PASTURE LAND RESEARCH IN DRY AREAS OF KENYA

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The inspiration for this paper came during a flight from Nairobi to the Kitich camp in the Mathews Range that was made with family in December, 2015. What impressed and disturbed me most as we headed north over Samburu, after leaving the Laikipia plateau, was the vast area of land that was totally denuded of ground cover and suffering from severe degradation as indicated by the pattern of gullies.

Since my appointment as a Pasture Research officer by the Kenya government in 1955, I have been interested in the issues surrounding grazing land management. I only spent six years in research with the Kenya Government but had opportunity to follow up my interests while concentrating on soil and water conservation as a staff member of the Department of Agricultural Engineering of the University of Nairobi from 1971-1994.

What has disturbed me is that a vast amount of researchhas been carried out on pasture land management in dry areas with no apparent impact on the land areas over which we were flying. Several questions may be raised. Was the research misdirected? Were the results inapplicable to the situation on the ground? Was there a failure in communication between the researchers and the people on the land?Does the socio-cultural environment inhibit better management? I believe that most of the land we crossed could be classified as semi-arid rather than arid or very arid. My experience and observations relate mainly to the semi-arid or sub-humid environments where the potential for rangeland improvement is greatest.

In this paper, I write about some of the research with which I was involved and the possible relevance it might have to the situation in Samburu. I have not worked in Samburu myself but there may be some benefit in summarising what has been done elsewhere that might be relevant. The socio-economic environment is changing fast and what could not be done in the past may become possible in the future. There is a need to keep up to date with what is known and look for opportunities to reverse the tide of degradation. Maybe we can learn something from history. I apologize in advance if what I write is long-winded and dis-jointed but there is a thread that links the topics.

Before reaching Kenya in August 1955, I was assigned to visit research stations in S. Africa and Zimbabwe (formerly S. Rhodesia). The journey took about 6 months and was a substitute for a training program which was not readily available at the time. The tour was very interesting and informative. My final stop was in Tanzania at Kongwa where the British government had established a scheme to grow groundnuts in 1947. Vast areas were cleared of the indigenous trees and shrubs leaving only the Baobab trees as sentinels in what became a complete fiasco. By the time I arrived the scheme had collapsed but there was a

Polish Scientist, Dr Brzostowski, researching the role of the grass *Cenchrus ciliaris* in making the land productive for livestock. Kongwa is now a designated ranch of 38,000 ha belonging to the National Ranching Company of Tanzania[1] with the potential to support 100,000 head of cattle.

Soon after reaching Kenya, I was posted to Machakos District and from early 1956 I was involved with others in developing Katumani as a research station. It is now the National Dryland Farming Research Station. My research focussed on the evaluation of grass species, the production of fodder crops and the control of bush encroachment. I was also asked to take on the supervision of a major experiment known as the Makavete Square Mile.[2]

This experiment was designed to find out the best way of restoring cover to denuded land. The government managed to get the Wakamba land owners to vacate a square mile of land for experimental purposes. The land was then laid out as a randomised block experiment with half acre plots and 4 replications. The treatments included a) protection from grazing to allow natural recover, b) planting of Makarikari grass (*Panicum coloratum var. makarikariensis)*, c) establishment of Star grass (*Cynodon dactylon*) from splits and d) establishment of a mixture of *Cenchrus ciliaris* and *Eragrostis superba* from seed.

Restoration of ground cover was quite rapid although the plots which had simply been protected from grazing animals took about one year longer to recover. When I took over supervision, the assignment was to use cattle to graze the plots and record production as the number of grazing days for each plot and treatment. Eventually the plots were cultivated and crop yields were measured over three seasons before the land was returned to the owners.

The conclusion was that ground cover can be restored by resting but is faster if the land is cultivated and suitable grasses are established by seed or splits. The successful restoration of the land was partly due to good soil conditions. Slopes were gentle and the land had not been eroded to the subsoil as in other places. [3]

The need to restore cover to very large areas of denuded land led to many initiatives in the years that followed. One of the earliest interventions was the practice of scratch ploughing in Kitui.[4]This was carried out using an ox-drawn plough with the mouldboard removed. Seed of *Eragrostis superba* and *Cenchrus ciliaris* was used to restore cover. There is a good review of ways of restoring cover in a pamphlet by Bogdan and Pratt.[5] The topic is also addressed in Rangeland Management in East Africa by Pratt and Gwynne.[6]

Another intervention that was tried, in Kitui, was the use of shallow pits or basins known as “Matengo” pits.[7] This idea was based on observations on the use of pitting on sloping cropland in Southern Tanzania. The transfer of technology to an entirely different environment did not look very promising but the effect of breaking the hard surface and keeping rainfall in situ until it soaks into the ground, in combination with reseeding, did assist in restoring cover though the labour involved was substantial.

Ed Barrow adopted a system of semi-circular bunds at Ngingyang in northern Baringo[8]. The bunds trapped rainfall and facilitated the establishment of dense stands of *Cenchrus ciliaris*. He also developed a donkey-drawn harrow for breaking the surface crust to facilitate rainfall infiltration and grass recovery. It is worth noting that some varieties of *Cenchrus ciliaris* have short rhizomes. These can break the surface crust from underneath. Whereas most efforts to improve infiltration of rainwater rely on breaking the surface from above, the ability of rhizomatous plants to break it from below is worth further investigation.

A further point in connection with *Cenchrus ciliaris* is that it has been widely used in Australia to replace pastureland dominated by *Heteropogon contortus*. The latter is anathema to sheep on account of the awns which get caught in the wool and burrow into the animals' skins causing irritation and weight loss. There are many varieties of Cenchrus with different characteristics. One that was popular at Katumani was the Mbalambala variety that came from the place with that name near Garissa.

The use of grass seed for restoring ground cover demands some understanding of the properties of grass seeds. Some grasses, such as Rhodes grass (*Chloris gayana*) are relatively easy to establish from seed but others require care in harvesting and storing seed. In some species the rate of germination may increase for a while after harvest but decrease significantly over a period of six months or more.

Facilities for seed testing are often not available and the use of grass splits is an option where labour is available. Star grass (*Cynodon spp.)* has been widely used for revegetating denuded areas. It can do well provided the soil in relatively fertile.

I had an interesting experience some years ago while working with a consulting firm at Olkaria, the geothermal site near Naivasha. The process of developing geothermal power involves the drilling of test wells. The procedure is to clear and level an area the size of a football pitch and then bore a well in the centre. Steam and water gush out and while the reliability of the steam is tested over many months, water is washing over the bare ground causing gullies.

The Power Company was alerted to the problem and set up an environmental unit to be headed by a forester. Not surprisingly, he started by establishing tree nurseries. While assessing the situation, I observed that star grass is native to the area. I suggested that we try using star grass to cover the bare ground around one of the test wells. Splits were planted and within a few months the ground was covered with star grass – faster than I could have imagined. Clearly the volcanic ash soils were fertile and the star was well adapted.

Not long after, I was told that an engineering firm in UK, that had some involvement in the project, was suggesting that we should use Vetiver grass (*Vetiver zizaniodes*) which is slow growing, tufted and clearly unsuitable. (Vetiver had become an obsession of a certain individual in the World Bank – but that is another story.)

The possibility of restoring cover to denuded land by simply closing the area and excluding livestock has often been tried. In some areas it has been very successful as for example

when denuded land around Esageri in Baringo was closed to livestock in the 1950s. Grass cover was restored with a predominance of star grass. In other areas, restoration of ground cover may be slow or virtually non-existent. This is a function partly of the soil characteristics. It also depends on the presence or absence of vegetative remnants that can regenerate if there is still some live tissue.The characteristics of soil that lead to sealing or crusting is very important and warrants more attention. Apparently algae play a role in this.

Complete closure of land is not necessarily a good way to reverse degradation and restore grazing land. It can lead to bush encroachment as it did during the HADO Project in central Tanzania.[9]

During the colonial era, the goat was frequently blamed for the degradation of land. At Katumani I established a grazing management trial on Acacia bushland to compare grazing with cattle alone to grazing/browsing with cattle and goats together. Clearly, combining the two leads to greater utilization of the available forage and greater output from the land. It also reduces the risk of bush encroachment. However, this can only happen if there is control. Uncontrolled grazing and browsing are the way to destruction.

While at the University of Nairobi, I was involved with other staff members and some postgraduate students in efforts to measure soil and water losses from cropland and grazing land. Two approaches were used. One was the use of a rainfall simulator and the other was the use of runoff plots to collect soil and water lost during natural rainfall events.

The rainfall simulator trials on grazing land were carried out at Iiuni in Machakos. The runoff plots on grazing land were installed at Mukogodo in Laikipia. Details of these experiments are available in various publications.[101112]

The rainfall simulator trials showed that very high rates of runoff can occur on denuded grazing land where the surface is bare and sealed. In such situations, it is unlikely that ground cover can be restored without some intervention. However, in other situations, natural erosion has stripped off the upper soil horizons leaving a layer of quartz pebbles on the surface. In this situation, rainfall is trapped between the stones thereby allowing infiltration to take place. As a result there is more vegetative cover on the sloping shallow soils with a stony cover than where the soils are deeper but sealed. A topic which needs investigation is the role of animal hooves in breaking the surface seal and promoting infiltration of rainfall.

The runoff plot trials carried out by Mutunga in Mukogodo, Laikipia were instructive.[13]The experiment was designed to determine runoff and soil loss under natural rainfall on two soil surface conditions. In the first the soil surface was virtually 100% bare of any plant species. In the second, there were some heavily grazed tufts of grass that looked as if they might recover if rested during a rainy period. To simulate realistic options in range reclamation the option of closure to grazing or leaving open to livestock was studied. The four treatments were:
Land which is completely bare and closed to grazing - BE
Land which is completely bare and open to grazing - BO
Land which has some perennial grass tufts and closed to grazing - PE

Land which has some perennial grass tufts and is open to grazing – PO

Runoff plots measuring 10 m x 2 m were laid out with the above treatments in three replications. In addition to measuring rainfall (amount and intensity), runoff and soil loss (over a period of 8 months) measurements were made of soil moisture using a neutron probe and the strength of surface crusts with a penetrometer.

What became clear during the experiment was that bare land without some remnants of perennial grass will not become revegetated even if closed to livestock. During rainfall of over 10 mm about 50% of the rain was lost as runoff from the bare plots. However, where there were some tufts of perennial grasses, runoff was reduced and ground cover improved markedly with protection from livestock.

The results compare well with those of Pereira, et al. [1415]He carried out research on two heavily grazed and denuded catchments near Moroto in Uganda. One catchment was cleared of bush with heavy machinery and closed to grazing. Grass recovery was very good. He notes that there was a mantle of stones on surface. No doubt this helped to protect some of the perennial grasses that were able to recover when the grazing was stopped. Prior to treatment about 40% of all rainfall was lost as runoff.

Where there is a tree or shrub on land that is otherwise seriously degraded, there is often a micro-environment that can allow greater infiltration of rainfall, retard runoff, and protect grass species from elimination. The debris of twigs and leaves encourages termites which limit the tendency to soil surface sealing. Slashing branches and leaving them on the surface can play a role in protecting grass seedlings, assisting infiltration and restoring cover to the ground.

As a general conclusion, recovery by resting alone is likely to be very slow unless some of the following conditions apply:

- The soil is relatively fertile
- The soil is relatively deep
- The A horizon has not been completely eroded
- The soil surface is partly covered with stones
- There are still some perennial grasses present
- The environment is semi-humid to semi-arid but not very arid.

The human element is the most influential in the management of the land. In the colonial era it was thought that the widespread erosion and degradation of land in Machakos District could be countered by reducing the number of people on the land. Settlement schemes were undertaken to move people to Shimba hills and drier areas of Makueni. A longtitudinal study carried out in Machakos District in the nineteen nineties led to a publication “More People Less Erosion.[16] The study showed that Machakos District had about four times as many inhabitants as in the nineteen twenties but the land was in better condition. This story is complex but the following points have emerged.

- People are now much better educated.
- Land has been demarcated and registered as individual holdings.

- Holdings are too small to make a living by pastoralism.
- The culture of keeping large number of animals as an insurance against hard times or for social customs, such as bride price, is no longer possible.
- Opportunities for off farm employment in Nairobi, Thika, Athi River, Mombasa, etc have improved.
- Markets for farm produce including cattle and goats have expanded in the nearby towns and cities.
- The value systems have changed and having well educated children and good housing carry much more importance that cattle and goats.
- The community self-help system known as Mwethya has facilitated a great deal of improvements in the conservation and management of the land.

Turning to Samburu, one has to ask if there is any sign of a trajectory that might lead to similar changes. But the population, history, culture, land use, markets, institutions, education and employment opportunities are so different that it is hard to predict the future.

It would be useful to compare pastoral land in Samburu with land that has been under pastoralism in other areas. Brief observations suggest that enclosure is becoming more common in Maasai land either under family or group management. It would be interesting to assess the impact of rotational grazing with concentration of cattle in close herds on the lines recommended by Alan Savory[17]. This system has been adopted in some areas of Kenya that are supported by the Northern Rangeland Trust.[18]There are many useful publications that can assist those working with pastoralists, e.g. The Drylands of Africa by Barrow[19]

Prime attention should be given to ways and means of restoring ground cover and ensuring that, as far as possible, rain which falls has a chance to infiltrate into the ground. Without water there is no grass and without grass there is no good future.

I can't resist ending with the well-known quotation from Jonathan Swift (1726):

"Whoever could make two ears of corn or two blades of grass grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together."

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