Drylands Programme

ISSUE PAPER

Recognising the Effectiveness of Traditional Pastoral Practices: Lessons from a controlled grazing experiment in Northern Senegal

Brigitte Thébaud
Hermann Grell
Sabine Miehe

IIED
INTERNATIONAL INSTITUTE FOR ENVIRONMENT AND DEVELOPMENT

Paper No. 55
April 1995

Brigitte Thébaud is a Rural economist and associate researcher, African Studies Centre, CNRS/EHESS. Hermann Grell is Head of Livestock, Veterinary and Fishing Services Division, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn. Sabine Miche is an Ecologist and Consultant.

Translation: Jean Lubbock

Recognising the Effectiveness of Traditional Pastoral Practices: Lessons from a controlled grazing experiment in Northern Senegal

Brigitte Thébaud
Hermann Grell
Sabine Miehe

TABLE OF CONTENTS

Recognising the effectiveness of traditional pastoral practices: Lessons from a controlled grazing experiment in Northern Senegal

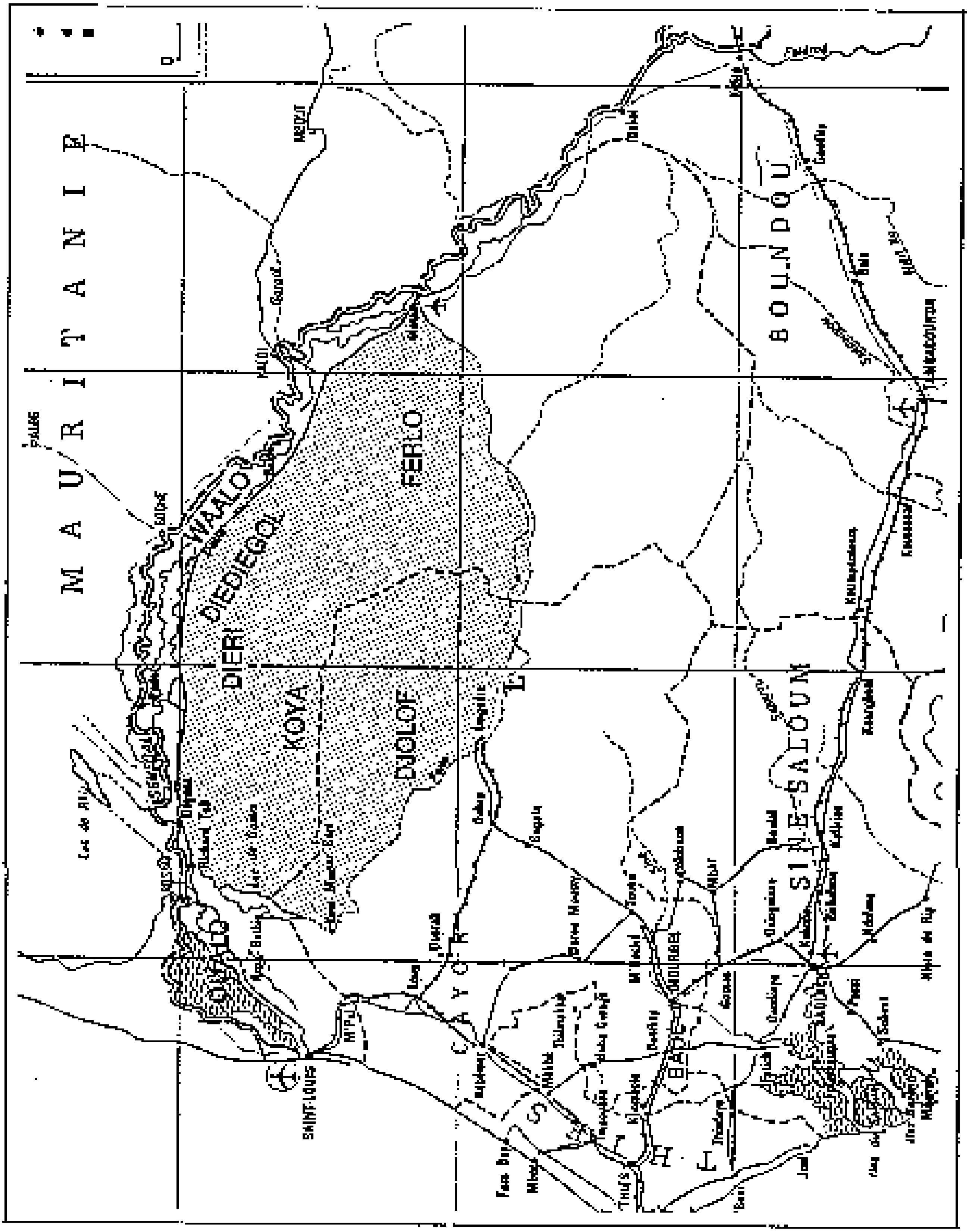
INTRODUCTION: The original features of the Widou Thiengoli experiment

At the beginning of the 1980s, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)[1] introduced a new method of pastoral resource management around the Widou Thiengoli borehole in the Ferlo region of Northern Senegal. The results of this experiment are important for two reasons.

The original feature of this management model was that it was based on the principle of sustaining a balance between available pasture and stocking rates in a pastoral area which had been heavily privatized for the purposes of the experiment. This is a relatively rare way of working with pastoralists in the Western Sahel, in comparison with East Africa where different formulas for controlling stocking density and privatizing pastoral land have been tested.

Secondly, the system was monitored for twelve consecutive years in order to check both the environmental impact and the socio-economic effects. Armed with the information thus collected, it is possible to take an objective look at the relevance of such a model to Sahelian pastoralism.

[1] German bi-lateral co-operation.



Geography of the Ferlo region
(Source: Touré and Arpaillange, 1986)

1. BOREHOLES AND DESERTIFICATION IN THE FERLO REGION

Ferlo before the boreholes: pastoralism in symbiosis with the river and hinterland

The name Ferlo is generally given to a vast region in the north of the country stretching from the Senegal river valley to the ancient kingdom of Diolof to the west. This region is crossed from east to west by the valley of the Ferlo, which dried out at the beginning of the 1950s following the construction of the Keur Momar Sarr dam to the south of Guiers lake. The lateritic area (in the south-east, on either side of the fossil valley of the Ferlo) is distinguished from the sandy area of the Ferlo whose central part is usually known as "Kooya". To the north, the name "Dieri" is given to a strip of about fifty kilometres on either side of the "Waalo", referring to the alluvial formations of the Senegal River Valley. From the "Diediegol", marking the border between these two zones, herds can have access to dry season grazing while continuing to drink from the river (O. Touré and J. Arpaillange, 1986).

The absence of permanent deep water points in Central Ferlo, apart from a limited number of traditional wells ("céanes"), meant that the pasture could only be used on a seasonal basis. Until the 1950s, the region was therefore frequented by Peuhls from the Waalo or Dieri, but only during the rainy season, using natural water holes to water their livestock. The location of rainy season encampments was closely linked to these areas of surface water, which set the pattern of land occupation. On the other hand, in the dry season, the herds had to move back towards the river in the north, as the water holes dried out. This system of transhumance actually represented optimal resource use, as livestock had access to green pasture and abundant water practically throughout the year.

The advent of boreholes and the transformation of pastoralism in Central Ferlo

Following the discovery of deep-lying underground water in the 1950s, the colonial administration proceeded to install a dense network of high-yielding pastoral boreholes, equipped with pumping stations. Considering that pasture is available to an animal within a radius of about 15 to 20 kilometres around a water point (Boudet, 1983), the grid pattern selected allowed optimal spacing between boreholes. Although it was inevitable that some areas of pasture accessible from two different water points would overlap, wasted interstices between catchment areas were kept to a minimum (Receveur, 1965). In 1953, the central zone with its six boreholes was designated a "sylvo-pastoral reserve" and placed under the administration of the Water and Forestry service, in order to protect this fragile area from the expansion of groundnut cultivation (Touré and Arpaillange, 1986).

At that time, as in other Sahelian regions, modern systems of pastoral water supply had to meet the demands of economic development. Faced with a growing population and an expanding market for meat for urban consumption and export, animal husbandry was a priority sector for intervention. The increasing number of water points in herding areas and the opening up of new pastures were to enable growing numbers of livestock to be kept.

In the Ferlo region, the boreholes brought about considerable transformation of pastoral practices. Being able to remain in the Kooya throughout the year led to a reduction in transhumance towards the river in the dry season and the Peuhls became permanent residents in the area. Having been seasonal in the past, rainy season encampments became more permanent structures. The "wuro" (camp) usually included several "galles", each made up of an extended family under a "djom galle" (head of the family). With increasing security in the area and the disappearance of wild animals, the "wuros" and "galles" tended to spread outwards, while maintaining the water point networks as their home territories. A sort of "micro-nomadism" came into being around each borehole, as well as from one borehole to the next, depending on the availability of pasture. The results of this can be seen to this day in the complex pattern of land use, in which the pastoral areas exploited around each borehole on a seasonal basis are closely interwoven (Barral, 1982). Finally, the polarization of pastoral territory around boreholes also altered pastoral practices: cattle were less closely watched by herdsmen, while family labour was, in theory, relieved of the work of watering livestock.

The Ferlo region in the 1970s: over-grazing and apparent desertification

The relevant abundance of pasture which characterized the 1950s and 60s was followed in the 1970s by a dry period which seemed to demonstrate pastoralists' inability to manage their territory rationally: excessive stocking density led to over-grazing and, thereby, to probably irreversible degradation of the rangeland around the boreholes. Pastoral inefficiency also found a theoretical basis in Hardin's famous "Tragedy of the Commons" (1968), according to which use of pasture accessible to everyone was incompatible with individual herd ownership. In such a situation, each pastoralist would try to increase size of his herd, thus obtaining maximum personal advantage while the loss of resources (water, pasture) would be minuscule, as it would be shared amongst a large number of users. Such behaviour, if adopted by a large number of pastoralists, would then result in unlimited growth in herd size and irreversible degradation of natural resources.

2. DEVELOPMENT SCHEMES IN THE FERLO REGION: THE CONTROLLED GRAZING MODEL

A model for controlling stocking density and assigning exclusive individual rights over water and pasture to families.

It was against this backdrop that German bi-lateral co-operation began the "Agro-sylvo-pastoral land use in Northern Senegal" project in 1975. This was initially focused on tree planting in the Ferlo region. Amongst others, gum trees (*Acacia Senegal*) were planted, as their economic value was recognized. However, in view of the mixed results of these tree planting operations, a pastoral component was introduced at the beginning of the 1980s. The idea was to try out a resource management model which could effectively combat the apparent desertification around the boreholes. This meant controlling use of pasture by maintaining moderate, constant stocking densities, to enable woody species to regenerate and to prevent environmental degradation.

Establishing an experimental scheme: Constant stocking density with a system for monitoring vegetation

The "controlled grazing" experiment began in 1981 around Widou Thiengoli. This borehole, one of the six in the sylvo-pastoral reserve, serves a grazing area of approximately 54,000 hectares. Beyond this are pastures accessible from neighbouring boreholes.

First of all, an experimental scheme was set up to the south of the borehole, in an area of 1,500 ha.[2] which was divided into six enclosed 200 ha. plots. Underground pipes brought water to drinking troughs for the animals from a water tower located close to the borehole.

A family of herders was settled on each plot with a control herd

[2] Including 200 ha. set aside for regeneration and 100 ha. of livestock routes.

whose size and species composition were strictly prescribed by the project. In order to test several scenarios, three plots were assigned a stocking density of 14 TLU/ha[3] (a herd of 17 cattle, 17 sheep and 8 goats). By way of comparison, density was increased on the three other plots to 10 ha. per TLU, i.e. 20 cattle, 20 sheep and 10 goats. The performance of these six "control" herds was to be compared regularly to that of animals located outside the scheme, on traditional, i.e. communal, grazing areas. In order to maintain constant stocking density, control herds would theoretically receive supplements in the event of a fodder deficit.[4]

Small control sites were also identified inside and outside the scheme, in order to compare the effects of controlled stocking densities on the herbaceous and ligneous layer. Regular vegetation analyses were thus conducted until 1994, following a detailed procedure.

Extensions to the scheme in 1985, 1986 and 1989

Over the next few years, three extensions to the scheme were established to the north and west of the boreholes: 8,000 ha., including 750 ha. set aside for regeneration (1985), 6,000 ha., including 950 ha. set aside for regeneration (1986) and 4,200 ha. (1989).

In the 1985 and 1986 schemes, individual plots of 1,000 ha. each were enclosed, with underground pipes supplying animal watering troughs, as in the case of the experimental scheme. Under the terms of a contract with the project[5], a total of 24 families were settled in

---

[3] Tropical Livestock Unit: a fully grown animal weighing 250 kilos (Boudet and Rivière standard, IEMVT).

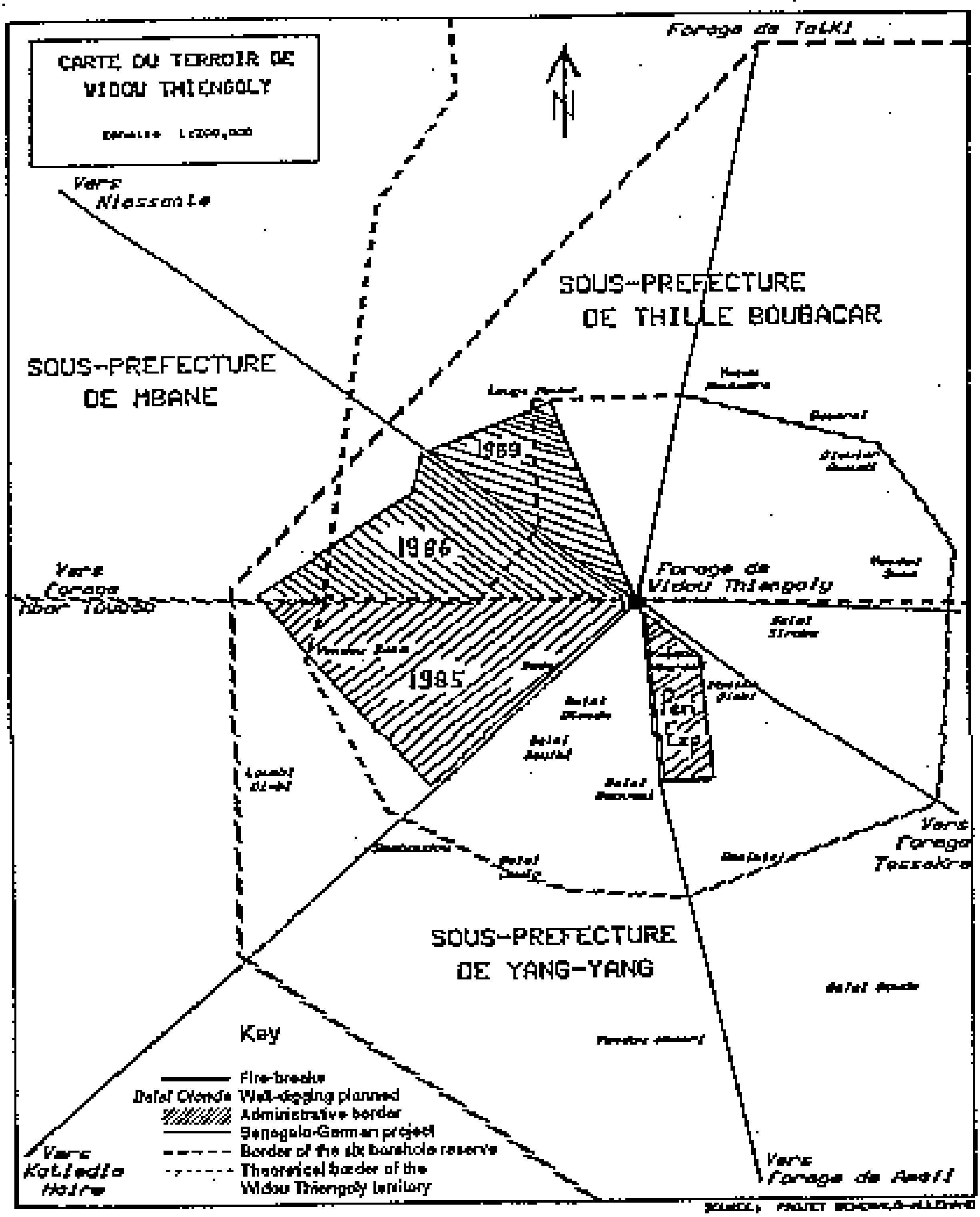
[4] These food supplements were mainly made up of rice straw (with molasses) and lick-stones. However, supply became intermittent as of 1985, obliging parts of the herds to move outside the experimental area in bad years.

[5] In particular, this contract obliged the herder to respect the prescribed stocking density, destock young animals, reimburse 10% of establishment costs (wire fencing, pipework and watering troughs) over ten years, participate in maintaining the equipment (repairing fencing, water pipes and troughs) and be responsible for operating costs (watering taxes, veterinary products and livestock feed).

these areas with their herds. In principle, these were to have a stocking density of 10 ha. per TLU, with 500 ha of pasture being theoretically available per family herd. The allocation of private plots to pastoralists gave them exclusive rights to use the water and pasture. On the other hand, for various reasons (including bringing down installation and running costs), the 1989 scheme allocated plots on a collective basis to the families who were already residing on the site.

Apart from monitoring the vegetation and herds on the plots in the experimental scheme, attention was paid to the economic viability of

Map of the Widou Thiengoli territory



the model. This mainly involved assessing the pastoralists' ability to cover the installation, running and depreciation costs of a scheme with the income from their animal production. Attempts were also made to monitor the social dynamics resulting from the individual, exclusive allocation of pastoral areas which had hitherto been shared by the whole community.

The area covered by the schemes (including the experimental one) is thus about 20,000 hectares, or 36% of the catchment area of the Widou borehole.

<u>The problem of matching stocking density with herbaceous production in extremely irregular rainfall conditions.</u>

Although they were "probably representative in terms of rainfall variation" (Miehe, 1991), the twelve years from 1981 to 1992 were characterized by extreme variability in rainfall and, thereby, in primary grass production in the experimental scheme:

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Rainfall	353	207	105	131	303	325	242	344	471	304	249	119
Yield	1000	610	210	112	931	955	1051	1055	1081	55	607	117

<u>Source:</u> *1992 Annual Report, compilation of readings taken from 1981 to 1992 on the experimental plot (rainfall is expressed here in mm and pasture yield in kg of dry matter per hectare).*

At the level of the region as a whole, the instability and heterogeneous nature of annual pasture resources from one borehole and one year to the next were also confirmed by maps of plant production drawn up on the basis of NOAA/AVHRR satellite images backed up by monitoring on the ground (CSE, 1989, 1990, 1991, 1992). In such circumstances, constant stocking density proved to be incompatible with the wide variations in available biomass from one year to another. In good years, there was too much pasture in relation to stocking density. In bad years, stocking density was too high and the herds were obliged to move out of the plots to survive (Grell, in Dimanche *et al.*, 1991). This meant that available fodder was insufficient in three years, but under-used in four years. Finally, stocking density and carrying capacity only really matched up in two years.

<u>Impact on grazing: more negative than positive effects, especially on the herbaceous layer</u>

In view of this instability of grazing resources, maintaining a fixed, conservative stocking density had very mixed consequences for vegetation. As far as the herbaceous layer is concerned, biomass readings taken over the last few years show that primary herbaceous production did not increase within the experimental scheme as compared to outside, even in years with adequate rainfall (Miehe, 1991, 1994). In fact, on the type of savannah which predominates within the scheme[6], a drop in the production level was noted in comparison with the observation sites located outside. Furthermore, in 1993, after several years of drought, it was noted that herbaceous production had recovered better outside the scheme.

Successive imbalances between stocking density and carrying capacity also had various negative effects on the quality of the herbaceous layer. In good years, under-exploitation of grazing caused an accumulation of unconsumed biomass which hindered plant growth in following years, sometimes resulting in lower production. On the other hand, in years of rainfall deficit following several rainy years, there was an almost total loss of production due to the lack of seed reserves of drought-resistant pioneer species.

---

[6] Rangeland with *Schoenefeldia gracilis* and *Aristida mutabilis*, with sparse shrubby steppe, often wooded (type PS3, according to the classification given by J. Valenza and A.K. Diallo, 1972).

The quality of pasture and, in particular, the stability of the herbaceous layer seem to have decreased markedly, in comparison with communal grazing areas, especially in plots which were undergrazed in good years. To be more specific, there has been a thinning out of drought-resistant pioneer fodder species which are palatable to livestock, hence a lack of available seed reserves in dry years. At the same time, grasses which are only eaten as young shoots in the rainy season are tending to increase, without providing acceptable fodder reserves for the dry season. This phenomenon could be due to insufficient browsing in the rainy season and hardening of the top soil due to insufficient trampling by the animals.

After the satisfactory 1993 rainy season which produced biomass of about 1 ton of dry matter per hectare, the latest measurements taken in January-February 1994 seemed to confirm these trends (Miehe, 1994). Within the experimental scheme, the heterogeneous nature of the herbaceous layer is clearly seen. In favoured spots receiving adequate water, a balanced combination of good quality grasses and legumes is found. On the other hand, low production can be seen on wide areas, with some grasses (*Schoenefeldia gracilis*) withering before flowering. Outside the scheme, the herbaceous layer is more homogeneous and richer in drought-resistant pioneer grass species. It is, however, lacking in fodder legumes such as *Zornia* (which is heavily grazed in bad years).

Mixed but generally positive results for ligneous species

Since 1981, however, ligneous vegetation regenerated better inside the scheme than outside, where such regeneration was only really satisfactory on the clayey soils between the dunes. Nevertheless, within the scheme, such regeneration is still slow and the results are only positive on about half the monitored sites. Yet, generally speaking, the droughts of 1983-84 and 1992-92 seem to have had much more effect on ligneous species than stocking densities. Furthermore, in order to give a positive result for ligneous species, natural regeneration would have demanded that stocking density should vary according to topography and be lower on the upper slopes and tops of dunes. The regenerative capacity of trees and shrubs thus seems to depend above all on rainfall, secondly on their position on the contours of the dunes and, finally, on grazing intensity: at unfavourable sites, the overall results for 1981/94 are negative, even on fenced off sites (Miehe, 1991).

Final observations in 1994 showed a strong increase in *Boscia Senegalensis* at all sites, which tends to indicate that the environment is drying out naturally. If the presence of these shrubs is excluded, nine of the fourteen observation sites located within the experimental scheme have still not reached the level of ligneous density noted in 1981. On the other hand, if the stands of *Boscia* are included, the regeneration of tree species is greater inside the scheme than outside, as only five out of fourteen sites are below the level observed in 1981. On the communal grazing area, regeneration is less marked but not non-existent, as only two sites (out of five) show reduced ligneous density and these are located at the top of a slope.

In conclusion, "the results clearly show that the hopes vested in controlled grazing with conservative stocking densities have not been realised so far with regard to regeneration of the savannah. In other words, the changes in vegetation which have occurred so far, as a result of reduced grazing intensity, do not offer any advantages for pastoralism" (Miehe, 1991). It is only during drought years and at favourable locations that quality of pasture within the experimental scheme was better. Yet, this advantage was offset by large variations in production and, in rainy years, by a thinning out of species adapted to drought (Miehe, 1994).

In order to avoid such negative effects, stocking density should ideally be adjusted constantly to available annual biomass. Thus, the idea in the project's later years of having flexible stocking levels within the scheme only went to confirm the benefits of pastoralism using communal grazing areas, since that strategy was already prevalent outside the scheme (Grell, 1991).

Controlled grazing and animal production: the effects are probably beneficial in good years, but the animals' vulnerability increases in the event of fodder shortages

In principle, animals were kept in ideal conditions within the schemes: access to water at all times and no competition with other animals for water or pasture (Tluczykont *et al.*, 1991). Consequently, the beneficial effects of controlled grazing on livestock condition could appear in various ways: increased fertility, lower mortality rate, better weight in the dry season or reaching breeding condition earlier.

Nevertheless, these optimistic views must be qualified. On the one hand, various difficulties in monitoring the control herds within and outside the plots made it impossible to obtain reliable data on the comparative condition of the animals, especially the young ones. Additionally, while the scheme offers undeniable advantages in good years (to the extent that some herders considered it to be an animal breeding-ground), the same did not apply in bad years if the animals had to go outside. In fact, after having enjoyed a very protected environment, herds in the later schemes turned out to be poorly prepared for the normal conditions of communal grazing and transhumance. They were more frail, lost weight quickly and had difficulty in tolerating being watered at the borehole only every two days (Richter, 1991).

The observations made by the Dahra Animal Science Research Centre on Zebu Gobra cattle in similar situations tend to confirm that animals coming from a protected environment often record a greater fall in zootechnic performance. Mortality rates amongst young animals are higher. Female fertility is more seriously affected than in herds used to moving around.

Coping strategies on the schemes: a complete takeover of the model without losing the advantages of communal grazing, to the detriment of other pastoralists.

Privatization on an individual basis of water and pasture within a shared resource system had numerous effects on the Widou pastoral community. These were analyzed by Richter (1991) and Touré (1990, 1991, 1993), amongst others. It was, however, a complex matter to decipher the processes involved. Initially, the schemes showed signs of success. The forestry services recorded a good rate of regeneration of woody species, while participating families expressed their satisfaction with this new management model to the project. This apparent success is largely responsible for the rapid establishment of further schemes soon after the experimental scheme was set up.

However, in fact, it turns out that the 1985 and 1986 schemes were appropriated by a limited number of influential families and their "clients". Such infiltration of the plot allocation process was all the more plausible in that these families had rapidly imposed themselves as intermediaries between the population and the project who could not be by-passed (Touré, 1991). These unfortunate effects seem to have persisted even in the 1989 collective scheme, although this had aimed at correcting the anomaly by insisting that plots should be awarded to residents of the zone. Some major herd owners were apparently able to get some of their animals onto the scheme by using the names of other pastoralists as fictitious owners (Touré, 1991).

If in fact most of the families benefitting from the project were well-off and had large numbers of animals, maintaining a fixed stocking density in closed plots was not acceptable. For such herders, the scheme could only represent a portion of individually-held pasture within a much larger, shared pastoral area: the scheme provided unequalled comparative advantages, but access to the wider rangeland was still essential.

In this way, coping strategies adopted by pastoralists on the schemes show that the model was taken over completely, but that access to communal grazing was retained (Grell in Müller Hohenstein *et al.*, 1986). The scheme constituted a protected area which was used to destock or restock herds depending on circumstances. If the rainy season got off to a shaky start, the plot could be profitably used to allow the herd from outside to recover rapidly, without any competition from other animals. In good years, dry season grazing areas would provide fodder reserves to which livestock would be driven in the lean season prior to the onset of the rains, in order to avoid frequenting the overcrowded borehole and see out the most difficult months in peace.

Such strategies obviously implied that stocking densities could not and should not be enforced within the schemes. Attempts to put a stop to these practices in 1989, which led to the temporary expulsion of a few families, were not adequate. In any event, maintaining such measures would have turned the project into a repressive apparatus.

On the contrary, optimum use of the schemes called for regular movement of livestock to and from the plots and the outside, but this was a one-sided process: a herder with a plot in the scheme could drive his animals into pastures usually frequented by other herders, but the latter could not, under any circumstances, go into the plots. Furthermore, these livestock movements generally resulted in an increase in stocking density outside the schemes: "enclosure of other pastoral areas since the beginning of the experiment in 1981 led to increased density on the remaining open spaces which are currently shrinking sharply around the borehole". (Miehe, 1991) Thus, "the enclosed schemes are protected at the expense of accentuating the imbalances between livestock and available resources in the undeveloped area" (Touré, 1991).

Animal movements are also reflected in the location of the 'galle'. In several cases, the part of the family living outside the scheme has settled only a few hundred metres from the entrance to the plots. It is just as beneficial to bring the herd in from the outside and water the animals inside the scheme. One can thereby escape payment of watering taxes, as these animals will not be accounted for at the borehole. All these advantages explain why a significant number of discreet openings have been arranged around the schemes, allowing discrete osmosis between the areas.

In such circumstances, relationships between families who have been allocated plots and pastoralists outside the schemes are bound to be strained. For the latter, there are many reasons for frustration: having to share grazing with animals from the plots but with no reciprocal rights; the need to go round the fencing to get to the borehole; and non payment of watering taxes by herders from the schemes. Quite logically, pastoralists outside the schemes are demanding plots in their turn. However, such claims are mainly motivated by a concern for equity, rather than by the real advantages offered by the schemes, whose many dangers they have come to realise: if all the bush were enclosed, whatever would happen? (Grell in Muller Hohenstein *et al.*, 1986). The creation of the 1985 and 1986 schemes also demanded the expulsion of a large number of families who suffered serious consequences: loss of grazing, loss of territory and loss of status (Thébaud *et al.*, 1993).

Viability and self-management of schemes: unfulfilled predictions

The various calculations made over the last few years also seem to indicate the limits to the viability of controlled grazing. These limitations are all the greater in that, theoretically, controlled grazing would imply regular destocking of animals after weaning, while retaining a few replacement heifers.

Thus, to quote Karsberger-Sanftl (1991), "controlled grazing as such is not viable. The end product just about covers depreciation, interest and the running costs of the infrastructure. This means that the herder suffers a loss of assets rather than receiving income for his work or profit on his own livestock capital". Eventually, the effective self-financing of a plot by a herder could result in negative growth in his herd.

In many respects, self-management of the scheme has turned out to be disappointing. Maintenance of fencing and coverage of the running costs have not actually been assured, thus showing the pastoralists' lack of interest in infrastructure of which they took advantage mainly because it was relatively free of charge. The contract concluded with the project was also ambiguous: rights over water and pasture were exclusive, but the land's status as a pastoral reserve made it impossible to set up formal ownership or specify the duration of such rights.

3. LESSONS FROM CONTROLLED GRAZING: Recognizing the effectiveness of traditional pastoral practices

The limitations of carrying capacity as a management tool in non-equilibrium systems

The concept of carrying capacity implies that production parameters, especially with regard to livestock feeding, must be fully mastered. Yet, outside some extremely privileged regions (such as the Niger river delta in Mali), the extreme variability of resources in the Sahelian environment does not permit such mastery and hence the establishment of a sustainable balance. On the contrary, Sahelian pastoralism relies on operating systems whose equilibrium is perpetually unstable in the face of heterogeneous resources which cannot be predicted. Pastoral mobility shows the constant need for pastoralists to off-set the alternation of high and low productivity of pasture, turning the heterogeneous nature of resources to advantage rather than banking on the latter's stability or uniform nature (Behnke and Scoones, 1992).

In the case of Widou, the closed model of pastoral exploitation was therefore unlikely to be able to resist external pressures, as is clearly shown by the rapid spread of the herds towards the outside. At the same time, establishing individual, exclusive rights over pastoral resources led to the abolition of the principle of reciprocity, without which pastoral effectiveness is in jeopardy. Controlling stocking densities also implied that family herds in each plot should be totally homogeneous, even in species distribution, although this was not realistic. The model thus also presupposed perfect stability of the human groups making their living from these herds. Yet it would have been impossible to achieve such mastery of demography (Thébaud *et al.*, 1993).

The idea that the Ferlo suffers from permanent overstocking must also be reviewed. Towards the end of the 1980s, the satellite data analyzed by the Centre de Suivi Écologique, combined with aerial surveys, showed that the Ferlo pastoral area tended to be under-grazed in an average year, while grazing intensity was much higher in agricultural areas (Prévost, 1989).

The difficulties of applying a closed model of water and grazing management on a large scale.

Extending this model throughout the Widou borehole area (and subsequently to other boreholes) would also have posed insurmountable problems. Considering the Widou Thiengoli catchment area in relation to the resident population, dividing up the land would have provided a usable area of only 13 ha. per person, with no opportunity to move outside. Taking the generally accepted pastoral viability threshold of three TLU per person in the Western Sahel (NRLP, 1984), such an area would have only been adequate in exceptionally good years. On the other hand, it is known that an open pastoral area allows higher stocking densities to be maintained as a result of herd mobility (Sandford *in* Behnke and Scoones, 1992).

Moreover, dividing up into plots could not have taken account of the heterogeneous nature of the environment: differences in relief or types of savannah, presence or otherwise of *bas-fonds* and location of the plot in relation to the borehole. Some plots would inevitably have been favoured compared with others which would include less favourable combinations of key resources. At the same time, the constant evolution of human and animal numbers in the plots would, in theory, make it necessary either for the animals and people deemed to be surplus to move out, or for the size and boundaries of the plots to be constantly revised.

Spatial mobility and flexibility: the key to effective pastoral exploitation and coping with imbalances

Herd mobility and flexible land use strategies are therefore vital to successful pastoralism, even in the presence of a dense network of high-yielding boreholes which would normally allow stable animal movements within the catchment areas. Where pastoral resources are unstable and impossible to predict in advance, the distance that the animals must travel to feed is bound to be different in good and bad years. By way of example, if a borehole's management plan allows for a density of 5,000 TLU, this will be correct in a normal year, with about 6 ha. per TLU. On the other hand, in a year of very low rainfall (145 mm), about 100,000 ha. would be needed (i.e. a radius of about 18 km) and some livestock would be almost certain to die before the rains came. With rainfall of 100 mm, the optimum density would have to come down to 500 TLU and a usable radius of more than 30 km would be needed, which is hardly conceivable, especially as other water points are likely to be competing for this space (Boudet, 1983).

Variability in the level of grazing resources in Widou over the period considered was virtually on a scale from one to ten depending on the year. Even the utopian application of a very low density of 20 ha. per TLU would not have stopped the pastoralists having to leave the region regularly. Furthermore, such a policy would have implied emptying the pastoral area in question of more than half its livestock and population (Tyc, 1994).

In such circumstances, it is extremely difficult to estimate an ideal, sustainable stocking density, even over one year. According to experiments conducted by Valenza and Fayolle (1965) in Northern Senegal with Zebu Gobra cattle in the 1960s, 3.4 to 8 ha. were needed for a 200 kg animal. Due to the variable quality of grazing depending on season, a constant density based only on rainy season and post-rainy season potential could not be maintained throughout the year, on pain of affecting the maintenance and production level of the animals.

Animals and the natural environment: a necessary symbiosis which is mutually beneficial

The experience of Widou Thiengoli also shows the need to take a new look at the impact of herding on the natural environment and to see its negative effects in context. It is a delicate matter to grasp the notion of land degradation (Warren and Agnew, 1988), especially *with regard to pastoral land whose primary productivity* depends on numerous factors. In Mali, the work of Hiernaux and Diarra (1993) in monitoring 30 sites in the Gourma region with different climatic conditions, soils and pasture, over the period 1984-1993, showed that the herbaceous layer was in fact remarkably resilient and that it was able to recover rapidly when rainfall returned to normal.

The work conducted in Widou would seem to indicate that in a situation of extreme variability from year to year, rainfall and the aridity factor have a more decisive effect on grazing than animal numbers, whose influence may in fact be only secondary (Miehe, 1991). It is important that the available biomass should be consumed by animals, since this favours the growth of new stocks as well as the regeneration of woody species through digestion of their seeds by animals. On the experimental scheme, such regeneration proved to be less marked in fenced off areas than at the observation sites where animals were present.

The amount of biomass available at the end of the rainy season must be able to sustain the livestock until the next rains. If the rate of consumption during the rainy season is too rapid, the animals rather than the natural environment will suffer. In the rainy season, the effect of the animals' passage on the vegetation will depend on various factors such as duration, soil structure and water retention capacity and the herbaceous species present. For annual species, the risk of damage by grazing is particularly serious at flowering time. However, many species are naturally protected from the teeth of livestock during this period, by thorns and spikes (Hiernaux and Diarra, 1993).

In the rainy season, grazing may also have positive effects on the stability and diversity of primary production. Plot monitoring at Widou clearly showed that browsing and trampling can foster the establishment of resilient annual species which are palatable to livestock, especially on sandy soils. The animals' hooves can in fact help to bury the seeds and facilitate their germination due to better penetration of the soil by the first rains (Boudet, 1987).

Finally, it is very difficult to establish an indisputable correlation between the evolution of the natural environment and stocking density. Apart from the climate, other parameters may also have a decisive influence: routes followed by pastoralists, herding techniques, the predominance of certain species and, above all, the diversity of types of savannah each having different regeneration potential depending on their original condition.[7]

Pastoral flexibility in spatial terms as well as in animal production: the growing importance of small ruminants in Central Ferlo and its implications.

In general, water and grazing management cannot be divorced from the context of the pastoral economy and the ways in which pastoralists adapt to imbalances. It was with this in mind that the project proceeded with a "health check" of the project area during 1994,

[7] Comment from M. Grouzis, ORSTOM/Dakar during the seminar on the "Sylvo-pastoral development model" held at the Hotel Savannah in Dakar on 22nd April 1994 (see also S. Michie, 1994).

carrying out detailed surveys around the Widou Thiengoli borehole and the neighbouring Buteyni borehole for comparison. Making such an assessment was all the more important in that after several years of intermittent transhumance, the good 1993 rainy season had brought herders back to the area. At the same time, a detailed study of livestock rearing and marketing in the borehole area was conducted (Tyc, 1994).

A total of 52 galles were surveyed during the assessment[8], each of which, from a pastoralist perspective, represented a coherent socio-economic unit (Barral, 1982, Santoir, 1982). With regard to herd size and composition in animal species, the growing importance of sheep and goats in the domestic economy is immediately obvious, even though large livestock still constitute an important part of the herds. Amongst the galles surveyed in Buteyni, the average ratio is 3.7 small ruminants for 1 bovine, as against 4 in Widou. By way of comparison, the ratio established by Santoir in 1978 for the Dieri Peuhls of Tille Boubacar was only 0.87 (Tyc, 1994). This herd structure means that sheep predominate. In Buteyni, for instance, the average ratio in the surveyed herds is 2.8 sheep for 1 bovine and 1 goat, with a virtually identical ratio between these last two species.

As far as the household economy is concerned, this development is entirely consistent with market conditions and the need to manage the considerable variations in the level of grazing resources. Sheep command a high price and are easy to market through well-established and effective channels. Moreover, these herds can be rebuilt quickly after drought. Small ruminants thus represent a way of *maximizing* market opportunities and managing resource imbalances more easily.

The relationship between family and herd size worked out at average availability of over three TLU per person in the surveyed galles,

[8] Including 33 in Buteyni and 19 in Widou Thiengoli. The latter sample included herders from the schemes as well as families outside them.

although this masked important disparities.[9] However, the presence of small ruminants is decisive: with the same TLU availability, a galle with fewer cattle, but a large number of small ruminants (especially sheep) will be in a better economic position than a herder with a larger ratio of large to small livestock. Depending on productivity and market conditions, sheep may provide a return of more than 6,000 FCFA per year and per animal in the herd against about 15,000 FCFA per bovine and 3,000 FCFA per goat, including dairy produce. Calculated by TLU[10], financial productivity amounts to 19,675 FCFA/TLU for cattle, 38,650 FCFA/TLU for goats and 60,495 FCFA/TLU for sheep (Tyc, 1994).

The structure of sheep flocks surveyed around the Widou Thiengoli and Buteyni boreholes confirms the intensive off-take of young stock, particularly of males. The same observation can be made for goats, with animals being quickly sent to market, and most especially young females, which suggests a voluntary strategy to limit the size of these herds on the part of pastoralists (Tyc, 1994).

However, keeping small ruminants means strict organization of family labour in comparison with cattle who are often left to roam free. Goats, and especially sheep, must usually be watered at the camp and watched by a shepherd while grazing. The work of collecting water from the borehole in inner tubes and transporting this water daily to the camp is very time consuming, especially for women. Labour constraints can be critical where herding is concerned, so that families increasingly resort to paid herdsmen, especially for sheep (Thébaud, 1994).

Furthermore, the mobility of small ruminants and their ability to go for long periods without water are less than that of cattle. In the event of a borehole breakdown, the risk is thus considerable. While

---

[9] As an illustration, in 37% of the galles surveyed at Widou Thiengoli and 52% in Buteyni, availability was less than three TLU per person in the family.

[10] Conversion to TLUs took into account the weight characteristics of the species concerned, especially sheep.

cattle can more easily fall back on a neighbouring borehole, the situation for small ruminants becomes critical if they have to go more than several days without water. The choice of location of the galle in relation to the various boreholes is therefore decisive (Thébaud, 1994).

Finally, small livestock must be fed on a combination of grass and tree species, in the absence or scarcity of which temporary transhumance to better provided areas may be necessary. This applies especially to *Zornia Glochidiata* which, when it becomes scarce in the rainy season, may cause herds to travel outside the area. In the dry season, grass and browse resources in the *bas-fonds* are essential. When the project followed up sheep and goats as they grazed at the end of the 1993-94 dry season, the importance of *Calotropis Procera* as fodder seemed to be confirmed, although this is less prevalent in the area than *Acacia Spp.* and *Balanites* (Thébaud, 1994). The research work conducted by ISRA/Dakar on this plant, despite its reputation of not being very palatable to livestock, supports this observation (Fall, 1993).

Securing pastoral land rights and access to fall-back areas in deficit years: the importance of a favourable institutional environment

Physical mobility, economic flexibility and optimum management of inter-annual imbalances would thus seem to be essential conditions for pastoral success in non equilibrium systems. For the Peuhls of the Ferlo region, as for many other Sahelian pastoralists, success depends on being able to move around. Analysis of the strategies employed in 1992-93 by the herders surveyed in Buteyni and Widou Thiengoli confirms the importance of being able to move outside the area in case of drought: there was a mass departure of herds towards a strip of land located to the south and south east of the Six Borehole Sylvo-pastoral Reserve. This migration strategy seems to have paid off for cattle, since a large proportion of the pre-drought numbers survived. For small ruminants, despite heavy off-take, the sheep and goat herds had been almost entirely reconstituted at the time of the surveys six months later.

However, in view of the current pressure from agriculture in Senegal, it is clear that pastoralists' ability to fit themselves into southern regions will come up against an increasing number of obstacles: reduction in fallowing and hence in interstitial grazing, together with growing interest in agricultural by-products by farmers for their own animals or for sale. Additionally, temporary access to fall-back areas relies above all on the ability of the Ferlo pastoralists to negotiate their right to stay and to offer some compensation in return. Their bargaining power is inevitably related to the status of the sylvo-pastoral reserve and the inability of its pastoral inhabitants to control the entry of herds from southern regions or the river.

As rice farming develops, the Senegal river valley cannot provide a viable fall-back area in the event of a crisis, or even at normal times, and given the Diama dam, there is uncertainty whether water will ever flow again in the Ferlo valley. The ability of the Ferlo herds to cross the valley in future in the event of drought is difficult to assess, especially if the banks are placed under intensive cultivation. Another danger comes from the inevitable development of animal husbandry by farmers along the Ferlo valley using income from agriculture. These herds will have to be sent regularly into the central Ferlo to take advantage of grazing there, which means additional animal pressure against which the Peuhls of Central Ferlo have few means of protecting themselves. Here again, the status of the reserve is at issue because it cannot guarantee protection against the arrival of these herds, or even against clearance for agriculture, as the case of the Mbegué forest clearly showed (Schoonmaker Freudenberger, 1991)

This controlled grazing experiment has shown that pastoral resource management cannot be dissociated from the wider environment: rainy season rangeland and networks of dry season water points, not to mention market sites, temporary fall-back or long-term migration areas (Marty, 1989).

CONCLUSION : Supporting pastoral self-reliance

The experience of the Widou Thiengoli controlled grazing model is a rich source of guidance for managing pastoral areas in West Africa. It shows the limitations of ready-made pastoral management systems taken from elsewhere which assumes that herders are incompetent.

Amongst other things, sustaining a balance between stocking densities and annual grazing implies that such density can be checked and kept under control at all times. Of necessity, this concept can only be applied within a defined area, which is marked out and voluntarily closed off for the benefit of individual families or a restricted community. As a consequence, herds can only be kept within an enclosed area if the level of resources is totally stable from one year to the next (Schaeffer and Samberger, 1992, Thébaud, 1994).

The Sahelian environment is characterized by great instability and dispersal of its resources. In the absence of mobility, herds would be decimated in a bad year and the human population whose livelihood comes from those herds would be reduced to helpless destitution. However, such mobility is hard to reconcile with exclusive rights over water and pasture, especially if such exclusiveness only benefits a minority of herders. The experiment conducted at Widou shows that a high social cost accompanies the indisputable ecological cost.

Having drawn these lessons, the German commitment to central Ferlo will be maintained, despite the difficulties encountered. Over the next few years, activities will follow a completely different direction. Instead of assuming that pastoralists are inefficient and require modernisation, the programme will try to alleviate the constraints faced by pastoralists, through an integrated approach to pastoral systems including not only water and grazing, but also the household economy (Grell, 1993).

Far from constituting a comfortable return to "laisser faire" after a failed attempt at intervention, this means making sure that the legislative and institutional environment is favourable to pastoralism in the Ferlo region. This is a complex manoeuvre, not without risk, as it touches on the issues of decentralization, pastoral land rights, effective community participation and the linking up of different levels of intervention (national, regional and local). At the same time, activities must also be co-ordinated with other donors in neighbouring regions, since access to fall-back areas is vital for the Ferlo pastoralists. Such an agenda requires not only trying to learn the sometimes bitter lessons of the past, but also counting on the professionalism of the pastoralists instead of condemning them out of hand.

REFERENCES

Barral H. 1982, *Le Ferlo des Forages, Gestion ancienne et actuelle de l'espace pastoral*, ORSTOM, Dakar.

Barral H. et al, 1983, *Systèmes de production d'élevage au Sénégal dans la région du Ferlo : synthèse de fin d'études d'une équipe de recherches pluridisciplinaires*, ORSTOM, Centre Régional de Documentation, Dakar.

Behnke R.H. et Scoones I., 1992, Rethinking Range Ecology : Implications for Rangeland Management in Africa, *Paper no 33 March 1992, International Institute for Environment and Development/Overseas Development Institute*

Boudet G., 1978, "Le rôle et les limites de la recherche dans l'amélioration de la gestion des parcours sahéliens" in *Colloque ORSTOM-CVRS, Maîtrise de l'Espace agraire et développement en Afrique au sud du Sahara.*

Boudet G., 1983, *"La transhumance et la gestion de l'eau et des pâturages dans l'espace"*, IEMVT, Paris.

Boudet G., 1987, "Connaissance et gestion de l'espace pastoral sahélien" in Terroirs pastoraux et agro-pastoraux en zone tropicale : gestion, aménagements et intensification fourragère", *Etudes et Synthèses de l'IEMVT no 24.*

CSE (Centre de Suivi Ecologique), *Bilan du suivi de la production végétale, situation des parcours naturels, années 1989, 1990, 1991 et 1992*, Ministère du Développement Rural et de l'Hydraulique, Dakar.

Dimanche P., Fischer H., Grell H., et Toure., *Agro-silvo-pastorale Landnutzungsmodelle zur Desertifikationsbekämpfung*, GTZ, Eschborn.

Fall Safietou et al., (ISRA/Dakar), 1993, Étude de la valeur nutritive de cinq espèces ligneuses d'Afrique de l'Ouest : leur aptitude à améliorer les rations à base de fourrages pauvres distribuées aux ovins, *Bulletin du Réseau Africain d'Alimentation du Bétail, Volume 3 (4).*

Grell Hermann (Dr), 1991, *Rapport préliminaire de la mission d'évaluation, Contribution Sylvo-pastorale, Project Sénégalo-Allemand d'Exploitation Agro-Sylvo-Pastorale des Sols dans le Nord du Sénégal.*

Grell Hermann (Dr), 1992, *Vers une gestion plus stable de l'espace pastoral, Séminaire bilan sur les recherches relatives au sylvo-pastoralisme au Sahel, Dakar, mai 1992.*

Grell Hermann (Dr), 1993, *A Future for Pastoralism, Paper presented at the Symposium Interdisciplinary Research on Animal Production in the Sahel*, Göttingen, Germany.

Hardin G., 1968, The Tragedy of the Commons, in *Science 162:1243-48.*

Hiernaux P., et Diarra L., 1993, Dynamique de la végétation sahélienne : un bilan du suivi des sites pastoraux du Gourma en 1992, Centre International pour l'Elevage en Afrique (CIPEA), *document de travail 001/93*, Bamako, Mali.

Kasberger-Sanftl Georg (Dr). 1992, *Recherches agro-économiques d'accompagnement dans le Projet "Exploitation Agro-Sylvo-Pastorale des Sols dans le Nord du Sénégal"*, Rapport d'une mission à court terme effectuée du 14. 03 au 04. 04. 1992 sur ordre de l'Office Allemand de la Coopération Technique.

Marty André, 1989, *Terroirs, foncier et approche locale : quelques jalons*, Paris, Institut de Recherches et d'Applications des Méthodes de Développement (IRAM), document à diffusion limitée.

Miehe Sabine (Dr), 1982, *Inventaire et Suivi de la végétation dans la parcelle d'élevage de Widou Thiengoli*, Rapport final.

Miehe Sabine (Dr), 1991, *Inventaire et Suivi de la Végétation dans les parcelles pastorales à Widou Thiengoli : résultats des recherches effectuées de 1988 à 1990 et évaluation globale provisoire de l'essai de pâturage contrôlé après une période de 10 ans* (traduction en français par A-M Coulibaly).

Miehe Sabine (Dr), 1992, *Inventaire et Suivi de la Végétation dans le Périmètre Expérimental à Widou Thiengoli dans le cadre du Projet Sénégalo - Allemand "Exploitation agro-sylvo-pastorale des Sols dans le Nord du Sénégal (No 87.2273.8-01.100) : L'Evolution de la strate herbacée au cours de la nouvelle sécheresse 1990-92,* Rapport d'une mission à court terme effectuée du 3 au 28.10.1992 sur ordre de la GTZ/Eschborn (Contrat no 1-1001 - 60114948, traduction en français par A-M Coulibaly).

Miehe Sabine (Dr), 1994, *Bilan des modifications de la végétation après 13 années d'essai et recommandations pour de futures phases du projet*, Rapport d'une mission à court terme effectuée du 14 janvier au 10 février 1994 sur ordre de la GTZ/Eschborn (Traduction en français par A-M Coulibaly).

Müller-Hohenstein K.,(Pr), Hoenisch U., (Dr), Grell H., (Dr) und Schutz R., 1986, *Aufforstung von Brunnenstellen im Norden Senegals, Zwischenevaluierung und Plannungsfortschreibung,* GTZ PN 75/2003.4, Eschborn.

NRLP, *Niger Range And Livestock Project, 1984, Pastoral Development in Central Niger*, Report of the Niger Range and Livestock Project, Edited by Jeremy Swift, République du Niger, Ministère du Développement Rural, USAID.

Prevost Y., 1989, *Analyse spatiale de la pression animale comme facteur de désertification dans le Nord du Sénégal,* Centre de Suivi

Ecologique, Ministère du Développement Rural et de l'Hydraulique, Dakar.

Receveur P., 1965, *Définition d'un programme d'aménagements hydro-pastoraux dans la zone sylvo-pastorale*, République du Sénégal, Ministère de l'Economie Rurale, Service de l'Elevage.

Santoir Christian, 1983, *Raison pastorale et développement (les problèmes des peul sénégalais face aux aménagements)*, ORSTOM, Paris.

Santoir Christian, 1982, *Contribution à l'Etude de l'Exploitation du Cheptel, Région du Ferlo-Sénégal*, ORSTOM, Groupe de Recherches Interdisciplinaires sur les Zones arides, Programme OG1.

Schaeffer Jörg et Samberger Nikolaus, 1992, *Sur les difficultés d'assurer l'autonomie des périmètres pastoraux : contribution à la discussion sur la gestion durable des ressources pastorales dans le Ferlo*, Projet Sénégalo-Allemand "Modèle d'aménagement sylvo-pastoral des terres en vue de la lutte contre la désertification, St Louis, et 02.09.92.

Schoonmaker Freudenberger K., 1991, *Mbegué : the disingenuous destruction of a Sahelian forest*, IIED Drylands Programme, Issue Paper 29.

Thébaud B. Toure O. et Kasberger-Sanftl G., 1993, *Projet Modèle d'Aménagement sylvo-pastoral des terres en vue de la lutte contre la désertification, Ebauche d'une nouvelle approche pour le projet PSA.*

Thébaud B., 1994, *Projet "Exploitation Agro-Sylvo-Pastorale des Sols dans le Nord du Sénégal", Bilan et identification d'un nouveau projet:* rapport de la mission du 28 mars au 5 mai 1994.

Tluczykont S., Richter M., et Kasberger-Sanftl G., (Dr), 1991, *Le pâturage contrôlé : un système d'exploitation sylvo-pastorale comme* *modèle pour la sauvegarde des ressources naturelles*, Saint-Louis.

Touré Oussouby et Arpaillange Joël, 1986, *Peul du Ferlo*, Editions de l'Harmattan, Paris.

Touré Oussouby, 1990, *Les sociétés peul du Ferlo : continuité, changements, menaces*, Centre de Suivi Ecologique, Dakar.

Touré Oussouby, Février 1991, *Mission d'évaluation*, Rapport sociologique, Minisère du Développement Rural et de l'Hydraulique, Direction des Eaux, Forêts, Chasses et de la Conservation des Sols, Projet Sénégalo Allemand d'Exploitation Agro-Sylvo-Pastorale des Sols dans le Nord du Sénégal.

Tyc J. 1994, *Etude diagnostic sur l'exploitation et la commercialisation du bétail dans la zone dite des "Six forages"*, Projet d'Exploitation Agro-Sylvo-Pastorale des Sols dans le Nord du Sénégal, Rapport de la mission effectuée au Sénégal du 1er mars au 6 avril 1994.

Valenza J. et Diallo A.K., 1972, *Etude des pâturages naturels du nord du Sénégal*, Laboratoire National de l'Elevage et de Recherches Vétérinaires, Dakar-Hann.

Valenza J., et Fayolle F., 1965, *Notes sur les essais de charges de pâturages en République du Sénégal*, Rev. Elev. Méd. vét. Pays trop., 18(3): 321-327.

Warren A., et Agnew C., 1988, *Une analyse de la désertification et de la dégradation des terres en zones arides et semi-arides*, Paper No 2, Drylands Programme, Institute for Environment and Development, London.

IIED

Drylands Programme
INTERNATIONAL INSTITUTE FOR ENVIRONMENT AND DEVELOPMENT
3 Endsleigh Street, London WC1H 0DD, UK
Tel: (44-171) 388.2117 Fax: (44-171) 388.2826
e-mail: ieddrylands@gn.apc.org