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ECONOMIC AND ECOLOGICAL CARRYING CAPACITY IMPLICATIONS FOR LIVESTOCK DEVELOPMENT IN THE DRYLAND COMMUNAL AREAS OF ZIMBABWE

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ECONOMIC AND ECOLOGICAL CARRYING CAPACITY: IMPLICATIONS FOR LIVESTOCK DEVELOPMENT IN THE DRYLAND COMMUNAL AREAS OF ZIMBABWE

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Introduction

Carrying capacity (CC) is a term often talked about in relation to livestock in the communal areas (CAs). It is the source of much confusion. This discussion paper will hopefully clarify some of the issues and make the implications for the policy debate clearer. It is based on the preliminary findings of field work carried out in Zvisharane District during 1986 and 1987.

The contradictions of policy

The inherent contradictions of thinking on CC are becoming increasingly apparent with the revival of the grazing schemes policy which is being vigorously pursued in the dryland CAs by government and donors.

My research on the ecology and economics of CA livestock is centred on a case study in Mazvihwa CA, Zvishavane District. Here, Agritex is planning a grazing scheme in one of the wards. The early planning documents for a subsection of the ward give the following data.

Area of scheme 4560 ha
Number of households 350
Number LSU 1753
Acceptable stocking rate (CC) 1 LSU: 9 ha

What are the implications of this? The data shows that the current stocking rate is 1 LSU: 2.6 ha with 5 LSU per household. When the data was collected, livestock populations were still recovering from the devastating effects of the early 1980s drought. In general in southern Zimbabwe, many households are recognised to be suffering severe draught shortages. This necessarily impairs agricultural production - the primary source of livelihood for CA residents.

However, the grazing scheme plan proposes an 'acceptable' stocking rate equivalent to 0.69 LSU per household. In other words, the choice of one cow or one donkey or three and a half goats for each home. This would clearly not be economically sustainable. Talk of reducing stocking rates to 'acceptable' levels is not new in Zimbabwe. Concern has been expressed about perceived overstocking for a long time (eg Martin Watt, 1913). Native Commissioners and government technical officers continually referred to the disastrous consequences that were imminent if carrying capacity levels were not attained and regularly bemoaned the 'low productivity' of African stock. A few examples drawn from archival records of my research area give a picture of early perceptions.

> Many cattle in the Lundi Reserve are so starved as to be unsaleable ... this state may be attributable to lack of pasturage in this poor and overstocked reserve (ANC, Belingwe, Annual Report, 1925)

> Overstocking ... and a host of other causes have all accelerated the destruction of our natural resources (ANC Shabani, 1945)

> (The grazing areas) have by continuous heavy grazing every growing season, year after year been pushed to a point from which, if relief is not afforded very soon, deterioration will become increasingly rapid (Dr O West, Pasture Officer's report after a visit to Belingwe Reserve, 1948).

Early attempts at government interventions in livestock development in African areas were concentrated during the 1920s and 30s on breed improvement. This gave way to the destocking policy of the following two decades where government tried to intervene directly and reduce stock to 'acceptable levels'. This was initially under the auspices of the Natural Resources Act (1942) and later under the Native Land Husbandry Act (1951). By the 1960s compulsory destocking had been abandoned largely due to political opposition, in favour of stock control in the context of rotational grazing schemes.

The experience of attempts to control stocking rates to fixed and carrying capacity levels is most relevant here. Two issues make a recurrent appearance in reports and recollections of the time. Firstly, there were doubts about the validity of the CC assessments.

The NC for Gutu in his 1944 report comments:

> So much has been said about overstocking in this district after the most cursory examination by folk deemed to have expert knowledge.

In a similar vein, the LDO for Gwanda comments in a letter to the NC in 1948:

> The development caused by hasty decisions made after hurried tours where little or nothing of the particular area is known might be disastrous ...

He goes on to warn against rushing into destocking, grazing management schemes, and a proposed programme of bush clearing. People in my study area recall the destocking in Mazvihwa. One old man remembers how

> There was plenty of grass for the cattle. They just came to brand our cattle and make us poor.

This memory is typical of many that both question the technical arguments behind the destocking policy and regarded it as an assault on their livelihoods. This latter impression is the second recurrent issue in discussion of destocking. The NC of Belingwe comments in a letter to the PNC Gwelo in 1947:

> One wonders if we are not doing the native cattle industry untold harm by cutting down his holdings to an uneconomic figure.

This was an early realisation of the impossibility of pursuing a supposedly environmentally sound policy that undermined the economic livelihoods of the people it was directed at.

Current policy is essentially similar to those being pursued since the 1940s. The First Five Year Development Plan (1986-1990) states:

> The most important aspect of livestock production which is occupying the mind of government is the accelerating and continuous deleterious effects of overstocking and overgrazing in the communal lands which are causing severe and potentially irreversible ecological degradation ... A comprehensive national programme that focuses on these issues will be implemented ... Such a programme will include stock control, better land management and destocking where necessary. (p27)

The Zimbabwe National Conservation Strategy (Zimbabwe, 1987) reemphasises the policy line:

> In many cases this may require that animal numbers are restricted to a stocking rate that does not suppress the perennial grasses in well managed areas and allows the grass cover to recover in degraded areas. (p25)

If current policy is to be successful, then a number of contradictions experienced by earlier policy makers must be faced up to. The most fundamental question is: how can the economic sustainability of livestock production be assured while maintaining ecological sustainability? To answer this we need to ask what are the determinants of economic and ecological sustainability in CA livestock production? What do we mean by 'CC', and what are the appropriate ways of assessing it? What aspects of the CA production system and CA environment can be developed to enhance sustainability? These questions will be the central themes of the following discussions.

<u>The productivity of CA livestock, or what is the economic CC?</u>

A useful distinction is that between economic and ecological CC (Caughley, 1983). Ecological CC refers to the maximum number of animals the land can hold without being subject to density dependent mortality and permanent environmental degradation. Ecological CC is determined by environmental factors. Economic CC is the stocking rate that offers maximum economic returns and is determined by the economic objectives of the producers, ie by their definition of ’productivity’. The distinction can be illustrated graphically (Figure 1).

How productivity is measured is a critical issue as this will determine the assessment of economic CC. There are a number of ways that the productivity of livestock systems can be measured. These can be recorded in terms of production per individual animal or per unit area (Behnke, 1985).

Figure 1

i) Biological measures for beef production

A beef producer's economic objective is to maximise the output of marketable meat. Productivity can be assessed in terms of a number of biological parameters that can be combined into a productivity index. Estimates are generally based on the weight of beef produced per cow per year calculated according to calving percentage, viability and pre/post weaning growth. There is a trade-off between productivity per animal and per unit land (Jones and Sandland, 1974) and the economic CC is at an intermediate stocking rate determined by the maximum economic returns per unit area.

ii) Energetic or protein value measures

If the livestock enterprise is concerned with both the output of meat and milk, then a measure which combines the values of these products is required. Energy measures have been used to assess the productivity of pastoral systems in East Africa (Coughenar et al, 1985) and protein output has been used as a way of comparing the productivity of different livestock systems in Botswana (de Ridder and Wagenaar, 1986).

iii) Economic measures

Where there are multiple economic uses of cattle then a monetary common currency can be used. In the case of subsistence production assigning monetary value to outputs is problematic, but a broad indication of productivity can be arrived at by providing replacement costs for those outputs not sold on the marked (Behnke, 1985).

Assessment of CC used in Zimbabwe use beef production parameters to estimate the stocking rate with maximum productivity (Kennan, 1969). Rangeland indicators of this stocking rate are then used to assess CC (Ivy, 1969). This CC level is the economic CC for beef production which may have little relevance to CA systems.

The latter economic measure is most applicable to CA cattle production, since the value of cattle is determined by a range of outputs including use for draught, transport, manure and milk production. They are also valued as capital assets and a relatively stable investment.

A preliminary assessment of the productivity of CA cattle can be made using the replacement cost method. This is based on a partial analysis of data derived from a year long case study of 70 households in Mazvihwa CA (Table 1).

The data highlights the high economic value of CA cattle. On the basis of these, admittedly rather rough, calculations their 'productivity' appears to be higher than that of commercial beef cattle that realise around $10/beast/year in the same district. The comparatively higher returns realised by CA cattle will be even larger when productivity/unit area is considered.

The influence of the draught function on CA cattle production is such that the economic CC will in turn be determined by a complex trade-off between the economic advantages of more draught/work animals and the effect of stocking rate on work ability, milk output, calf production and the probability of death through poverty as stocking rate rises. The economic CC will therefore tend towards the ecological CC limit (see Figure 1). It will be advantageous to increase stocking rates to satisfy the demand for draught, as shortages are currently due to the absolute lack of animals and not so much because of distributional factors, which are evened out by sharing and loaning practices.

High stocking rates in the CAs make economic sense. They are not the result of irrational behaviour, poor management or backward attitudes. CA livestock keepers are not beef producers; it simply does not make sense to stock at economic CC levels designed for beef production. The question to ask now is whether CA farmers' economic strategy is ecologically sustainable.

Table 1

Ecological sustainability: limits to livestock numbers in CAs

How is CC assessed in CAs? It is instructive to look at recommended procedures and the technical basis for estimating CC and ask whether these methods are appropriate to CA grazing lands.

The earliest assessments of CC carried out in Zimbabwe were based simply on assigning the area to one of 3 rainfall zones and the CC was given as 10 acres/beast for high rainfall, 13 1/3 acres/beast for medium rainfall
and 16 2/3 acres/beast for low rainfall (Report of the Secretary for Native Affairs, 1947). This was established in a government notice of 1944 and emanated from the investigations of the Committee of Enquiry into the natural resources situation in 1942 (NRB, 1942), policy from South Africa, and early work at the Matopos Research Station (Pole-Evans, 1932; Hayle, H, 1932). The grazing area was calculated simply on the basis of the total area of the reserve less wasteland.

By the time of the grazing assessments for the Native Land Husbandry Act, the rules for assessing the area of available grazing land had become more elaborate, being calculated as 5/6 of the total useable land which assumed that arable areas would be used for two months of the year. A further 7% would then be deducted to account for young stock not estimated in LSU calculations of stock numbers (Director of Native Agriculture 51/53). The actual assessment of CC was still based on guesswork and experience of common ranching. Pasture assessment officers were sent out on tours when they made qualitative assessment of grazing condition and CC for different zones of each reserve. The visits were extremely cursory; for instance, Dr West visited Belingwe reserve with a total area of 375,000 ha for a total of 6 days in the late dry season of 1948 to make his assessment. The pasture reports were then presented to the assessment committee for that area who would make the final decision on the stocking rate to be aimed for.

More recently attempts have been made to make grazing condition and CC assessments more rigorous. CC levels for different veld types have been indicated by the Matopos stocking rate trials (eg Kennan, 1969; Denny and Barnes, 1977) and in ICA investigations. These have investigated the relationship between average weight gain per head and per acre at different stocking rates. The CC of a particular area is estimated by veld condition scoring (Ivy, 1969). Species composition, basae cover/density, vigour and forage production, litter and plant residues, and soil compaction and erosion are assessed and scores given out of a total of 50. The vegetation assessment is derived from the argument that a ’climax vegetation’ is that which provides the best economic returns in beef production. ’Decreasers’ are to be encouraged, while ’increasers’ and ’invaders’ are indicators of poor condition (Rattray, 1960). The condition % gives the assessor the recommended CC as a percentage of the potential as determined by stocking rate trials. For region V areas, the rule of thumb appears to be 1 LSU: 10 ha, or 1:25 on degraded veld. The stocking level is then in practice determined by multiplying the assessed CC in LSU/unit area by the area of available grazing land (the practice of including an allowance for arable grazing is not part of current assessment procedures in Zvishavane at least). As an Agritex training resource puts its:

> It has been a question of trial and error by experienced people which have given us our guidelines, using sensible estimates based on the good farmers in a given region. From this figure, a somewhat arbitrary reduction is made from the potential grazing capacity to give a figure for current grazing capacity (Anon/Agritex. Undated)

Vorster’s comment made in 1960 is equally relevant today. He notes:

> There seems to be no definite information available on the extent to which the pastures may be stocked without causing erosion, and the stocking rates recommended for the reserves appear to be based on lower levels of veld utilisation rather than on maximum carrying capacity. (Vorster, 1960)

Despite the increased complexity of assessment procedures, the underlying assumption is still that stocking rate trials measuring productivity with beef production parameters or experience of well run commercial ranches and the associated range indicators used are appropriate to CA situations. This can be questioned.

In beef ranching systems, economic objectives are different and the economic CC is at a low stocking rate, where a 'climax' herbaceous vegetation with low bush/tree cover may be optimal for the production system. This is not necessarily so in the CAs where higher stocking rates are economically desirable. A few examples will serve to illustrate this:

i) The replacement of perennials by annuals is regarded in conventional range management as a bad thing. However, this may represent a shift in response to changing rainfall rather than an indicator of range trend (cf Dye and Spear, 1983). The presence of annuals may be advantageous in systems where protein deficiencies are a major constraint and where rapid responses to occasional rainfall sustains production (cf Penning de Vries et al, 1983).

ii) 'Bush encroachment' is another indicator of poor range condition, but in most instances increased woody plants in dryland grazing areas are a definite advantage. Not only is browse crucial forage for all stock in the resource crunch periods of the dry season, but also some trees encourage valuable grass species such as <u>Panicum maximum</u> (Kennard and Walker, 1973).

What are needed are indicators that reflect ecological CC and do not translate the objectives of a particular production system into a picture of what the environment should look like in all situations. By confounding economic and ecological CC, existing assessment procedures may end up recommending stocking rates that undermine economic sustainability in CAs and do not directly address the key issue of ecological sustainability.

We need to know whether irreversible degradation caused by excessive stocking rates is occurring. With the possible exception of erosion assessments, the present veld condition measures are inadequate: it is not clear that the presence of 'sub climax' grassland or a high density woodland are indicators of permanent degradation.

A major obstacle in the way to finding out what ecological CC is for a particular area is that CC is not a fixed quantity and is not readily measurable. This is specially so in dryland areas where environmental variation creates large fluctuations both in grass production and species composition. The concept of ecological CC is mathematically described in simple logistic population models. 'K', the ecological CC, is reached when the rate of growth of the population becomes zero. Density dependent mortality then maintains the population at this level. The population, then overshoots 'K' for a period. If this coincides with drought when grass production and so 'K' are temporarily reduced, the environmental effects may be serious.

With the unoptimistic conclusions that conventional range management indicators are largely inappropriate and that CC is a complex concept that is difficult to measure, how do we assess whether CA livestock populations are exceeding ecologically sustainable levels or not?

Sandford (1982) states that there is no firm evidence for overstocking in Zimbabwe's CAs. I would agree with this, but this leaves no room for complacency. What are the avenues for research into this critical issue? There appear to be two routes of investigation concentrating on trends in primary and secondary production over time.

i) <u>Trends in primary production</u>

Monitoring of primary production in semi-arid areas needs detailed study over very long periods since trends in potential productivity, (related to the long term ecological CC of land) are masked by the 'noise' created by widely fluctuating levels of actual productivity primarily determined by rainfall. No studies of this type have been done in the CAs of Zimbabwe. The universal perception of people from Mazvihwa is that no permanent decline is occurring (except in particular patches) and that as soon as rain falls again the grassland will be restored to previous levels just as in all previous drought cycles. This perception needs testing.

ii) Trends in secondary production

Short term monitoring of cattle production also fails to reveal any trends. Although NCs in their reports often commented on the poor state of grazing, deaths from poverty and the likelihood of imminent collapse (see earlier), these are interspersed by comments that contradict any claim that there is a terminal downward trend. A time series of qualitative observations for the Belingwe district illustrate the point.

> Considerable deaths occurred from either poverty or disease, particulary in the Lundi reserve that is overstocked. (Belingwe NC, 1930)

> On the whole grazing conditions have been shocking ... (Belingwe NC, 1934)

> He (Cattle Inspector Gifford) is of the opinion that the reserve (Belingwe) is not overstocked and contained some of the finest native cattle he had yet seen (Belingwe NC 9138)

> The reserve (Lundi) is overstocked; as a consequence and aggravated by drought 1000 out of a total 1700 head died of poverty (NC Belingwe, 1942)

> Cattle continued despite the unprecedented drought in good condition (in Lundi reserve) (NC Belingwe, 1947)

These observations refer to variations in actual productivity but because of its variability they can reveal little of trends in potential productivity.

A quantitative assessment can be attempted by looking at the trend in cattle population size over time. This is plotted for Runde, Mberengwa and Chivi CAs for the period 1923-1986 (Figure 2). The data is derived from annual NC returns and veterinary department records. With some compensation for boundary alterations and acknowledgement of differences in measuring methods, the general pattern of change can be regarded as reasonably accurate.

Does the data reveal any density dependent regulation about an ecological carrying capacity level? To discover this, the data must be replotted concentrating on biological changes in numbers (ie births/immigration - deaths/emigration), removing economic (sales/purchases) influences. This can be done for the data set with a number of reasonable assumptions and further data on marketing for the period.

Figure 2

A production curve is then fitted to the data which extrapolates to a 'K'-value estimate. This analysis has yet to be attempted. Will it suggest that the plateau levels of livestock population observed represent a density dependent regulated level? If so, is this higher than the recommended CC for the area?

Whatever the results are, the conclusions will only be suggestive; an indication of the possible limits of ecological sustainability. Although at present we do not know where this lies, there are some indications that it is higher than present assessment techniques suggest. In particular, it needs to be asked: how have so many livestock survived in the CAs for so long at levels well above 'acceptable CC'?

The determinants of ecological CC: how do cattle survive in the CAs when they should not?

In semi-arid systems animals survive by adaptive use of spatially and temporally heterogeneous resources. This is well documented for wildlife (eg McNaughton, 1985; Sinclair and Norton-Griffiths, 1979) and for nomadic pastoralists' herds (eg Dyson-Hudson, 1984). It is equally true for cattle in Zimbabwe's dryland CAs. A recognition of this brings us some way towards an understanding of what actually determines ecological CC. It also suggests appropriate directions for the development of livestock and grazing management in these areas. Two issues are particularly pertinent: the significance of drought induced movement of stock and the role of 'key resources' in sustaining livestock.

Drought movements of cattle

Movement in response to spatially variable forage production is a regular phenomenon in CAs. The movements observed in 1987 in Mazvihwa CA, as well as those reported for the 1981-4 drought from the Mototi Ward study area are shown in Figure 3.

Figure 3

The 1987 season has resulted in localised shortages of forage in Mazvihwa. In April this was so for the cattle of Indava Ward; by August the cattle of Mototi Ward were beginning to be moved. During 1982/83, the lack of forage was more widespread. Cattle from Mototi Ward were moved into the hilly areas of Murowa and Mtambi Wards, before being moved on a large scale to areas of Chivi and especially to Mapanzure area, Runde CA via Zvishavane town. Some cattle moved as far as Shurugwe and Gwera to farms 150 km or more away from their home areas.

Movements have tended to be from areas of eutrophic, drought susceptible savanna (Mototi or Indava Wards) to areas of more stable production: the dystrophic zones of Murowa Ward, Chivi and Runde CAs. This macro level patterning of resources is important in understanding the dynamics of cattle populations in southern Zimbabwe's CAs.

The loaning system (Kuronzera) is central to the redistribution of grazing pressure in CAs. Cattle may be loaned on a temporary basis for the duration of the local crisis to relatives or friends or on a more long term arrangement which helps in reducing grazing pressure for the herd still resident at the owner's home. Large herd owners rarely keep more than 10 - 15 cattle in their home kraal but prefer to loan out to a number of 'miraga' sites. This not only lowers the risk of local overgrazing but reduces herding and management requirements at the same time as assisting stockless relatives.

In the case of the 1982/83 crisis the situation was too extreme for local redistribution and the loaning system to cope. Many people adopted a transhumant existence for the duration of the movement, often living with their cattle in distant grazing areas or on commercial farms. Large scale movements of the type experienced in 1982/83 have been rare in the relatively recently settled area of Mototi Ward, Mizvihwa, although a similar exodus is remembered for the 1965 drought. In the nearby areas of central Chivi, people recall movements from the eutrophic plains areas into the hilly zones with their plentiful vleis in the droughts of 1947, 1965, 1973 and 1982. In the low veld CAs where grass production is even more variable and nearby dystrophic zone refuges are absent, NCs report having to make frequent arrangements for large scale migrations of cattle. For instance, the NC for Gwanda reports between 1925 and 1948 the necessity of moving thousands of cattle in 1938, 1941, 1942 and 1947.

Although many stock died in the 1981/4 drought, the toll was certainly reduced through the strategy of timely movement (see Table 2). Similarly, the local movements of 1987 seem to have offset any serious level of mortality so far.

These observations have a number of important implications for policy. CA farmers prefer to follow an opportunistic stocking strategy: stocking at a high rate to ensure economic sustainability and by engaging in local destocking through movement when drought causes a collapse in available primary production. People prefer the tactic of movement to destocking through sales and later repurchasing animals because the low prices gained at the onset of drought do not, in their experience, allow repurchase at the end. In addition, a sales decision cannot be quickly reversed, whereas cattle can always be recalled to plough and graze locally if rains unexpectedly fall. Movements can therefore track the environment more effectively than adjustments through the marketing system.

Sandford (1982) has compared two extreme types of stocking strategy. At one extreme is an opportunistic strategy that perfectly tracks environmental fluctuations adjusting stock levels to actual productivity. At the other is a conservative strategy that aims to keep stocking rates at a stable level in line with actual production in deficit years. In more variable environments, the costs of underutilisation under the conservative strategy rise and an opportunistic strategy is increasingly favourable.

A conservative strategy is usually recommended: it may be ’safe’, but the lower stocking rate it entails may undermine the economic sustainability of a CA system. On the other hand, a perfect opportunist strategy is infeasible, exact environmental tracking is not possible so some costs of temporary overstocking will be incurred. These trade-offs need to be closely examined. It seems that for CAs, drought planning should aim at encouraging opportunistic responses with contingencies being made for movements of cattle. Restrictions on such flexible and

Table 2

locally specific responses imposed by fenced grazing schemes or veterinary controls should be carefully examined in this context lest they reduce the sustainability of the system.

Key resources

The use of the local grazing resource is equally patchy and adaptive. Much of CA cattle's feeding time, especially in the critical end of dry season period, is spent in small areas (perhaps 5% of the total grazing area); the rest of the grazing area is simply unused for most of the year. These small areas I shall call key resources. A key resource is a patch that offsets critical constraints either of forage quality (especially in dystrophic zones) or quantity (especially in eutrophic zones). This has an important seasonal dimension that suggests that key resources - vleis, river banks and drainage lines - are critical in determining ecological CC.

A seasonal calendar for the utilisation of components of the dryland grazing resource is presented in Figure 4. This has been described by farmers from a number of areas and is being further investigated by a detailed study of cattle foraging behaviour in Mazvihwa CA. It illustrates a patchy and temporally specific use of resources. The existing system is a form of rotational grazing influenced by the sequential availability of different resources, the reservation of the arable land grazing of the farming season and regulation through directed herding or foraging preferences.

Ecological CC is basically determined by the availability of fodder at the close of the dry season particularly in rainfall deficit years: browse and key resources are the components that are critical. It is the availability of these resources and the facility of flexible utilisation that has sustained high livestock populations in the CAs for a long period.

If the CC is to be increased these are the components that should be focussed on, as they directly determine CC levels. They are the most valuable components of the grazing system and should be where conservation efforts are first concentrated. Improvements in the extensive grazing land, although beneficial, will have a less direct effect on CC, and because they represent a far larger area, any attempts at intervention will be financially and operationally more difficult than a focussed approach.

With draught provision being a primary objective for CA livestock development, key resources that provide end of dry season fodder are vital. More selective use of key resources opens up the possibilities of their use for selective feeding (eg draught animals/milking cows), reserved dry season grazing and their development as fodder banks.

The design of grazing schemes

As already noted, CA systems are different in a number of important respects to commercial beef ranching. Each of these differences derives from the influence of alternative economic objectives on attitudes to stocking rates. Therefore, interventions applicable to commercial systems do not necessarily transfer to the CA situation. In low stocking rate commercial systems, forage consumption rarely exceeds actual primary production in non-key resource areas. Therefore, livestock can use the grazing resource in a relatively spatially uniform manner; key resources are not so critical. Paddocking systems that divide up the land with paddocks of comparable size are an effective way of managing the grazing land and the herd. This is in contrast to high stocking rate systems of CAs where actual production in non-key resource areas is rarely sufficient for dry season requirements. A much more sensitive design of grazing management is required that allows flexible and adaptive use. Many of the grazing schemes currently being designed for the CAs do not fulfill these requirements. Paddock design rarely acknowledges the patchiness of available resources under high stocking rates. Applying a more or less uniform grid of paddocks to a highly heterogeneous environment, made more so by high levels of use, will mean that grazing schemes become quickly unsustainable. Farmers widely recognise this problem, but presently planners do not.

Figs 4 and 5

One farmer in Mazvihwa comments:

> What is the point of putting the wire across the bare land; the cattle will just die with the coming of the paddocks.

In order to make the paddock schemes functional, destocking to commercial levels may be the only option as it is generally assumed that rotational grazing operates best at low stocking rates. This policy though, as has already been discussed, is not economically desirable.

How might appropriate grazing schemes be designed? One option is to focus on key resources. A possible strategy would be the identification of key resources for particular communities (eg VIDCO's) fencing them off and establishing a system of regulated use. Any grazing management scheme will be locally specific, dependent on the critical constraints (eg quantity vs quality of forage), the availability of forage in non-key resource areas, the browse resource and the objectives and management abilities of the local community. It is essential, therefore, that planning is locally based with farmers, with local knowledge of resources and their use, being the primary participants in design and development.
Figure 5 compares 'key resource schemes' with conventional fenced grazing schemes. It can be seen that the principle characteristics of key resource schemes are that they are in line with CA farmer objectives (high stocking rates and the provision of draught animals) and are aimed directly at improving ecological CC.

Conclusions

This discussion has tried to show how the confusion over the term CC has arisen and attempted to unravel some of the contradictions in order to shed light on current policy dilemmas. In the past, the confusion has resulted in inappropriate measures of productivity and CC being applied to the CA situation. These have resulted in environmental policies which are not in line with local economic objectives. Such policies inevitably fail.

CAs will always be high stocking rate systems because of the multipurpose nature of cattle production: having a high economic CC makes economic sense. In order to find development strategies that ensure economic and ecological sustainability in tandem, we need to look at how CA grazing systems are actually managed and concentrate on those factors that can maintain an economically viable stocking rate at ecologically sustainable levels. Two factors have been highlighted: macro level use of resource by adaptive movement, and temporally and spatially specific use of 'key resources'. These two factors ought to be the cornerstone of the design of grazing policies. Currently they are basically not considered in development attempts, since the focus is on the transfer of commercial management systems to CAs. These may not be applicable as they assume different production objectives and are based on technical criteria that are open to question.

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