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ECONOMIC IMPLICATIONS OF ECOLOGICAL CARRYING CAPACITY

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In the entire Sahel region living conditions of animal keepers have been getting worse consistently in a process where economic, ecological and social factors influence each other. The balance between utilization and availability of resources has been damaged. This becomes evident, for example, in an inappropriate stocking rate and uncontrolled methods of grazing, which result in serious degradation of the vegetation. As a result of the high variability of rainfall, the available fodder resources of the Sahel, including the Butana, are subject to extreme interannual changes. Thus, grazing practices which can secure the necessaries of life for the pastoral population seem only possible if animal keepers can retreat to other areas in times of need and where this retreat is also economically viable.

Within this context, the rainfed and irrigated areas are of primary importance to the animal keepers of the eastern Central Butana. Crop residues from these fields used as fodder could substantially reduce, under certain circumstances even eliminate, fodder shortages. However, since this fodder has to be paid for (Bascom 1990) – and this in times of relatively low prices for animals – animal keepers use the natural pastures in the north for as long as possible and thus overuse them for periods of time. It is for this reason that the analyses of

carrying capacity (see Pflaumbaum, "Rangeland Carrying Capacity in the Butana", in this volume) were not based on averages since this would have implied that in 50 % of all years animal keepers would have to switch over to fodder from the cultivated fields, something that in practice cannot be realized. Rather, we used the data for 1991, which was a year when the amount of rainfall was much below average and we thus deduced a carrying capacity – or rather a range of carrying capacity – of 110,000 – 140,000 TLU (this figure refers first of all to the entire animal stock, i. e. it includes the local herds as well as those of seasonal migrators to the area. It can, however, also be used as a reference for the local herds alone, if we assume that in a drier year such as 1991, in-migration of external herds during the rainy season was not larger than ex-migration of local animal stock during the dry season).

Compared with long-term pricipitation records the amount of rainfall in 1991 (and, consequently, the available fodder resources) is reached in over 90 % of all years. With an animal stock of around 125,000 TLU, the natural resources would therefore only be overused in a limited way every tenth year. From an ecological point of view this seems justifiable because in wetter years the vegetation cover could regenerate itself sufficiently ('regeneration' here means that there is no other qualitative deterioration of the vegetation compound; however, for improving its quality, additional measures (sowing, grazing control, etc.) would be necessary).

These relations become even more evident if (using 1991 as the base year) we project or calculate the available dry matter for the previous years. (Here we used the Le Houerou (1984) Rain Use Efficiency Concept: The dry matter produced in the different fodder regions in 1991 is correlated with the annual rainfall (also per region) and an RUE-factor (kg DM/ha/mm) is calculated. Using this factor we can then calculate the dry matter for other years with different precipitation values. It is essential that all fodder regions are situated in a specific morphological unit such as a basement peneplain. In addition, we took into consideration that a minimum of precipitation is necessary for the grass to germinate. We did not factor in, however, precipitation differences in small areas, nor vegetation dynamics, i.e. changes in the composition over several years as well as changes in the fodder value within one year (for details, see Pflaumbaum, "Rangeland Carrying Capacity in the Butana", in this volume). The results for 1980-1991 are shown in Figure 1 (hatched area, not subdivided into fodder regions), where the dry matter produced in the eastern Central Butana (available = 30 %) was converted into the needs of 1000 TLU and is compared to an economic model (see below). As Fig. 1 indicates, natural pastures could have covered the needs of approximately 373,000 TLU in 1988, but only around 44,000 TLU in 1990. Only 1984 and 1990 – extreme years of drought – fall short of the carrying capacity of 110,000 – 140,000 TLU (as based on data from 1991).

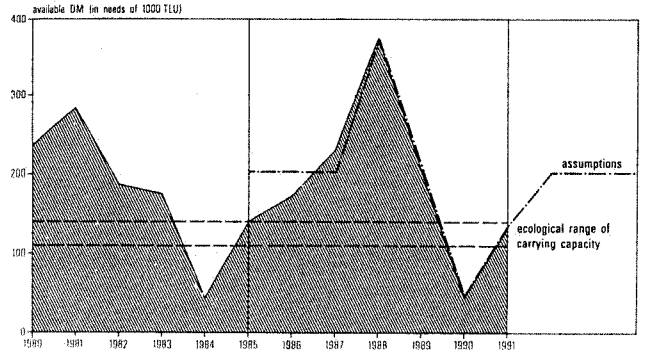

Fig. 1 – *Fodder resources (1980–1991), carrying capacity and basic assumptions for the economic model (eastern Central Butana).*

Calculations and design by Pflaumbaum.

Using a higher carrying capacity value would result in more years of insufficient fodder production and the overuse in the respective years would also be higher (the animal stock of 182,000 TLU calculated for 1983 – roughly corresponding to the average of available dry matter (covering the needs of 185,000 TLU) during 1980-1991 – led to a serious overuse of pasture in the following period of drought). Thus, a stocking rate of 110,000 – 140,000 TLU can be considered ecologically sound. It would enable a lasting, sustainable and resource-preserving usage of pasture. We now have to ask whether the ecological demands can also be met when we consider the economic aspects.

In the following we attempt to show the economic implications of an ecologically justifiable stocking rate. We use the results of the income analysis in a model of a ten-year animal keeping development plan and calculate an animal stock which is to be the same at the beginning and the end of the model time period.

The model includes not only the objective (exact) economic results of the income analysis, but also the underlying patterns of action. Crucial variables are the fluctuating production results and consumer demands in various years and in various animal keepers households. These are closely related to the terms of trade of animals to necessary consumer goods and the accessibility of certain resources in times of crises (droughts). In addition, we factored in that

there are other sources of income which are of different significance from year to year.

The basis of the model of the 10-year animal keeping development plan is, first of all, a number of characteristic years which show the following probabilities of occurrence (based on precipitation data of 1972-1991) (these encompass the years from 1988-1991, that is, the production years 1988/89-1991/92 (see Fig. 1). 1988/89 was a very good year (i. e. extremely wet). 1989/90, weatherwise a normal year, was good to moderate for animal keeping. This was followed by a very bad (extremely dry) year (1990/91). During 1991/92, conditions were better (moderate), but were still largely influenced by the consequences of the previous year):

1988/89 very good (extremely wet): 10%
1989/90 good/moderate (normal year): 70%
1990/91 very bad (extremely dry): 10%
1991/92 moderate but following an extremely dry year: 10%.

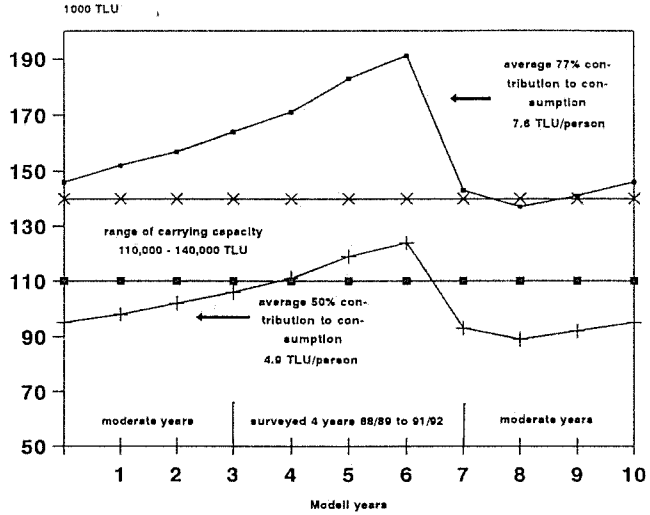

Fig. 2 – *Model of herd development over 10 years with regard to ecological carrying capacity. Calculations and design by Rahmann.*

Taking this into consideration, the model (see Figs 1 & 2) assumes that conditions are good to moderate – i. e. meteorologically normal – for animal keeping for the first three years and very good (extremely wet) in the fourth year. An additional moderate year is followed by a very bad (extremely dry) one, the consequences of which are still noticable in the seventh year, although the conditions for animal keeping can be considered moderate. Conditions for animal keeping in the eighth to tenth years are again good to moderate.

Further calculations were based on empirical economic data (income from animal keeping and agriculture, patterns of consumption, market prices, etc.) from animal keeping in the Um Sarha camp and the village of Banat (see Rahmann, "The Impact of Droughts on the Economics of Traditional Animal Production Systems", in this volume). Both groups represent typical camp and village communities of the eastern Central Butana respectively. Even though not applicable to all other camps and villages, an extrapolation to the population of the Central Butana (viewed throught a model) gives an impression of the dimensions of an ecologically justifiable and economically necessary animal stock in this region.

The portion of consumption which has to be financed through animal keeping is of central importance. Meat consumption as well as sale of animals in order to finance consumption both need to play an important role. Demand for animals for satisfying consumer needs varies, depending on the year's characteristics, between 82% and 47%. During a span of 10 years under the conditions outlined above, approximately 77% of consumer needs are covered by animal keeping, not including milk consumption, since it does not influence animal stock.

Taking these 77% as a starting point, a hypothetical animal stock of 7.6 TLU/person is needed in order to retain the stock after 10 years. This takes into consideration that the herd is composed of a variety of species (64% camels, 10% cattle, 19% sheep, and 8% goats), and the proportion changes depending on the year's characteristics, and thus costs vary as well.

With an animal stock of 7.6 TLU/person, the herd can grow in good to moderate years (after offtakes). However, herd growth of up to 9.6 TLU/person is necessary in order to compensate for the high deduction in years of extreme drought. Animal stock then plummets to 6.9 TLU/person. After three normal years, the animal stock is again at the level of 7.6 TLU/person.

A comparison of these (model) figures with the actual livestock numbers of the animal keepers researched – i. e. only 5.6 TLU/person in 1983/84 – shows that this amount of livestock can only cover 50% of the consumption if the cycle is to return to its beginning after 10 years.

In reality, 77% of the consumption requirements are covered with the amount of livestock, which means more than is justifiable according to the

model. As a consequence, the livestock has diminished from 5.6 (1989/90) to 3.6 TLU/person (1991/92), which means that the herd did not constitute a lasting basis for the costs of living. This effect was exacerbated because there were two extremely dry years or droughts, respectively – i. e. twice as many as assumed in the model. The livestock per person decreased by 64 % over nine years (see Rahmann, "The Impact of Droughts on the Economics of Traditional Animal Production Systems", in this volume).

This leads to two conclusions: Either the livestock has to be raised to 7.6 TLU/person, or the amount of consumption that is covered by animal keeping has to be diminished from 77 % to 50 %.

If – as the first conclusion suggests – we were to raise the livestock to. 7.6 TLU/person, the limit of carrying capacity (110,000 – 140,000 TLU) would be substantially overextended temporarily (to 200,000 TLU) (see Fig. 2) – and this although the model only included the herds of the indigenous groups in the eastern Central Butana, but not the Arab villages on the edge of the New Halfa irrigation project. Thus, this would only be a useful solution if 35 % of the population were to quit animal keeping completely and were to use other sources of income entirely. There are, however, only very limited possibilities of doing so.

The second conclusion suggests a need for change in the animal keeper's economic conduct, either through diminishing consumption or through finding new sources of income. Indeed, 4.9 TLU/person would be sufficient if only 50 % of the consumption requirements were covered by animal keeping (instead of 77 %). This would mean an ecological carrying capacity of maximally 124,000 TLU.

Consumption could be diminished, for example, through cheaper or cost-free crop residues during time of crisis. New sources of income could be created by giving animal keepers of the Central Butana exclusive rights to use natural pasture and water. These resources could then be used without competition with other groups, or could be sold to them. All these ideas can, however, only be realized if basic legal changes occur.

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