Tribal Grazing in Botswana and the Tragedy of the Commons

by Stephen P. Holland

Stephen P. Holland
Department of Economics
260 Heady Hall
Iowa State University
Ames, IA 50011

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FOREWORD

Throughout this paper I will use terms such as "tribe" and "chief" which may carry certain negative connotations. Some people would recommend using the terms "ethnic group" and "king" instead of tribe and chief. Unfortunately, these two terms are not an improvement for two main reasons. First, they do not accurately reflect the actual institutions. The Bangwaketse, Bangwato, Bakwena and Bakgatla, four of the major tribes, *merafe,* of Botswana, are all of the same ethnic group since they share a common history, language and culture. However, they are still separate entities. Perhaps "nation" would be a better term to use, but nation is commonly used to refer to the present nation state of the Republic of Botswana. On the other hand, kings are a European institution implying absolute power and divine right. Although chiefs, *dikgosi,* were very powerful, there were a number of checks on their power and there was always extensive discussion of public policy among the Batswana. The actual system of government was probably closer to a participatory democracy than to a European absolute monarchy.

The second reason for not using "king" or "ethnic group" is more subtle. That these European terms are considered improvements is only due to the illusion of many people (including Africans) that European institutions are somehow inherently superior to African institutions. Often the argument is even made in evolutionary terminology, i.e. Europeans used to be organized in tribes which "evolved" into monarchies as society "progressed". This is the very premise that I will be arguing against in this paper. European institutions, including a system of private property rights, are not inherently superior to African institutions and certainly should not be simply adopted without careful deliberation.

For these reasons, I will use the terms tribe and chief since they are the commonly accepted translations in Botswana of the Setswana terms *morafe* and *kgosi.* I will limit my use of Setswana to the word *kgotia* which is a tribal gathering place and rather defies translation.

INTRODUCTION

Common property (or pool) resources (CPR) have been much studied and are quite controversial, especially when CPR's which have been managed effectively for long periods of time by various groups throughout the world, are suddenly converted to private property in the interest of increased "economic efficiency". While much has been contributed to the understanding of CPR's and their management, (Ostrom) the issue of efficiency is far from settled. It is the intent of this paper to examine the case of grazing policy in Botswana and the factors that contribute to efficiency and/or inefficiency in both the private property and common property solutions.

The organization of the paper will be to describe the pre-independence system of range land control, the factors that necessitated a change and the theory and workings of the subsequent Tribal Grazing Lands Programme (TGLP). The consequences of the TGLP will then be discussed in light of more recent theoretical developments followed by policy recommendations and directions for further study.

Pre-Independence Botswana

Botswana is a land about the size of Texas located in southern Africa. It ranges in climate from semi-arid to arid and most of the land is not well suited for arable farming due to lack of rainfall and poor soils. One of the primary geographical features is the vast Kalahari sandveld which is only agriculturally suitable for grazing. Historically, cattle have been of great importance to the Batswana.

The late nineteenth century was a time of great turmoil in southern Africa. As the European settlers began to expand northward from the Cape, various Bantu groups were pushed southward by the tsetse fly which preyed on cattle and humans. It was during this time that the

Batswana were pushed by the Zulu wars to the fringes of the Kalahari desert and into present day Botswana. The people brought with them their cattle and system of governance. Each tribe was ruled by a chief whose position was hereditary. The chief ruled with the consent of the people and was not able to force his will on the people. Important decisions were reached by consensus after extensive discussion at the *kgotia* and serious disagreements sometimes led to splits in the tribe, with one group leaving to form a new village.

Each village was divided into wards for administrative purposes. Ward heads were in charge of local disputes and also controlled grazing within their allocated area. Since the scarcest factor in Botswana was water, the control of the range was primarily through the control of the water resources. In order to graze in a certain area, farmers needed the permission of the ward head. Since everyone theoretically had equal rights to the range land, the ward head could not deny a person access to grazing land, he could only state that his range was already full and that the person would have to graze elsewhere. The farmer would then have to search for another place to graze his cattle. This system worked quite well as long as there was plenty of open space for new wards to be started.

Restrictions and improvements were sometimes made by the local chiefs. For example, the Bakgatla implemented a tax to support an extensive borehole drilling project (Schapera). On different occasions rules existed regarding castration of non-breeding stock, small stock dipping, and sale of breeding animals. While administration was usually passive, the occasional adoption of progressive techniques shows the extent to which collective management was practiced.

Several factors began to put pressure on this system in the twentieth century (Arntzen). a) Population pressures meant that ever more marginal lands needed to be grazed. b) The adoption of borehole drilling techniques gave access to existing groundwater, but contributed to overgrazing. Since boreholes drilled by private individuals or groups were generally

considered private, this made it difficult for the ward heads to keep control of the various ranges. c) The developing cash economy meant that there was a need to increase off-take to pay school fees and hut taxes and to purchase consumer goods on a local level. On a national level, beef exports were the primary source of foreign exchange. d) There was a perception that grazing allocations by chiefs were arbitrary and thus contributed to inequality among the people. e) It was believed that for production to increase "modern" animal husbandry practices needed to be adopted such as range fencing and introduction of better genetic stock. f) In order to adopt modern techniques, access to capital was needed, and banks were unwilling to grant loans without proper collateral. g) Inefficiencies were believed to be inherent in the system of common ownership of rangeland. These factors contributed to the formulation of the Tribal Grazing Land Programme (TGLP) shortly after independence.

The Tragedy of the Commons

The tragedy of the commons refers to the tendency of individuals to overexploit a common property resource. A CPR is a public good which is rival but is nonexcludable. If we think of the CPR as a grazing range, it is rival because if my cattle eat the grass, it is not available for your cattle. However, it is nonexcludable since I cannot deny your cattle access to the grass, as we both have the same rights to the resource. It is important to note here the interaction between public and private goods. The range is held communally, but the cattle are owned privately. In addition, although the range is nonexcludable to members who share in the common ownership, it may very well be excludable to others outside the group. Nonexcludability (open access) is clearly the main problem since if one can completely exclude other appropriators, then the difference between common property and private property is simply a question of group size.

In deciding the number of cattle to graze on the range, each individual will need to consider both the costs and benefits of grazing additional head of livestock. Here the individual will equate marginal cost with marginal benefit. The problem is that the individual does not bear the full marginal cost since the cost (in terms of range degradation) is born by all the members of the group. Thus each individual equates marginal benefits to average cost, causing the resource to be overexploited. This is the usual model of the tragedy of the commons.

Another simple model of the CPR problem is the well known prisoner's dilemma game. Here each player has a dominant strategy to defect, i.e. overgraze, which leads to a suboptimal Nash equilibrium with resource degradation.

These two models are simple and convincing and usually were taken to imply that the CPR problem was best solved by either state or private ownership of the resource since common ownership was suboptimal. It was in this understanding that the TGLP was conceived.

The Tribal Grazing Land Programme (TGLP)

The TGLP was a large privatization program designed shortly after independence in 1966 but not promulgated until 1975 (Arntzen and Lawry). The TGLP was funded by the World Bank and offered prospective ranchers 50 year leases with 50 year options on ranches 8 km square at very cheap rental rates with a 3 year grace period. The policy was designed with the stated objectives: a) To decrease overgrazing by moving stock from the communal grazing areas onto the new ranches. b) To give incentives to develop ranches along modern, commercial lines, c) To promote equality of incomes. None of these objectives has been effectively met (Morton and Arntzen).

The TGLP was based on several faulty assumptions. Most importantly was the assumption that Botswana had large unoccupied spaces which could be converted to ranches.

When some land was surveyed and the new owners went to take possession, it was found that there were already people living in these areas. These people then needed to be compensated and they moved with their stock into the communal grazing areas, producing a net migration toward the communal areas. Since the TGLP did not require that ranchers remove their stock from the communal areas, many simply overgrazed their ranches and then returned their livestock to the communal areas. Improvements to the new ranches were not required, so many ranchers never intended to fence or build firebreaks or adopt Western ranching techniques. In addition, much confusion was created about who actually controlled the land, the government or the tribal authorities, and a whole new bureaucracy was created to replace the tribal authorities with a deeded land registry system. The newly created Land Boards encountered numerous difficulties such as no uniform record keeping system, self-allocations and old allocations, and inadequate enforcement of decisions. Although many of the initial problems have since been corrected, a better understanding of the economic efficiency of common property resources could perhaps have enabled policy makers to concentrate directly on the stated objectives, instead of assuming that things would be simply meliorated by adoption of a Western system of property rights as the simple models predict.

A Closer Look at the CPR Problem

To this point we only considered a rather simplistic model of the CPR problem. In this section we will expand the model by adding more agents, uncertainty, and temporal optimization. The effects of the new models on the tragedy of he commons will then be considered.

a) The n-person Prisoner's Dilemma

It is debatable whether the prisoner's dilemma or assurance game is a better model of

the CPR problem (see Runge 1981). The prisoner's dilemma would seem to be a more suitable model since there are always individual gains to be had by defecting. However, a greater understanding can be gained when the prisoner's dilemma is extended to *n* people (Runge 1985).

Figure 1 shows the payoff for defecting (D) and cooperating (C) to the nth person given that x people are cooperating. The payoffs are normalized such that there are zero payoffs when everyone defects. Since the defect payoffs (D) are everywhere higher than cooperate (C), defecting will be a dominant strategy and the Nash solution will have zero payoffs. When everyone cooperates, there will be positive payoffs to everyone because of the Nash suboptimality of the prisoner's dilemma. Thus there must be some point *k* beyond which payoffs become positive. Therefore *k* people is the size of the minimum coalition that could positively benefit all its members. Note that there is still a strong incentive to free ride and benefits are greater to those outside the coalition than to those in the coalition, but the coalition is still a Paretian improvement. Coalition formation may be enhanced if the agents are heterogenous, and some type of leader-follower strategy is followed. If the C and D lines cross, the game can be transformed into an assurance game, however the prisoner's dilemma seems the better model, as shown in the study of the Mexican *ejidos* where free riders tended to exist in spite of the existence of strong, Pareto improving coalitions (Wilson and Thompson).

b) Non-Nash Hybrid Behavior

Another weakness of the two simple models is their reliance on Nash type behavior where each person takes the actions of the others individuals as exogenously given. This assumption may be valid in a single period setting, but does not accurately reflect most CPR settings where the actions of one agent may well depend on expectations about the actions of the other agents.

This would be especially true in a communal setting where agents know each other and reputations are important. Comes and Sandier (1983) showed that by optimizing over these expectations, a positive expected response to the exploiter's increased activity, caused a lessening of the tragedy of the commons. In other words, if each agent expected that when he grazed more cattle, each of his neighbors would also graze more cattle, there would be less range exploitation by each agent.

c) Harvest Uncertainty I

In a recent work, Sandier and Sterbenz have applied harvest uncertainty to the commons model. Their basic model of stock uncertainty is:

$$C=Z(R)X_0v$$

where C is total production, X_o is the average amount of resource available, *Z(R)* is an increasing concave function between zero and one of *R* the expended effort, and *v* is a random variable greater than or equal to zero with a mean of one. For our purposes, *R* will be the total number of cattle and X_o is the amount of biomass available in the range. In this context the restriction *0<Z(R)<1,* which was originally used as a constraint to limit total catch to no greater than the total stock, is meaningless. Here *Z(R)* is the production function for beef per unit of biomass. *Z(R)* still will be bounded but not necessarily by one. Fortunately, this does not change any of the derived results. By maximizing expected utility, Sandier an Sterbenz were then able to show that for a fixed number of risk-averse firms, uncertainty with respect to the initial stock level of the CPR reduces the tendency toward overexploitation of the resource.

d) Harvest Uncertainty II

Another situation involves harvest uncertainty, but this time the CPR is not uniform. Think

of rainfall as the random factor and a rangeland either as a CPR or as *n* heterogenous privately owned ranches. Intuitively, it is obvious that if rainfall is uneven, each rancher will be better off if he can move his cattle to find the best grass rather than to be constrained to stay on his own ranch. This holds even if rainfall on the various ranches is positively correlated, but is especially obvious if the correlation is negative. This result has not been clearly proved in the literature, and may be one area for further study.

Wilson and Thompson use variability of rainfall to represent this uncertainty. They divide the commons into two regions, *i* and *j*. Total variability is given by:

$$\sigma^2_T=\sigma^2_i+\sigma^2_j+2\rho_{ij}\sigma_i\sigma_j$$

They then conclude that total variability, σ^2_T, can be reduced over the entire commons when the correlation coefficient, ρ_{ij}, between the two individual grazing areas is negative. This seems to be a rather strained conclusion at best. From the above intuitive argument there is no reason to assert that the correlation need be negative. Furthermore, the total variation will still be greater than the individual variations since they are taking the sum of the two variations. They then present a formula for the total variability when there are *n* regions under the additional assumptions that the variances are equal in each region and the ρ is the arithmetic mean of all ρ_{ij}'s:

$$\sigma^2_T=(\sigma^2/n)\,[1+(n-1)\,\rho]$$

Since this equation gives a total variation different from the above variation in the special case of $n=2$ it would be rather naive to accept the conclusions which they draw from these models. In general, while the intuitive argument seems logical, the formalization as presented by Wilson and Thompson does not seem acceptable.

e) Dynamic Extension and the Discount Rate

In dealing with a common pool resource such as range land, it is important to remember that the range is a renewable resource and therefore the dynamic aspect of the resource must be considered. With the grazing problem, we are actually dealing with two renewable resources, one privately owned (cattle) and one publicly owned (the pasture). We will concentrate on the commonly held rangeland. Let S_t denote the stand of grass (biomass) at time *t* and *g(S)* the growth function of the useable biomass. If we assume that at high levels of utilization, overgrazing occurs and S_t=0 then *g(S)=O.* At low levels of utilization, the range is overrun by unusable weeds and although the biomass is high, the useable grass is low. Thus, we have the concave curve *OS** shown in Figure 2. Clearly, the optimal stand is at S^M with offtake of Y^M. However, this is not the solution when the future stream of benefits is discounted (see Carlson et al). The steady state solution is at the point S* where:

$$g_s(S^*) = r$$

and *r* equals the discount rate. Since *r* is positive, the steady state point C in Fig. 2 must be to the left of A where the slope of *g(S)* is positive. Assuming concavity, we see that the greater the discount rate, the farther the steady state point C will be from the optimal point A. If the discount rate is high enough, it could mean that the steady state solution implies exhaustion of the resource. Thus, the degree of exploitation of the renewable resource depends directly on the discount rate. Note that the above analysis is perfectly general and applies to private property as well as common property. Thus there is no indication that individual property owners would better conserve a renewable resource than would communal owners. In fact the opposite may well be the case.

A social discount rate is a difficult concept (Sen and Daly). In the sense of the above

model, it is the rate at which future benefits are discounted. Thus if one cares little about future generations, one would discount them heavily and exploit the resource more. While the discount rate is not the same as an interest rate, (Bromley) the latter is often used as a proxy for the former. An interest rate is the opportunity cost of investment, whereas the discount rate represents a rate of time preference for future benefits. The interest rate is determined by governmental monetary and fiscal policy as well as the savings and investment rates. The social discount rate, however, depends upon such factors as the length of time over which the benefits are considered and individual preferences. Thus one would expect to find greater variability in the interest rate than in the social discount rate. Since the planning horizons of a community are typically longer than the planning horizons of individuals, a convincing argument could be made that the social discount rates of communities are lower than discount rates for individuals. Also one could argue that individuals will tend to base decisions on resource use on the interest rate rather than the social discount rate (i.e. equate their discount rate with the interest rate) since the monetary trade-off is more apparent to individuals than to the community. However, these are largely empirical questions.

In reexamining the CPR problem we have seen that by extending the prisoner's dilemma to *n* people, rational individuals could form coalitions which could lead to a Pareto improvement. We have also seen that harvest uncertainty and non-Nash hybrid behavior can ameliorate the tragedy of the commons. Finally, when the commons is not homogenous or varying social discount rates are considered, it is seen that common ownership can be superior to private ownership.

Policy Implications for Botswana

Given the more careful analysis of the CPR problem, it is not surprising that the TGLP has

failed to meet its admirable objectives. The problem of overgrazing is seen to depend more heavily on the discount rate and lack of control of the resource, than on the property rights structure. Since communal ownership of resources has been practiced by the Batswana for centuries, it should be assumed that it is in some sense superior to private ownership in this setting (possibly for reasons of social equality), and should not be simply abandoned. Emphasis could be shifted from converting property rights structures to finding ways to better control grazing on the commons. In this respect, there is great scope for increased cooperation between the government, with its administrative and record keeping skills, and the tribal authorities, with their communication abilities and long term interest in preserving the resource. It would be quite useful for all livestock in communal areas to be branded and registered so that ward heads can keep track of precisely how many animals are grazing in their individual region. Also existing allocations should be recorded so that records can be kept on the fairness of individual ward allocations.

The problem of actually limiting the number of livestock that can be grazed on the commons is historically more difficult in Botswana. One possible solution would be a system of tradeable grazing quotas. First, the above mentioned records should be kept so that the extent and primary locations of overgrazing can be discovered. In areas which are experiencing overgrazing, the total number of head that can be safely grazed on the range should be determined and then tradeable grazing coupons issued according to some method deemed fair.

The credit problem is probably better solved by better recognition of existing assets, than by changing the property rights structure. By documenting the livestock owned by each grazier, the livestock could be used for loan collateral, possibly guaranteed by the tribe, if necessary. This would more directly address the problem.

Proposed Experiment

In total, this paper has raised many more questions than it has answered. In particular, it has raised questions regarding the social discount rate and income equality which are difficult to address using standard economic theory. For this reason a simple experiment is recommended.

While there have been several simulation experiments involving CPR's, (often as a didactic tool; see Kirts) this route seems quite promising for further research. In a recent article, Walker and Gardner examined probabilistic destruction of a CPR. Their experiment involved a simple concave quadratic production function similar to that shown in Figure 2. The agents were then allowed to invest in either the CPR or a safe investment which yielded a lower return than the optimal return on the CPR. Probabilistic destruction of the resource was added in two ways. In Design I there was the case where every token invested in the CPR increased the probability of destruction of the CPR. Design II had a "safe" zone which allowed a certain level of investment with zero probability of destruction. The play was for twenty periods.

The Pareto paths and subgame perfect equilibria were calculated and the results were compared to these baselines. The results were quite striking in the rapid destruction of the resource. In Design I no group lasted for more than 6 periods, and in Design II five of the seven groups destroyed the resource before the seventh period. The authors then conclude that there is "hardly cause for optimism with regard to CPR survival in environments where no institutions exist to foster cooperative behaviour."

The results here seem rather strange in that the game did not follow the computed subgame perfect equilibrium. We must assume that agents were either not rational, they were following some other Nash path, or they simply did not understand the subtlety of the game. It would have been interesting to see the same experiment run where there was only one agent

involved, i.e. analogous to the private property situation. If the agent then did not approximate the Pareto path, we could assume that the agent did not properly understand the game or that the game was simply too complex for economics undergraduates. Also it would have been useful to see the game repeated as a commons problem but with zero probability of destruction. This would serve as an experimental control and would have been the proper baseline with which to compare the observed results. (I suspect that even here the commons would have been seriously overexploited.)

Other variations of this experiment could be used to compute a social discount rate for both individual and common ownership and to compare the social discount rate with the interest rate, i.e. the rate of return on alternative investments (see Mannix for such an experiment). Other designs could be used to test whether common ownership promoted equality or inequality. There is also no reason to assume that economics undergraduates somehow represent a societal norm. It would be interesting to run the experiments among different age, sex and ethnic groups, to see if there are significant differences. I think that it would be especially interesting to compare the results of modern American farmers to Amish farmers or Batswana graziers or some other group with a strong sense of community. In short, there are many directions that this experiment could be extended, but a thorough understanding of the baseline (control) cases is necessary before any concrete conclusions can be drawn.

Conclusions

In this paper, I have examined the common grazing land in Botswana and the Tribal Grazing Land Programme (TGLP) in an historical sense and in the light of recent advances in the theory of common property resources. As has been emphasized, harvest uncertainty, hybrid non-Nash behavior, a heterogenous resource, and a lower communal discount rate all tend to

ameliorate the tragedy of the commons. Thus it is impossible to state at this point whether common property or private property regimes are inherently more efficient. Policy recommendations were then made based on the assumption that policy objectives should be addressed directly, as there is little hope of reaching diverse policy objectives through a change in the property rights regime alone. Since many questions regarding the social discount rate, income distribution, and agent heterogeneity have not been addressed by economic theory, an experimental framework is outlined which could possibly shed light on some of these remaining questions.

Figure 1

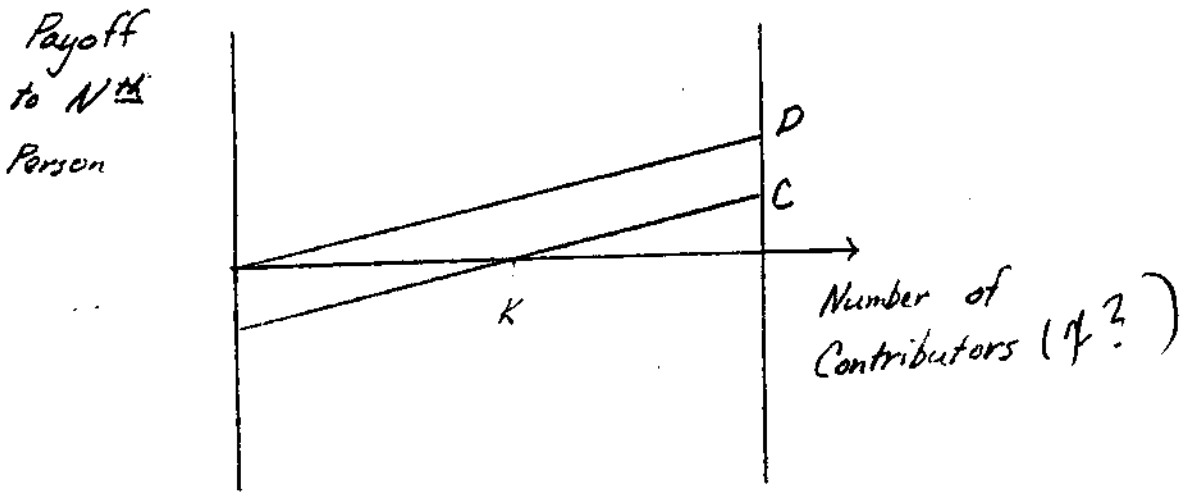
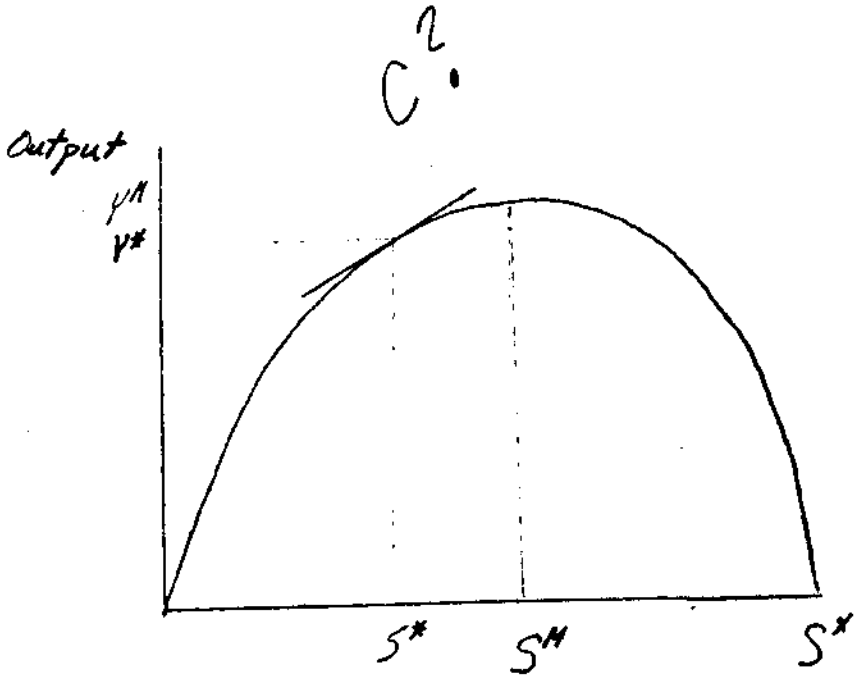


Figure 2



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