestic Animal Diversity (Scherf, 2000). In industrialized countries, organisations, e.g. the Rare Breeds Survival Trust and Pro Specie Rara or governments started breed conservation some decades ago, by e.g. uniting breeders, setting up herdbooks, initiating breeding programs, cryoconserving semen or paying incentives to farmers keeping the rare breed. However, most of today's diversity is only found in developing countries (Scherf, 2000).

The African continent hosts more than 20% of the world's cattle breeds, yet more than 20% of the African breeds are still unknown. There is little literature about breeding programs – and even less about conservation programs - with indigenous African cattle. The available information mainly deals with performance of purebred or crossed animals on station or on government farms, with little known about their performance under field conditions. What is almost inexistent in literature is data on costs and benefits of breeding or conservation programs with indigenous cattle in Africa. Gandini (1999) states that all literature on costs of conservation programs refers to simulated costs and no data from field projects are available. However, there is some information on costs and benefits of village cattle production in Tsetse infected areas using trypanotolerant breeds (Itty, 1992). Yet, a holistic approach on effects of a breeding program considering monetary and non-monetary benefits is missing. This study therefore initiated a survey aimed at giving a detailed and multidisciplinary cost-benefit analysis of breeding programs with indigenous African cattle. It however turned out to be difficult getting the required information because of a number of factors that include: scarcity of such programs, the simple lack of data, data protection and difficulty in finding competent people willing to answer the questionnaire. Hence, the survey was extended on indigenous and adapted breeds in pure breeding and crossbreeding programs in Africa. This study presents an analysis of the unique data compiled. This data may be helpful for further research on costs and benefits of breeding programs as well as the design and financing of conservation programs.

MATERIAL AND METHODS

Seven breeding programs with indigenous and adapted cattle of Southern and East Africa were evaluated. In Southern Africa Bonsmara (Swaziland: SW, South Africa: SA), Nguni (South Africa) and Tswana (Botswana) cattle were bred and in Kenya the Sahiwal and Small East African Zebu (SEAZ). The breeding program in Tanzania crossed Boran cattle with Tanzanian Shorthorn Zebus (TSZ).

All informants were asked to complete a detailed questionnaire about costs, benefits, aims and financing of the breeding program assuming an average year. Fixed costs included infrastructure (e.g. cars, stables, crushes, computers, road maintenance), salaries for employees and administrative costs (e.g. fees to breeding society). Variable costs resulted from fodder (e.g. grazing ground, lick), treatment (e.g. vaccination) and miscellaneous input (e.g. water supply). Returns were grouped as sale of animals, renting out of animals and sale of animal products (milk, meat, hides and dung).

The informants were further asked to give the (achieved or expected) improvement in certain traits after running the program for ten years. The informants had to assess the effects of the breeding program on factors influencing the extinction probability (endangerment) of a breed as defined by Reist-Marti et al. (2003), the profit of breed owners from the breeding program as well as the reasons why farmers do keep the breed. If requested, data was made anonymous as far as necessary to protect privacy of informants.

To allow direct comparison of the results, local currencies were converted into international dollars using the purchasing power parity (PPP) conversion factor. This factor is the number of units of a country's currency required to buy the same amount of goods and services in the domestic market as a U.S. dollar would buy in the United States (World Bank, 2003). For all countries the latest PPP conversion factor available (year 2001) from the World Bank (World Bank, 2003) was used, except for Tanzania. The Boran x TSZ project was finished in the year 1994. Therefore the PPP conversion factor of 1990 was used. Whenever values from literature were converted, the conversion factor – usually the PPP conversion factor of the respective year - of local currency into international dollar ($) will be given in brackets [ ]. The gross margin was calculated as returns minus variable costs. It shows how far fixed and variable costs are covered by returns. A negative gross margin results if variable costs and partly fixed costs are not covered by the returns.
Average gross margin, costs, returns and profit were calculated by dividing the totals by the number of mature animals. If only own offspring is used for replacement of sold or culled animals, the average gross margin, costs, returns and profit are given for one mature animal including its offspring (replacement).

RESULTS AND DISCUSSION

Setup and financing. The evaluated breeding programs were highly diverse with regard to breed, aim, financing, size, profitability and success. An overview of setup and financing is given in Table 1.
The size of the breeding programs ranged from 110 to 1'600 mature animals, with the SEAZ program having only 11 adults, but 195 young animals. This program was started recently and not fully implemented, yet. The aims of breeding were production and improvement for privately financed programs and improvement and conservation for governmentally and internationally financed breeding programs. The governmental programs were not profit oriented and were on small scale compared to the private programs.

Profitability. Table 1 and Figure 1 show the costs, returns and profit in total and on average and the average gross margin for the programs. The following costs and returns could not be given by the informants for the respective programs (in brackets): grazing ground (Bonsmara SW), storage (Bonsmara SA), offices, ground, computer, handling pens, weighing facilities and electronic scale (Nguni), night enclosures, offices, laboratories, grazing ground, computer, plunge dip, crushes, watering troughs, fixed/mobile weighbridges, self-made hay, natural service, value of culled animals and milk (SEAZ) and offices (Boran x TSZ).
The SEAZ program had much higher fixed costs per adult animal than the other programs but no returns, yet. For this program, figures could only be given for the current year (2002) as it was still in its starting phase and does not represent an average year of the fully implemented program. Therefore, the SEAZ program is not shown in Figure 1 and will not be analysed further below.
There are methods to economically evaluate breeding programs (Weller, 2000). However, these methods depend on full knowledge and monetary definitions of costs, returns and goals of a breeding program. These preconditions can scarcely be met in practice. Most informants mentioned that it was difficult or impossible to estimate costs for infrastructure and fodder (grazing, hay) as they were provided for free by the government, were used for different purposes at the same time or were "just available" (no purchase, amortisation or evident production costs). As a consequence, total costs were underestimated for most programs. Only two breeding programs aimed at production and profit, whereas the other five programs headed primarily for improvement and conservation. Therefore, costs-benefit analysis will focus on factors contributing to high costs, returns or profit rather than on absolute monetary values.
Costs. Average fixed costs were similar for all programs ($ 240 - $ 505), with lowest costs for the Boran x TSZ and Tswana breeding program. Both programs had low salary costs, which seem to be a crucial factor for low fixed and total costs. For all breeds, salaries accounted for more than 40 percent of the costs and outranged infrastructure costs by a factor 1.5 or higher, except for Boran x TSZ crosses, where treatments summed up to more than 50 percent of the total costs. Available evidence indicates that the share of salary costs in total costs ranges from 15% (Ethiopia) to 66% (Togo) for herds with less than 150 animals (Itty, 1992) and 19% to 30% for ranching systems in Kenya with more than 1500 heads of cattle (Doppler, 1991).
Average variable costs were lowest for the purebred indigenous breeds Tswana, Nguni and Sahiwal ($ 36, $ 41 and $ 82, respectively), medium for the adapted Bonsmara cattle and highest for the Boran x TSZ cross ($ 550). The crucial factor for high variable costs was treatment costs, which were lower for indigenous breeds with good adaptation. This is in line with the findings of Itty (1992) for trypanotolerant cattle in Tsetse infected areas. He reported treatment costs as 1% (Gambia) to 11% (Zaire) of the total costs.
Average total costs did not depend on size of the program or the integrity of cost data. High average costs were due to high salary and treatment costs, both of them linked to the purpose of the breeding program and the breed. In the literature total costs per head vary from $ 37 to $ 53 [DM 2 = $ 1] for large scale Kenyan ranches (Doppler, 1991)

and from $ 17 in former Zaire [Z 380 = $ 1] to $ 179 in The Gambia [D 1.57 = $ 1] for trypanotolerant cattle breeds (Itty, 1992). Kahi (2000) assumed daily heifer costs per cow of $ 0.16 to $ 0.3 for different breeds, which sums up to offspring costs of $ 21 to $ 110 per cow and year. Considering that in the present study average total costs included costs for offspring, the findings were comparable to the figures reported in literature.
Returns. Average returns varied between $ 263 for the Tswana and $ 858 for the Boran x TSZ breeding program. Returns of the Boran x TSZ program were lower than they could have been as products were sold at government prices instead of higher market prices. The majority of programs sold the animals alive and not as meat or hides and did not milk them. For bulls, cows and offspring, Bonsmara and Nguni cattle yielded high prices ($ 750 to $ 2'000) compared to the other breeds ($ 264 to $ 1'374) resulting in higher returns per head for these programs. This could be due to the market orientation of the Bonsmara breeding programs and general higher prices for cattle in Southern Africa. Doppler (1991) calculates returns of $ 39 to $ 96 [DM 2 = $ 1] per animal for large scale ranches in Kenya and Itty (1992) reports returns per head and year for herds smaller than 150 animals of $ 59 for Kenya [KSh 7.64 = $ 1], $ 109 [EB 0.7 = $1] for Ethiopia and $ 40 [Z 380 = $ 1] to $ 243 [D 1.57 = $ 1] for Zaire and West Africa. Mean price per animal of the years 1994-97 for Kenyan markets were $ 362$\pm$207 in Marsabit and $ 460$\pm$170 in Moyale [KSh 18.47] Barrett et al. (2003). The same authors estimate that drought reduces the cattle prices by 22 to 52 percent. There are many factors that influence the price of cattle e.g. breed, age, condition, season, weather and market, making it difficult to compare and forecast prices.
Average gross margin was positive for all breeding programs, which means that returns covered at least the variable costs.
Profit. For the Bonsmara breeding programs average profit was $ 274 and $ 128 for South Africa and Swaziland, respectively. For the Boran x TSZ crossbreeding program the average profit was $ 59. All other programs showed negative profit i.e. loss. Doppler (1991) calculated the profit per animal of large scale ranches in Kenya as $ 1.5 to $ 43.5 [DM 2 = $ 1]. Lömker (1993) estimated costs for in situ conservation of 16 bulls and 64 cows of a rare breed over 50 years for a milk breed in Germany. The average yearly costs per animal (= opportunity costs) were $ 48 for suckling cows, $ 181 for 3'000 kg milking cows and $ 44 for 5'000 kg milking cows [DM 1.97 = $ 1]. These estimates are in range with the magnitude of loss for the Nguni, Tswana and Sahiwal breeding programs, though these breeds are not rare. Profit or loss of a breeding program depends on several factors and should best be assessed for each program individually.

Improvement and effects. All breeds were assumed to be superior to other locally farmed breeds in climate adaptation, tick resistance and trypanotolerance and inferior in milk production, meat production and appearance. The expected or achieved magnitude of improvement varied from 2% to 95%. For hides, improvement focused on quality (Tswana, Boran x TSZ), colour and pattern (SEAZ, Boran x TSZ). Better climate adaptation aimed at increasing survival (Tswana, Boran x TSZ) and performance (Tswana), with a main selection criterion for Nguni of one calf per year. Appearance improvement focused on legs (Tswana) and conformation (Boran x TSZ). Farmers were assumed to keep the breeds because they were adapted and had unique characteristics (Bonsmara, Nguni, Tswana, Boran x TSZ and Sahiwal). Some breeds are required for socio-cultural functions (Sahiwal), milk and meat consumption, draught power, manure production and income generation (SEAZ). The breeding programs of Nguni, Tswana, Boran x TSZ and Sahiwal had a positive impact on the standard of living of people owing indigenous cattle. Affection was mainly indirectly as few (< 5%) to no people owing the indigenous cattle participated in the breeding programs except for Sahiwal (60%).

Endangerment. The Southern African programs had no negative effects on factors influencing the endangerment of a breed, whereas effects of the East African programs were mixed or not assessable. Only one program (Nguni) appeared to positively influence socio-cultural importance. A study by Ouma (2003) on showed for smallholder production systems in Western Kenya showed that 30% - 90% of the households viewed dowry payment as one of the reasons for cattle rearing and that non-market socio-economic benefits contributed 14%-18% to the average annual household income. The potential conservation effect of socio-cultural use was not (yet) exploited by the other programs aiming at conservation (Tswana, Sahiwal).

CONCLUSIONS
Total average costs were mainly influenced by (fixed) salary costs and (variable) treatment costs. There was only one program having moderate salary costs (Boran x TSZ). Treatment costs were clearly lower for indigenous breeds. Costs and returns were only weakly correlated with the size of a breeding program.
Returns varied a lot among programs as they were influenced by many factors. It was difficult to give a general statement on the prices for animals and products as only few programs could be analysed which themselves were highly divers. Moreover, data on animal and product prices for African cattle breeds are scarce to non-existent in

literature. For most programs returns covered only fixed costs. In this study, the factors 'aims' and 'financing' could not be separated. From a monetary point of view, the production oriented and privately financed programs were profitable, whereas the non-private and improving/conservation programs broke even or showed loss. These additional costs for conservation breeding were found to be similar in Africa and Europe.
The indigenous breeds were assumed to be superior to other breeds farmed in the same region for climate adaptation, tick resistance, trypanotolerance and ceremonial use. With regard to milk and meat, the indigenous breeds were less productive. The breeding programs aimed at improving these two traits only fairly. It could be concluded that the future of these indigenous breeds will not lie predominantly in high milk and meat production. But their real strength will be climate adaptation, tick resistance, trypanotolerance and ceremonial use. The indigenous breeds were assumed to be worse in appearance than other (exotic) breeds farmed in the same region. A comprehensive study is needed to clarify, why indigenous breeds do not convince in appearance as much as other exotic breeds do. Effects on the endangerment of a breed were mainly positive for all programs.
There are theoretical approaches for monetary evaluation of breeding programs, but the required, detailed information on costs and returns are often not available in practice. Moreover, costs and benefits, which can scarcely be expressed in terms of money (e.g. importance of a certain breed to pay dowry), may play an important role in the decision making of keeping certain cattle breeds – and thus conservation of genetic diversity.
It has to be emphasised that seven highly divers breeding programs are not suitable to allow a general statement about costs and benefits, but they can show trends and indicate problems. And hopefully it can initiate further research in this direction, which is highly needed to be able to discuss topics such as management, profitability and conservation of Africa's cattle diversity.

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ACKNOWLEDGEMENTS

We kindly acknowledge the contribution of G. Jeyaruban (Department of Agricultural Research, Botswana), W. Muhuyi (KARI Naivasha, Kenya), J. Mwacharo, C. Nowers, A. Patterson, one anonymous informant, and J.E.O. Rege (ILRI Addis Ababa, Ethiopia).

Table 1 *Cattle breeding programs in Southern and East Africa: Setup, effects, cost and returns*

Breed*)	**Bonsmara SW**	**Bonsmara SA**	**Nguni**	**Tswana**	**Boran x TSZ**	**Sahiwal**	**SEAZ**
Origin of data	Ubombo Ranches Swaziland	- South Africa	Nguni Stud South Africa	Musi Ranch Botswana	- Tanzania	KARI Kenya	ARSP II Kenya
Aim	Production	Improvement Production	Improvement conservation	Improvement conservation	Improvement	Improvement conservation	Improvement conservation
Financing	Private	Private	Government	Government	Government	Government World Bank	Government EU
Mature/immature animals	1'600 / 1700	1'270 / 1400	110 / 92	609 / 660	475 / 440	996 / 493	11 / 195
Effect on…							
- indiscriminate crossing	+ +	+ +	+	+	+	-	
- organization of breeders	+ +	+ +	+			+ +	+
- population size	+ +	+ +			-	- -	
- socio-cultural importance			+				
- special traits	+	+	+	+ +	+ +	-	
- reliability of information	+ +	+ +	+ +	+ +	0	+	+
- start of conservation	no objective	no objective	yes	yes	yes	(yes)	yes
Costs	979'500	707'500	64'907	167'823	379'525	423'546	82'735
Fixed costs	808'500	543'500	60'425	146'055	118'177	342'203	80'006
- Infrastructure	148'000	194'500	6'000	20'444	71'334	34'806	9'259
° Vehicles	99'000	165'000	6'000	12'174	63'408	12'752	9'259
°Facilities	49'000	29'500	0	8'270	2'642	17'003	0
°Miscellaneous	0	0	0	0	5'284	5'051	0
- Salaries	585'500	314'000	52'000	125'176	19'102	295'192	70'747
- Administrative costs	75'000	35'000	2'425	435	27'741	12'205	0
Variable costs	171'000	164'000	4'482	21'768	261'348	81'343	2'729
- Maintenance of animals	171'000	164'000	4'482	21'768	261'348	81'343	2'729
° Fodder	0+	110'000	4'276	9'715	95'958	45'290	0
° Treatment	171'000	54'000	206	8'151	165'390	29'799	2'729
° Miscellaneous	0	0	0	3'902	0	6'254	0
Returns	1'185'000	1'055'000	52'750	160'132	407'662	409'585	0
- Animals	1'185'000	1'055'000	52'750	160'132	380'449	259'933	
° Sale	1'185'000	1'055'000	52'750	160'132	221'292	259'933	
° Renting out	0	0	0	0	158'520	0	
- Products	0	0	0	0	27'213	149'652	
Profit	205'500	347'500	-12'157	-7'691	28'137	-13'961	
Average gross margin*)	633	702	439	227	308	329	

*) For abbreviations and explanations see text.

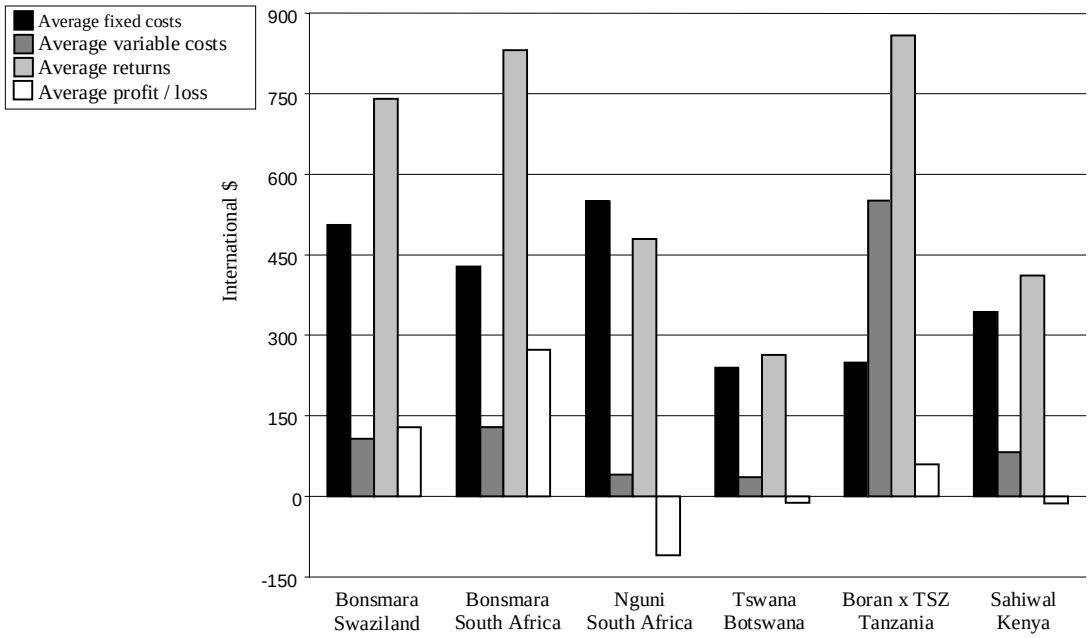

Figure 1 *Costs, returns and profit per mature animal of cattle breeding programs in Southern and East Africa*