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The perfect drought? Constraints limiting Kalahari agro-pastoral communities from coping and adapting

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Rural Kalahari agro-pastoral communities of Southern Africa have been exposed to drought shocks throughout history and have adapted their livelihoods accordingly. Yet, drought continues to disrupt or threaten to disrupt their production systems. With semi arid Botswana as a case study, this paper hence sought to unearth the factors limiting agro-pastoral communities from adequately coping and adapting to drought. Low rainfall, which is also highly variable, coupled with relatively low soil fertility status make subsistence livestock keeping and crop cultivation risky. This marginal agricultural potential of the land is further compounded by other constraints. Some of the major constraints included persistence of droughts, limited diversification options outside agriculture, inadequate and poor quality drinking water (high salinity) for livestock, crop damage by wild animals as well as the current land tenure system which curtails the traditional response of livestock mobility during drought. All these factors may act solely or in combination to render rural communities vulnerable during droughts. It is therefore recommended that effective interventions be tailored to local conditions to enhance resilience among Kalahari's rural population.

Key words: Adaptation, Botswana, coping, drought, variability, vulnerability.

INTRODUCTION

Droughts are common phenomena in many parts of Southern Africa. Not only is the region drought-prone, but the rural communities inhabiting these areas are well aware of the adverse effects of droughts on their environment-dependent livelihoods. Smallholder farmers, who are the most likely to experience disruptions to their production efforts, are even more vulnerable during droughts. This increasingly becomes vivid with extended periods of droughts, when crop failure and livestock mortalities peak. This exposure to drought hazards has necessitated responses involving a myriad of coping and adaptive strategies among the communities (Owens et al., 2003; Enfors and Gordon, 2008; Eriksen and Silva, 2009). And although droughts may be geographically localised, their non structural effects, which may spread to other sectors of the economy have even prompted action from national governments in the region (SADC, 1999; FAO, 2004). Coping and adaptation,both distinct but intricately related processes (Adger, 1996), have drawn widespread attention over the years especially with the compounded threat of climate change, perhaps the most overriding issue of our time. But despite the significant research effort aimed at understanding the physical aspects of droughts and the effects thereof, as well as the attendant coping and adaptation mechanisms, agro-pastoral communities still continue to struggle to increase production and/or sustain their livelihoods in the semi arid environment of Southern Africa. What then, could we be missing in our efforts? Could there be a crack in the armour, so to speak? Frankenberger (1992) argues that, over the years, environmental degradation (for example through overgrazing and deforestation) and lack of water conservation measures may have served to further exacerbate the effects of droughts. Other researchers (Fako and Molamu, 1995) have argued that poverty may be the underlying problem. According to FAO (2004), it is generally acknowledged that low-resource agriculture is unable to sustain livelihoods in

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these fragile semi arid environments. This study therefore set out to identify the main factors limiting households in the Kalahari from adequately coping and adapting to droughts, with Botswana's subsistence agro-pastoralists as a case study. Understanding the prevailing conditions, as seen by the farmers, could inform policy makers and launch better-coordinated intervention programmes to enhance farmers' resilience to future drought shocks, which are generally expected to increase in the region (Reed et al., 2007).

METHODOLOGY

Study areas

Kgalagadi North is part of Kgalagadi (Kalahari) desert ecosystem, the driest district in Botswana and the least inhabited. The highly variable and erratic rainfall regime characterizes the area, with an average of about 350 mm annually (Bhalotra, 1985). Rainfall follows a uni-modal pattern, falling mainly between October to April. Maximum summer temperatures (October to April) average 41°C in January and February and a mean minimum for August of -8°C in winter months (May to September). Thus evapo-transpiration rates are quite high, exceeding precipitation by more than a factor of three (Chanda et al., 2003) and resulting in the absence of surface water for most times of the year. The soils of the area are arenosols (FAO, 1991). The vegetation type is Southern Kalahari bush savanna (Skarpe, 1986). The main perennial grasses include *Stipagrostis uniplumis*, *Eragrostis lehmanniana*, *Schmidtia pappophoroides* and *Aristida meridionalis*. Annual grasses include *Schmidtia kalahariensis* and *Aristida congesta*. Woody species include *Acacia erioloba*, *Acacia Leuderitzii*, *Acacia mellifera*, *Boscia albitrunca*, *Grewia* species, *Dichrostachys cinerea*, *Ziziphus mucronata* and *Terminalia sericea*.

The other study site was in the Bobonong region within the Central district. Temperatures above 33ºC are common in summers, and they sometimes decline to 4ºC in winters. Long-term rainfall averages 350 mm per annum and occurs mostly in October to April. The main soil type is Eutric Regosols and in some areas petric calcisols/chromic luvisols (FAO, 1991). The vegetation consists of tree savanna and *Acacia* shrub savanna (Weare and Yalala, 1971). Woody species include *Colophospermum mopane, Combretum* species, *Grewia flava, Acacia tortillis*, *Dichrostachys cineria* and *Commiphora* species. The major grass species are *S. uniplumis, Eragrostis rigidior, Digitaria eriantha, Aristida congesta* and *Urochloa* species. Various species of forbs are found.

Agriculture is the main source of livelihood of the rural communities in both study areas. Pastoral farming is dominated by traditional production systems within communal grazing areas termed cattleposts or 'meraka'. Subsistence crop cultivation is practiced but to a lesser extent compared to livestock keeping.

Data collection

Rainfall

The long-term annual rainfall data for the study areas were sourced from the Department of Meteorological Services. For the Bobonong Sub-district, the Bobonong field station was used while the Tshane station was used for the Kgalagadi North study area. The data for both sites were from 1959 to 2009, totalling 50 years.

Soil

Soil sampling was done once during the study period at sampling points on randomly-placed line transects. Three 5 km line transects were set up along a representative grazing area in each study site. Topsoil cores (0 to 7.5 cm) were taken at 1 km intervals and the soils were analyzed for chemical properties at the Soil and Plant Analytical Laboratory in Sebele, Botswana. Exchangeable bases calcium (Ca), magnesium (Mg) and potassium (K) were determined using ammonium acetate as described by Thomas (1982). The Walkley and Black method (Walkley, 1935) was used to determine the organic carbon (OC) content in the soil samples, while the Bray II method (Bray and Kurtz, 1945) was followed in determining phosphorous (P) amounts. In addition soil pH was determined.

Vegetation

Vegetation analyses included density, species composition and frequency and herbaceous cover using the quadrat method (Cook and Stubbendieck, 1986). For important woody browse species, the point-centred quarter (PCQ) method was used to determine their density, along the same line transects, following Browser and Zar (1984) and Cook and Stubbendieck (1986).

Social data collection

The agro-pastoral households[1] were selected at random with the input of the extension officers from the Ministry of Agriculture in the respective areas. In the Bobonong Sub-district (Lepokole and surrounding communal areas of Sekgopswe, Mmamanaka and Mmaditshwene), 50 households were interviewed while 38 were interviewed in Kgalagadi North (Hukuntsi, Lehututu and Tshane villages). The survey collected information on demographic characteristics, socioeconomic status (e.g. income sources), land tenure, crop and livestock management, input use, access to information, extension, technology, markets and credit as well as constraints to coping and adaptation efforts. Data triangulation was done through participatory rural appraisal and key informant interviews in each study area.

Statistical analysis

Data were subjected to the Statistical Package for Social Sciences (SPSS). Frequencies were calculated using descriptive statistics for respondent demographics, socio-economic characteristics and related variables. A one way analysis of variance (ANOVA) was carried out for soil chemical properties between the two study sites. Where significant differences existed ($p < 0.05$), Tukey's HSD was used for means separation. The same procedure was used with vegetation data (percentage cover and density). The density of important woody species was determined as described by Browser and Zar (1984) and Cook and Stubbendieck (1986).

RESULTS AND DISCUSSION

Biophysical characteristics

Rainfall

The semi arid environment of Botswana exhibit erratic and variable rainfall regimes, both spatially and

[1] Following Niehof (2004), a household herein refers to a family-based co-residential unit that takes care of resource management and the primary needs of its members.

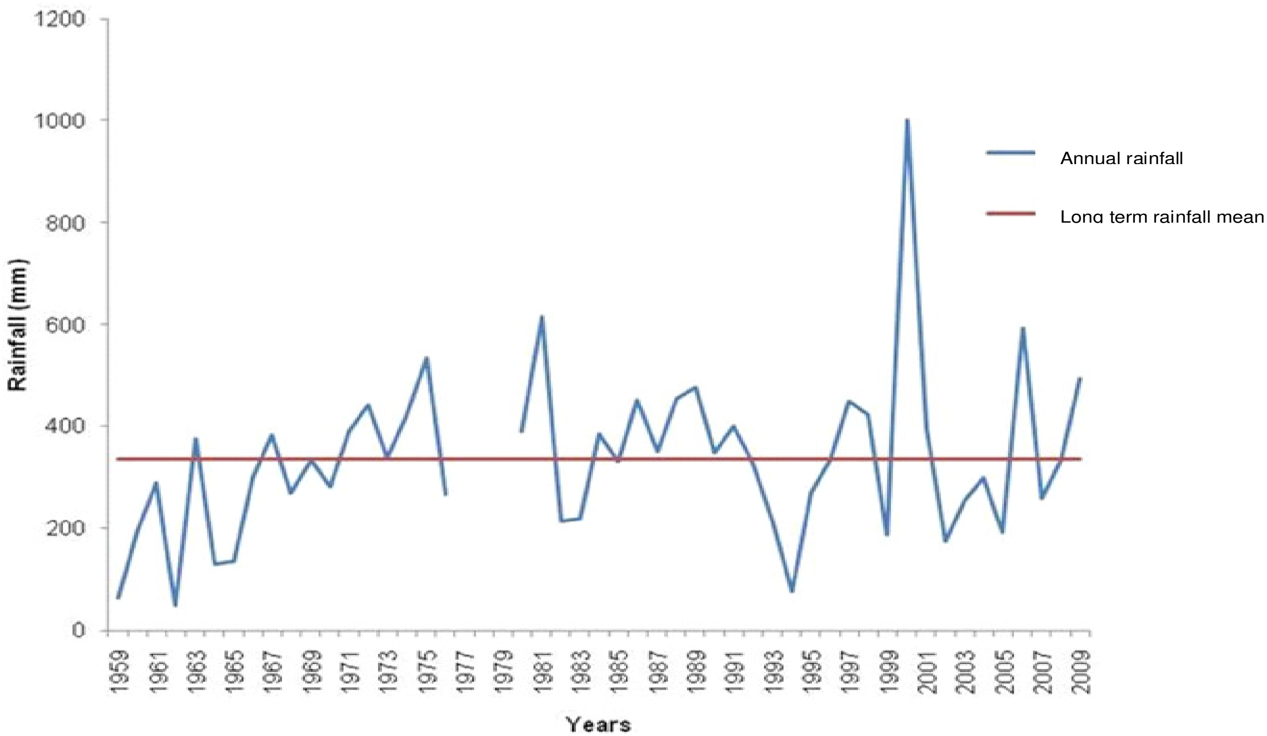

Figure 1. Rainfall pattern and long term mean for Bobonong (Bobonong Sub-district). Gaps in graph indicate missing data.

temporally. The study sites showed such trends for a period exceeding 30 years (Figures 1 and 2), with no distinct pattern-further underlining the unpredictable nature of rainfall.

The high variability in rainfall (44 and 41% coefficients of variation for Bobonong (Bobonong Sub-district) and Tshane (Kgalagadi North Sub-district) respectively[2]) has implications for the rural communities dependent on rain-fed agriculture for subsistence. Dry extremes are common. Even in non-drought years, crop cultivation is a risky undertaking. Seasonal non-availability of surface water and deterioration of forage for livestock results in reduced productivity and at times of extended droughts, possible livestock deaths.

Soil chemical properties

The important chemical properties from the two study sites are as summarized in Table 1.

The results of the analysis showed significant differences ($p < 0.05$) in magnesium (Mg), cation exchange capacity (CEC), organic carbon (OC) and phosphorous (P) levels between the two sites. The significantly higher CEC of soils in Bobonong could be attributed to the higher clay content found in the soils dominant in the area (FAO, 1991), which generally also have better water holding capacity. The soil CEC is important as it allows exchangeable cations such as Mg, calcium (Ca) and potassium (K) to be readily available for uptake by plants. In general, the higher the organic matter and clay content, the higher the CEC (Brady and Weil, 2001). Thus the low CEC in Kgalagadi North rangeland soils could partly be due to the low OC content of the soil (0.15%). Apart from increasing soil water holding and cation exchange capacities, the organic fraction is important as it also serves as a reservoir for the plant essential nutrients and enhances soil aggregation and structure.

Phosphorus levels in Kgalagadi North were significantly lower ($p < 0.05$) than in Bobonong, further attesting to the poor fertility status of the Kalahari sands. The vegetation would also likely be low in P. According to APRU (1980), P levels in Botswana grasses rarely exceed 1.0 /kg, thus farmers have to supplement their animals to avoid increased incidences of Aphosphorosis (Stiff Sickness) due to consumption of poor grasses. Animal manure is a common source of P especially in grazing areas, but Chanda et al. (2003) note that due to the low rainfall amounts in Kgalagadi, natural input of P is insignificant. Also, P becomes less available for uptake by plants if soil pH is relatively low. The average pH values for Kgalagadi North and Bobonong Sub-districts were 5.47 and 6.25, respectively. P is thus a limiting factor in the productivity of the Kgalagadi North soils. The generally low soil

[2] CVs of 33% mark the critical value where non-equilibrium dynamics emerge (Ellis, 1995).

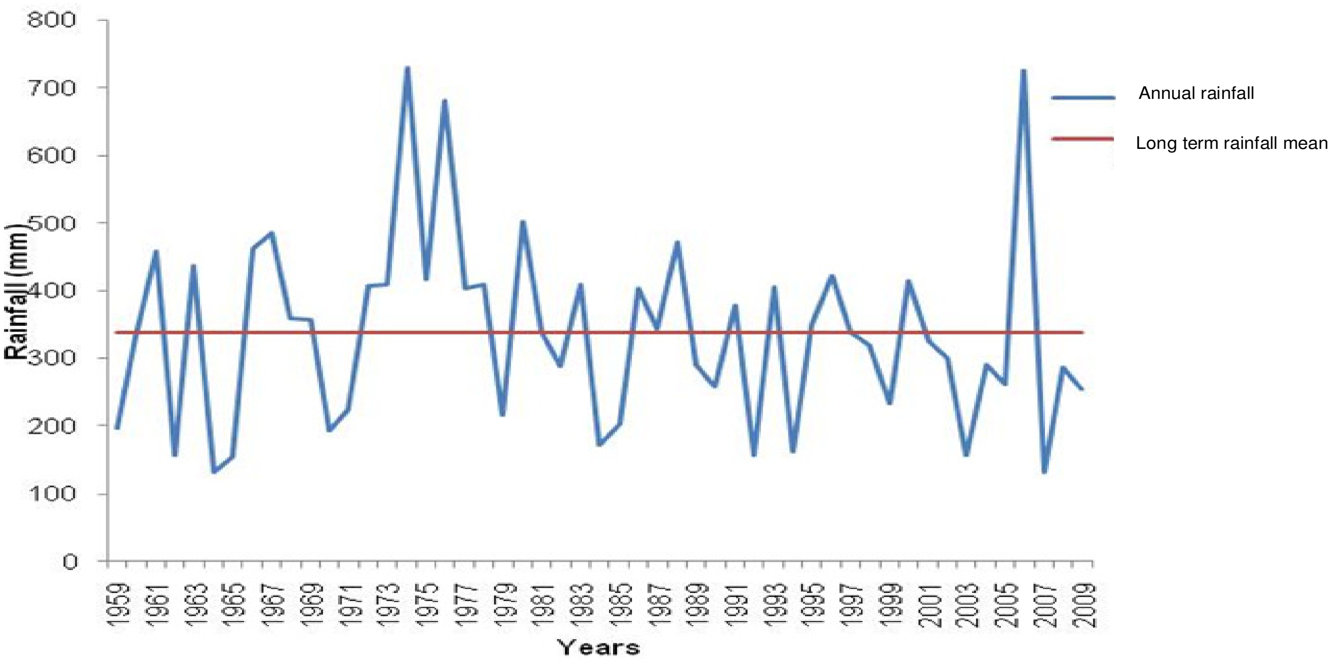

Figure 2. Rainfall pattern and long-term mean for Tshane (Kgalagadi North Sub-district).

Table 1. Some soil chemical properties of the study sites.

Study site	K	Ca	Mg	CEC	OC (%)	P (ppm)
	cmol/kg					
Kgalagadi North	0.23±0.03[a]	3.70±2.67[a]	0.60±0.05[a]	2.34±0.26[a]	0.15±0.01[a]	4.52±1.55[a]
Bobonong	0.33±0.04[a]	9.13±2.49[a]	1.07±0.22[b]	6.91±0.88[b]	0.40±0.04[b]	16.96±4.30[b]

Column means with different superscripts are significantly different at $p < 0.05$.

fertility findings of Kgalagadi are echoed by Perkins (1991), who attributes it partly to their sandy nature. So, based on the results, where Kgalagadi North has significantly lower soil chemical properties than Bobonong except for Mg and Ca, coupled with erratic and low rainfall in the area, one could conclude that cost-effective arable farming would be a challenge for Kgalagadi North rural communities. Thus households dependent on crop cultivation and natural pastures for livestock are likely to be more vulnerable to droughts because of the low ecological productivity of the soils.

Vegetation characteristics

Plant frequency

The frequencies of some important plant species found in the study sites are given in Table 2.

Grasses of economic importance with regard to livestock production (APRU 1976) such as *Eragrostis* spp., *Urochloa* spp. and *Digitaria* spp. were encountered. *Aristida* spp. on the other hand, was a key indicator of poor range condition together with the invasive forb *Elephantorrhiza elephantina* which dominated in some grazing areas not far from water points in Kgalagadi North.

Percentage herbaceous cover

The percentage herbaceous cover for the two study sites is presented in Table 3.

There was a significant difference ($p < 0.05$) in cover between the two sites. The average cover for the herbaceous layer towards the end of the growing season in March was 61.78 and 76.67% for Bobonong and Kgalagadi North respectively, which is expected to be less during the dry winter season (May to August). This is especially so for Bobonong area as the bulk of the herbaceous cover constituted of annual grasses and forbs. Cover is important as it protects the soil layer from being exposed to elements of erosion. Thus soils in Bobonong area, because of lower percentage cover, are

Table 2. Frequencies of selected important plant species in the study areas.

Plant species	Relative frequency (%)	
	Bobonong	Kgalagadi North
Perennial		
S. uniplumis	-	40
Eragrostis spp.	24.4	27.78
Digitaria spp.	4.44	8.89
Enneapogon cencroides	6.67	-
Annual		
Aristida spp.	35.56	33.33
S. kalahariensis	-	20
Urochloa trichopus	60	35.56
Tragus spp.	22.22	13.33
S. pappophoroides	-	22.22
Chloris virgata	22.22	-
Melenis spp.	2.22	13.33
Forb		
E. elephantina	-	33.33
Other forbs	75.76	88.89

Table 3. Percentage cover of the herbaceous layer in the two study sites.

Study site	Herbaceous layer cover (%)
Bobonong	61.78 ± 5.95^a
Kgalagadi North	76.67 ± 3.57^b

Column mean with different superscripts are significantly different at $p < 0.05$.

more prone to wind and water erosion.

Density of woody plant species

The total densities for woody species in Bobonong and Kgalagadi North study sites averaged 790 and 345 plants/ha respectively (Table 4), which was significantly different ($p < 0.05$). The most abundant woody species, based on relative densities, in Bobonong Sub-district were *Grewia* species (28.89%), *C. mopane* (22.78%), *A. tortilis* (13.33%), *Combretum apiculatum* (7.78%), *D. cineria* (7.22%) and *Commiphora* species (5.56%). In Kgalagadi North study site, *Grewia* species (37.22%, especially *G. flava*), *A. mellifera* (19.44%), *Acacia erioloba* (10.00%), *Terminalia sericea* (10.56%), *Acacia luederitzii* (8.33%) and *Boscia albitrunca* (7.22%) dominated. The lower woody species density in Kgalagadi is consistent with its classification as a bush savanna (Skarpe, 1986), giving it an 'open canopy' look in contrast to the denser Bobonong area.

Six (6) woody species were common to both areas. Sorenson's community similarity index showed that the two study areas were 37.5% similar in terms of woody plant species composition. Woody species are especially important as browse (including pods) for livestock during the dry season (May to August) and drought periods. This stems primarily from the fact that although important livestock grasses decline drastically in both quantity and quality during the non-rainy period in Botswana (APRU, 1976), woody browse species can still provide enough nutrients for livestock maintenance requirements (Moleele, 1998). But not all woody species are necessarily desirable. For example, in Kgalagadi North area, the dominance of *A. mellifera* was more pronounced near water points (natural pans). Moleele and Mainah (2003) noted the same trend. The species is one of the thorny encroachers, and Fraser et al. (2006) suggest that it thrives due to a combination of factors-namely, intense grazing, drought and a reduction in frequency and intensity of natural fires.

From the vegetation characteristics previously discussed, the herbaceous cover can be an important element in the agro-pastoral communities' efforts to cope and adapt to drought shocks. However, the bulk of the herbaceous cover in Bobonong area was annual grasses and forbs-offering a temporary resource base not available during the dry season and drought years for livestock to feed on. The transient nature of this resource leaves livestock susceptible to weight loss, emaciation and possible deaths, and thus threatening the livelihood base of the communities during droughts. On the other

Table 4. Mean woody species densities and number per site.

Study site	Mean absolute density (plants/ha)	Number of woody species
Bobonong	789.67±101.60[a]	20
Kgalagadi North	345.33±27.95[b]	12

Column means with different superscripts are significantly different at $p < 0.05$.

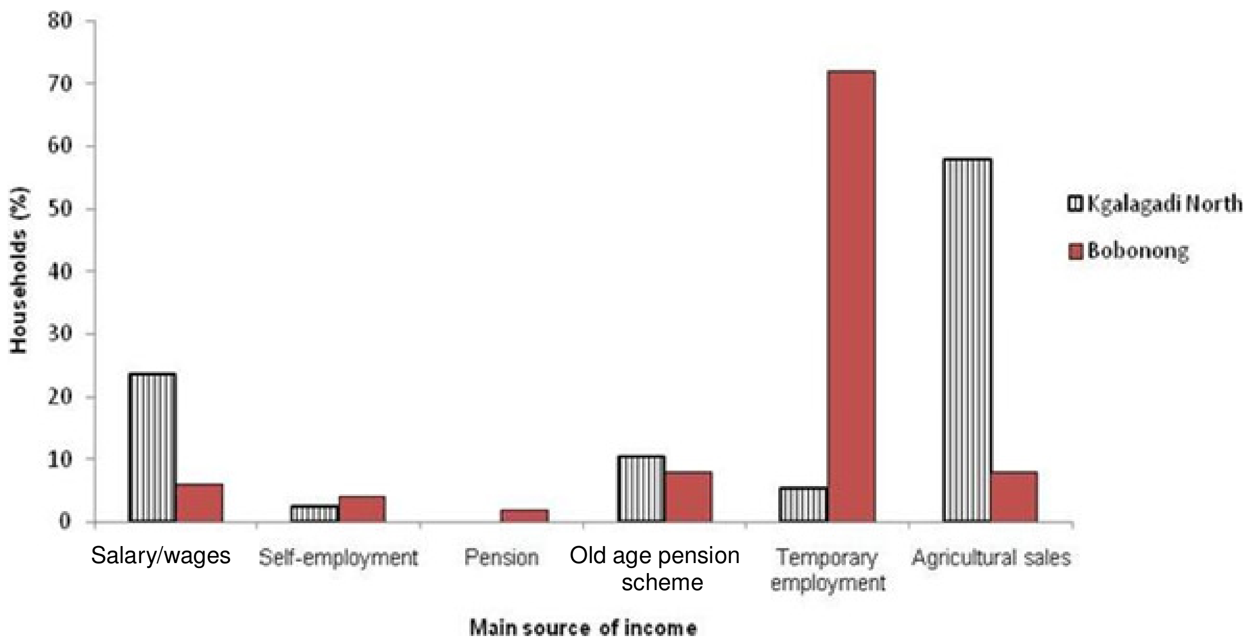

Figure 3. Main sources of income for households in Kgalagadi North and Bobonong Sub-districts.

hand, the palatable perennial grasses and woody plant species provide the nutritional requirements of livestock deep into the dry season and to some extent during droughts. Thus, this first line of defence can be critical especially for poorer households heavily dependent on the natural resource base.

Socioeconomic characteristics of households

Main sources of income

Most of the surveyed households in both study areas had between 5 and 7 members each. Households also had several sources of income (Figure 3). In Kgalagadi North, the majority of households had sales from agriculture, both crops and livestock, as their main source of income (57.9%). Selling of livestock (especially cattle and goats) was done primarily on a subsistence basis-usually to buy food for the household, buy livestock feed, pay bride price ('bogadi') or for other social functions affecting the family. Other sources included salaries from working household members (23.7%) and for all elderly citizens aged 65 and above, a monthly allowance from the government's Old Age Pension Scheme (10.5%).

In contrast, most households (72%) in Bobonong study site earned their main income through temporary employment or 'piece jobs'. These are traditionally low paying jobs like herding livestock, weeding of crop fields and joining the government's Labour Intensive Public Works Programme, among others. Sales from agriculture and allowances from the Old Age Pension Scheme were the main source of income for some households (8% each), followed closely by salaries at 6%. Unemployment rate in the area was recorded at 19.1% in 2003 (MFDP, 2007).

Gender and education levels

Most households were headed by members aged 41 years and older, with 72 and 89% in Bobonong and Kgalagadi North Sub-districts respectively, very few of whom had gone beyond primary education. The level of formal education of the head of a household has some significance, as higher literacy is more likely to encourage better planning and decision making. There were 56% of heads of households with some formal education in

Bobonong, while Kgalagadi had 76.3% of such respondents. There was a disparity in gender-where 64% of the households were female-headed in Bobonong while 23.7% were headed by females in Kgalagadi North. Special attention has been paid to rural female-headed households over the years (Cownie and Blake, 1982; Molutsi, 1992) as they tend to be prone to shocks because of high poverty levels (Jefferis and Kelly, 1999), lack of access to land, low literacy levels (Eriksen et al., 2005), lack of draught power, and high dependency ratios (Fako and Molamu, 1995). In Bobonong, of all household heads with no formal education, 68.2% were female-headed and their main source of income was the low paying temporary employment opportunities (69.4%), characteristics which Jacques (1995) argues, indicates high likelihood of vulnerability to drought.

Ownership of livestock

Livestock rearing has long been regarded as Batswana's (citizenry of Botswana) way of life (Edwards et al., 1989), despite its declining contribution to the country's Gross Domestic Product over the years (BIDPA, 2001). This is further supported by the study findings where 94% of all households surveyed owned some livestock (cattle, goats, sheep, horses, donkeys, pigs and poultry). Cattle are especially important as they affect the culture, politics, economy and the ecology of rural Botswana and its inhabitants (Keijsper, 1993). Looking at the livestock ownership dynamics in Bobonong, the most common were poultry (68%), goats (64%), donkeys (60%) followed by cattle (50%) and lastly sheep (16%). Donkeys are an important mode of transport for rural farmers (e.g. transporting water and harvests to markets), but their true worth are as draught power during the ploughing and planting seasons. A point to note is the relatively lower percentage of households owning cattle in the area. A possible explanation for this anomaly is the persistence of the economically important Foot and Mouth Disease (FMD) in the area, which results in the mass killing of all infected cattle by the government. Or the combination of recurrent droughts and FMD means that farmers spend most of their time trying to accumulate enough numbers for subsistence and possible sales. So cattle ownership in the area may be low not necessarily because cattle are less valued, but because of the associated risk.

By contrast, Kgalagadi North Sub-district has no FMD threat and had more households owning cattle (84.2%), goats (81.6%), poultry (60.5%), donkeys (52.6), horses (39.5%) and sheep (15.9%). Horses are used by herdsmen mainly when looking after other livestock, especially suited to navigate Kgalagadi's extensive and predator-filled terrain. Livestock ownership versus age and gender also drew special attention. Of all the households without cattle in both sub-districts, 74.2% were female-headed and were thus termed 'poor'. There was also skewed ownership of livestock with regard to the age of the household head. For example, the youth (≤ 40 years) owned only 16 and 12.5% of all cattle in Bobonong and Kgalagadi North sub-districts respectively, further fuelling the perception that they are not keen on agricultural-related activities (CAR, 2005).

Factors limiting households from coping with drought

Though households may have strategies in place to avert the negative consequences of droughts; there are some factors that hamper the full success of their efforts (Figure 4).

In the study area of Bobonong, the top-ranked constraints were persistence of droughts (20%), lack of diversified sources of income (20%), limited alternative options (18%) and wildlife menace (14%).

Recurrent droughts are seen as constraint primarily because they disrupt the agro-pastoral communities' efforts to subsist on the land. There is no regular pattern of drought episodes in Botswana, but an average periodicity of approximately 16 to 20 years has been observed (MFDP, 1997). Hitchcock (1979) argues that variability in rainfall has increased since 1954. This increased frequency of droughts in the study areas could have overwhelmed some of the traditional coping and adaptation strategies and rendering them ineffective. This has necessitated adoption of more responsive coping strategies among the agro-pastoralists, which may not always be available. For example, while in the past, the 'Mafisa' system enabled beneficiaries to 'lease' livestock and water points from wealthy members of their community (BIDPA, 1997); nowadays an animal would be adversely affected by recurrent droughts and hence produce less milk or be too weak to provide draught power or even die. Thus this strategy would not only be risky to the one 'leasing' out their resource (like livestock), but also to the one in whose custody the resource is temporarily transferred. Instead, the wealthy would rather hold on to their investment, while the poor would rather harvest firewood for sale or enrol in the government's Labour Intensive Public Works Programme where there is a guarantee of monthly payment which is a highly responsive strategy vis-à-vis 'Mafisa' with a delayed time lag before benefits are realized.

The over-reliance on one source for income (rain-fed agriculture), coupled with limited alternatives also make it difficult for households to cushion droughts once the agricultural sector experiences shortfalls. The area of Bobonong is also occasionally affected by elephants (*Loxodonta africana*), especially during extended dry seasons and droughts. The animals are attracted to the water in hand-dug wells meant for livestock and also destroy farmers' crops. Considering the recurrent droughts, the risky subsistence nature of farming, lack of

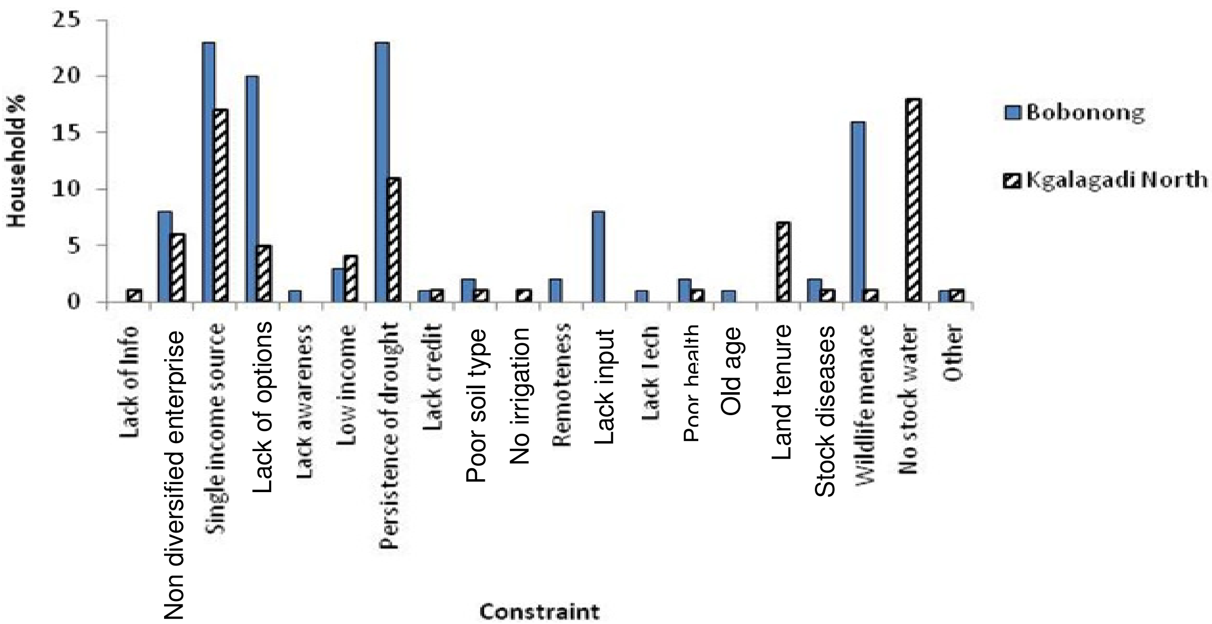

Figure 4. Constraints limiting households from coping and adapting to drought.

employment opportunities, and outbreaks of Foot and Mouth disease in the Bobonong sub-district, perhaps the communities ought to look at the elephants and other wildlife as a blessing in disguise. The community-based natural resource management (CBNRM) policy (1997) encourages communities in Wildlife Management Areas to form trusts and develop land use and management plans with the assistance of the Department of Wildlife and National Parks. The CBNRM concept satisfies both economic interests of the local residents (e.g. through tourism, hunting quotas and cultural villages) and the country's resource conservation objectives, thereby promoting sustainable development.

In the other sub-district of Kgalagadi North, lack of water or its poor quality (high salinity) were cited and ranked as the main constraints by farmers (23%), followed closely by lack of diversified sources of income (21%). Like in Bobonong study area, persistence of drought was seen as a constraint (14%). The other important constraint was the land tenure system (9%) which hampered farmers' efforts to cope with droughts.

Low, erratic rainfall and associated excessive evaporation rates make water a limiting factor for agro-pastoral communities of Kgalagadi North. Hand-dug wells at the edges of the numerous pans around the district are the main source of livestock drinking water. During drought years, because of depletion of palatable forage in the vicinity of the water bodies, animals have to traverse greater distances between distant grazing areas and water points. Thus borehole drilling in the communal areas offers a lifeline for farmer groups (syndicates) where underground water is not too saline. According to the farmers, if they had to choose one of the lesser evils between lack of feed (natural pastures) for their livestock and lack of water, they would opt for the former. This demonstrates the invaluable need for water in their agricultural activities. The persistence of droughts in this area could have also contributed to some households not cultivating crops at all, as the arable sector is more sensitive to moisture deficits than livestock. According to Van der Jagt (1995), a possibility of crop failure in the area ranges between 1 in 5 and 1 in 4 years.

Seasonal movements of livestock across the rangeland to exploit the high spatial variability of rainfall as well as heterogeneity of forage are the norm in semi arid and arid environments. But the current land tenure system in Botswana curtails such mobility. This gives rise to another constraint in efforts to cope with drought. In the case of Kgalagadi North, the communal area in which the cattleposts are located is adjacent to Wildlife Management Areas and the Kgalagadi Transfrontier Park (State Land), some privately-owned ranches (leased under Tribal Land) and the permanent human settlements/villages (Tribal Land). Because of the different land uses bordering them, agro-pastoralists can only move their livestock within the communal area itself. The physiology of cattle also dictates where to move to, and thus mobility is often restricted to natural water bodies (pans). A proposal is offered by Nyangito (2005), who suggests that pastoral mobility can be enhanced by employing secondary land tenure rights to access privately-owned grazing resources during critical periods like droughts. This remains largely unexplored in the case of Botswana.

The preceding constraints may act solely or in combination to hamper the communities' efforts in coping adequately with droughts, and thus increase their vulnerability. If one adds to these challenges the low, highly variable rainfall regime and climate-dependent livelihoods in both study areas, then there can only be one outcome, the perfect drought.

Conclusions

Rural agro-pastoral communities of the Kalahari are exposed to recurrent droughts at increased frequencies. The low soil fertility status, coupled with the low and highly variable rainfall regime make for a challenging environment for the farmers to operate under. Apart from this marginal agricultural potential of the land, there are other social and economic factors hampering farmers' efforts to make ends meet. It is thus necessary to understand and appreciate these often subtle and complex challenges for effective future intervention strategies to reduce vulnerability among agro-pastoral communities and ensure sustainable rural development.

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