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Chapter 8.4

MALI

G. BOUDET

Mali covers 1,240,000 km^2 in the heart of West Africa, between 10° and 25° N latitude.

If the 100 mm isohyet is taken as the boundary of the Sahara, and the 550 mm isohyet as that between the stock-breeding Sahel and the more agricultural Sudanian zone, then Mali is divided into 430,000 km^2 of desert, 500,000 km^2 of Sahelian area and 310,000 km^2 of Sudanian sector (Fig. 8.4.1).

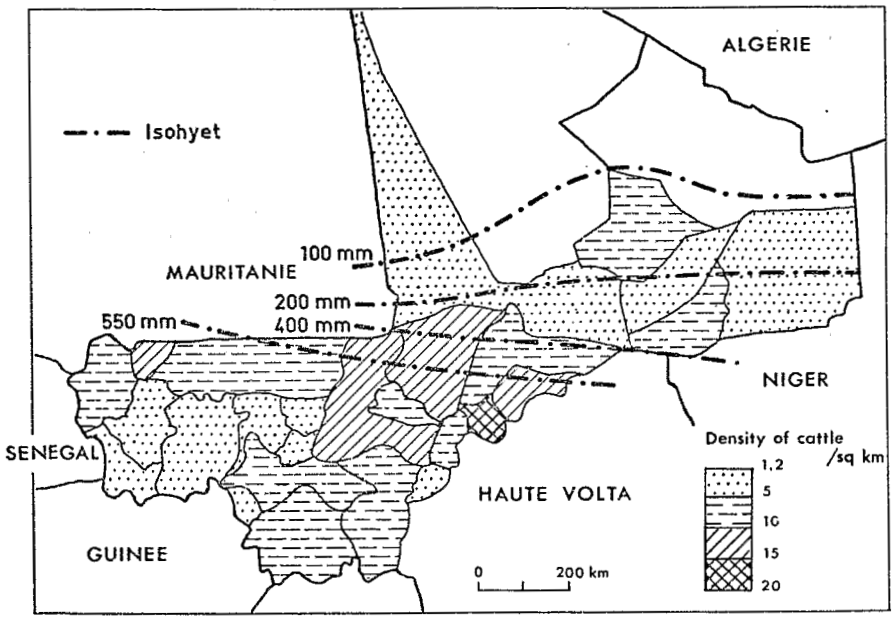


Figure 8.4.1. Map of Mali with rainfall and cattle density.

Drought and pastoral economy

The drought period has made itself cruelly felt in Mali (Table 8.4.1), as can be adjudged by the rainfall measured at Gao (latitude 16° 16′ N):

Average: 263 mm
Coefficient of variation: 31 %
Standard deviation: 182 mm.

Table 8.4.1. Rainfall recorded during the drought period at Gao, Mali.

Year	Rainfall recorded (mm)
1968	256
1969	186
1970	238
1971	173
1972	157
1973	144
1974	128
1975	307

Appreciable losses have resulted, not only in herds of cattle (Table 8.4.2) but also in the numbers of sheep and goats; the nationwide stock of these fell from 11.5 million head in 1971 to 9.2 million in 1974.

Table 8.4.2. Livestock in Mali (thousands of head)

	Cattle						Sheep/Goats	
	1970		1972		1974		1972	
Regions	Number	%	Number	%	Number	%	Number	%
Sahelian zone								
Gao (G)	1,800	33.6	1,266	23.9	384	10.5	3,884	44
Mopti (M)	1,400	26.2	1,596	30.1	1,493	41.0	2,129	24
Total	3,200	59.8	2,862	54.0	1,877	51.5	6.013	68
Sudanian zone								
Ségou (Se)	620	11.6	509	9.6	280	7.7	592	7
Bamako (B)	530	9.9	675	12.7	432	11.9	609	7
Kayes (K)	520	9.7	547	10.3	471	12.9	1,285	15
Sikasso (Si)	480	9.0	707	13.4	581	16.0	266	3
Total	2,150	40.2	2,438	46.0	1,764	48.5	2,752	32
	5,350	100	5,300	100	3,641	100	8,765	100

A substantial decrease has followed in the livestock supported (Table 8.4.3).

Table 8.4.3. Variation in number of cattle supported.

	Area (1000 km^2)	Cattle per km^2 1970	1974	Hectares per head of cattle 1970	1974
Sahelian zone	500	6.4	3.8	15.6	26.3
Sudanian zone	310	6.9	5.7	14.5	17.5
Mali	1,240	4.3	2.9	23.2	34.5

Drought and potentialities of the rangelands

Impact of the drought on sandy soil

At a normal rainfall of 200 mm, woody species with thorns thrive and production of the herbaceous cover varies between 400 and 800 kg ha^{-1} on a dry-weight basis. Areas denuded by wind and sheetwash erosion may reduce the productive surface by 5–50 %, according to where the areas are situated on the catenas; gentle slopes are the most affected. The consumable production may be estimated at 300–400 kg ha^{-1} of dry matter.

At a normal rainfall of 300 mm the ligneous species are always thorny, and the productivity of the herbaceous cover then varies between 1600 and 2200 kg ha^{-1}, but the areas denuded by erosion spread over nearly 20 % of the countryside. The mean consumable production may be estimated at 1600 kg ha^{-1} of dry matter.

At a normal rainfall of 500 mm the woody species are no longer thorny but bear large, deciduous leaves. The herbaceous cover does not now give way to eroded areas, but the biomass produced contains a large proportion of non-consumable species – possibly as high as 50–70 %. In spite of their greater rainfall, these rangelands provide a consumable herbaceous production of less than 900 kg ha^{-1} of dry matter out of a total production of 1300 kg ha^{-1}.

The typical, sandy Sahelian rangelands, which have an average rainfall of 300–400 mm and are situated not far from 16° N latitude, prove to be the most productive, with a consumable production of 1500 kg ha^{-1} of dry matter.

The scoured areas in these rangelands are probably recurrently eroded in a cyclic manner.

Particularly under a tree, the shady herbaceous carpet may promote intense biotic activity, which reduces resistance to erosion of the upper soil horizon and can lead to scouring followed by cementation of the soil pores on the surface of ablation. Later, the heavy seeds of perennial species (*Blepharis linariifolia, Chrozophora brocchiana, Tephrosia purpurea*) can be caught at the bottom of cracks in the scoured surface and there germinate during the rainy season. Then, in the dry season which follows, the hardy stems of these plants will trap small eolian deposits, and in subsequent rains the

deposits will serve as seedbeds for annual graminoids (*Aristida mutabilis, Cenchrus biflorus*) and for the wild water-melon (*Citrullus colocynthis*). Accumulations of sand around obstacles – "nebkas" as they are called – spread year after year until they restore the scoured area; meanwhile, the perennial species dwindle and the herbaceous cover is reconstituted.

Effects of drought on skeletal soils

Rocky outcrops are often characterized by scattered domes of dazzlingly white quartzite stones. The only growth here consists of rare and stunted *Acacia ehrenbergiana*, which manage to form groups along the drainage axes, and together with them areas of the annual graminoid *Tetrapogon cenchriformis*. Drainage channels at the bases of the domes are at present silted up with erosive deposits, and here, curiously, the stands of *Acacia ehrenbergiana* have become destroyed; probably the great bulk of their roots has been overly obstructed, and prolonged insufficient aeration has brought on the death of the trees.

While a few exceptional shrubs may survive on rocky outcrops, because of their location at spots where their roots can enter cracks and find enough moisture, trees on the sandy cover around the outcrops generally die from an inadequate supply of moisture.

Where there are semiskeletal soils with light horizons at about 10–20 cm and receiving less than 400 mm of rainfall, vegetation consists of striped bush (*brousse tigrée*). In 1970, thickets of *Pterocarpus lucens* were accompanied by grassy borders whose floristic zones were adapted to microvariations of the soil, and in the microbasins dominated by *Diheteropogon hagerupii* production was able to reach 7000 kg ha^{-1} of dry matter. In 1975, the shrubs in the thickets appeared to be dead, but some shoots revealed that many individual plants were capable of regrowing from stocks. The herbaceous cover seemed, however, to have completely disappeared, and the soil was evidently scoured and rendered sterile by sheetwash.

At a rainfall of about 500 mm the development of vegetation on identical soils seems less dramatic. Shrubby steppe containing *Pterocarpus lucens* tends to be scoured on slight and little-wooded slopes, with elimination of the herbaceous cover, crusting and sealing of the soil; meanwhile dense stands of *Pterocarpus lucens* survive in microbasins and at the tops of slopes in spite of some individual withered growths, along with the herbaceous vegetation they entrain (Fig. 8.4.2).

Effect of drought on colluvial soils

In the 200 mm rainfall zone, the countryside can be unrecognizable, as is the case at Tin Ahara in the Gourma. In 1970, the plain was covered with micro-dunes of sand, not more than 5–10 cm high, and it was colonized by annual graminoids: *Aristida mutabilis, Cenchrus biflorus, Schoenefeldia gracilis* and *Tribulus terrestris*. In 1975, the undulations of the dunes had disappeared, and the herbaceous vegetation was replaced by a dusty expanse of sandy loess (Fig. 8.4.3).

On the drainage axes, thick stands of *Acacia ehrenbergiana* and areas of the perennial graminoid *Cymbopogon proximus* have been succeeded by assemblages of the cruciferous *Schouwia thebaica*, a Saharan species which, owing to the period of drought, seems to have widely extended its spread on colluvia in the Gourma. It adjoins the clumps of *Cymbopogon proximus* that have kept their hold and also isolated stems of such other semi-desert species as *Corchorus depressus* and *Morettia philaeana*.

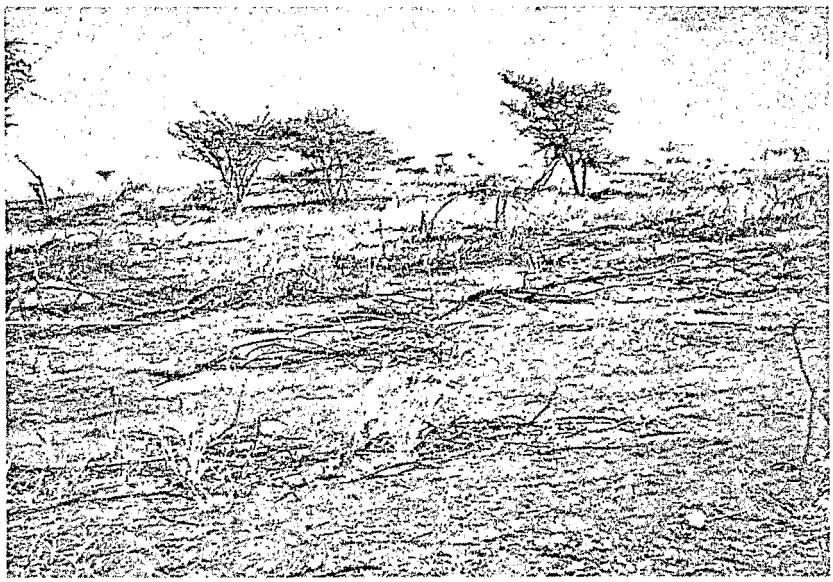


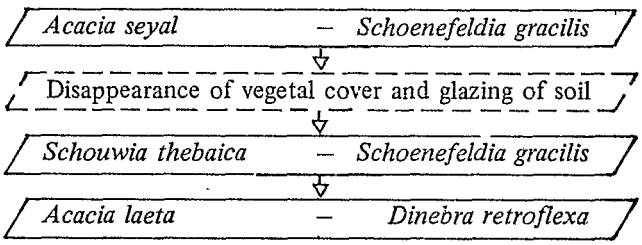
Figure 8.4.2. Death of shrubs in the drainage channels of skeletal soils.

Figure 8.4.3. Shrubby steppe with *Pterocarpus lucens* denuded and sealed slope with withering thicket of shrubs.

Ought we to conclude from this that the territory is turning into a real Sahara? We have increased reason to do so as woody species are no longer represented by more than a few stumps, and only rare leafy shoots of *Cadaba glandulosa* and *Maerus crassifolia* survive there.

Parallel to the observations already given, it is interesting to compare the development of vegetation on vertisols where there is an average rainfall of 400 mm. On one site, a thick stand of *Acacia seyal* and a compact sward with *Schoenefeldia gracilis* were withering in strips, the herbaceous cover was disappearing, bringing denudation, crusting and sealing of the soil. Five years later, crusted and denuded zones were still to be found, but beside them now were patches of herbaceous cover in which the graminoid *Schoenefeldia gracilis* surrounded central assemblages of *Schouwia thebaica*. Curiously, although a comparable community had been observed on another site, it was replaced by a dense herbaceous one dominated by the annual graminoids *Brachiaria ramosa, Dinebra retroflexa, Sehima ischaemoides* and a composite, *Bidens* sp.; in the shelter of this, vigorous young stalks of ligneous species flourished: *Acacia laeta, Balanites aegyptiaca, Grewia villosa.*

Perhaps we may already deduce the following outline of vegetative succession:



Vegetation on colluvia would, then, be evolving towards a Saharan type in the north of the Gourma and towards an adaptation to very impermeable soils in the south.

As a rule, the colluvia of large drainage axes are sealed and crusted generally and only patches of herbaceous sward with *Panicum laetum* survive, but on rather thin colluvia and on localized outcrops of ferruginous sandstone, the vegetation – striped bush – is diversified in strips that seem distinctly to shift their positions, an impression confirmed by stumps still existing on denuded and crusted soil.

Drought and its effect on fodder

Sometimes the herbaceous cover is totally different on two adjacent sandy formations, although the woody vegetation there is comparable. In particular, there may be a marked decrease in palatable forage species to the advantage of nonpalatable ones and an increase in the proportion of bare earth. Parallel to this, even if the overall productivity of the herbaceous sward remains above 1000 kg ha^{-1}, palatable production, except at the foot of slopes, diminishes. This change in vegetation might suggest that there has

been overgrazing, but we should not ignore the hypothesis of a slight localized rainfall, such being frequent in the Sahel where squalls take certain directions for no apparent reason.

B. Toutain, a researcher of IEMVT (Institute for Research in Stock Farming and Veterinary Medicine in Tropical Countries) has been able to make some very interesting observations in the Upper Volta, where he is carrying out a three-year study of South Sahelian pasturelands. While the mean annual rainfall there is 413 mm, it was 422 mm in 1974 but only 322 mm in 1975. At the end of July 1974, 284 mm had fallen as against only 164 mm in 1975. The result on sandy rangelands was a change in the herbaceous sward comparable to an effect of overgrazing: a proportion of 92 % of annual graminoids in 1974 and 8 % in 1975; no unpalatable varieties in 1974, but 37 % in 1975; 2000 kg ha^{-1} of dry matter in 1974, but only 200 kg ha^{-1} in 1975.

This change in the herbaceous flora and its productivity was sharper because the shortage of moisture is accentuated by slanting drainage. There are thus few or no graminoids on the sandy summits; they occur in slight density on slopes, but are relatively abundant at the foot of these slopes, where productivity reached 3000 kg ha^{-1} in 1975.

The grazing effect can be elucidated by continuous monitoring, starting from a watering-hole. Observation points for this purpose are chosen on the most representative facies of the pasturelands. The ligneous cover here is calculated by using a reference scale:

r = rare (a few individual growths per hectare)
f = frequent (numerous individual growths, but covering less than 5 % of the area)
a = abundant (convering more than 5 %).

The herbaceous species are estimated by computing from 100 readings, and the contribution they make is given in percent (calculated within a confidence interval of 10 %). These species are divided up into palatable graminoids, diverse palatable species and nonconsumable ones.

Productivity of the herbaceous cover is assessed as consumable or nonconsumable, then a balance is worked out which takes into account the denuded areas and the relative importance possessed by the facies of the characteristic sequences.

Where a dry-season water-hole is concerned the ligneous stratum is fairly homogenous (Table 8.4.4), even if *Balanites* and *Acacia raddiana* are more abundant in the vicinity of the pool. In fact, *Balanites* constitutes a genuine, semiclosed forest cover, 200 to 300 m wide, surrounding the pool. The herbaceous sward has no large scoured areas and grassy growth varies between 85 and 100 %.

In the herbaceous cover the importance of the decreasers is diminished by the grazing effect, particularly in the first kilometre: this makes it of interest to place the observation points at close intervals – the more so, since an inverse situation applies to the increasers.

Stationing livestock in the vicinity of a pool seems to promote both the species *Chloris prieurii* and productivity. Further outward, production increases progressively up to 5 km; it is as if, in the long run, dry-season grazing had a depressive effect on yield, a circumstance that could be explained by transfer of nutrients to the neighbourhood of the pool by the manure from cattle on places at rest.

Around a dry-season watering-hole, the woody vegetation is comparable, but the herbaceous flora is distinctly altered, especially close to the pool, where the invader *Heliotropium strigosum* is semi-dominant. To a distance of 4 km from the pool, the increaser

Table 8.4.4. Effect of grazing on the herbaceous stratum

Localization	Dry-season watering-hole									Rainy-season watering				
	0.5 km	1 km	2 km	3 km	4 km	5 km	6 km	7 km	8 km	5 km	4 km	3 km	2 km	1 km
Ligneous														
Cover (100 points)	5	5	5	1	5	5	5	15	1	5	5	5	+	5
Balanites aegyptiaca	a	a		f		r		r	f	f	r	f	f	f
Acacia raddiana	a	a	f	a	f	f	f	a	f	f	f	a	r	f
Acacia senegal		r	f	f	a	a	a	a	f	a	a		r	a
Combretum aculeatum		r	a	a			f	f	f		r	r	r	f
Commiphora africana		r			r		f	r	r	r		f		
Herbaceous cover (%)														
Bare soil	8	22	15	19	13	9	13	15	17	12	9	20	14	22	36
Number of readings	119	107	107	115	373	127	118	127	144	156	129	92	103	87	80
Accuracy	±8.0	±9.6	±9.3	±9.1	±5.1	±8.5	±9.2	±8.5	±8.1	±7.2	±8.8	±9.3	±9.8	±10.5	±10.8
Species														
Aristida mutabilis	2	8	36	33	44		8	9	12	29	24	1			
Brachiaria xantholeuca		8	14	3	1	64	49	9	3	1	47	12	37	28	1
Alysicarpus ovalifolius	4	18	14		3	1	8	12	6	8	3	9	4	7	3
Gisekia pharnaceoides		2	3	8	5	1	3	36		3					
Fimbristylis hispidula				4	2	1			40	19					
Tragus berteronianus									5	13					
Total of decreasers	6	36	67	48	55	67	68	66	66	73	74	22	41	35	4
Chloris prieurii	26														
Digitaria horizontalis	18	1						1							
Cenchrus biflorus	25	51	27	44	32	30	28	30	32	19	23	73	56	59	38
Zornia glochidiata		4												1	9
Tribulus terrestris	21					1		2	2	5					
Diverse	4	2					2			1		1	3	5	
Total of increasers	94	58	27	44	32	31	30	33	34	25	23	74	59	65	47
Heliotropium strigosum		6	6	8	12	1	1	1		1	3	4			36
Other invaders					1	1	1			1					13
Productivity (kg ha^{-1} d.w.)															
Nonpalatable varieties				50								50			495
Graminoids	1300	300	625	1185		2000	2175	1500	925	625	1125	1000	1125	1175	665
Legumes	50	100	60					50		125	100	150	125	60	
% of area	100	85	95	100		95	95	95	100	85	100	95	90	100	95
Yield per geographical ha	1350	340	650	1185		1900	2065	1470	925	635	1225	1090	1125	1235	630

Cenchrus biflorus clearly dominates, but *Brachiaria xantholeuca* takes over at 5 km, along with its companion *Aristida mutabilis*.

From 2–5 km productivity becomes stable at over 1000 kg ha^{-1}. This production, remaining after rainy-season grazing, testifies that a moderate number of livestock can be supported in spite of degradation of the rangeland near the pool.

Management of Sahelian lands

In using the Sahelian pasturelands, there should be a system which would allow a certain number of livestock to be kept there throughout the year, thus profiting from the water and forage, but by which the production potential would be retained. The livestock ought, meanwhile, to ensure the economic survival of stockbreeders by their production of milk and meat, and their increase in number.

Principles for managing a Sahelian area

At the juncture where rain will probably arrive, residual dry forage is indispensable to ensure a satisfactory feed of dry matter, and the young ligneous production, regrowth of perennial graminoids and young growth of annual ones should make an addition to this.

Thereafter, annual growth can provide what is necessary to maintain forage and also for production on new rangelands reopened for use because temporary watering-holes there are replenished with water. All the herbaceous production should not be consumed in the rainy period: some graminoids ought to remain so that they can multiply and the straw protects these pastures against wind in the dry season.

At the end of the rains, when the armed spikelets of graminoid seeds not yet have fallen on the dunes, it is indispensable that pastures should be rich in graminoids with invulnerable infructescences (*Schoenefeldia gracilis, Panicum laetum*). Unfortunately, the channels in loess and sand, which carry these graminoids, are often subjected to the effects of erosion with sealing of the soil; this leads to disappearance of the herbaceous cover and causes the woody vegetation to die out.

At the height of the dry season, the graminoids are all consumable in a dry state, and they constitute the basic fodder of ruminants. The legumes and various herbaceous species, along with leaves and fruits of ligneous ones, provide the necessary nitrogen. Recent observations have established that, during this period, cattle are in better health if they are watered only every other day, if they are able to graze both day and night, and if they can visit shrubby pasturage as they move about.

Livestock in these conditions show no clinical signs of vitamin-A deficiency at the end of the dry season, and their daily activity becomes similar to that which applies in temperate countries:

7 hours 10 minutes spent grazing
6 hours 40 minutes ruminating
3 hours 30 minutes resting
5 minutes watering.

To improve the management of pasturelands, it is necessary to take into account not only the watering possibilities there but also the extent and allocation of the principal

types of pasture. The necessity for vegetation mapping thus arises, adapted to the needs of those using the maps.

Here the regional carrying capacity of livestock enters in, provided that we are able to estimate the capacity of the principal existent rangelands. This can be assessed with exactitude only through a valuation of the herbaceous biomass which is palatable. The result must be given per geographical unit of the rangeland and with reservations made for variations due to climatic and grazing hazards.

It must not be forgotten that the Sahelian ecosystem also involves natural consumers – insects (ants, termites), birds and mammals – and that the litter cover is permanently bombarded by soil particles carried by the wind. A large part of the biomass is consumed and another portion is integrated with the soil in the form of debris of varying size.

Recent observations establish that there is a loss of about 40 % of the biomass during four dry-season months, so it is reasonable to assume that half of the net herbaceous biomass remains at the disposal of herbivorous domestic animals. However, it is necessary to keep the soil covered and to provide for residual straw at the beginning of the rains, the proportion consumable by herds could thus be a third of the herbaceous biomass, estimated on parts undisturbed at the end of the active period.

As a bovine daily consumes on average 2.5 kg of dry matter for 100 kg of its liveweight, its needs for a year can be estimated at 913 kg for each 100 kg of its weight, which requires a herbaceous biomass amounting to 2750 kg of dry matter.

The theoretical carrying capacity of Sahelian pasturelands can thus be calculated by starting from an average estimate of the aerial herbaceous biomass and using the following critera:

– 27.5 kg of dry matter for 1 kg of liveweight supported per hectare and year
– 19 kg of dry matter for a day's grazing on one 250-kg Tropical Bovine Unit (TBU).

When a pastureland no longer possesses more than a slight carrying capacity – less than one TBU to 10 ha – it does not justify the making of expensive arrangements. Either it can be used seasonally to support a satisfactory number of livestock, watering them from natural sources (pools) during brief transhumance in the semiarid Sahel, or it is suited only for use as a reserve: a nature reserve or one for wild animals (this in Sahel-type pasturelands on outcropping rocky substrata, with colluvial and grass-grown drainage axes). If made a reserve, the pastureland would later warrant being equipped for tourist purposes or with organized game-meat business in view.

As far as one knows, the way of dealing with climatic hazards would be to place 30 % of the pasturage in reserve, but leave it at rest for no more than a year or two. This would permit regeneration of the ligneous cover.

Many individual young ligneous plants are destroyed by rodents, but those of medium size develop even if they are habitually browsed on. The small branches lengthen until they reach the ground (*Balanites aegyptiaca, Ziziphus mauritiana*); shrubs which are reduced to stumps produce leafy branches more than 50 cm long; and shrubby trees diminished to dwarf size develop branches from 20 to 30 cm in length (*Cadaba glandulosa*). The quantity of leaves available increases to a notable extent and constitutes a living reserve rich in nitrogen.

Parallel with this, it is possible for the herbaceous cover to be regenerated on eroded and sealed zones merely through scraping with a harrow or a scarifier, preferably in

contour-line strips. In 1974 and 1975, spectacular results were obtained by this in the Voltaic section of the Oudalan. Simple tilling of the soil in contour-line strips a few metres wide permits regeneration of a cover with *Schoenefeldia gracilis*: this comes without preliminary sowing, the seeds being supplied by surface drainage. Young plantlets of *Acacia seyal* then sprout under the cover.

To sum up, one may say that reorganization of Sahelian rural territory should aim at rationalizing and improving the transhumance system, meanwhile reducing the distance traversed to only about 10 km between rainy-season pasturelands and dry-season ones. Nevertheless, with a view to maintaining rights to seasonal pastures in the north and to their use, a herd could be selected – oxen, dried-up cows and so on – at the beginning of the rains and sent on the long trek to pasturelands previously allocated within the framework of regional planning. Similarly, each year the surplus of animals (culled, steers) should be removed from the land, placed on the market or sent to rebreeding centres (cooperative or otherwise) either in the Sahel or in the Sudanian zone. Each area of land could be organized in accordance with the following plan (Fig. 8.4.4):

- Rainy-season pastures served by temporary watering-points, preferably pastures on sandy substrata even if the points are mostly establishable on skeletal soils.
- Dry-season pastures served by a permanent watering-hole. Dry-season foraging would take place along a centripetal course: at the start of the dry season and in cool weather, the herds graze at a distance, and they draw near only with the heat. Movement back and forth to the water would follow a favoured path, trampling of the herd thus becoming a genuine measure against the outbreak of fires. In a year with normal rainfall, 30 % of the pasturelands should be kept in reserve, various sections being placed at rest for a year or two in rotation. A shortage of rain in one section would automatically bring about its exclosure, at the expense of a more favoured part.

Dry-season foraging ought to take place in different kinds of pasture: on sands, at the beginning of the dry season, on loess, starting in January on wooded land that can be ranged through. Some wooded sites or those being covered with bush might not be used for pasture but kept in reserve to supply those who use the land with firewood.

These disposed pasturelands should be apportioned according to their resources of water and forage, and if possible along lines that follow the traditional ones for the whole rangelands as these have long been used by groups of breeders.

Use of the newly-arranged lands ought to be judiciously scheduled in order to prevent the created centres of attraction from being damaged by an afflux of stockbreeders. As far as financing permits, the units of pasturage should be set out on an ethnic or administrative basis and the scale adapted to their resources. The dispositions made at watering-holes should proceed in a parallel manner at the various sites and if necessary be spaced out in time.

The management of newly-equipped land ought to be delegated immediately to its users, the council administering it being guided during the first period by a multivalent and closely worked-out framework for their actions.

Although the theoretic scheme of organization can be followed without great alterations in a well-equipped forage region, certain adaptations may be required in such areas as the Malian part of the Gourma.

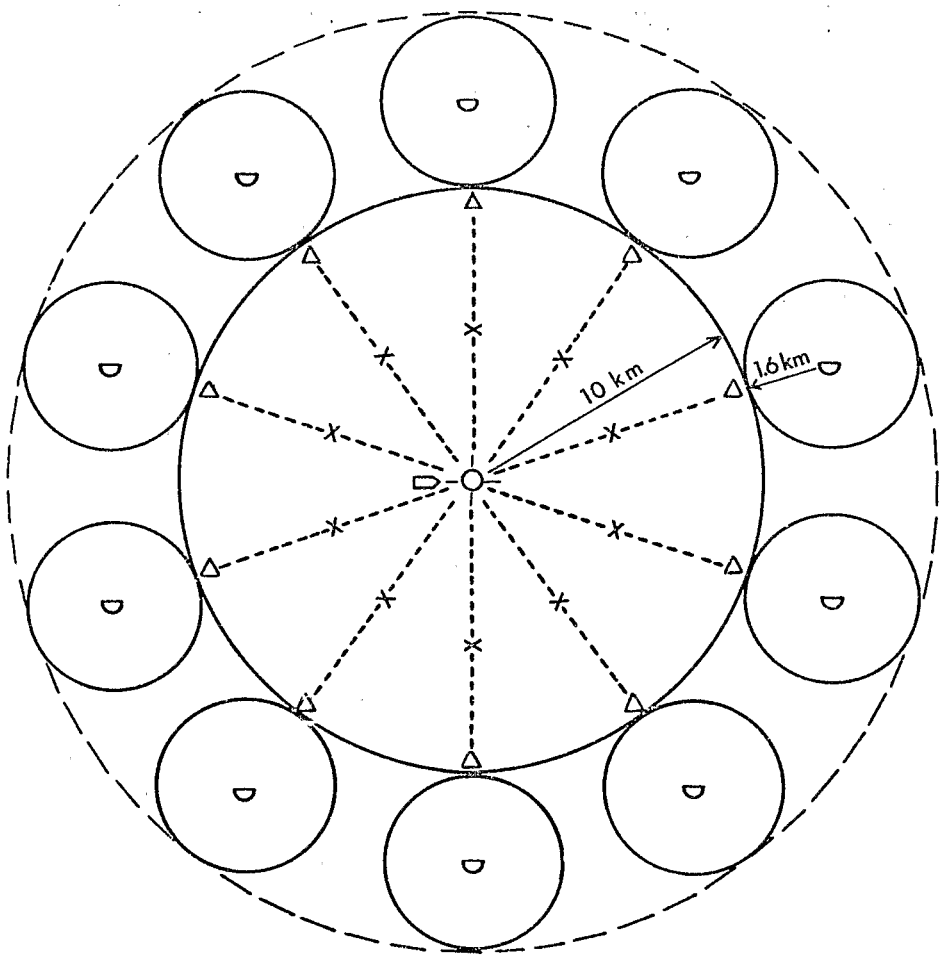


Figure 8.4.4. Planning of Sahelian land.

Case of the Malian Gourma

J. Gallais has located the main zones of traditional group-usage in the Malian Gourma, these sectors of transhumance being superimposed on the principal gathering places: water-holes and salt licks (Fig. 8.4.5).

On the inclined north-south line between Gourma Rharous and Ndaki, there are two main zones of traditional group-usage: these contain 17,500 head of migratory livestock out of the 117,000 officially counted within the bend of the Niger River.

10,500 Igouadaren, belonging to the warrior group under Commander Imochar, move between the river, the salt licks of Karouassa and the pools of Bambou, Fintrou and Gossi. 7000 Kel Gossi, belonging to the Imrad warrior group, move among the pools of Doro, Gossi, Ndaki and the salt licks of Amniganda.

Where the Igouadaren are concerned, transhumance takes place according to the following itinerary:

After the belated arrival of rains in the Gourma Rharous neighbourhood, herds must fortify themselves on the regrown pasturage; then, in July and August, moving in easy stages they reach the salt licks of Tin Ahara and the pools of Bambou and Fintrou.

In September and October, they graze around the little pools near Gossi and visit the salt licks of Karouassa.

At the end of October, they return to the sandy formations along the river; starting in February, they enter marshes of the inland Niger delta which are rich in "bourgou", a graminoid of the *Panicum* family.

This itinerary is marked by drawbacks that should be removed in order to improve management of the pasturelands:

- The line of verdure advances from south to north, and the breeders have to wait near the river in pastures which are overcharged and unproductive because they are semidesert.
- The fodder yielded by these pastures is further reduced as a result of the young shoots being grazed on at the beginning of the rains.
- The salt licks of Karouassa is visited by three groups of breeders; 10,500 Igouadaren, 2,500 Takarangat and 3,700 Kel Reris overgraze the surrounding pastures.
- Pasturage around the pools of the south (Adiora, Tézé, Fintrou) and the hill dam of In Alata is curtailed by the necessity of reaching the river before the pools in between – such as that of Tin Tadeini – dry up.
- The "bourgou" marshes of the Gourma Rharous region cover about 10,000 ha with a production reduced to 6000 kg ha^{-1} as result of the semidesert surroundings. They are used from February to June: with the capacity to supply 315 days of grazing. They can theoretically support only 21,000 TBU, but the livestock able to visit the marshes in 1971 was estimated at 130,000 TBU.

The result of these drawbacks is that, while pastures lying to the south of rangelands used by the traditional groups are comparatively little used, those of the Gourma Rharous region are overcharged during nine months of the year (November to July) in spite of their low productivity. However, isolated areas of overloading often exist at gathering places (salt licks and principal pools) to the south, for breeders give proof of a highly developed gregarious instinct, but the overloading is frequently due to the concentration of watering-holes.

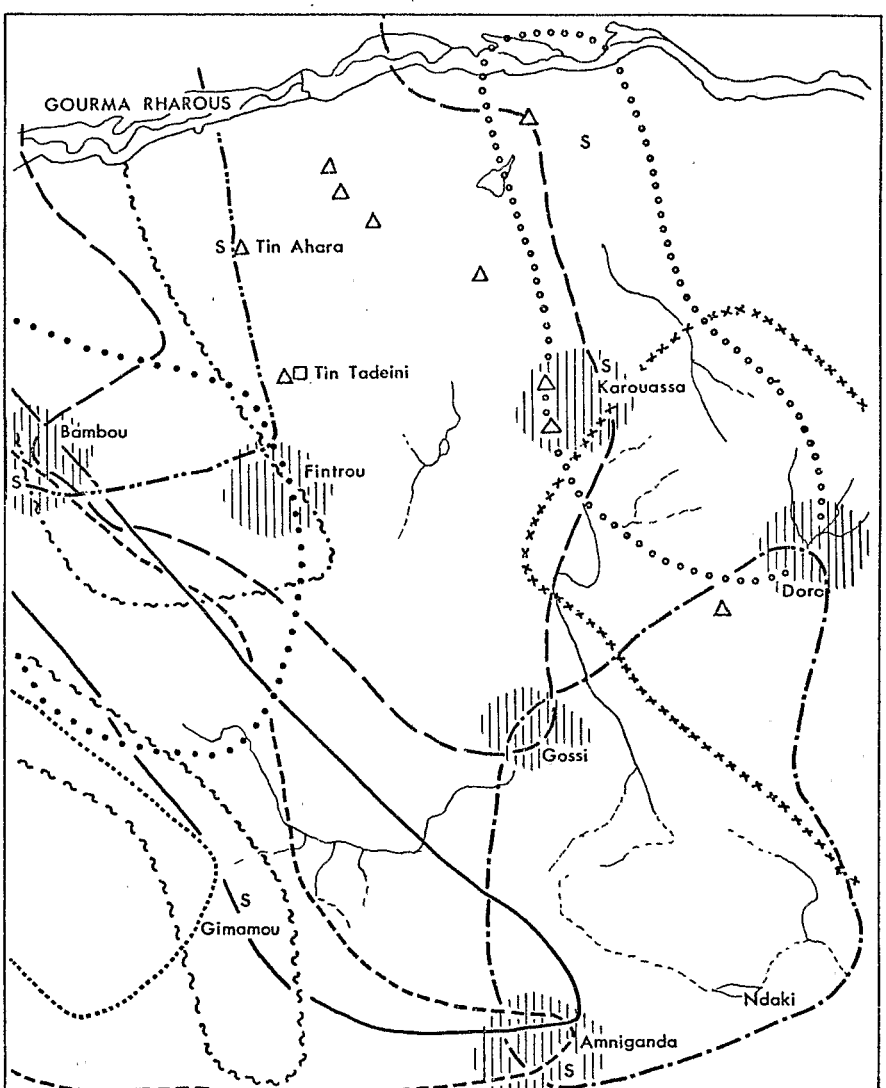


Figure 8.4.5. Grazing areas of different nomadic groups south of the Niger River. The boundaries of the different groups are marked on the map.

Improvement in management of the pasturelands means altering the dates of migration, but this cannot be done by making regulations and inflicting penalties on those who break them. Before that, "safety exits" must be offered to breeders.

While it has been possible to codify and regulate entry of herds into the "bourgou" delta-lands, the date of their return towards the river depends mainly on watering opportunities along the way. The authorities responsible have tried to improve water resources by a campaign for water prospecting by drilling.

Water resources are limited, by proximity of the basement bedrock, to a few localized ground-water supplies along the drainage axes, and the wells sunk are often adjacent to pools which are much frequented in the rainy season (Tin Tadeini, Ararous, Quinarden). Thus, forage in the vicinity is already consumed when the wells are put to use. The output of these wells, which have a depth of 60–100 m, is estimated at between 1500 and 3000 l h^{-1} hour (0.4–0.8 l s^{-1}). Water can be drawn up from 50–70 m by pumping with animal power. Each well has five forks, and about 700 cattle can be watered there each day. While the wells are capable of supplying some breeders in the course of the dry season, they are unable to ensure the watering of the bulk of animals in movement at the time of return to the river.

In the past, two cisterns were fitted into the Bambou and Tin Tadeini pools, and they constitute, along with the In Alata dam, an attempt at what could be done to make the best use of the territory. There have, however, been only a few years when water has remained in the In Alata dam throughout the dry season. It would be preferable to establish less ambitious dams on rock bases and to deepen pools where temporary ones already exist, thus ensuring certain watering points every 30 or 40 km during a late withdrawal of herds towards the river (in December–January). This relay system of surface watering points should lead to other such places, also of small capacity, which would add to the opportunities of watering offered by the large pools, and thus serve the pastures on dunes and drainage channels.

Such an arrangement would prevent too many visits to watering-holes on what may genuinely be called the axis of herd movement – where the forage stock, being left in place, would be consumable at the first rains, as soon as the impluvia, prepared if need be, allow a start at filling the reservoir to a satisfactory level for watering herds.

Management of the pasturelands ought, then, to be directed at carrying out the following ideal plan:

- Gradual departure of the herds as soon as the pools have water for them, without waiting for a fresh growth for browsing on land near the river
- Dispersal of the herds as quickly as possible to the small, prepared pools
- From the end of October, concentration of the herds at the big pools
- Starting in December, gradual return of the herds, in stages and on a schedule of which the Peul transhumances from the Niger Delta give an example
- Stay on the dune pastures bordering the river
- Starting in February, use of the "bourgou" land, then return towards the dunes in order to permit fresh growth of the "bourgou". After consumption of the "bourgou" stock, it is alternately left at rest for one month because of the return to the dunes, then grazed upon the next month.

Parallel with this activity, the manufacture of licking blocks, with addition of elements which the land lacks, could be organized at Karouassa. At the height of the rainy

season, these blocks would be distributed to encampments at the level of the little pools, traditional concentration around Karouassa would thus gradually be limited.

The surface of vast stretches of land in this pastoral area is sealed and denuded. Although its regeneration may be difficult because of the light rainfall, efforts to bring this about are justified.

Possibility of complementary activity in the Sudanian zone

Sahelian stockbreeding might be considered to aim at reproduction, and the rearing of young livestock ought to be carried out in the Sudanian zone. Such a scheme for tropical stock-farming of the future may, however, encounter numerous problems which for the moment are insoluble.

The Sudanian zone is primarily of an agricultural function, and its inhabitants are for the most part strictly farmers. However, revenues from farming activities are habitually invested in livestock. This is usually entrusted to salaried Peul herdsmen and badly managed. The herds – genuine savings banks for large farmers – are pastured in uncultivated areas and consume what remains of crops in the fields. At the height of the dry season, they may range over the vast expanses of brush, scoured by fires, where the total carrying capacity at this period can drop as far as a single TBU to 10 ha.

This extensive breeding of acessory type is, by itself, incapable of absorbing the surplus Sahelian animals, and the traditional system would have to be totally altered. The pasturelands would need to be demarcated and protected against the spreading of fires, which could not be done without previously revising the distribution of cultivated areas and their concentration on land with the most profitable yield. Adoption of crop rotation would also be required, as well as measures for preventing erosion and conserving fertility.

Along with the improved management of cultivated lands, adequate terrain could be freed for use as rangelands. However, in order to obtain the necessary intensification of stock-rearing, preliminary experiments need to be carried out, both as regards management of the rangelands and the introduction of breeds which will give better herds. Options and techniques involved here have only been outlined, especially where the northern Sahelian districts, with their long dry periods, are concerned.

At the first period, however, a certain number of young Sahelian steers could be absorbed by developing the use of draught-oxen in land cultivation. If the use of animal traction by farm-workers becomes general, after 4–5 years the steers will furnish good-quality meat.

If we consider the current rise in population, only the poverty of the soil, the dearth of permanent watering places or the presence of endemic diseases can explain the empty areas encountered in the Sudanian ecological zone. If it is possible to remove these obstacles, plans could be made to colonize the new lands, and here consideration should be taken of the need to ensure a certain complementary activity in the Sahel, with a greater amount of stock-rearing there in view. However, we must also take into account the necessity of diminishing the population in certain districts where it is too great and consider the unsolved difficulties posed by breeding in the Sudanian zone. Here, again, agreement should be reached on an effort to carry out experiments related to pastoralism in order to prepare for this new stage in national and transnational development.

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