

Country Pasture/Forage Resource Profiles

MALI



by
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1. INTRODUCTION

Mali is a continental country lying between 10° and 25° N and 4° and 12° E (see Figure 1). Surrounded by seven countries (Algeria to the north, Mauritania to the northwest, Burkina Faso to the southeast, Côte d'Ivoire and Ghana to the south and Senegal to the west), it is also landlocked. Its capital is Bamako and the main towns are Kayes, Segou, Sikasso, Mopti, Gao and Tombouctou.

Mali covers 1 241 138 km² and has a population of 11 000 000 (according to the World Factbook this had reached 11 716 829 by July 2006 with a growth rate of 2.63%) comprising thirteen great races divided into five groups over the whole territory:

- The Manding group formed of Bambaras and Malinkés represents 40% of the population
- The Sudanian group, 20% of the population, is formed of Sarakolés, Sonrhaï, Dogons and Bozos
- The Voltaic group formed of Sénoufos, Miniankas and Bobos represents 12% of the population
- The nomadic group (17%) is formed of Peulhs, Touaregs and Moors
- The remainder (Tocouleurs and others) represent 11% of the population.

Some of these groups have a precise geographical location (see Figure 2).

The population is essentially rural and the present degree of urbanization is about 30%. Population growth is 3% per annum. The official language of the country is French.

It is classed among the semi-arid countries.

Crop and pasture land. Mali is an agropastoral country, the rural lands, that is to say the crop and pasture land, cover 64% of the territory. This, according to the Project for Inventory of Land Resources (1986) (see table 3 and legend) is composed of arable land, 15.8% of the territory, non-arable zones, 39.68% and zones unsuitable for agriculture, 8.73%; this distribution is not stable; it evolves according to the need for land and following developments which render non-arable land to pass into the category of arable. Similarly land exhausted by cropping often passes into the sylvopastoral class. According to the study mentioned, potential agricultural land covers 12 000 000 ha of which 28 000 000–35 000 000 are regularly cultivated.

Crops on soils of varying potential, increase from north to south according to a general gradient of rainfall and soil quality. They are mainly cereals (millet, maize, sorghum, rice and wheat) and covered a little over 2 464 000 ha during the agricultural campaign 1999–2000. Industrial crops like sugar cane, cotton and groundnuts only covered 740 163 at the same period. Cereal production in 2000 was 2 894 000 tonnes and cotton, the main industrial crop, yielded 598 000 tonnes.



Figure 1. Map of Mali

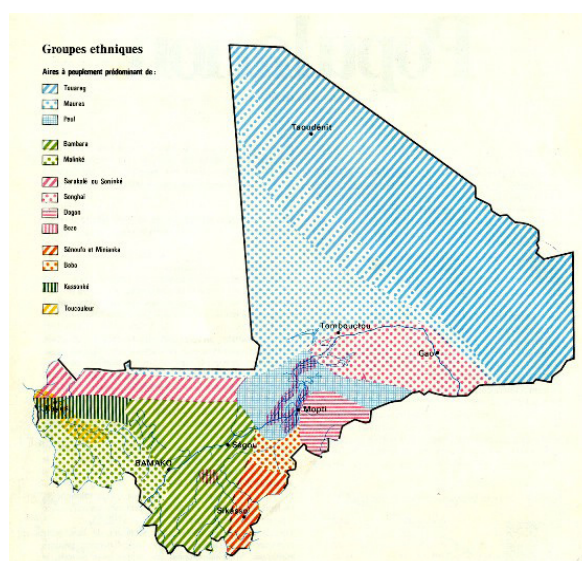


Figure 2. Map showing the distribution of the main ethnic groups

Sources : Atlas Jeune Afrique : Le Mali

Land not occupied by crops is generally considered as having a sylvopastoral use. Pastures under these conditions cover about 49 000 000 ha. Their composition and productivity vary from north to south following a rainfall gradient and according to soil quality and their topographical position.

Ruminant livestock

Stock-rearing is practiced throughout the country. The bulk of the livestock are found above the 600 mm isohyet despite the scarcity of water resources there.

The species kept are bovines, small ruminants and camels. Bovine breeds are represented by zebu, taurins and their crosses. In general Azaouak and Touareg zebu are kept in the north, Moors in the west. As for the taurins they are raised in the south, especially the N'dama breed. Small ruminants are distributed in all the zones, often with precise localities for the different breeds. Thus for sheep, the Sahel sheep and wool sheep predominate in the Sahel and the semi-desert zones whereas Djallonke sheep colonise the south (Sudanese and pre-Guinean zones). Two breeds of goat are recognized: the breed called Sahelian is abundant from the Sahel to the sun-Saharan zone and the Djallonke goat goes from the Sahel to the pre-Guinean zone. As for the camels they are only kept in the regions of Mopti, Gao, Kidal and Timbuktu.

The development of stock numbers is given in Table 1. The number of cattle, small stock and camels reached 22 949 000 in 1999 according to the Mali Office of Livestock and Meat (OMBEVI). Despite the size of these herds, animal production is generally fairly low. Also the amount of milk produced (about 500,000 M tonnes in 1999 and 601 770 M tonnes in 2004 – see Table 2) does not cover national needs and has to be supplemented by imports of dairy products worth 15 000 000 000 CFA Francs (US\$ 1 = 566 CFA Francs in October 2003) (according to the FAO database milk equivalent imports were valued at USD25 755 000 in 1998 and USD14 954 000 in 2003). It should be noted that in 2004 the contribution to the total milk production of 601 770 tonnes was approximately 183 800 tonnes of cow milk, 238 320 tonnes of goat milk, 124 500 tonnes of sheep milk and 55 200 tonnes of camel milk. Meat production reached 169 300 tonnes (OMBEVI) in 1999. This is less than 1998 when it rose to 206 716 tonnes (FAO database shows total meat production in 1991 of 206 849 M tonnes and 247 417 M tonnes in 2004).

Since the devaluation of the CFA franc the trade in animals and meat has been characterised by a drop in local consumption and a reconquest of export markets. Exports are mainly of stock on the hoof destined for the coastal countries. In 2000 it concerned 279 356 cattle and 439 057 small stock (see Table 2 – 279 000 live cattle and 450 000 small stock). The export of products such as hides and skins (FAO database indicates 17 390 Mt of fresh cattle hides produced in 2003 with 676 Mt of hides exported valued at USD 1 618 000) reached 5 118 673 000 Francs CFA in 1998. These figures bear witness to the importance of livestock in the Malian economy. Nevertheless the meat-livestock chain does not manage to come up to the expectations of national consumers and only partially to exterior demand for livestock products.

Farming systems. Rural land use is agropastoral, based on livestock and crop production. These two activities are extensive and itinerant and are based on the notions of farming in the agricultural zone and of pastoral land in the nomadic zone. Agriculture employs 90% of the rural population.

Land tenure. Land use is governed by a double system: both traditional and national law.

Traditional law recognizes, in rural areas, the utilization of land the allocation of which is under a chief. This recognition is only tacit, the State can reappropriate some land for works of common interest. That legislation, while recognising the application of traditional rights does

Table 1. Stock numbers in Mali (head)

Year	Cattle	Sheep	Goats	Horses	Asses	Camels
1980	5 850 000	6 250 000	6 750 000	142 000	470 000	231 000
1985	4 344 000	5 000 000	4 847 000	54 600	436 000	230 000
1990	4 996 000	6 086 000	6 086 000	77 000	576 000	245 000
1995	5 780 000	5 431 000	7 748 000	111 999	624 999	292 001
1996	5 882 000	5 707 000	8 102 000	123 120	637 500	327 040
1997	6 058 000	5 992 500	8 507 000	135 700	651 500	369 000
1998	6 239 750	6 292 400	8 932 350	149 500	665 770	415 008
1999	6 427 500	6 607 020	9 378 970	164 774	680 350	466 937
2000	6 620 300	6 200 000	9 848 900	165 000	680 000	467 000
2001	6 692 000	6 881 850	9 903 150	165 000	680 000	467 000
2002	6 893 000	7 225 840	10 398 160	170 000	700 000	470 000
2003	7 312 000	7 966 710	11 464 290	170 000	700 000	470 000
2004	7 500 000	8 364 000	12 036 000	172 000	720 000	472 000
2005	7 700 000	8 370 000	12 050 000	172 000	720 000	472 000

Table 2. Mali meat and milk production and live animal exports for the period 1996–2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004*	2005
Beef and veal prod. (.000 mt.)	85.8	88.4	91.1	88.7	75.7	84.6	103.5	113.0	97.8	97.8
Sheep meat prod. (.000 mt)	19.4	23.1	26.2	25.0	26.3	28.9	30.6	33.8	36.0	36.0
Goat meat prod. (.000 mt)	30.8	32.2	32.3	35.0	36.4	39.5	41.6	46.1	48.5	48.5
Total milk prod. (.000 mt) [Of which cow]	441.5 [139.9]	464.7 [144.6]	467.2 [148.5]	500.0 [156.8]	508.2 [161.7]	523.5 [167.8]	537.8 [169.1]	578.3 [179.3]	601.8** [183.8]	608.4 [188.7]
Live cattle exports (.000 head)	229.6	118.9	108.3	129.1	279.0	227.0	107.0	88.0	n.r.	n.r.
Live sheep exports (.000 head)	288.7	250.0	230.0	200.0	150.0	150.0	100.0	120.0	100.0	n.r.
Live goat exports (.000 head)	154.8	150.0	150.0	150.0	150.0	200.0	150.0	150.0	150.0	n.r.

Source: FAOSTAT 2006; n.r. no record

* In 2004 there was also an estimated production of 18 000 mt of Game Meat and 34 800 mt of Chicken Meat.

** In 2004 sheep milk production was 124 500 mt, goat milk 238 320 mt and camel milk 55 200 mt.

not fix the limit of their application. If customary law recognizes the pre-eminence of certain families or social groups over certain categories of land or resources, the appropriation of land in the rural zone is still collective and the users only have the usufruct.

Forest and land legislation, inherited from the colonial period, stipulates that all land belongs to the State. Lands are classified in three categories:

- public state land (inalienable)
- the private National lands (non-classified)
- land belonging to particular communities

The state authorizes the exploitation of part of its land by the people. All unexploited land and those not registered are in the public domain. The laws have evolved since 1974 and the regulations tie land rights to the economy, and the development of land became the sole criterion of application of ownership. This has been practiced in operations of rural development

In 1986 a revision of the code favoured all having access to private land. This brought about immediately a proliferation of rural concessions in peri-urban areas. In the countryside, on the other hand, that policy had little effect, and for reasons of social cohesion, the system of land tenure remained collective.

Land legislation and decentralization. The political and economic changes which have intervened since its enactment have made a revision of the legislation obligatory. In the context of a great movement of decentralisation, a great part of the prerogatives of management of land and resources which belonged to the State ought to be transferred to decentralised collectivities. The modalities for transferring the management of private state land are ongoing. They should lead to the definition of the role of rural communes in management of their land. The bequest of the legal ownership of land to rural communities should also be matched by transfer of part or all of the means for their management.

Farm types. The production systems of the sedentary zone are agropastoral. Each farmer gains his subsistence from the land and, secondarily, that of his livestock. The farm corresponds, consequently, to an area of land used for essentially agricultural ends. It is an agricultural landscape formed mainly by cropped areas. It represents “a series of fields developed by a group of family workers which cultivates at least one main communal field with which several secondary fields of varying size may or may not be associated having their own decision centre”.

Since in the sedentary zone the staple needs are based on food crops, the accent is on crops which are slowly being transformed from manual to mechanized production. These crops are grown on holdings the size of which varies according to land availability and means of production (number of active workers, equipment...). The average area of holdings varies from place to place. In south Mali with strong technical support the areas vary from 4–5 ha for unequipped farms to 27 ha for a farm with 4 or 5 or more pairs of oxen. In the west of the country (Kaarta) holdings are 2 ha for unequipped and 3 – 7 for equipped farms. In the rice-growing areas holdings are between 2 and 5 ha.

Most of the cereals grown are consumed locally. They suffice (except in disasters) to meet the population's needs. In 1996–1997 the agricultural campaign produced a saleable surplus of 123 000 tonnes of millet and 14 368 tonnes of sorghum. These surpluses are sold at local markets, or to outside ones (Côte d'Ivoire, Burkina Faso, Senegal). There is a potential demand in Mali for maize as an ingredient of livestock feed both for internal use and for the coastal countries. Mali could, according to

the specialists, be a rice exporter with a judicious policy of imports at the lean season. The cotton crop is exported; it reached a record 522 000 tonnes in 1999.

The pastoral zone. There are no farms in the classic sense in the pastoral zone. Resources are exploited collectively over the vast pastoral areas. These territories are units characterised by their water and grazing resources necessary for the production process. This production is either carried out according to a seasonal cycle in nomadic areas or to an annual cycle in transhumance areas. The herding skills of each stock-owner allows them to obtain the best benefit from the resources available.

The problems encountered in both farming and pastoral zones are of two kinds: social problems and socio-economic problems.

Social problems. These are essentially concerned with land tenure. The difficulties of access to land for certain social categories, the diminution of the useful and useable land for certain crops, and the challenging of the rights of pre-eminence of some groups, are always sources of latent conflicts. Administrative divisions which are only partially superimposed on traditional boundaries disturb local structures and often impose two foci of decision-making. That bipolarisation brings about changes within traditional institutions with loss of authority for the established hierarchies.

Aspirations for land by certain groups (young households and the landless) within a social group also causes disputes which lead to disruption of the extended family and the fragmentation of holdings.

Socio-economic problems. One of the constraints to rural development is that the people do not have security of tenure on their land. The pre-eminence of the state over land divests traditional structures of any responsibility for management and it is difficult for users to make long-term investments on land that does not belong to them. The user who only has the usufruct of the land limits himself to simple subsistence production, or production that gives him immediate returns. That production, from farms which are smaller and smaller, yields little surplus and is out of range of any intensification.

2. SOILS AND TOPOGRAPHY

Main topographic characteristics and soil types

Mali has a relief dominated by flat surfaces at an average altitude of 200 m, studded here and there with hills and buttes which hardly exceed 1 000 m altitude (see Figure 3). Its topography varies according to geology and varies according to natural region. The survey of land resources has identified fourteen regions within the four bioclimatic zones which characterize the country.

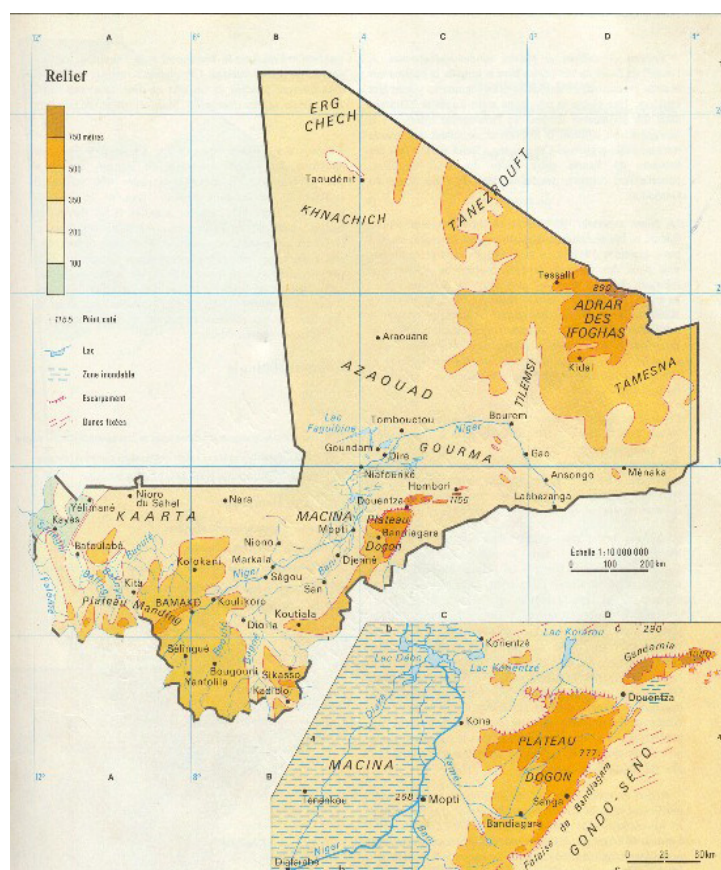
The Saharan zone

This contains the natural zones of Adrar-Timéteine, the Azouak of Tilemsi and the Aklé Azouad.

The Adrar-Timéteine is the most northerly part of the region, it is a vast massif on crystalline rock. The landscape is formed of relic buttes and plains formed by differential erosion. There are many glacis and valleys. The soils are aeolian deposits or heaps of gravel of colluvial origin.

The Aklé Azouad corresponds to the western part of the region. Situated north of the Central Niger delta and of the Hodh, north of the Gourma, it occupies the basin of Taoudénit. It is a vast erg with small dunes and great longitudinal cordons. It is a subsidence basin covered by fluvio-lacustrine beds of the terminal Continental and the early Quaternary. The soils here are dunal soils.

The Azouak is the eastern part of the region. It is a depression corresponding in the east to the basin of the Illumenden. It is bordered by the Adrar-Timétrine and the Tilemsi to the west and to the east by the Ténéré and to the south by the Niger border. The soils are sandy or rocky.

**Figure 3. Relief map of Mali**

(Source : Atlas Jeune Afrique : le Mali)

Legend for relief map

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Land type	Class unit	Soil	Restrictions to use	Area ha.	% rural land	% of Mali
Arable						
Category A1	I and II	Potential productivity high to very high	Minor limitations	5 657 752	24.6	15.8
Category A2	III & IV	Potential productivity moderate	Severe limitations (choice of crops)	13 937 376		
Non arable (pastoral & forest)						
Category B1 – wet land	V & some IV & VI	Potential variable	Restriction on type of plants	8 221 028	61.79	39.68
Category B2 – dry lands	VI & VII	Potential very low	Permanent limitations Erosion risks Lack of water Presence of stones and boulders	40 993 693		
Unsuitable for agriculture						
Category C	VIII	Production potential nil	Used by wildlife and for gathering natural products.	10 832 966	13.6	8.73
Total rural land				79 642 814	100	64.22

NB Non arable land may pass into the arable class after some development

The Tilemsi. It borders to the north and east on the Adrar des Iforas, to the west on Timétrine and the Azouad and to the south the valley of the Niger. It is an ancient subsidence zone filled by the sediments of the terminal Continental. The landscape is wide plains and low dissected plateaux. The soils are colluviums in the valleys and sandy on their edges.

The Sahelian zone

This comprises the Gourma, the Dogon Plateau, the Gondo-Mondoro, the Hodh and the Central Delta of the Niger.

The Plateau of Bandiagara-Hombori. This is a sandstone plateau that extends from south to north over 350 km. In the north it is a great table of hard sandstone sloping to the west. The beds of sandstone are cut by the network of a tributary of the Niger (the Yamé). The basins are filled by red sand. The Dogon Plateau extends to the northeast by the Gandamia which is a high sandstone relief reaching 1 080 m. Further east stand the buttes of Hombori, the highest reaches 1 115 m, the highest point in Mali. The soils are of colluvio-alluvial origin in the drainage lines or rocky and hardpans elsewhere.

The Gondo-Mondoro. Situated on the south-east of the Dogon Plateau, it is a vast zone of rock pavement covered by lines of dunes and recent deposits. Soils of alluvial origin are sandy loams, loamy sands or clay loams.

The Hodh. Situated in the west of the Sahel, the Hodh is a vast depression, locally sand-filled in the centre and dominated by the massif of Saeakolé. The soils are sands to sandy loams, or even clays in the plains.

The Gourma. Situated at the heart of the Malian Sahel, the Gourma is a vast peneplain at a mean altitude of 300 m. The clay-schist substrate is covered by series of lines of dunes. The substrate shows here and there as hillocks and crests of less than 50 m in height. The soils are dunal.

The Central Delta of the Niger. The delta is a humid ecological complex in a Sahelian context. It corresponds to the flood-plains of the Niger and the Bani surrounded by a continental glacis. The region has several lakes forming a lacustrine zone. Here and there buttes called “tougerés” sometimes emerge. The soils are of aeolian, fluvial or fluvial-lacustrine origin.

The Sudanian Zone

This contains the Mandingue Plateau, the Koutiala Plateau, the Guidimaks and the Falémé.

The Koutiala Plateau. As the eastern part of the Sudan zone the Koutiala Plateau is attached to the south of the group of sandstone plateaux of the Dogon country. It is constituted by a series of elevated areas separated by accumulation glacis and alluvial valleys. The soils are alluvial in the plains and derived from erosion on the laterite caps and high areas.

The Mandingue Plateau. Situated in the west of the zone the Mandingue Plateau has a broken relief formed by a succession of sandstone plateaux separated by basins and plains. The plateau ends, in the west, at the cliffs of Tambaoura which dominates the Falémé Plain. To the southeast the last plateaux of the Mandingue hills stand above the basin of the upper Niger. In the north the plateau is prolonged by the heights of Kaarta. The soils are of colluvial or colluvio-alluvial origin.

The Guidimaka. The Guidimaka, situated in the northwest of the zone, is a vast plain under 100 m in altitude. It is dotted with some sandstone hills which do not exceed 200 m. The soils are sandy loams or hydromorphic belonging to the Térékolé-Magui-Karakoro system.

The Falémé. This is situated in the extreme west of the zone. It is limited to the south by the Fantofa Plateau and to the north by the Senegal River. It is a plain with a relief of hills, buttes and glacis with gentle slopes. The soils are of alluvial or alluvio-colluvial origin. They are of moderate depth over the cuirasse and deep in the plains.

The Guinea Zone

This contains two natural regions: The High Bani-Niger and a part of the Mandingo Plateau. It is a peneplain with a series of glacis and more or less wide plains as in the region of Bamako at the foot of Mount. A relief of hills and hillocks dominates elsewhere as in the region of Bougouni. The soils are of alluvial or alluvio-colluvial origin. These are silts or silty loams but are lateritic on the cuirasse.

3. CLIMATE AND AGRO-ECOLOGICAL ZONES

General climate

Mali is a country with little marked relief. Also its climate depends narrowly on factors like the winds, rainfall and temperature. Four homogenous bioclimatic zones are based on these factors.

The Saharan zone

The Saharan zone is hyper-arid and desertic with water as its limiting factor. The rainfall (0 to 250 mm annually) is low, random or accidental with as a consequence an aridity aggravated by the harmattan. Temperatures there are high with great differences between day and night.

The soils are skeletal (sandy or stony) with a poor water-holding capacity. Crops are only possible under special conditions. Stock-rearing, where it is possible, reigns without competition.

The Sahel Zone

It is arid with rainfall between 250 and 550 mm. It is characterized by a long dry season of 9 to 11 months. The soils are either sandy or aeolian origin forming dunes separated by numerous peneplains, or skeletal on rock outcrops and cuirasses. The main activity is subsistence agriculture associated with transhumant and nomadic stock-rearing.

The Sudan Zone

The Sudan zone is semi-arid to sub-humid. Its rainfall is between 550 and 1 100 mm. The soils are ferruginous tropical ones with colluvions in the depressions. Because of the more abundant rainfall, the agricultural activities are more intensive with a certain guarantee of success. Stock-rearing is sedentary with a seasonal migration; it is more and more integrated with crop production.

The North Guinea Zone

The climate of the North Guinea zone is subhumid with rainfall over 1 100 mm. The rainy season lasts five to seven months. This zone corresponds to a forest area. The soils are red ferralitic. Agricultural activities are more and more oriented towards the production of fruits and tubers.

Table 3. Natural zones and agro-ecological zones

Bioclimatic zone	Natural region	Rainfall	Agro-ecological zone
SAHARAN	Adrar-Timétrine	0 to 150 mm	Adrar Timétrine
	Azaouak	0 to 200 mm	In Tallak In Erzegar
	Tilemsi	150 mm in the North 200 to 350 in the South	Vallée du Tilemsi Abourak Kounta
	Aklé-Azaouad	0 mm in the North 200 mm in the South	Minkiri Berabich
SAHELIAN	Gourma	250 mm in the North 500 mm in the South	Gandéras Tin Bilal In Tillit
	Plateau de Bandiagara Hombori	450 mm in the North 800 mm au Sud	Bas Plateau Bobo Haut Plateau Dogon Djoundjé
	Gondo-Mondoro	450 mm in the North 800 mm in the South	Plaine du Gondo Plaine du Sourou Le Mondoro
	Le Hodh	350 in the North 750 mm in the South	Mamanan Guidé Toronké Bas Kaarta Haut Kaarta occidentale Ouagadou Tyemandali Daounas
	Le Delta Central Nigérien	250 mm to 800 mm	Delta vif Moyen Bani-Niger Delta mort Zone lacustre
SUDANIAN	Plateau Mandingue	550 mm to 1 400 mm	Tambaoura Bambouk Gangaran Wenia Bélédougou Fladougou
	Plateau de Koutiala	650 mm to 1 300 mm	KénéDougou Moyen Bani oriental Moyen Bani occidental Falo
	Guidimaka	350 mm to 550 mm	Bérédji Séro
	La Falémé	750 mm to 1 400 mm	Falémé Nord Falémé Sud
GUINEAN	Haut Bani-Niger	1 000 mm to 1 400 mm	Haut Bani-Niger occidental Djitoumou Ganadougou Haut Bagoé
	Plateau Mandingue	1 100 mm to 1 400 mm	Tambaoura Bambouk Monts mandingues

Source: *Stratégie nationale de conservation de la diversité biologique.*

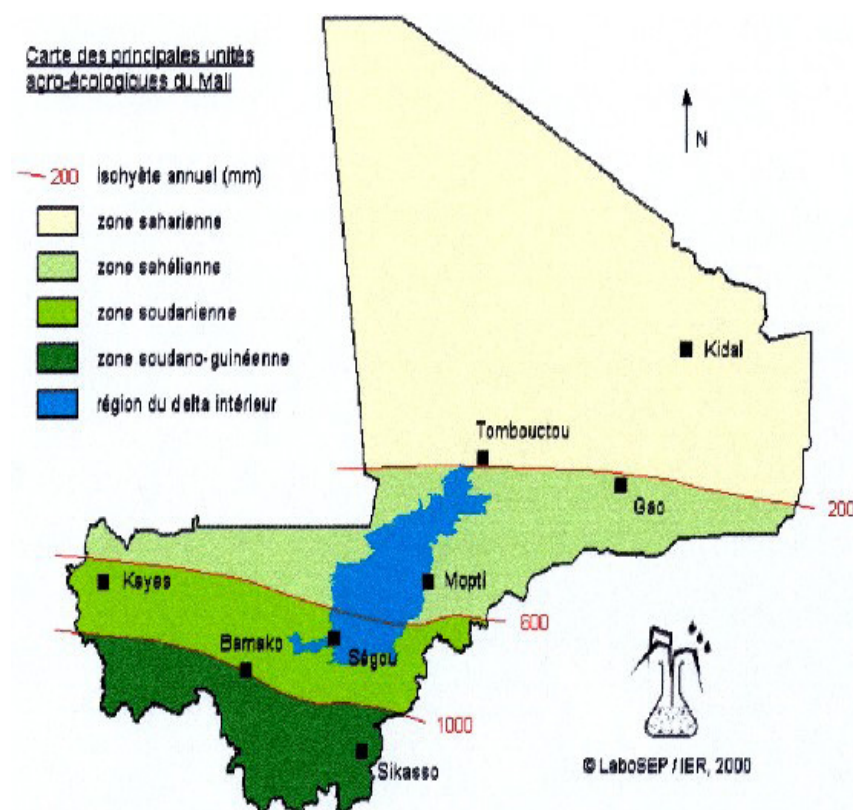


Figure 4. Agro-ecological units of Mali

Agro-ecological zones

The agro-ecological zones are the result of combining of ecological and agroclimatic zones. Forty-nine zones have been identified by the Projet Inventaire des Ressources Terrestres (PIRT) within the great natural regions. Each of them is characterized by its resources of soils, vegetation and water. The general characteristics of these zones, therefore, arise from those of the natural region to which they belong with nevertheless local variations which allow of their identification (see Table3.). Figure 4 gives an overview of the great agro-ecological units of Mali.

4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

Pastoral systems

These are practised in zones where land pressure is light and where crop production is almost absent because of low rainfall and the quality of the soil. The lands representative of these systems have a pastoral and woodland vocation.

Nomadic stock rearing

Nomadic stock raising is characterized by frequent movements of the herders and their stock, without fixed campments, according to the availability of resources. The areas of nomadic stock-rearing are either distinct or confluent and the family groups are more or less separated. Production follows a seasonal cycle. This type of system, or pure pastoral system, is found in the sub-desert zones in the north of the country (Adrar, Azaouad, Azaouak and Tilemsi) and in those of the northern Sahel such as the Gourma and the Hodh. The breeds raised in these regions are zebus (Moor and Tuareg) for cattle, Sahelian sheep and goats for the small ruminants and camels. The products are milk, meat and wool. The milk provided by cattle, goats and camels is insufficient and is all consumed fresh or made into cheese. Meat is provided by goats and hair sheep. Long-haired sheep produce wool. There is no saleable surplus of these products.

Transhumant systems

Transhumant stock rearing involves a system associated with rainfed and falling-flood agriculture. It is characterized by movements back and forwards between pastoral territories by pastoral groups or communities seeking resources on land other than their own. These movements called transhumance are made according to fixed axes and for a given period of time. Transhumance is characteristic of the Sahel. It takes the herders from south to north at the onset of the rainy season to remove the herds from the agricultural areas or areas which are flooded (in the case of the Niger Delta). The return south is made according to the progressive drying up of watering points and the exhaustion of the northern pastures. It is in the dry season that resources available for the animals are more plentiful in the south (water in watercourses, pasture after floods recede, perennial grasses, crop by-products and residues).

In the agropastoral zone of the internal Delta of the Niger there was a pastoral code inherited from the Dina empire at the beginning of the nineteenth century. According to the code the Delta was sub-divided into grazing areas or *leyde*. A *leydi* consisted of villages of sedentarised Peulh(ouro) and their pastures, of villages of Rimaïbé farmers and their crop lands and a network of corridors for stock movement. The coexistence of stock raising and cropping necessitated a separation of grazing land and arable as well as rules for pasture use. The definition of different classes of land “responded to the needs of the people and the livestock in a sedentary context”. The flooding of the Delta during the rains meant that the livestock could not stay there at that season, the herds were divided into:

- *garti* formed by large herds which undertook transhumance under a chief herder;
- *benti* composed of milking cattle and young calves which remained close to the villages but made a small transhumance;
- *dumti* composed of a small dairy herds to assure the food supply of those who remained in the village (women, children and the aged).

The land too was organised in pastures after the flood receded, *bourgoutières*, with control of the order of access of livestock to the *bourgou* (*Echinochloa stagnina*) on their return from transhumance with payment of a grazing fee for the livestock of strangers and resting and collecting areas (*bille*) which were communal land where cultivation was forbidden and *harrima* or a village's protected pasture and a network of tracks giving access without danger for the crops.

“The organization of the population and the grazing land avoided overexploitation of the land and its resources”.

After independence the administration declared the grazing land to be open to all and abolished the collection of grazing fees. “It nevertheless continued to recognize the rights of bourti (singular of *bourtol*), *bille* and *harrima* and the order of entry to the *bourgou*.”

The herds are much greater here than in the previous system and contain Fulani and Moor zebus for the cattle, Macina sheep and Sahel goats. The productivity of the cattle is mediocre but comparable according to some authors, to that found in other zones of Africa. Stock trading is highly developed in this system which, because of the size of the herds, produces a considerable saleable surplus.

Agropastoral systems

These are systems where crop production and stock rearing cohabit. According to the predominance of one or the other component a system where livestock predominate or where crops are more important can be distinguished.

Livestock-dominated sub-system

This system is found on the northern fringe of the Sahelian zone where the irregularity of the rainfall cannot guarantee a crop but assures forage production on still wide areas. The herders cultivate some bottom land and areas of peneplain in the rainy season to have some complementary subsistence production. Transhumance is the rule here as well. The livestock receives little care and is poorly integrated with crop production; they provide milk and meat for domestic consumption and mainly play a role as savings.

Crop-dominated sub-system

This is a sedentary system with the emphasis on agriculture. Some sedentarized herders who have become farmers practise a minor transhumance of short duration. Stock keeping develops in this system

through farmers acquiring livestock thanks to cash earned from agriculture. These animals, always constituting savings, are integrated into the agricultural production as a means of work (work oxen) and of dung (dung contracts between herders and farmers).

There is a variant within this system where livestock serve as a real support for farming. This system is highly developed in areas of cash crop production (cotton zone) and of agriculture which is becoming intensified (zone of cotton and rice production, zones with strong technical support inputs). The livestock have constant care (health care, shelters, feeding) and participate increasingly in agricultural production supplying dung, draught and marketable products (milk, fattened stock). Thanks to the relative plenty of feed resources stock movements are very short. The productivity of the stock is not very high and attempts are being made to improve it.

Commercial production systems

The improvement of livestock production not only aims at increasing output for the domestic consumption of stock-rearers, but also to provide a marketable surplus. Commercial production systems are therefore in two main fields, milk production and fattening.

Milk

To increase their milk production some agro-pastoralists have begun to select the best milkers of their herd in order to improve their feeding. The improvement in feeding by the use of cultivated forage, cotton cake, molasses, treated straw and cotton seed or concentrates has made it possible to raise milk production from zero to 3 to 5 litres per day during the dry season in some farms of the cotton zone. Their milk is sold to small dairies which have set themselves up in some urban centres. Producers, attracted by the income are now turning to genetic improvement through artificial insemination to increase their milk production. This strategy is adopted by some stock owners in the CMDT zone of Koutiala and Sikasso and by others in Mopti and Ségou. Milk production has become the dominant activity of urban and peri-urban livestock keeping and these have a number of stock of improved breeds. Peak productions of 20 litres per day have been achieved by farmers in the periurban zone of Bamako.

Fattening

This is less developed than milk production. It is done by a few stock-owners in peri-urban areas and some agro-pastoralists in the rural areas. The stock fattened are essentially cattle in peri-urban areas and sheep (for Tabaski) or cull cattle (sterile cattle, work oxen or other males at the end of their useful life) in rural areas.

The rations used for this fattening vary according to availability. Those recommended by the Institut d'Economie Rurale in the Niono area are:

For 3–4 year old stock, of 220–250 kg for a daily gain of 780 g during 90 days, daily: rice bran 8 kg, cowpea haulms 0–1.5 kg, molasses 1 kg, “Achar” concentrate 1 to 2 kg, urea zero–0.1 kg.

For 7 – 10 year old beasts of 300 kilos for a daily gain of 850 g, daily: rice bran 10 kg, cowpea haulms 0 – 1.5 kg, molasses 1.5 – 2 kg, “Achar” concentrate “ 2 – 3 kg, rice hulls zero – 2.5 kg, urea zero – 0.1 kg

(Source : Orientation stratégique des appuis à l'élevage au Mali. (Ambruster *et al.* 1999)

Fattened stocks are either destined for local, profitable markets or, mainly for external markets.

Livestock feeding systems

Natural pastures

Animal feeding in all livestock productions systems is based in the first place on exploitation of natural pastures. The animals go to graze on different types of pasture the resources of which (forage on offer) varies with the seasons, the availability of water and the quality of the soil. The availability of natural pasture increases, like the rainfall, from north to south while its quality diminishes in the same direction.

The use of pasture alone as a source of livestock feed is an absolute rule in the north Sahel and the sub-desert zones. In the south the use of crop residues helps to complement the pastoral resources. The greater availability of the forage on offer in the south has attracted the descent of a good number of Sahelian herds.

Despite the importance natural pastures have in the nutrition of livestock, there are no comprehensive studies on Mali's pastures. Those already done are fragmentary and only deal with particular zones. They do not permit the preparation of a pasture map except through reference to the great vegetation zones. It seems indispensable, therefore, to carry out such studies so as to provide a tool for planning livestock development.

Stall feeding

This feeding method takes two forms and concerns sedentary systems in agropastoral and peri-urban areas.

Grazing with supplementation. The animal still exploits the pastoral resources, but it receives a complement of hay, dried pulse haulms, cotton seed, cake or concentrates, in the evening on its return to the stall or kraal. The quantity given varies according to the stock owners and the resources available. This feeding is more controlled in commercial production systems where the rations ought to be balanced.

Permanent stall feeding. This is the rule in intensive livestock production (dairy cattle, fattening) where the gains in productivity must pay for the cost of production. It is mainly carried out by some well-off stock-owners in peri-urban areas with a limited number of animals.

Tethering. This is used for dealing with a few animals; especially for work oxen during the cropping season, small ruminants and a few milking cows. The animals are tethered during the day on uncultivated land not far from the village. Some fodder is given in the evening when they return to the enclosures.

Integration of livestock into production systems

In improved agricultural production systems, the plough and other implements have largely replaced the traditional ploughing instruments. The use of animal powered cultivation has since developed, notably in areas with strong technical support and extension. A substitution of animal power for manual labour has come about with an increase in the number of oxen per farm and per zone. This is notably the case in the cotton-producing zone of the CMDT, for rice growing of the Office du Niger and of those rainfed crops under the Opérations de Développement.

The changes which have come about in the ways of looking after livestock (construction of enclosures, rotational grazing in the dry season, on crop land) have contributed to a better collection of dung and the making of compost and farmyard manure. The animal, providing work and manure became a true support for the farmer who, in return, provides it with the necessary resources for its requirements in maintenance and production. These resources are crop residues to which it is necessary to add cultivated fodder, even if these are at present insufficient in quantity.

Constraints to livestock production

Constraints due to diseases and lack of resources

Diseases. The main diseases of cattle are Pasteurellosis, Rickettsiasis, Trypanosomiasis, Tuberculosis, Brucellosis and Black quarter and Anthrax. Cases of peripneumonia and rinderpest appear sporadically in some places. To these great diseases have to be added parasitic diseases (internal and external) which affect mainly the young and cause a high mortality of the order of 30% in the under twelve month age group. All these diseases, because of insufficient vaccination cover and the absence of systematic deparasitation, cause a fall in the animals' productivity and losses within herds.

Water. The main livestock rearing areas (except for the Delta and near rivers) are without permanent water points. The surface water there dries up rapidly after the onset of the dry season. The search for water consequently becomes a serious problem throughout the dry season for the herds and their owners. The dispersion of existing water points (permanent ponds, wells, shallow wells) and their distance from pastures exploitable in the dry season necessitates long travel which exhausts the animals. The available resources only suffice, just, to cover maintenance needs. Herd productivity drops during this period.

Diseases and lack of resources are the most severe limitations of livestock production systems.

Socio-economic constraints

Several factors come together in the socio-economic limitations to livestock production. The first factor is doubtlessly, in many cases, competition between livestock and farming for land. That competition is very severe in areas of limited potential. Thus there is competition for land in agropastoral zones and for resources in pastoral zones. No rule defines the strict conditions of use of resources which are communal; each uses the strategy which seems best to satisfy their needs and those of the herd. That strategy is not based on any particular obligation; exploitation of resources is similar to gathering.

The second factor is insecurity of tenure which prevents agropastoralists from investing in improving resources.

Farming and livestock could nevertheless complement each other mutually as has been described for integrated and agropastoral systems. To achieve the rules for land ownership and management ought to be reviewed so as to lift the burden of insecurity of tenure from rural people. Development plans and codes of management should be drawn up with the farmers and stock owners to whom the legal property rights and power to manage the land would be transferred.

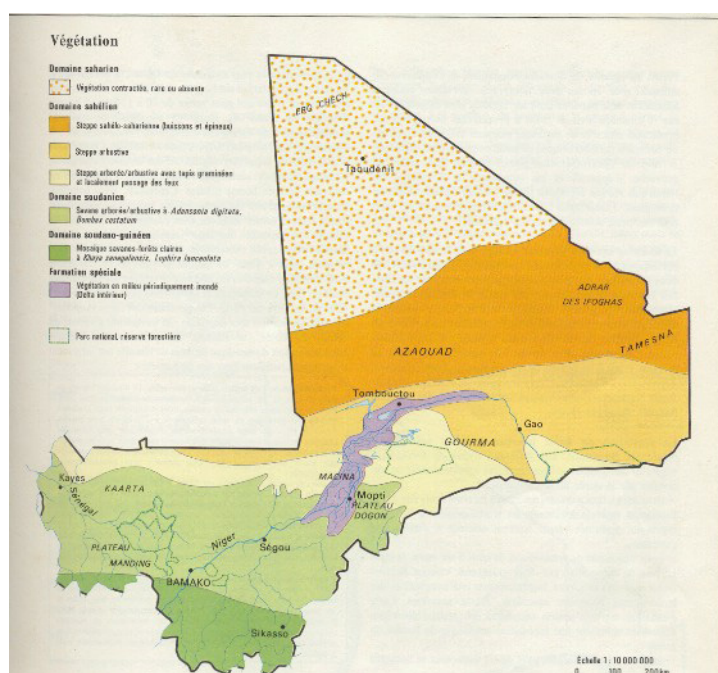
Low herd productivity

The third constraint limiting animal production is the low level of production of the livestock. The offtake is of the order of 14% for cattle and 34% for small ruminants (U.E / KIT= Union Européenne/ Institut Royal des Tropiques). Herders and agropastoralists tend to keep animals as long as possible, even unproductive ones, for reasons of security, to have a big herd or for production. The imbalance between stock numbers and resources explains low herd productivity and the low level of development of the pastoral economy.

5. THE PASTURE RESOURCE

The vegetation and pasture types

There are four great climatic types to which the four great vegetation zones are tied. The distribution of that vegetation varies with soil and topography. Figure 5 shows the main vegetation types in Mali.



Legend for vegetation map

Vegetation

Saharan Domain

Vegetation low-growing, rare or absent

Sahelian Domain

Sahara-Sahelian steppe (bushes and thorn scrub)

Shrubby steppe

Shrubby/treed steppe with grass understorey sometimes affected by fires

Sudanian Domain

Savanna with trees or bushes and *Adansonia digitata* and *Bombax costata*

Sudano-Guinean Domain

Mosaic of *davannas* and open forest with *Khaya senegalensis* and *Lophira lanceolata*

Special Formation

Vegetation of land periodically flooded – the Interior Delta

Figure 5. Main Vegetation Types in Mali

The Saharan zone

The Saharan steppe. The northern part of the Saharan zone with zero to 150 mm of rainfall has little importance for stock-rearing. It is a zone where one passes without ever stopping. Its vegetation of *Cornulaca monacantha*, *Panicum turgidum* and *Aristida pungens* forms pastures whose production varies from zero to 500 kg of dry matter per hectare.

The zone of the sub-Saharan steppe. This is found between the isohyets of 150 and 250 mm and carries vegetation located in the wadis and ravines. That dwarf vegetation is formed by a herbaceous cover based on short cycle annuals (*Aristida hordaceae*, *Morettia philaeana*, *Farsetia stylosa*, ...) and a sparse woody layer of *Acacia ehrenbergiana*, *Acacia tortilis*, *Balanites aegyptiaca* and *Maeura crassifolia*. Vegetation can be abundant in the depressions and plains corresponding to the beds of wadis like the Adrar, or to zones of spreading spates (Adrar, Tilemsi, Tamesna). These areas carry pastures of *Aristida* sp., *Shouwia thebaica* the productivity of which varies according to the rains from 1000 to 2 000 kg DM/ha. On lines of dunes and sandy areas *Aristida* dominates (*A. mutabilis*, *A. pallida*, *A. papposa*) and *Panicum turgidum*. The woody species cited above are associated with these grasses. The spatial dispersion of the pastures and the rapid consumption of the forage on offer, as well as the rapid drying of water points obliges the herders to be nomads.

The Sahelian steppe. It is situated between 250 and 500 mm of rainfall. Its vegetation on dunes in the north is xerophyllous; the grass component is dominated by *Cenchrus biflorus*, *Aristida mutabilis* and *Schoenfeldia gracilis* while the woody component contains *Acacia senegal*, *Acacia laeta* and i. The vegetation is open on dunes with low water retention and slopes with high runoff. To the south the vegetation is mesophyll steppe. It is localised in the silty depressions with *Schoenfeldia gracilis*, *Panicum laetum*, *Acacia laeta* and *Salvadora persica*, and in the flood areas of rivers where aquatic grasslands are formed with perennials like *Echinochloa stagnina*, *Oryza barthii* and *Vossia cuspidata*. These pastures are excellent grazing after the floods recede.

On the plateaux, the lateritic cuirasses are colonized by *Combretum nigricans*, *Guiera senegalensis*, *Lannea acida* and *Sclerocarya birrea*.

The best pastures of that zone are those after floods (borgoutières of the Central Niger delta and the lacustrine zone the productivity of which can reach 10 tonnes DM/ha), and the pastures on the dunes and sandy formations whose mean productivity varies from north to south between 1 000 and 2 000 kg DM/ha. The extent of these pastures enables livestock to remain in the north Sahel for quite a long period. Floristically the southern Sahel forms the transition between the Sahelian and Sudanian zones. It contains elements of both biogeographical zones with, however, a marked abundance of north Sudanian elements (*Combretaceae*) and a predominance of tall species in the grass cover.

The Sudanian zone

This zone between 800 and 1 400 mm of rainfall is the “parkland savanna” zone with a full herbaceous cover. This savanna is characterised by *Vitellaria paradoxa*, *Parkia biglobosa*, *Sclerocarya birrea* and *Lannea acida*. The herbaceous layer is dominated by perennials of which *Andropogon gayanus* is now tending to become scarcer because of clearing. In cultivated areas only fragments of formations of *A. gayanus* survive with vast areas of the unpalatable *Andropogon pseudapricus*, *Cymbopogon giganteus* and *Pennisetum perdecellatum*. Sudanian pastures have a biomass that goes from 800 kg of dry matter in the north to 2 000 kg in the south. The forage is generally of poorer quality than in the Sahelian zone.

The Sudano-Guinean zone

This zone, with over 1 000 mm of rainfall is the domain of the woodland savanna and the light forest. It becomes richer in tall perennial grasses such as several *Hyparrhenia*. The woody layer is dominated by *Daniellia oliveri* and *Isoberlina doka*, which are associated with grasses like *Schizachyrium rupestre*, *S. semi-herbe* and *Diheteropogon hagerupii*.

The pastures have a high mean production between 2 000 and 4 000 kg of dry matter per hectare. This is often difficult of access because of the height and density of the grass.

Improved pastures, cultivated forages and crop residues

Improved pastures

Few natural pastures have been the subject of development work in Mali despite the existence of numerous improvement techniques. There have been some attempts in the framework of studies or development projects. The most notable examples have been:

- development of the bourgoutières in the lacustrine zone (UNSO project);
- development of water points and organisation of the management of natural pastures (PRODESO) in the zones of Dilly and Nara Est by the pastoral communities;
- the improvement of the management of the sylvopastoral area of Kaniko (studies of production systems) in the Koutiala region.

These works, most of which were experimental, have concentrated on delimiting grazing areas, pastoral water supplies and often the establishment of normative plans for the management of the pastoral zones. They have covered tiny areas compared to the extent of Mali's pastures. These improvement works are however obligatory in livestock development programmes to ensure a good management of resources and preservation of the environment. The technical difficulties and the social constraints that this kind of work raises should be removed to allow agropastoralists to invest in the development of resources of which they should have the rights of use.

Cultivated forage

The growing of cowpea and groundnuts has always represented a source of sown forage for Mali's stock-rearers. Grown as a dual purpose crop their fodder production is in the class of crop residues. Fodder crops understood in the sense of "growing grass for the animals" is little developed in Mali. The few species grown at present, apart from cowpeas, are represented by a few plots of *Dolichos* and of *Stylosanthes hamata* with some agropastoralists in the southern zone and by collective or individual plots of bourgou on developed areas in the Central Niger Delta and the lacustrine zone. The areas exploited by producers rarely exceed a hectare. They are only large (15 to 20 ha) in the case of cultivating bourgou (*Echinochloa stagnina*) in its natural zone. The production obtained from small plots, although of high quality, does not cover the animals' needs. The stock-keepers must have recourse to other types of resources.

Crop residues

Farming produces residues (cereal straw, haulms of pulse crops) which contribute to fodder availability. The quantity of residues estimated from the grain/straw ratio varies from year to year in proportion to the areas sown and the yields. Yields can reach 2 to 3 tonnes/ha of dry matter. Thus in the farming zones cereals provide residues which, according to estimates, represent 10% of the total available fodder (PPS or Productivité Primaire au Sahel).

Cereal residues are generally of poor feeding value (0.28 to 0.35 Fodder Units and 40 to 50 g of digestible protein per kg of dry matter) and are not greatly used by the livestock. The level of their use can be improved through treatment with molasses and urea.

Haulms of pulse crops (cowpea, Bambara groundnut and groundnut) produce 600 to 1 000 kg/ha and are very good fodders (0.60–0.70 fodder units/kg and 60–90 g of digestible protein). Grown as subsistence crops, the pulses mentioned are often grown in association with cereals and in pure stand only occupy small areas.

Constraints to fodder resources

There are several constraints to fodder resources among which are recognized:

Rainfall. Although it is closely related to other environmental factors rainfall is "the most determining factor for primary pasture production". Thus the floristic composition of pastures depends on the amount and distribution of rainfall. The herbaceous species, which compete for the increase of the biomass, multiply or recede from one vegetation unit to another. A gradient of increasing availability of forage is tied to the rainfall gradient. As for fodder quality it diminishes according to the same gradient. Water thus becomes the main limiting factor for pasture productivity below the 400 mm isohyet, whereas the quality of the soils is the main constraint at higher rainfalls.

Soils. The influence of the nature of the substrate on plant production is incontestable. According to the nature of the substrate differences in productivity will appear under a given isohyet. These differences can go from single to double on substrates varying from loamy to sandy loam in the Malian Sahel. The quality of the soil also influences pasture productivity. On poor soils, as in Mali, fertilizer trials have shown coefficients of increase of two to five times on the production of some pastures (PPS).

The nature of the species and the floristic composition. Species do not all have the same production potential. The biomass that they provide varies according to the dominant species and the floristic composition they are in. A study in the Sudanian zone showed that a woody cover of ten% corresponded to a herbaceous production of 5 000 kg dry matter per hectare, but that production was only 1 000 kg with a bush and tree cover of 40%. A predominantly grassy formation will have a higher herbaceous biomass than one with a severe encroachment of bushes.

Poor pasture management. Usually sited on marginal soils: fragile soils (dunal soils, capped soils), worn out soils, rock outcrops and cuirasses, natural pastures have often low productivity. Their uncontrolled use (absence of stocking plan, prolonged stay of high numbers on different pasture types) is one of the principal reasons for their degradation. Selective grazing of species, especially at the stages of flower stem elongation or before flowering, causes their disappearance and replacement by less palatable species. That fluctuation of floristic composition is found in all pasture types, notably those with a high proportion of annuals.

Excessive trampling of fragile soils (colluvial soils, sandy soils) makes them crumbly. The removal of superficial layers by wind and runoff uncovers the underlying rock in the southern zones whence the formation of bare patches in areas of poor vegetative cover (the case of the Gourma).

Difficult access to inputs. The regeneration of degraded pastures can be done, despite the scarcity of information in Mali, by interventions such as ploughing, seeding or planting and protection. This type of work has only been done in specific projects such as the regeneration of the bourgoutières. The cost of inputs (ploughing, fertilization, seed, depreciation) for the regeneration of a hectare of bourgou was established at 414 515 F CFA (Van Duivenbooden and Gossèye 1990). That cost seems too high for herders especially when it is compared with the grazing tax of 20 000 F CFA they collect for three month's stay of 50 to 100 head of cattle on their receding-flood pastures (Eriksen and Traoré 1995). This type of investment is of the order of 52 000 F CFA for the regeneration of a hectare of Sahelian pasture.

The works cited have necessitated, it goes without saying, the use of large amounts of seed and cuttings of the species used. In the absence of regular supplies of fodder planting material in Mali, it had doubtless been necessary to assure either a massive importation or an integral or complementary harvest of seed and cuttings locally.

We can conclude therefore that the difficulties inherent in this kind of operation are not only in the high cost of the operations, but equally in the unavailability of seed and planting material because of the lack of a specialized structure for their production locally.

6. OPPORTUNITIES FOR IMPROVEMENT OF FODDER RESOURCES

Many opportunities exist at the present moment for improving pastoral resources. Among those which might be cited are:

- **The new concepts** in the development and management of resources (development and integrated management) putting the users and their techniques and habits at the centre of a system in which improvement has for its objective to produce management tools adapted to the different cases.
- **Security of tenure.** Securing the producers on their lands ought to be undertaken by an adjustment of the legislation which would attribute to them the ownership, control and management of

resources in their respective areas and lands. This arrangement would allow sustainable development to be foreseen.

- **Pasture resource survey.** Survey of resources and the definition of land use capability are prerequisites to the conception of development plans which take account of the relationship between needs and resources for sustainable management. The various plans which will be produced will take into account the agropastoral customs with an ecological appreciation of the zones.
- **Improvement of pastoral potential.** This will be done by introduction of species, notably those which are tending to disappear, or legumes. Trials have, however, shown that indigenous legumes are very poor competitors and thus of little interest for pasture improvement. The same is true for exotic species which are not competitive under Sahel conditions (low rainfall, poor soils). As for the introduction of fodder trees and shrubs, it could be envisaged in all zones using the fodder species which grow there naturally, and with exotics in areas of good soil and rainfall.
- **Control of pasture management.** The rehabilitation of pastures will be done through their development and the control of their management. This control will be made obligatory, especially after the efforts which have been expended for developments such as creation of water points (wells, deepening of ponds ...) and the improvement of the pastoral potential. It will be exercised by the communities, principally those which have participated in the works.
- **Social organisation.** The organization of the populations is a prerequisite for undertaking the works mentioned. It will take on different forms according to the zones and the centres of interest (village associations, groups of graziers or forestry groups). Within these associations management committees will be appointed to be responsible for the application of regulations established for the development and use of resources. These committees will be supported by the Administration and technical services.
- **Seed production.** Large-scale improvement of pasture potential could not be carried out unless it is supported by a parallel production of seeds and planting material. That production does not exist locally and the needs of users are only met by supplies provided by projects within their programmes. Some agropastoralists who have benefited from such gifts are thereafter called upon to produce seeds themselves for the continuation of work begun at their level. Individual efforts undertaken in that direction should be multiplied and reinforced. But, taking into account the new livestock production systems and the increased needs for quality fodder, structures of the kind "groups of common interest" could be established and specialize in the supply of quality seed and planting material. Quality control would be assured by national seed testing centres.

Conclusions

The different studies undertaken on pastures have shown that Mali has a great pasture potential both in the Sahelian and Sudanian zones. They are generally poorly exploited and especially badly managed. The various projects put in place to improve the fodder situation have lacked continuity and the efforts have been fragmentary and done little to convince the producers. The latter, for lack of credible references, continue to use the land and its resources in their traditional way with the risk of degrading them. Under such conditions only long term actions in the form of true development programmes should be undertaken to give full credibility to actions of pastoral improvement. These programmes will be based on a participatory approach helped by the transfer of competence for management and development of their lands to rural collectivities.

Work in the field will be supported by complementary research on pastures and forages. Research would address the classification of pastures, study and reinforcement of pasture improvement work where it is feasible, continuation and strengthening research on fallows. For fodder crops, trials should be carried out on local fodder species as well as field trials under farm conditions to determine their economic viability in production systems.

All these activities should converge to develop management tools for fodder resources and respond to the new models of livestock production.

7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

Outline of research and development organizations

Research institutions. The Institut d'Economie Rurale (IER) is the main institution in agricultural research in Mali. Its mission is to contribute to the definition and putting into operation of research and studies for agricultural development, to elaborate and conduct agricultural research programmes, to provide technical support to agricultural development, to develop and perfect appropriate technologies for rural development and to disseminate research results. It accomplishes this mission through its regional branches called Centres Regionaux de Recherche Agronomique (CRRA) in the different administrative regions of the country. The IER is supported in its mission by other units of the national research system such as the Laboratoire Centrale Vétérinaire (LCV), training institutes, the Institut Supérieure de Formation appliquée (ISFRA), the Institut Polytechnique Rural de Katibougou (IPR), and the associated programmes of relevant national and international institutions.

The present priorities in the domain of pastures and fodder resources deal with:

- The definition, development and management of sylvopastoral areas within land use systems, notably in agrosylvopastoral zones;
- The development and management of natural pasture in the pastoral zones;
- The encouragement of fodder crops for improving fallows and within farms.

These programmes instead of being the subject of thematic research are integrated into a framework of development and management of natural resources, which is to say in the wider field of production systems. They are not independent and funding is made even more difficult because the immediate priority is food security. The abandoning of thematic research on pastures and fodders by the system teams is difficult to explain because of the scant knowledge on characterization of the pastures in the north as in the south and the lack of knowledge on indigenous fodder plants.

Support organizations. The regional centres of the IER work closely with development organizations (some of which fund certain programmes), the NGOs and professional associations, all users of research results. Among these organizations the structures for supporting rural work situated within the Ministry of Rural Development can be mentioned: la Direction Nationale de l'appui au monde rural, le Programme national de vulgarisation agricole, la Direction nationale de l'aménagement et de l'équipement rural, la Direction nationale du contrôle et de la réglementation. As for agricultural enterprises, the larger ones have already been mentioned above. Collaboration is also maintained with the different projects operating through the numerous NGOs in the agricultural sector.

Resource persons

The resource persons concerned with pasture and fodder production insofar as research is concerned are within the production systems research teams of the IER. They are represented by the agropastoralists, ecologists and fodder production specialists of the CRRA. These specialists assure, with the participation of the target groups, the programming, setting up and monitoring and evaluation of activities in pasture development and management. Some are also found in projects where, assisted or not by research, they participate in pastoral development work.

List of resource persons

1. CRRA de Kayes
Mamadou SISSOKO : agro-pastoraliste
2. CRRA de Mopti BP 205 Mopti, République du Mali
Amadou KODIO : agro-pastoraliste
Mamadou COULIBALY : agro-pastoraliste
3. CRRA de Niono BP 21 Niono, République du Mali
Daouda KONE : agronome
Drissa YOSSI : agronome. Spécialiste des fourrages
4. CRRA de Sikasso BP 16 Sikasso, République du Mali

- Mémé TOGOLA : agropastoraliste
 Issa KANTE : Gestion des terroirs-environnement
 M'Pé BENGALY :
5. CRRA de Sotuba BP 1704 Bamako, République du Mali
 Lassine DIARRA : écologue-pastoraliste
 Salif Founkomo TRAORE: agronome des fourrages
 Kalifa KONE : spécialiste production fourragère
 Lassine COULIBALY : spécialiste production fourragère
 Mahalmadane DJITEYE : écologue-agropastoraliste
 Abou BERTHE : zootechnicien-agro-pastoraliste
 6. Ressources forestières s/c CRRA de Sotuba
 Moussa KARAMBE : amélioration des jachères
 7. CRRA de Gao Tél. (223) 820411 Gao, Rép. du Mali
 Abdou Yehiya MAIGA : forestier-aménagiste
 8. DNAER
 Bréhima DIALLO : agro-pastoraliste.

8. REFERENCES

- Ambruster T; Cook A; Legast P; N'Diaye M; Rooleveld L.** (1999): Orientation stratégique des Appuis à l'Elevage au Mali. Union Européenne/Mali/KIT. Amsterdam.
- Cellule de Planification et de Statistique.** (1998) : Recueil des statistiques du secteur rural au Mali. MDR/CPS. Bamako.
- Coulibaly A.** (1979) : Approche phyto-écologique et phytosociologique de pâturages Sahéliens au Mali (région du Gourma). Thèse de Doctorat. Univ. Nice.
- Coulibaly A.** (2001) : Manuel sur la vulgarisation des productions fourragères. FAO. Rome.
- Coulibaly A ; Kessler J.J.** (1990) : L'agro-pastoralisme au Mali-Sud. Analyse des contraintes et propositions d'amélioration. CMDT / KIT. Amsterdam.
- Coulibaly A; Mortensen P; Traversac R.P; Verstegen A.** (1995): Etude d'impact sur l'environnement. Cas du Projet de mise en valeur des plaines du Moyen-Bani. Hedeselskabet/ Denconsult.
- Eriksen J.H; Traoré N.** (1995): Etude sur l'Orientation du Projet de Gestion des Ressources Naturelles au Mali. « Elevage- Economie- Environnement ». MDRE/PGRN. Bamako.
- Friedrich Ebert Stiftung.** (1997): Litiges fonciers au Mali. Ministère de la Justice/ Instit. Nat. Form. Jurid. Bamako.
- Les Editions Jeune Afrique.** (1981) : Atlas du Mali. 3, Rue Roquebrune 75008 Paris.
- Ministère de l'Environnement.** (1999) : Stratégie nationale de conservation de la diversité biologique. S.N.P.A /DB. Bamako.
- Penning de Vries F.W.T; Djitèye M.A.** (1982): La productivité des pâturages sahéliens Centre of Agricultural Publishing and Documentation. Wageningen.
- Projet Inventaire des Ressources Terrestres.** (1986) : Zonage agroécologique du Mali. Ministère de l'Elevage et de l'Environnement. Bamako.
- Van Duivenbooden N; Gosseye P.A.** (1990): Compétition pour des ressources limitées: le cas de la 5^è Région du Mali. Rapport 2. CABO, Wageningen, Pays-Bas

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[The profile was prepared in June 2002 and finalized in October 2003; the English translation was undertaken by J.M. Suttie in July 2002 and editing was done by J.M. Suttie and S.G. Reynolds in October 2003; the French version was edited by J.M. Suttie.

Brahim Kebe of the FAO Accra Office ensured that the profile was prepared and followed up on various drafts. Livestock data were updated in August 2006 by S.G. Reynolds.]