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Impacts of Multifunctionality of Livestock Keeping on Biodiversity Preservation

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Abstract
The paper highlights the multifunctionality of livestock in selected Namibian and South African communities. Livestock is a crucial endowment for subsistence-oriented farmers. It affects their life in various ways and provides different private and public goods. This has impacts on biodiversity management as well as on development efforts.

Research in the BIOTA-Southern Africa project has shown that population growth and biased institutional incentives, such as tendencies to centralise governance, increase the pressure on natural resources. All four researched rural communities in Namibia and South Africa along the BIOTA-transect recognise the disappearance of certain plants and animals and experience negative consequences for their economic and social well-being. Overgrazing is one major reason for the loss of biodiversity. The observed farmers are, however, very resistant to reduce stocking rates. Multifunctionality of livestock is one explanation for this behaviour, which has been assessed using a mix of concepts and instruments. These include economic, psychological and sociological approaches. The research shows that livestock keeping satisfies a wide range of needs and is investment in the capital base of the farmers. The communities prevent livestock sales by group members through informal social sanctions. Opportunity and transaction costs for substituting various livestock functions are very high for most communal farmers. Efforts to implement alternative livelihood strategies which reduce the stocking rate need to consider these complex costs of livestock reduction. Many farmers, however, recognise as well the environmental costs of high livestock numbers. Thus, typical common property resource problems are prevalent in the research region. In the long run livestock will fulfil its livelihood functions only if natural capital can be preserved.

Due to the multifunctionality of livestock, commercialisation and income diversification is no simple alternative to the maintenance and re-establishment of regulated common property management. Strong institutions are essential to conserve biodiversity.

2 Background Information

Intensive analysis of the bundles of property rights showed that in all four settlements, substantial access and use regulations for grazing and other natural resources exist. The complex set of traditional and statutory laws is however, hardly enforced. Neither the government as the formal owner, nor the traditional authorities as the administrator, nor the residents as the users have the

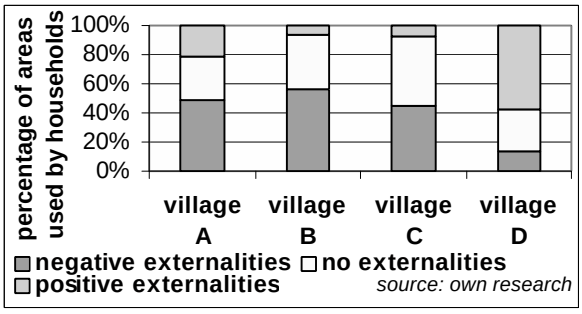


Figure 1: Externalities of resource use

	village A (percent)	**village B** (percent)	**village C** (percent)	**village D** (percent)
percentage of total community **cattle sold** 2001	0	4	10 *	-
per cent of total community **small-stock** herd **sold** 2001	3	0.4	4 *	16
households of settlement keeping livestock	86	89	74	37
livestock as **important** or **very important** source of income for household (per cent of households)	86	54	78	28

Table 1: Livestock as source of income (source: Ute Schneiderat BIOTA S11) **data for 2002*

capacity to fight against problems such as illegal wood cutting, uncontrolled bush-fires as well as overgrazing. This proved to be one of the major hazards for natural resource and biodiversity conservation in the region. The farmers' recognition of negative externalities in many of the areas used by the households, is an indicator for those institutional weaknesses mirrored in environmental degradation (see figure 1). With the exception of the to date understocked village D commonage, the natural capital is perceived to decrease in all observed communities. This reduces not only the natural resource base, but as well incentives to manage it sustainably. Obtaining individual returns on investments is not assured.

In village B and C, farmers often associate negative externalities and environmental degradation with grazing activities. Data show that these areas are overstocked. The selling and slaughtering numbers in all four settlements indicate a high resistance against livestock reduction. Despite these numbers, the farmers perceive livestock as an important source of income. This leads to the conclusion that the role of livestock keeping is more complex in subsistence oriented farming systems.

3 Hypothesis

Based on substantial research on multifunctionality of domestic animals in southern Africa, the following two hypotheses have been tested: Firstly, the propensity to increase herd size is rational from the farmers' point of view. Due to multifunctionality of livestock, large herds maintain and increase the households' capital endowments and secure their need satisfaction. (Cousins 1996, Rohde et al 2001, Shackleton et al 1999, Shackleton et al 2000, Shackleton et al 2001, Düvel et al 2000). Secondly it was examined whether or not the opportunity costs incurred through the reduction of livestock, constrain nature conservation initiatives and policies.

4 Research Sites

The selection of the research sites was done by the BIOTA project (Biodiversity Monitoring Transect Analysis in Southern Africa). With the intention to monitor biodiversity changes and to identify the driving forces for such changes, a number of observation sites have been established on a transect stretching from north-eastern Namibia down to Cape Town, South Africa. Integrated interdisciplinary research is being carried out at these locations. Our empirical fieldwork was concentrated on four of the BIOTA observatories: three settlements in Namibia and one in South Africa. The Namibian settlements are situated in the Kapako- (village A), the Ovitoto- (village B) and the Berseba constituency (village C). Focus of the South African research lies on Namaqualand (village D).

5 The Capital-Need-Institution Model

As a conceptual framework for the analysis the Capital-Need-Institution-Model has been developed. The model describes how an individual decides, which action maximises her/his utility function. Main factors determining a person's behaviour are a) capital access, b) internal motives and needs and c) institutional incentives.

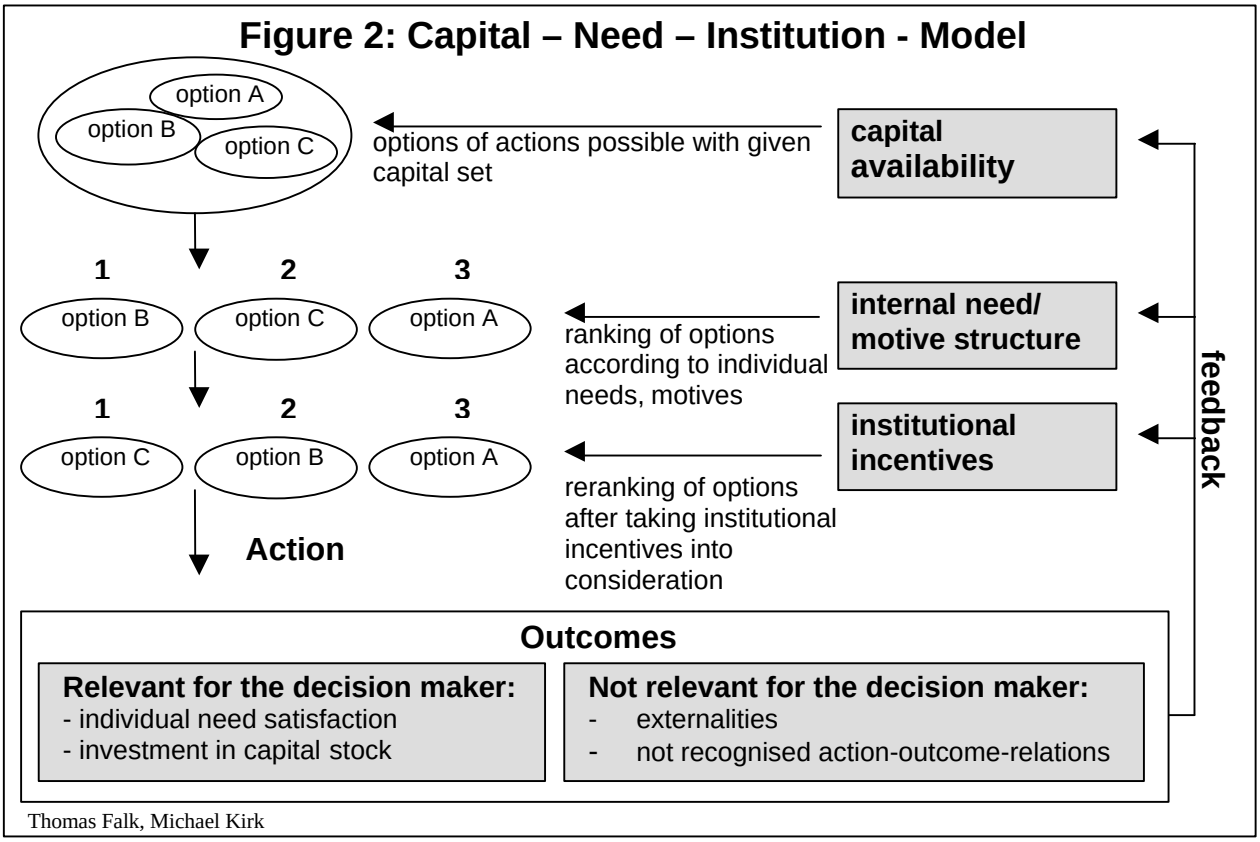
The given set of natural-, financial-, physical-, social- and human capital determines which action options are possible (Ellis 2000). Due to capital restrictions, farmers usually cannot opt for all options and she/he has to rank the alternatives according to their suitability to maximise the utility function. A common way to quantify utility functions is to measure the monetary benefit of a business. Money is, however, only a means to reduce transaction costs. Subsistence oriented farmers in the research areas, demonstrate that the satisfaction of needs is possible without using money. An alternative way of utility measurement was therefore used. Based on the theory of human motivation by Maslow, it was measured how physiological, safety, belongingness and esteem needs are satisfied by alternative action options (Maslow 1987).

In the case of scarce resources, the need satisfaction of an individual affects that of others. To manage such situations, institutional set-ups are necessary. Institutions and organisations provide positive and negative incentives, which can influence the attractiveness of alternative ways of behaviour. This may lead to the re-ranking of action options.

At the end of the decision making process, the individual decides which action is possible and, considering institutional incentives, most appropriate to satisfy her/his needs. The outcomes of the resulting actions can be divided into those which affect the decision maker directly and those which do not. Relevant for the decision maker is the effective need satisfaction. In addition people invest into their capital base to improve future options. Such an investment can be the preservation or even rehabilitation of biodiversity. Outcomes which do not really affect the actor, pose as hazards to nature and the society. Individual utility maximisation often leads to positive or negative externalities, where uninvolved parties have to cover costs. Changes in biodiversity and natural resources usually lead to such a situation. The major function of institutions is to internalise these externalities in order to avoid inefficient resource allocation and to provide incentives to invest in the resource base.

The outcomes of all actions affect future decision making. Therefore feedback relations exist to all three main factors.

Figure 2: Capital – Need – Institution - Model



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5 Methods and Results

The communities interviews were based on semi-structured questionnaires at the household level. Group discussions as well as observation walks have been conducted. All relevant stakeholders, such as traditional authorities, state representatives both on the regional and national level and local scientists have been interviewed as well. The data collected were analysed using qualitative methods, descriptive statistics as well as conjoint and regression models.

In a first step, the household heads of the three Namibian communities[1] were asked to rank their preferences for selling, slaughtering and keeping one head of livestock, using an ordinal scale between –2 (don't like it at all) and 2 (like it very much). Figure 3 shows, with almost no deviation, that keeping is a much better preferred option for farmers as opposed to slaughtering and selling. Non-parametric significance tests prove this trend. With the Wilcoxon-Test, significances of variances between the observations on the preferences to keep, sell and slaughter were tested within each settlement. In all three settlements, the variances between the preference values of keeping and slaughtering as well as between keeping and selling are very or even highly significant. In village B, the values for selling and slaughtering vary significantly, but not in village A and C. Using the Kolmogorov-Smirnov-Test, the significance of variances of the preference values between the settlements was tested. The results confirm that there are no significant variances for the preference of keeping animals between the communities. Selling values vary only significantly between village A and B as do slaughtering values between village A and C.

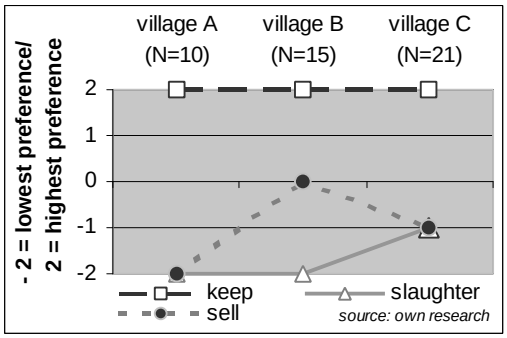

Figure 3: Median of preference values

	Village A	Village B	Village C
keep ⇔ slaughter	0.002	0.000	0.000
keep ⇔ sell	0.005	0.008	0.000
sell ⇔ slaughter	0.109	0.002	0.577

Table 2: Significance of Wilcoxon-Test for general preference *(source: own research)*

In order to derive at a non-monetary, but metric utility function, the conjoint measurement was applied as an instrument in village A. Conjoint analysis is a tool for measuring how strategy elements, like the decision to sell a cow or to slaughter a goat, affect the farmers' preference for a strategy. Out of the respondents' ranking of the strategies, a conjoint analysis calculates the relative importance of the different attributes as well as utility values for each attribute level. A) to slaughter and B) to sell livestock have been identified as the two attributes for the strategic decision. Attribute levels for both variables include A) no animal B) a goat and C) a cow. Two attributes each with three attribute levels add up to $3^2=9$ strategies. These nine strategies had to be ranked by the farmers according to their preferences. Analysing the preference orders of all households with conjoint measurement leads to the results in table 3. The bold numbers show the attributes' utility of each attribute level. No slaughtering got the highest utility (1.85) followed by no selling (0.63). Slaughtering a cow (-2.07) got the lowest value. By adding up the values for each attribute combination, the utility of the strategies can be calculated (e.g. neither selling nor slaughtering: 0.63+1.85=2.48). There is an interesting order in the preference values of the strategies. The three options

attribute levels		does not slaughter	slaughter goat	slaughter cow
	attribute utility	**1.85**	**0.22**	**-2.07**
does not sell	**0.63**	2.48 *(4.00)*	0.85 *(3.83)*	-1.44 *(5.22)*
sell goat	**0.04**	1.89 *(2.72)*	0.26 *(4.67)*	-2.03 *(7.56)*
sell cow	**-0.67**	1.18 *(2.78)*	-0.45 *(5.79)*	-2.74 *(8.44)*

Table 3: Conjoint-Model for Village A (N=9) *(source: own research)*

[1] Since the farming history of Village D is still too short and stocking rates are low it was decided not to do the assessment at this site.

where no animal has to be slaughtered, are most preferred. Within this strategy group, there is the preference order of 1) not selling 2) selling a goat 3) selling a cow. If an animal has to be slaughtered, the household prefers it to be a goat rather than a cow. Within both strategy groups of slaughtering a goat and a cow, the best option is to sell no animal followed by a goat and in the worst case, a cow. In order to verify the obtained results, it was calculated how an attribute combination was ranked on average by the households. The predicted conjoint-preference values, correspond well with the averaged strategies' ranking (numbers in brackets). Testing the conjoint model with Pearson's correlation coefficient, shows that the model's predictions fit highly significantly.

The results of the general preference assessment and the conjoint analysis do not explain why households favour the keeping of livestock so much. For better understanding, a motive assessment was done in village A, B and C. The household heads were asked how the decision whether to slaughter, sell or keep affects the satisfaction of physiological, safety, belongingness and esteem needs as well as the availability of natural, physical, social, human and financial capital. Figure 4 shows the catalogue of used indicators. The same method, as for the above presented general assessment of preferences for keeping, slaughtering and selling, was applied. Again, the respondents had to indicate on an ordinal scale between –2 and 2 the parameter value of the different variables. To give an example: It was asked whether the selling of one head of livestock increases or decreases the perceived livelihood security in the household. If the answer is yes, the respondents were asked whether the impact on the security is positive or negative and how strong it is. The same was done for slaughtering and keeping. The resulting data set comprehends three sub-sets, each with the whole range of variables: one for keeping, one for selling and one for slaughtering. For each household and each sub-set, data are available with regard to all variables of the need and capital categories.

Figure 4 shows the median of all variables for all three sub-sets and all three settlements. Trends are obvious and all data have been analysed with non-parametric significance tests. It was first tested

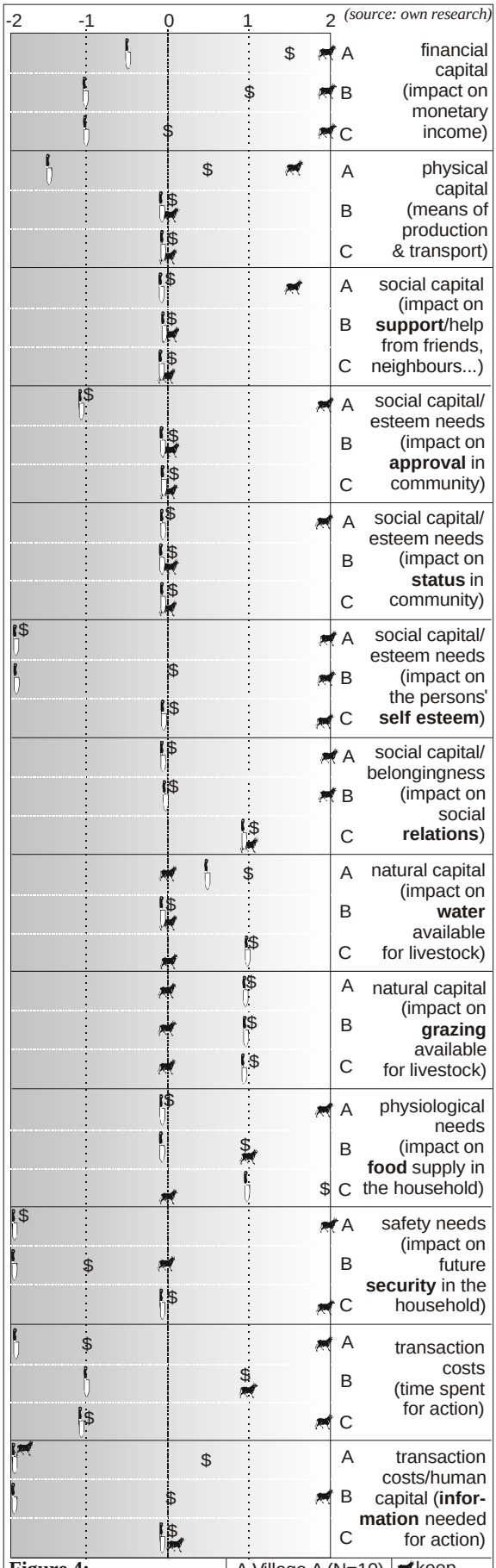

Figure 4: Median of capital and need categories

whether there are significant variances between keeping, selling and slaughtering for each settlement and each variable separately (tested with the *Wilcoxon-Test).* Then it was tested, using each variable and each option (keep, sell, slaughter), whether there are significant variances between the settlements (tested with the *Kolmogorov-Smirnov-Test).*

The following summarises the most interesting results:
1) Despite low selling numbers, the monetary income is perceived to be the highest when keeping and selling, with no significant variance between those two options. Keeping is seen as a monetary investment in all settlements.
2) Only in village A is livestock intensively used as a means of transport and production. This explains significantly higher values for keeping in this settlement compared to the others.
3) The impact of social capital and esteem needs has an effect on different variables in the different settlements. In village A, the approval in the community and in village B, the positive impact on the social relations are significantly higher for keeping than for the other options.
4) Only in village A is the perceived impact of keeping on the households' status within the community significantly higher than for selling or slaughtering. No significant variance could be observed in villages B and C.
5) Subsistence oriented farmers in village A perceive their food supply as significantly higher if they keep livestock. In village C, where the community has more alternative monetary income sources, the values for selling are significantly higher than for slaughtering and keeping. This was explained with the higher variety of food available in the household after selling.
6) The feeling that the household´s future security is negatively affected by selling and slaughtering was strong in villages A and B. One of the most important livestock functions in these settlements is the insurance component. Farmers in village C did not recognise a significant impact.
7) In all settlements, it is recognised that livestock reduction increases the natural capital available for the rest of the herd. This is however, no significant factor for the rating of an option.

Apart from significance tests, regression models for categorical data have been calculated to assess the impact of different need and capital categories (exogenous variables, see figure 4) on the general ranking (endogenous variable, see figure 3) of the three options. For this purpose, the three sub-sets for keeping, selling and slaughtering were combined. In the new data set, it is not discernible anymore to which option a data series belongs. In village A, with only one exogenous variable, the calculated regression model explains 92 percent of the endogenous variable "general ranking" (Corrected R^2=0.923). This variable is the perceived impact on the households' future security (standardized coefficient: 0.96). Risk mitigation is therefore the overwhelming motive for livestock production in village A. In village B, with three exogenous variables, 64 percent of the endogenous variable "general ranking" can be explained (Corrected R^2=0.636). Monetary income (standardized coefficient: 0.57) is of highest importance, followed by security ambitions (standardized coefficient: 0.39). Expected future support from relatives and friends (standardized coefficient: 0.26) also plays a role. In village C, only 33 percent of the dependant variable "general rating" can be explained (Corrected R^2=0.326). Monetary income has the strongest impact (standardized coefficient: 0,54). Future support by other people (standardized coefficient: 0.40) and status in the community (standardized coefficient: 0.29) also play a significant role. All three models are highly significant in their explanations.

6 Discussion

The results of the research prove that the building up of large herds is a rational strategy. Maximisation of short-term monetary income is however, not the motivation of the farmers. An alternative interpretation of their behaviour will be done based on the Capital-Need-Institution-Model.

Which role do capital constraints play in the decision making? The pressure on natural resources, especially in times of increasing resource scarcity due to population growth, limits the farmers' options. It is not clear, at least in some of the observed settlements, whether the present stocking rates can be maintained in the long run. If the natural capital declines, the action scope of the community will decrease and livestock will not be able to fulfil its functions anymore. Most farmers recognise that the reduction of livestock has a positive impact on natural resources. This awareness does however, not play an important role in their decision making.

It is also interesting that multifunctionality of livestock keeping is higher in the rather subsistence-oriented community A than in communities B and C, where the financial, physical and human capital endowment is better. The enhanced opportunities allow a broader substitution of livestock functions. In all observed communities though, livestock is seen as a means of investment in financial, social and physical capital. Apart from an investment in the capital base, livestock satisfies a wide range of needs without the involvement of money. Selling and slaughtering of one head of cattle satisfies physiological, safety, belongingness and esteem needs, mostly to a lower or at most, to the same degree as keeping. The regional differences between the parameter values of these variables are an indicator for cultural differences between the communities.

The impact of the decision on status, support, approval and social relations can also be interpreted as an informal institutional incentive of the community. Since families and friends benefit from the animals, they try to prevent the household head from selling and slaughtering livestock.

It can be summarised, that livestock fulfils a wide range of functions and plays an important role in the livelihoods of the whole community. Any initiative to reduce livestock numbers will be supported by the farmers, only if the various functions are substituted. This produces high opportunity costs for commercialisation or alternative income generating projects. The sustainability of such projects will depend on the recognition of those motives which cannot be measured easily in monetary terms. Despite high opportunity costs for livestock reduction, destructive environmental consequences due to the overuse of natural resources must be recognised. Income diversification is often seen as an option to decrease the pressure on resources. Alternative income sources make the user less dependant on natural resources and allows her/him to reduce her/his herd size. On the other hand, the lower dependence level decreases incentives for the farmer to maintain the resources. He/she will survive even if the pasture becomes a desert in the future. The empirical data show that farmers with regular monetary income own the largest herds in the communities. For them it is still rational to use the livestock as investment and life, health, disability and retirement insurance. Substituting these functions with alternative products and services on the commercial market would be more expensive for them. Livestock has the advantage that it can be easily shifted from one use form to another, which is not possible with an insurance for example. Poverty is the most important driving force for livestock reduction of most interviewed farmers, since they sell or slaughter only in emergency situations. Another approach to unburden communal pasture is the establishment of resettlement projects which try to motivate wealthier emergent farmers to move from the commons to private farms. Examples are reported from villages B and C. This might improve the situation temporarily, but it is no solution in the long run as a growing population will fill the gap.

The dilemma can only be solved with regulated common resource management. Since governmental regulatory efforts have failed due to limited enforcement capacity, devolved institutions must control grazing practices and intensities. Communal farmers have to be

encouraged to control natural resources. To date, the government still intensifies the societies' perception that communal lands are openly accessible to anybody. This leads to a situation where existing regulatory structures, e.g. of customary law, are inefficient. The sense of ownership decreases. However, the problem is not that ownership of communal lands is vested in the government. More importantly, communities have to be aware of the fact that they can control resource access, use and decision making. Local institutional structures must be strengthened to ensure the maintenance of natural resources and biodiversity. Livelihoods, especially that of the poor, depend on natural capital, which is the base for a multifunctional use of livestock.

7 Conclusion

The research proved that the resistance of communal farmers in the observed communities against livestock reduction is based on rational considerations. Their preferences for building up large herds is based on the recognition of multiple functions of livestock. Many of these functions are difficult to measure in monetary terms, but play an important role in the decision making of the farmers. A dilemma between short term need satisfaction and exploitation of natural capital exists. A reduced natural capital base will decrease the livelihood opportunities of communal farmers in the future. Income diversification and resettlement programs alone will not solve the problem as long as the substitutes of livestock functions delivered by markets are too expensive. Only strong institutions which restrict natural resource use can ensure the maintenance of biodiversity and natural resources.

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