

SENSITIVITY ANALYSIS FOR FAMILY HERD MODEL

We conducted a local sensitivity analysis to examine the impact of small changes in nine parameters (P) on system-level outcomes (Railsback and Grimm 2012) (see Table 1). We did this by varying the value of each of these sixteen parameters by plus and minus 5% (dP) and then examining how much that changes the system-level outcome of total herd size (C). We ran 100 simulations for 100 years. Following the simulation, we calculated sensitivity (S-, S+) for each parameter with the following formula:

$$S- = [(C) * (C-)] / [(dP) / (P)] \text{ and } S+ = [(C) * (C+)] / [(dP) / (P)]$$

The outcome of final herd size is most sensitive to changes in the calving rate, calf mortality, and cow offtake. This was predicted by Dahl and Hjort's review of the literature on herd demography in pastoral systems (1976). The relative differences between the sensitivity of the other parameters were relatively small (S- and S+), which indicates that the overall behavior of the system is not much more sensitive to one parameter than another. Table 1 shows the results for the sensitivity analysis measured in terms of herd size after 100 years.

Table 1: Sensitivity of final herd size to changes in model parameters

Parameter	P	ΔP	Quality of knowledge sources	Source type	S-	S+
Calving Rate	70%	3.5	4	Literature review	28874959	116837489
Mortality - Calves	21.96%	1.098	4	Literature review	111673786	48298399
Mortality – Male calves	21.96%	1.098	4	Literature review	111673786	48298399
Mortality - Heifers	6.06%	0.303	4	Literature review	78063905	60835680
Mortality - Bullocks	6.06%	0.303	4	Literature review	78063905	60835680
Mortality - Cows	5.72%	0.286	4	Literature review	81032393	64232950
Mortality - Bulls	5.72%	0.286	4	Literature review	81032393	64232950
Mortality - Elderly Cows	69.50%	3.475	4	Literature review	65075854	69422306
Offtake Rate- Calves	0.10%	0.005	3	Sutter (1987)	78019927	67153795
Offtake Rate- Male calves	0.30%	0.015	3	Sutter (1987)	75546187	7166751

Offtake Rate- Heifers	3.70%	0.185	3	Sutter (1987)	71771443	74490725
Offtake Rate- Bullocks	5.20%	0.26	3	Sutter (1987)	73050458	75586500
Offtake Rate- Mature Cows	1.40%	0.07	3	Sutter (1987)	84297730	67934398
Offtake Rate- Bulls	2%	0.1	3	Sutter (1987)	65270088	72852559
Offtake Rate- Elderly Cows	0.70%	0.035	3	Sutter (1987)	72445766	70606037
Initial Herd Size	100	5	1	Simulation	63815162	60791702

References Cited

- Dahl, Gudrun, and Anders Hjort. 1976. *Having herds: pastoral herd growth and household economy*, *Stockholm Studies in Social Anthropology*. Stockholm (Sweden): Department of Social Anthropology, University of Stockholm.
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- Sutter, John W. 1987. Cattle and inequality: herd size differences and pastoral production among the Fulani of northeastern Senegal. *Africa* 57 (2):196-218.