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Sustainable Management of Semi-Arid Rangelands and Optimal Paddock Size--An Ecological-Economic Modelling Analysis

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Sustainable management of semi-arid rangelands and optimal paddock size-An ecological-economic modelling analysis

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Key words : semi-arid rangeland ,simulation model ,rotational grazing management ,ecological-economic modelling .

Introduction Livestock grazing is the most important form of land use in arid and semi-arid landscapes .Due to harsh climatic conditions ,rangeland management requires good ecological knowledge to maintain the pasture in a viable condition .Rangeland scientists have proposed different types of grazing management strategies in order to solve these problems .

The basis of many strategies is a rotational grazing scheme : the pasture land is divided into a large number of paddocks ,each of which is grazed for a short period ,and then is rested for a certain ,usually longer ,time .The rotational grazing scheme has proven to be a viable strategy in southern Africa .A common explanation for this observation is that rotational grazing prevents selective grazing by putting a high and uniform grazing pressure on the vegetation for a short time (e .g .Savory 1998) .To this end ,a large number of paddocks with short grazing periods has been recommended by ,e .g . ,Savory (1998) .

Materials and Methods We use a simple stochastic simulation model based on difference equations .Paddocks vegetation is represented by a perennial grass species ,described by reserve biomass (the vitality of the plant) and three age classes of green biomass ,which provide forage for the livestock .Vegetation growth rates increase with precipitation ,which underlies stochastic fluctuations due to spatiotemporal heterogeneity of the rainfall .We model selective grazing as a preference of livestock for young age classes of green biomass .As a reference case ,we also consider non-selective grazing ,where all age classes are grazed equally .

We analyze the viability of grazing management by computing the reserve biomass after grazing for a varying number of paddocks and two different extreme strategies of rotational grazing management : (i) graze each paddock until all forage is used up before moving to the next one and (ii) weekly rotation of the grazed paddock .Moreover ,we analyze economic profitability to find the optimal strategy given farm size and environmental (climatic) conditions .

Results Selective grazing reduces the reserve biomass on a farm .The intensity of this effect strongly depends on the management strategy and the number of paddocks .Under the proper strategy few paddocks suffice to prevent selective grazing .Nevertheless a large number of paddocks enhances the viability of grazing .

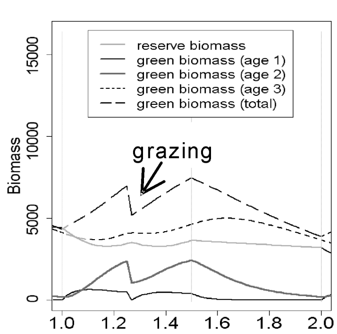

Figure 1 *The amount of biomass over one year ; one week of grazing in the middle of the growing season .*

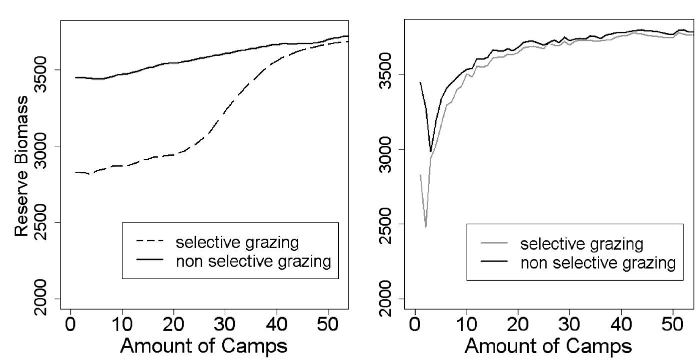

Figure 2 *The reserve biomass depending on the number of paddocks for the two differant grazing strategies [weekly rotation of the padock (left) and grazing one padock ,until all forage is used up (right)] .*

Conclusions We can show that selective grazing has a negative effect on the viability of rangeland management .A rotational grazing scheme solves this problem .In contrast to the recommendations of Savory (1998) ,we found that already a small number of paddocks are sufficient to prevent selective grazing .Yet ,more paddocks improve the growth of the reserve biomass .There is an optimal paddock size as this effect decreases in magnitude while marginal costs of maintaining a paddock are constant .

References

Savory ,Allan ,Jody Butterfield ,1998 .Holistic Management : A New Framework for Decision Making ,2nd ed . ,*Washington ,D .C . : Island Press .*