ECONOMIC INCENTIVES FOR RANGELAND MANAGEMENT IN NORTHERN BOTSWANA: IMPLICATIONS FOR BIODIVERSITY

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ABSTRACT

Results of an analysis of economic returns and financial incentives in rangeland use in northern Botswana are presented. Land use systems involving small-scale livestock keeping, medium-scale cattle post livestock production, commercial livestock production, commercial wildlife viewing tourism, and community wildlife use were examined with detailed budget/cost-benefit models, developed from empirical data. Development of both wildlife and livestock land uses will maximise returns of economic direct use value, and meet development objectives. Wildlife-based tourism in high quality wildlife areas is extremely economically efficient, and should have priority. Community use of wildlife can also be economically efficient and should be promoted where its values exceed those of livestock. Small-scale production of livestock provides significant household income, primarily through subsidies. It has potential to generate high economic values, but is economically inefficient due to its open access nature, and itsconsequent low herd productivity. Capital-intensive commercial livestock ranching is economically inefficient and should not be promoted. Attempts to promote expansion of beef production should focus on low input systems. Wildlife activities appear have positive impact on biodiversity. Livestock activities do not, but only open access livestock systems have negative impact. Improved common property management of rangeland among traditional livestock keepers will enhance both economic returns, and biodiversity conservation.

1. INTRODUCTION

This paper has emerged from a study in which the financial profitability and economic efficiency of the primary land uses in Ngamiland District, north western Botswana, were analysed (Barnes *et al*. 2001). The study was aimed at the planning of economically and environmentally beneficial land uses, and allowing Botswana to avoid the economic inefficiencies, resource wastage, and the adverse environmental impacts of inappropriate land use. Land use in the district is dominated by livestock and wildlife, both of which tend to compete for rangeland resources. We examine the implications of the findings in Barnes *et al*. (2001) for biodiversity conservation.

Two main forces drive the livestock sector in Botswana. Firstly, beef exports, primarily to the EU, are important for the national economy. Second, traditional livestock keeping, primarily involving cattle, is an important contributor to the livelihoods of rural people. Traditional livestock keeping takes place on the communal lands of Botswana which occupy some 60 % of the land surface. Only some 50 % of national beef exports come from these communal lands, the rest coming from privately owned commercial ranches which occupy some 6 % of the land surface. An important policy thrust in livestock development, since the 1970s, has sought to increase beef output from the large communal land herds.

Fairly large areas of the communal lands, notably on Kalahari sand, are unutilised by livestock. Some of these are zoned for wildlife use (wildlife management areas), and others are in the process of being occupied for livestock, as ground water development takes place. The tribal grazing land policy (TGLP) is a programme, in which larger herd owners from the communal lands are established on new large scale commercial ranches on communal land (McGowan International 1988). This has been an important part of livestock development. Both TGLP ranch development, and small-scale livestock keeping in the communal land, have benefited from subsidies.

Livestock development is expanding into the southern, western and northern parts of Ngamiland in north west Botswana. This area is generally lightly inhabited and undeveloped communal land, and constraints to this expansion have been reduced through massive government interventions in livestock disease control.

The areas is now almost completely encircled and crossed by veterinary cordon fences, and this makes it a target for expansion of livestock land use. The Botswana government undertook a detailed environmental impact assessment of the veterinary fences in Ngamiland (the "fences EIA").

This EIA assessed the ecological and economic costs of the veterinary fencing programme and the different fencing options (Scott Wilson Resource Consultants & Environment and Development Group 2000), and the study by Barnes *et al*. (2001), complemented it.

On the eastern side of Ngamiland lie the highly valuable wetlands and wildlife habitats of the internationally renowned Okavango Delta. While there is a powerful constituency in favour of livestock development in Ngamiland, there is also a growing constituency in favour of wildlife-based development. The findings of Barnes *et al*. (2001), partially reported here and also by Barnes (2001), support the notion that both livestock and wildlife have important economic roles to play in Ngamiland (Barnes 1998, 2002).

No detailed studies have been conducted on the effects of the different livestock and wildlife land uses on biodiversity conservation. Biodiversity is understood here to mean diversity at all of genetic, species, and ecosystems levels (Griffin & Barnard 1996). We can thus only make assertions, based on subjective analysis, regarding the likely effects of these land uses on biodiversity. Thus in this study we determined what might be done to maximise economic efficiency, and then assessed the likely impact of such a strategy on biodiversity.

2. STUDY AREA

Ngamiland occupies predominantly flat, semi-arid, northern Kalahari, at around 1,000 meters above sea level. The soils are mostly very infertile aeolian sands of the Kalahari beds. Permanent surface water is absent except in the Kwando river, and the Okavango river and inland delta system. Here, there is seasonal flooding as waters from Angola arrive in the dry season. Away from the wetlands, groundwater resources are variable with respect to salinity and yield (van der Sluis 1992). About one third of the Kalahari sand area is not suitable for livestock water point development.

The climate is mild in winter and hot in summer, when the rains fall, and these average between 450 and 550 mm per annum. The dominant vegetation is northern Kalahari tree savanna. Tree species such as *Terminalia sericea*, *Lonchocarpus nelsii* and *Acacia fleckii* occur in the drier south west, while in the more mesic north western areas, *Burkea africana* and *Baikaea plurijuga* are found. Along rivers, and in and around the delta, floodplain grasslands, sedge wetlands, riverine thicket formations, and *Colophospermum mopane* woodlands occur in mosaics with the savannas. Plant species diversity is highest in the wetland areas and lowest in the southern sandveld.

As rangeland, the habitats in Ngamiland are dominated by bulk *grazing* resources. Palatable browse exists but its carrying capacity for obligate browsers is low, mainly because dry season leaf-loss results in a bottleneck. The grass sward is dominated by coarse grasses, such as *Eragrostis lehmanniana*, *Eragrostis pallens, Stipagrostis uniplumis* and *Aristida stipitata*, so that fully stocked ungulate populations are dominated by bulk feeders with mixed feeders taking a secondary role. Thus cattle, elephant, buffalo, zebra, goats, and impala can dominate, depending on the locality. The range is suitable for livestock, dominated by the bulk grazer, cattle; or mixed wildlife populations, dominated by bulk feeding species.

Rangeland is sweet, i.e. it can produce weight gains in livestock and game throughout the year. Grazing stock suffer limited protein and phosphate deficiencies which can be ameliorated through supplementary licks. "Economic" carrying capacities (those that can maximise animal production spatially) range from some 15 hectares per large stock unit equivalent (LSU) in the south west, to some 10 hectares per LSU in the north east. Ecological carrying capacities (those that can sustain the maximum number of animals spatially) are some twice as high as the "economic" ones. The extra water availability in the wetlands results in higher carrying capacity and a tendency for slightly sour rangeland conditions (where grazers can lose weight in the non-growing season)..

Wildlife populations are highest and most diverse in the delta, riverine areas, and their vicinities. Here, species such as elephant, buffalo, hippopotamus, giraffe, lion, leopard, impala, lechwe, sitatunga, kudu, sable, zebra, roan and many others occur in densities approaching 30 hectares per LSU equivalent. These areas also have high scenic variety and attributes which attract tourist visitors. In the sandveld habitats away from water, the wildlife densities and diversity are lower. Here most large charismatic species are absent or rare, and common species of interest include gemsbok, kudu, hartebeest, leopard and ostrich. There are small numbers of species such a giraffe, eland, lion. Wildlife densities are low, ranging from some 80 hectares to 500 hectares per LSU equivalent. The sandveld savanna areas are generally flat and scenically fairly monotonous so that their potential for tourism is limited.

3. METHODOLOGY

The first task was the identification of the important competing land uses in Ngamiland, and this was done by Barnes *et al*. (2001). The land uses selected for analysis were primary land uses, or those which can have a substantial effect on incomes, or those which are incompatible with other uses, requiring some exclusivity. It is these which are likely to have comparative advantage, and capacity to influence the national welfare.

Thus, economic and financial analysis focused on the following land use activities.

- Commercial livestock production on ranches in the south east of Ngamiland, typified by the Hainaveld tribal grazing land policy (TGLP) settlement,
- Cattle post livestock keeping in the more remote sandveld areas of in the southern, western parts of the district,
- Small-scale livestock keeping in core areas of human settlement. This is mostly along the southern and western edges of the Okavango delta, and along the Okavango panhandle,
- Community use of wildlife in low quality wildlife areas of the sandveld, west and north of the Okavango Delta. Here, the Quihaba proposed Wildlife Management Area is a typical example,
- Community use of wildlife in moderate to high quality wildlife areas surrounding the Okavango Delta. Examples of this are the Seronga community, or the Khwai community,
- Wildlife viewing tourism through private sector lodge development in the high quality wildlife areas of the Okavango Delta and along the Kwando/Linyanti river.
- Economic and financial analysis

The methods used for the financial and economic analysis were aimed at determining the direct use values of the land uses, as defined within the context of the "total economic value" of natural resources, as described by Pearce & Turner (1990)[1]. Direct use values contribute directly to income and employment, and have high importance for decision-makers in Botswana. The other components of total economic value, while important, particularly in the international context, are difficult to measure and have not been studied in Botswana. One of these is the economic value of biodiversity, which may embrace indirect use value, option value and existence or bequeath values.

The primary measure of economic direct use value used is that of *national income*, as defined by Gittinger (1982) and Pearce (1986). In the context of the land uses studied, national income refers to the income received by the factors of production (labour and capital) from the sale of their services to production in the form of wages, rent and net income. With some adjustments for trading gains or losses, it is equivalent to the concept of national product, which is the value added generated in these land use activities (total value of the goods and services produced, less raw materials and other goods and services consumed during the production process). We used value added as a base to estimate *net national income*, which is gross national income less depreciation of capital.

The estimates of net national income were measured using *economic* prices, which reflect the costs to society, of using or producing resources. Economic prices reflect opportunity costs (the values of the resources' best alternative use). Where financial prices differed significantly from opportunity cost, *shadow pricing* was applied, using criteria of the Ministry of Finance and Development Planning (Ministry of Finance and Development Planning 1986, Matambo 1988). The approach was similar to those described in manuals developed for South Africa (CEAS 1989) and the World Bank (Gittinger 1982). The measures of gross and net national income were *measures of economic efficiency*. They provided an indication of the contribution of the land use to economic growth and development.

The financial analyses resulted in profitability measures, indicating the private incentives for investment in the activity. The extent to which these private returns differ from the economic ones indicated the influence of policy and/or market imperfections, as described by Jansen *et al.* (1992).

Models took the form of detailed spreadsheets with annualised income statements and ten-year cost-benefit, investment analyses. They were developed, as representative examples of the land uses, using data from both the literature, as well as empirical survey conducted in Botswana and Namibia. Sensitivity analysis was used to test robustness of models and assumptions, and determine the strength of conclusions to be drawn from results.

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[1] The components of total economic value include direct use, indirect use, option, bequest and existence values associated with the resources. *Direct use values* are derived from the actual *utilisation* of the resource. They contribute tangible value in the form of *income*, and make up the main component of formal economic growth, which in turn is the focus of national development efforts. Indirect use values are derived from ecological or social function (such as erosion protection, waste assimilation, political stability, etc.). Option values reflect the values perceived in retaining the option to use the resource in the future. Bequest values reflect the value perceived in preserving or retaining the resource for others in the future. Existence values reflect the value perceived in retaining the mere existence of the resource.

All models, except those for commercial tourism on leased land, contained wildlife or livestock herd/flock projections, incorporating birth rates, mortality rates, off-takes and purchases, within the constraint of rangeland carrying capacities. Detailed descriptions of the assumptions for each model were provided in Barnes *et al*. (2001).

The three livestock systems modeled were distinctive in terms of parameters such as herd sizes, stocking rates, calving rates, mortality rates, off-take rates, milk production, use of stock for transport, etc. Detailed description of the systems and the assumptions are given by Barnes *et al.* (2001). The assumptions for these livestock models were synthesised from the results of Flint (1986), Bailey (1982), McGowan International & Coopers and Lybrand (1987), McGowan International (1988), Townsend and Sigwele (1998), Arntzen (1989, 1998), Abel (1993), Behnke (1982, 1985), Phuti (1984, 1985), Hubbard (1982) Bekure (1982) and Vierich, (1979). Some corroboration of these assumptions was possible with results of Yaron, *et al*. (1992), LaFranchi (1996), Ashley and LaFranchi (1997), Metzger (1994), Scoones (1992), Barrett (1992), Campbell, *et al*. (2000), Tapson (1991), Loxton, Venn and Associates & Rural Development Services (Pty) Ltd (1985), Division of Economics and Markets (1952), and van Wyk (1967).

The wildlife viewing tourism model comprised private sector investment on public land in the Okavango delta. The two community wildlife use models describe initiatives in which local communities have been allocated rights to manage and use the wildlife resource. Community-private sector joint venture tourism investments were prominent in these initiatives. The two are distinctive in terms of their size, wildlife composition, wildlife densities, potential for different wildlife uses, and human populations. The assumptions for the wildlife models were synthesised from results of Barnes (1989a, 1989b, 1991a, 1991b, 1995a, 1995b, 1998) and Barnes & MacGregor (1999). Empirical physical and financial data, collected from operators and projects between 1986 and 1999, had formed the basis for these studies.

Sensitivity analyses were conducted on the base-case land use models by varying parameters such as livestock calving rates, livestock mortality rates, livestock prices, capital costs, stock purchases, stock off-take rates, and income from tourism. Barnes *et al*. (2001) used the findings in the models to build dynamic cost benefit analysis models of land use development options, incorporating some price effects and the costs and benefits of livestock disease control.

Biodiversity

The concept of biodiversity is an abstract one. Gaston (1996:2) provides a useful definition: “variety and variability among living organisms and the ecological complexes in which they occur”. According to McNeely *et al*. (1990), Gaston (1996), Griffin & Barnard (1996) it is commonly considered at three levels, in terms of genetic richness, species richness and ecosystem richness. It has come to be used as a socio-political construct; to refer to the loss of the natural environment and its contents, simply as a synonym for nature conservation, and also to refer to ecosystem integrity and function Gaston (1996). We examined the land uses studied in this paper subjectively in terms of their impact on “genetic richness”, “species richness”, “ecosystem richness”, “nature conservation”, and “ecological integrity”.

4. RESULTS AND DISCUSSION

4.1 Economic returns and development

Table 1 summarises some key economic and financial characteristics of the land uses, extracted from the detailed results of Barnes *et al*. (2001). These findings, with the supporting sensitivity analysis and cost-benefit modeling (conducted to assess the viability of different veterinary fencing options), provide the following important insights as to how land can be allocated to improve returns of economic direct use value,and meet economic development objectives.

Certain land uses stand out from the others. Wildlife-based tourism in high quality wildlife areas such as the Okavango delta is extremely economically efficient. This form of land use should get priority where these conditions exist. Community use of wildlife is also very economically efficient, where people and high quality wildlife resources exist (in and around the delta). Community initiatives should be promoted where conditions permit, and where the economic values exceed those of livestock (generally, where wildlife densities and diversity are high enough).

Investment in wildlife-based tourism by the private sector and communities provides a reasonable *financial* return on investment. For communities themselves, use of wildlife provides significant cash income, which can effectively complement their income from livestock keeping, livestock production and crop production, where communities live in or near higher value wildlife areas. In addition to the high direct use values measured here, investment in wildlife tends to attract high foreign non-use values, which can be captured by Botswana. This further enhances its value as an investment.

Table 1. Comparative results from base-case financial and economic models for wildlife and livestock land uses in Ngamiland, Botswana (pula, 2000).

Land use	Requirements for:		Economic measures		Financial measures	
	Land (ha)	Capital (P/ha)	NVA/ha[1]	ERR[2]	NCI/ha[3]	FRR[2]
Livestock						
a – Cattle ranching	10 000	157	-13	-[4]	-4.00	2.9%
b – Cattle post production	6 400	78	1.86	2.0%	4.00	6.8%
c – Small-scale cattle keeping	180	225	0.26	10.1%	26	11.5%
Wildlife						
d – Community use, low[5]	900 000	1.98	0.50	24.8%	0.06	8.0%
e – Community use, high[5]	80 100	14	9.70	54.1%	0.76	8.1%
f – Wildlife viewing	14 400	139	76	64.0%	17	9.6%

[1]Annual net value added to national income per hectare (economic efficiency)
[2]Financial (FRR) and economic (ERR) internal rates of return over ten years
[3]Annual net cash income per hectare (financial profitability)
[4]Rate of return is negative
[5]Community-based wildlife use projects in high- and low-quality areas

Small-scale production of livestock provides significant household income in the more densely settled areas. This is primarily as a result of subsidies. This land use tends to be economically inefficient, due to the open access grazing system and consequent low herd productivity. However, sensitivity analysis shows that it has potential to generate high economic values if it can be accompanied by implementation of programmes, which allow some restriction of access, some de-stocking, and consequently some improvement in herd productivity. The results suggest that, in this way, significant economic values could be generated and, in addition, subsidies could likely be removed. The results tend to confirm the theoretical premise that *de facto* open access to grazing results in the dissipation of net benefits (where positive returns in good years are cancelled out by negative ones in poor years).

The results indicate that capital intensive commercial livestock ranching, as espoused through the tribal grazing land policy (TGLP), is economically inefficient. This is partly due to the remoteness of Ngamiland, and the conclusion is that commercial ranches should not be promoted. Instead, initiatives to promote the expansion of livestock production in unsettled areas, should focus on beef production through low input systems, such as occurs at cattle posts. Cattle post livestock production was found to be the most economically efficient land use for sandveld areas, moderately remote from human settlement, with good groundwater quality, and with relatively low wildlife densities. However, returns per unit of land in this environment are generally low. The study does not confirm the economic efficiency of the livestock sector as a whole, but the indications are that low input, small- to large-scale livestock systems can generate positive economic returns in Ngamiland.

Community use of wildlife in the low value wildlife areas, is economically efficient, but the economic and financial returns, per unit of land, tend to be very low. This land use has merit in the more remote parts of the sandveld, where transport costs reduce the value of cattle post livestock production, or where water quality is poor, and where wildlife densities are adequate (denser than about 200 hectares per LSU equivalent). As stated, wildlife use tends to provide cash, which can complement the other income-earning strategies of households. Wildlife also provides diversity in income, reducing risk for households. Investment in wildlife stocks by communities can draw foreign existence and option values, which can often be captured by communities as income (such as through donor-funded assistance to wildlife conservation).

4.2 Impacts on biodiversity

The lack of information on the effects that the different land uses have on biodiversity is largely due to the difficulties of measuring it, which are exacerbated by the uncertainties in its definition. Table 2 depicts the anticipated effects that the land uses might have on several different elements attributable to biodiversity. The striking feature is that the wildlife land uses will generally have positive impacts on biodiversity measures. This conforms with common wisdom and is expected.

The wildlife uses in Ngamiland are dominated by tourism activities, and the products of these seem fairly closely correlated with positive biodiversity measures. Investment in these land uses will have the effect of enhancing biodiversity. This is particularly the case with commercial tourism, for which profitability is linked to the actual products having visual and biological diversity. This land use is associated with the protected area core of the delta, where conservation of biodiversity is explicit. Bruner *et al*. (2001) have confirmed that parks were generally successful in protecting biodiversity in Africa.

Table 2. Subjective assessment of the possible impacts of different livestock and wildlife land uses on various elements of biodiversity (+ = positive, +- = neutral, - = negative).

Biodiversity measure	**Category of land use**					
	Livestock land uses			**Wildlife land uses**		
	(a) Traditional	(b) Cattle Post	(c) Commercial	Community Use – Low Quality (d)	Community Use – High Quality (e)	Commercial Tourism (f)
Genetic richness	-	+-	+	++	++	+++
Species richness	-	-	+-	+	++	+++
Ecosystem richness	-	+-	+	++	++	+++
Nature conservation	-	-	+-	++	++	++++
Ecological integrity	-	+-	+-	+++	+++	++++

The livestock land uses are aimed at producing livestock products, and it is not unexpected that these will tend to have negative or at least neutral effects on diversity in the natural environment. Commercial livestock ranching likely has the most positive effect on biodiversity. Investments in commercial livestock production aim to maintain the rangeland in its most productive state for cattle and in this much of the natural biodiversity would tend to be preserved. Commercial ranching investments are mostly in the biologically unexciting Kalahari sand habitat, and the impact of variable levels of livestock grazing around water-points might tend to introduce some new genetic or system variability. Most Kalahari large game populations can coexist tolerably well with commercial livestock herds in this setting. Overall the impact on biodiversity is likely to be neutral or slightly positive.

The traditional small-scale livestock keeping land use system is considered to have an overall negative effect on biodiversity. This can be ascribed to the open access problem inherent in this system, which results in excessive grazing pressure at levels around the ecological carrying capacity. The generally continuous, and spatially even, heavy grazing pressure drives down livestock productivity, but it also squeezes out any wildlife stocks and reduces spatial variability in habitats which are naturally fairly diverse (such as around the margins of the delta). Cattle post investments are likely to fall in between the commercial and small-scale livestock systems in their biodiversity impacts. The negative effects of biodiversity caused by livestock systems are closely correlated with grazing pressure. Measures which control open access to grazing, such as common property rangeland management initiatives, should have positive impacts on biodiversity.

5. CONCLUSION

The findings of the economic and financial analysis confirm those of Barnes *et al*. (2001) Barnes (2001, 2002) which indicate that, in terms of direct sue value, economically efficient allocation of land in Ngamiland will include both livestock and wildlife systems spread spatially along a spectrum.

Wildlife-based tourism activities run by the communities or private sector investors, have real comparative economic advantage in the wilder areas with good wildlife stocks. In the more accessible and more densely settled areas, small- to medium-scale, or low input traditional livestock systems, at least potentially, have real comparative advantage. Of the land uses examined, only commercial livestock ranching is considered to have no economic potential. Wildlife and livestock activities, as generators of economic income and livelihood, regionally and sometimes locally, tend to be complementary.

There are indications (Metroeconomica Economic Consultants, 1996; Sigwele & Khupe, 1996; Townsend & Sigwele 1998) that livestock values will drop in the long term and that livestock may lose its comparative advantage. Wildlife values, on the other hand are likely to increase in the long term (Barnes *et al*., 2001), increasing the comparative economic advantage of wildlife-based land uses.

An economically efficient allocation of land would likely have mixed effects on biodiversity, with investments in wildlife being positive and investments in livestock tending to be neutral or negative. However, the traditional small-scale livestock system can only be economically efficient if it can incorporate measures to reduce the open access problem. This should have the effect of reversing at least some of, the negative effect of this livestock system on biodiversity.

Interesting questions arise for future research. Further work could focus on refining the economic and financial models developed by Barnes et al. (2001), perhaps using *Monte Carlo* simulations, and development of maximisation models for land use allocation. Probably most important, however, research is urgently needed on the components of biodiversity and the effects of different land use strategies on them. A specific research programme starting with a national baseline, like that of Barnard (1998) for Namibia, followed by measurement and monitoring work along the lines described by Steinitz (1996) or Margules (2000) is needed. Work which can give an idea of the magnitude of indirect and non-use economic values associated with biodiversity is also needed.

6. ACKNOWLEDGEMENTS

We wish to thank Phoebe Barnard and Sue Milton for the invitation to prepare this paper. The research was made possible with funding from Conservation International (CI). Some of Jonathan Barnes' time was funded by the Swedish government, though Sida. We wish to thank Karen Ross and Karl Morrison, of CI, for logistical assistance and support. Ann Gollifer, Gary Mullins, Beth Terry, Jeremy Perkins, Jan Isaksen, Jaap Arntzen and Deb Gibson assisted greatly with collection of documents and data in Botswana.

7. REFERENCES

Abel NOJ 1993. Reducing cattle numbers on southern African communal range: is it worth it? In: RH Behnke, I Scoones and C Kerven (Eds.). Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas. Overseas Development Institute, London, UK. 173-195.

Arntzen JW 1989. Environmental pressure and adaptation in rural Botswana. Ph.D. Thesis, Free University of Amsterdam, Amsterdam, Holland. 249pp.

Arntzen J 1998. Economic valuation of communal rangelands in Botswana: a case study. CREED Working Paper No. 17, International Institute for Environment and Development (IIED), London, UK, and Institute for Environmental Studies (IVM), Amsterdam, Holland. 47pp.

Ashley C and LaFranchi C 1997. Livelihood strategies of rural households in Caprivi: implications for conservancies and natural resource management. Research Discussion Paper No. 20, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek, Namibia. 96pp.

Bailey CR 1982. Cattle husbandry in the communal areas of eastern Botswana. Ph.D. Thesis, Cornell University, Ithaca, New York, USA. 367pp.

Barnard P 1998. Biological diversity in Namibia: a country study. Namibian National Biodiversity Task Force, Windhoek, Namibia. 332pp.

Barnes JI 1989a. Bere Game Harvesting Project, Mathlo-a-Phuduhudu Wildlife Management Area, Ghanzi District: financial and economic analysis. Unpublished Paper, Department of Wildlife and National Parks, Gaborone, Botswana. 23pp.

Barnes JI 1989b. Western Ngwaketse, Southern District, Game Harvesting Project: financial and economic analysis. Unpublished Paper, Department of Wildlife and National Parks, Gaborone, Botswana. 16pp.

Barnes J 1991a. The development of Botswana's wildlife resources as a tourist attraction. In: Pfotenhauer, L. (Ed.). Tourism in Botswana. The Botswana Society, Gaborone, Botswana. 346-369.

Barnes JI 1991b. Chobe Enclave Community Wildlife Utilisation Project - Chobe District: financial and economic analysis. Unpublished Paper, Department of Wildlife and National Parks, Gaborone, Botswana. 18pp.

Barnes JI 1995a. Economic analysis of community-based wildlife utilisation initiatives in Botswana. Development Southern Africa 12: 783-803.

Barnes JI 1995b. Preliminary financial and economic analysis of the Salambala conservancy project, Caprivi region, Namibia. Unpublished Paper, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek, Namibia. 23pp.

Barnes JI 1998a. Wildlife economics: a study of direct use values in Botswana's wildlife sector. Ph.D. Thesis, University of London, London, UK. 370pp.

Barnes JI 2001. Economic returns and allocation of resources in the wildlife sector of Botswana. South African Journal of Wildlife Research 31: 141-153.

Barnes JI 2002. The economic returns to wildlife management in southern Africa. In: Pearce, D., Pearce, C. and Palmer, C. (Eds.). Valuing the environment in developing countries: case studies. Edward Elgar, Cheltenham, UK. 274-288.

Barnes JI & MacGregor J 1999. Financial and economic analysis of the Nyae Nyae Conservancy Project, Otjozondjupa region Namibia. Unpublished Paper, Directorate of Environmental affairs, Ministry of Environment and tourism, Windhoek, Namibia. 34pp.

Barnes J, Cannon J & Morrison K 2001. Economic returns to selected land uses in Ngamiland, Botswana. Unpublished Report, Conservation International, Washington, DC, USA. 166pp.

Barrett JC 1992. The economic role of cattle in communal farming systems in Zimbabwe. Pastoral Development Network Paper No. 32b, Overseas Development Institute (ODI), London, UK. 35pp.

Behnke R 1982. Closing the gap: a reevaluation of the APRU studies of cattle post and ranch productivity. In: RK Hitchcock (Ed.) Botswana's first livestock development project and its future implications. National Institute of Development and Cultural Research, University College of Botswana, Gaborone, Botswana. 75-87.

Behnke RH 1985. Measuring the benefits of subsistence versus commercial livestock production in Africa. Agricultural Systems 16: 109-135.

Bekure S 1982. The economics of commercial ranches. In: Hitchcock, R.K. (Ed.). Botswana's first livestock development project and its future implications. National Institute of Development and Cultural Research, University College of Botswana, Gaborone. 209-216.

Bruner AG, Gullison RE, Rice RE & da Fonseca GAB 2001. Effectiveness of parks in protecting tropical biodiversity. Science 291: 125-128.

Campbell BM, Doré D, Luckert M, Mukamuri B & Gambiza J 2000. Economic comparisons of livestock production in communal grazing lands in Zimbabwe. Ecological Economics 33: 413-438.

CEAS 1989. Manual for cost-benefit analysis in South Africa. Central Economic Advisory Service, Pretoria, South Africa. 83pp.

Division of Economics and Markets 1952. Agro-economic survey of the Union V (extensive cattle farming areas). Department of Agriculture Bulletin No. 325, Government Printer, Pretoria, South Africa. 93pp.

Flint MES 1986. Crop and livestock production in the Pelotshetlha lands area: the main report of the IFPP Phase 2 Farm Management Survey (2 volumes). Integrated Farming Pilot Project, Ministry of Agriculture, Lobatse, Botswana. 292pp.

Gaston KJ 1996. What is biodiversity? In: Gaston, K.J. (Ed). Biodiversity: a biology of numbers and difference. Blackwell Science Ltd., Oxford, UK. 1-9.

Gittinger JP 1982. Economic analysis of agricultural projects, 2nd edition. John Hopkins University Press, Baltimore, Maryland, USA. 505pp.

Griffin M & Barnard P 1996. What is this thing called biodiversity? In: Tarr, P. (Ed.). Namibia Environment, volume 1. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek, Namibia. 122-125.

Hubbard M 1982. Comparisons of cattle herd performance in Botswana and their consequences for cattle production investment planning: additional observations from the 1979 and 1980 "agricultural statisitics". In: RK Hitchcock (Ed.) Botswana's first livestock development project and its future implications. National Institute of Development and Cultural Research, University College of Botswana, Gaborone, Botswana. 62-74.

Jansen DJ, Bond I & Child B 1992. Cattle, wildlife, both or neither: results of a financial and economic survey of commercial ranches in southern Zimbabwe. Project Paper No. 27, WWF Multispecies Animal Production Systems Project, Harare, Zimbabwe. 203pp.

Lafranchi C 1996. Small-scale livestock and cropping enterprises in northern Namibian communal areas. Unpublished Paper, World Wildlife Fund (US) Living in a Finite Environment (LIFE) Programme, Windhoek, Namibia. 75pp.

Loxton, Venn and Associates & Rural Development Services (Pty) Ltd. 1985. Land allocation proposals for the Marico Block, Bophuthatswana. AGRICOR, Mmabatho, Bophuthatswana, North West Province, South Africa. 134pp.

Margules C 2000. Biodiversity planning and monitoring in Namibia. DEA Research Discussion Paper No 35, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek, Namibia. 27pp.

Matambo OK 1988. Shadow pricing in cost benefit analysis of projects. Unpublished Circular, Ministry of Finance and Development Planning, Gaborone, Botswana. 3pp.

McGowan International & Coopers and Lybrand 1987. National Land Management and Livestock Project, incentives/ disincentives study (3 volumes). Ministry of Agriculture, Gaborone, Botswana. 336pp.

McGowan International 1988. National Land Management and Livestock Project, study of the National Development Bank TGLP ranch loan portfolio. Ministry of Agriculture, Gaborone, Botswana. 198pp.

McNeely JA, Miller K, Reid WV, Mittermeier RA & Werner TB 1990. Conserving the world's biodiversity. IUCN, Gland, Switzerland; WRI, CI, WWF-US and The World Bank, Washington, DC, USA. 193pp.

Metroeconomica Economic Consultants 1996. Development cooperation objectives and the beef protocol: economic analysis of the case of Botswana (confidential draft interim report). European Commission: DGVIII. 58pp.

Metzger D 1994. Livestock sector study for the eastern communal areas (former Hereroland) and southern communal areas (former Namaland). Ministry of Agriculture, Water and Rural Development and Deutsche Gesellschaft fuer Technische Zusammenarbiet (GTZ), Windhoek, Namibia. 66pp.

Ministry of Finance and Development Planning 1986. Planning officer's manual. Government Printer, Gaborone, Botswana. 128pp.

Pearce DW 1986. Macmillan dictionary of modern economics. The Macmillan Press, London, UK. 462pp.

Pearce DW & Turner RK 1990. Economics of natural resources and the environment. Harvester Wheatsleaf, London, UK. 378pp.

Phuti LM 1984. Herd management study results: 1983 survey. Division of Planning and Statistics, Ministry of Agriculture, Gaborone, Botswana. 55pp.

Phuti LM 1985. Herd management study results: 1984 survey. Division of Planning and Statistics, Ministry of Agriculture, Gaborone, Botswana. 32pp.

Scoones I 1992. The economic value of livestock in the communal areas of southern Zimbabwe. Agricultural Systems 39: 339-359.

Scott Wilson Resource Consultants & Environment and Development Group 2000. Environmental assessment of veterinary fences in Ngamiland (6 volumes). Department of Animal Health and Production, Ministry of Agriculture, Gaborone, Botswana. 640pp.

Sigwele HK & Khupe C 1996. Implications of the World trade Organisation (WTO) to Botswana's livestock sector. Paper for National Development Policy Conference, Grand Palm Hotel, Gaborone, 24 – 28 June 1996. 22pp.

Steinitz C 1996. Biodiversity and landscape planning: alternative futures for the region of Camp Pendleton, California. US Department of Defense, US Department of Energy, and US Environmental Protection Agency, Washington, DC, USA. 142pp.

Tapson DR 1991. The overstocking and offtake controversy reexamined for the case of KwaZulu. Pastoral Development Network Paper No. 31a, Overseas Development Institute (ODI), London, UK. 22pp.

Townsend RF & Sigwele HK 1998. Socio-economic cost-benefit analysis of action and alternatives for the control of contagious bovine pleuropneumonia in Ngamiland, Botswana. Unpublished Paper, Department of Agricultural Economics, University of Pretoria, Pretoria, South Africa. 99pp.

van der Sluis T 1992. Baseline survey, Western Communal Remote Zone (Planning Zone 6), Ngamiland West, volume 1: natural resources, socio-economic survey, land and resources utilization. Ministry of Agriculture and Ngamiland District Council, Maun, Botswana. 183pp.

van Wyk SP 1967. Some economic aspects of beef production. Division of Agricultural Production Economics, Department of Agricultural Economics and Marketing, Pretoria, South Africa. 173pp.

Vierich H 1979. Drought 1979: socio-economic survey of drought impact in Kweneng. Ministry of Agriculture, Gaborone, Botswana. 130pp.

Yaron G, Janssen G, Maamberua U & Hubbard D 1992. Rural development in the Okavango region of Namibia: an assessment of needs, opportunities and constraints. Gamsberg Macmillan, Windhoek, Namibia. 245pp.