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ORGANISATION FOR ECONOMIC
COOPERATION AND DEVELOPMENT
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PERMANENT INTERSTATE
COMMITTEE FOR DROUGHT
CONTROL IN THE SAHEL
CILSS

CLUB DU SAHEL

SAHEL D(80)73
Or.: Fr.
September, 1980

ELEMENTS FOR A LIVESTOCK DEVELOPMENT STRATEGY IN SAHEL COUNTRIES

Institut d'Elevage
et de
Médecine Vétérinaire
des Pays Tropicaux
10, rue Pierre Curie
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France

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This document was prepared by the Institut d'Elevage et de Médecine Vétérinaire des pays Tropicaux (IEMVT) in collaboration with the CILSS/Club du Sahel Livestock Team.

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During a meeting of the Livestock Team held in Bamako on 18th-21st March, 1980, under the Chairmanship of Dr. Almouzar Maiga, Leader of the Team and Director of OMBEVI, assisted by Dr. Sitta Barry, Rapporteur of the CILSS/Club du Sahel Team, an in-depth discussion of the preliminary report took place. Participants at the meeting were as follows:

Dr. Touray Bakary (Gambia); Dr. Diallo Seydou (Upper Volta); Dr. Goncalves Luciano (Cape Verde); Dr. Sidibé Samba, Dr. Mody Touré, Dr. Diakité Noumou, Dr. Coulibaly Mantalla, Dr. Diallo Brehima, Dr. Diallo Amadou, Dr. Traoré Moussa (Mali); Dr. Ary T. Ibrahim (Niger); Dr. D'Erneville Théophile (Senegal); Dr. Abdelmajit Mohamat Saleh (Chad); M. Frank Greiling (FED): Dr. Simon Bertrand (France); M. Antinori Pierro (Italy); Dr. Manfred Lindau (Germany); M. Thomas Burge (Switzerland); M. Jean N. Marchal (UNSO); Dr. J.R. Dickey (USAID); Dr. Ba Abdoul (CEAO); M. Nalla Kane, M. Joël Barrault (Sahel Institute); M. Gabriel Boudet, Dr. Jacques Coulomb (IEMVT); M. Arthur M. Fell, Dr. Simon Carrier (Club du Sahel); Dr. Almouzar Maiga, Dr. Sitta Barry, Dr. Moulaye Diallo and Dr. Sangaré Samou (CILSS).

Note

Throughout this report an exchange rate of 210CFA = $1 has been used to provide rough equivalencies of orders of magnitude. The abbreviation UBT = Unité Bétail Tropical or Tropical Livestock Unit, is a theoretical reference animal weighing 250 kg. The term Unité Fourragère UF or Forage Unit refers to a theoretical unit of measure of forage equal to 1 kilogram of barley.

The reader is advised that a Synthesis Document for this report exists.

Official versions of the present document are available in both French and English. For additional copies apply to the Club du Sahel or the CILSS at the following addresses:

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INTRODUCTION

One of the first ideas that comes to mind when we speak of livestock in the Sahel is that of the Sahel countries as a source of supply of meat for the African coastal countries, or even Europe.

From this standpoint it would be possible to devise a strategy mainly directed at developing and harmonizing the successive stages of a meat production chain.

This begins with the production of young animals in the typically Sahelian extensive grazing areas, where the possibilities of more intensive production of feedstuff are confined to those areas where there are opportunities for developing water supplies and agriculture. At this stage the aim is to raise the productivity of herds in terms of their numbers, which can be done by increasing the birth rate, reducing mortality and early final fattening of those animals whose final destination is the slaughterhouse.

The grouping of young animals in downstream organisations for further rearing, which may be peasant farms, semi-industrial or industrial enterprises run by the State, co-operatives or private individuals, is the second stage in this process. Its duration must be long enough to enable the animals raised on extensive grazing immediately after weaning to reach the required state of development. It must be carried on in areas where the existing or potential feed resources (natural pasture, fallow land, dry or irrigated crops, or agricultural or agro-industrial by-products) are adequate to feed the animals in the best way to enable them to complete this stage as quickly as possible and then be sent either directly to the slaughterhouse or to fattening lots for intensive finishing.

The purpose of finishing, the third stage in the process, is to bring the animals to the state of fattening where the carcase will be of the quality required by consumers. It may be done in industrial feedlots or family enterprises. This final stage, which can take various forms, must be of short duration so that the observed conversion rates do not become incompatible with good operating economics.

The process then continues with the sending of the animals to slaughtering centres and the distribution of the meat to consumers, either directly in fresh form or after preparation and storage for a shorter or longer period of time.

This sectoral approach would perhaps have had the advantage of putting livestock production in an economic perspective, but it involved the risk of overlooking the incidence of some essential aspects of livestock in the Sahel, such as subsistence

milk production which enables large populations to live in a particularly difficult environment; the important part played by small ruminants in a family economy; the special place of livestock in the social relationships of pastoral populations; etc.

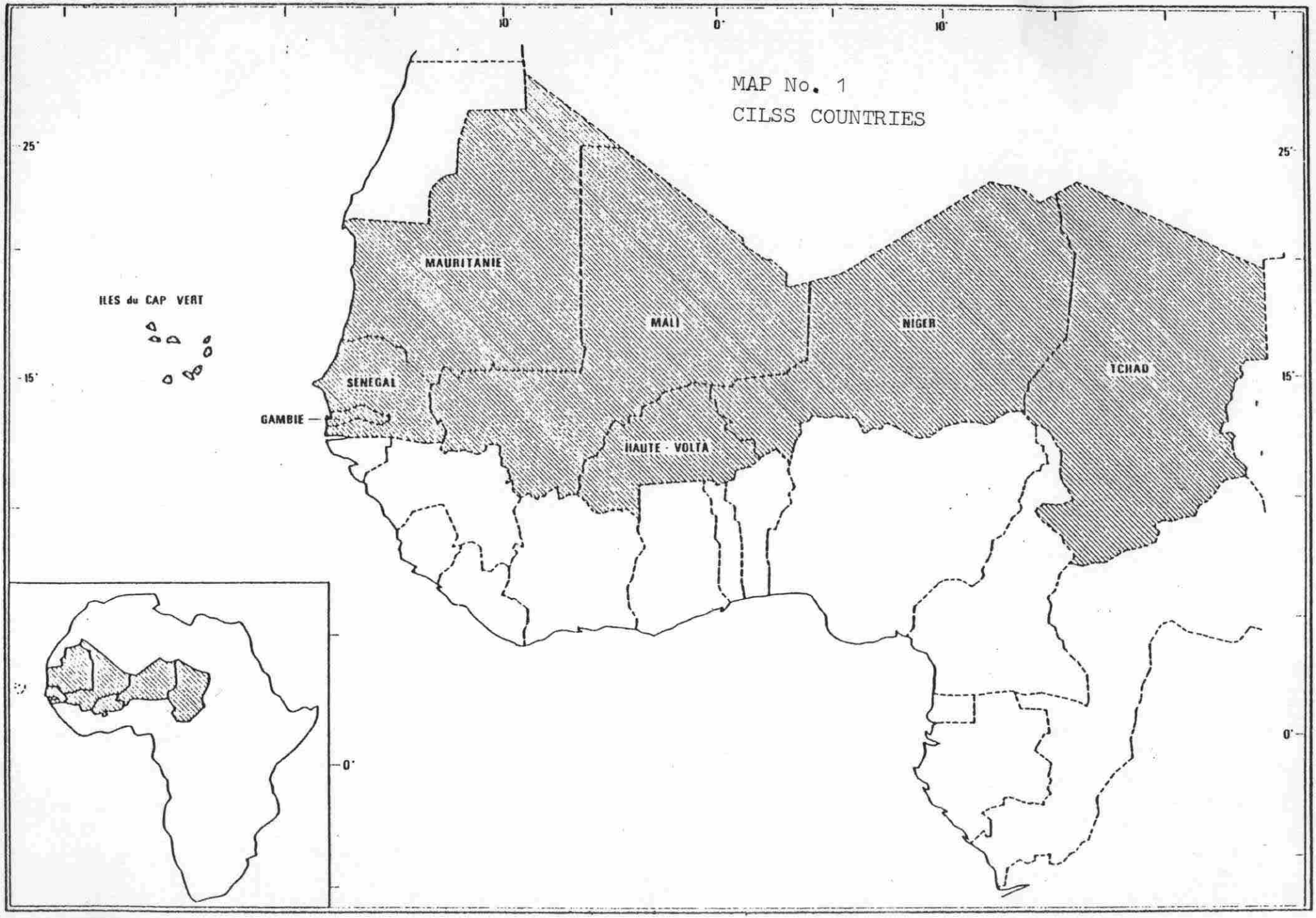
It seemed advisable rather to choose an integrated approach. Starting from an analysis of the potentialities of the area, we can assess its possible output. Comparison of this with the prospects of development of demand resulting both from changes in individual consumption patterns and a large increase in population reveals the essential points at which effort, sometimes considerable, must be applied, to preserve for livestock production the vital place it occupies in the economy of the Sahel countries.

NOTE

Though cognizant of the fact that differences may exist between the statistical data published by the countries and that published by the FAO in Production Annuals, the authors deemed it preferable to use the latter in the interest of homogeneity and coherence among the countries.

As a matter of fact, the statistics available do not all agree in the same year of reference, and their sources not always known, may differ considerably.

Nevertheless the differences in figures suggested for certain countries remain relatively low. Taking them into account would not change the conclusions of a document that is a synthesis and broad in scope.


MAP No. 1
CILSS COUNTRIES
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HAUTE - VOLTA
ILES du CAP VERT

CHAPTER I

THE ROLE OF LIVESTOCK IN THE DEVELOPMENT OF THE SAHEL COUNTRIES

1. THE ROLE OF LIVESTOCK IN THE DEVELOPMENT OF SAHEL COUNTRIES

The Sahel countries, whose geographical situation is shown in Map 1, are among the poorest in the world. For the countries as a whole the GNP in 1976 was on the order of 1,200 billion CFA francs (US$5 billion) and the GNP per capita, 40,000 CFA francs (US$183). This average figure conceals some very wide differences:

(i) The countries include a group that are cut off from the sea, without mineral resources, and a GNP per capita ranging from 22,000 to 27,000 CFA francs (US$100 to 120); and another group including countries that either have access to the sea or have mineral resources which they are beginning to develop, with a GNP per capita ranging from 36,000 to 88,000 CFA francs (US$160 to 390).

(ii) The disparity between the various social groups is still greater than that between countries.

Between 1960 and 1976 the average annual rate of growth of GNP per capita varied from country to country, but the average over that period for the whole of the Sahel countries remained constant.

After the drought, and although the effects varied from country to country, the primary sector accounted for between 33 and 58 per cent of GNP.

The share of agriculture in GDP was 46 per cent in 1960 for the whole Sahel region. In 1976 its share was only 36 per cent and varied, according to the country, from 28 to 52 per cent. The share fell in all countries, even those which had not discovered mineral resources or had not been able to develop fishing.

The extent to which the agricultural sector has fallen behind is thus considerable, since from 1960 to 1976 the gross agricultural product per farm inhabitant fell from 21,000 CFA francs to 17,000 CFA francs, an overall decline of 18 per cent and an annual decline of 1.3 per cent.

The share of livestock varies greatly and, since the drought, ranges from 5 per cent (Gambia) to 22 per cent (Mauritania).

Livestock is a key asset for the trade balance of the Sahel countries, and especially for the landlocked countries that have no mineral resources. In 1968 net exports of animal products were valued at 21 billion CFA francs. In 1977 they were

23 billion, but there were increasing net imports of dairy products (dried and condensed milk, butter and cheese) which accounted for 14 billion CFA francs in 1977.

The share of animal products in the countries' total imports and exports varies greatly, ranging from 0.7 per cent of imports in the case of Niger to 3.5 per cent for Senegal, while in the case of exports it ranges from 1 per cent for Gambia to 66 per cent for Mali.

A summary of net exports of animal products by volume and by value is given for each country for 1977 and 1968 in Tables 24 and 25.

Generally speaking it may be said that both domestic production and foreign trade are dominated in all the Sahel countries by agriculture and livestock production.

Livestock production, besides its economic role, represents a capital asset for the Sahel countries which it is absolutely necessary to preserve.

In 1977 the total value of herds was estimated at 750 billion CFA francs, and their production at 200 billion CFA francs.

Tables 21 and 22 show the basis for this statement.

2. ROLE OF LIVESTOCK IN RURAL AREAS

In the semi-arid areas of of Africa there is a tendency to separate livestock production from agriculture on the basis of the differences between the ecosystems and the various ethnic groups taking part in the two sectors of production.

This division is becoming less marked, as those who formerly lived entirely by livestock production are tending to develop a small-scale subsistence agriculture or even to offer their services for hire in typically agricultural areas, while those who formerly lived entirely by growing crops are, thanks to the spread of measures of protection against disease, tending to introduce some animals, if not actual livestock production, into their farming systems. In addition, two new trends appear to be emerging under the pressure of population increase which is leading to more intensive cultivation: growth of agriculture in areas naturally suitable for grazing, and growth of livestock agricultural areas.

2.1 Role of livestock in mainly pastoral areas

A preliminary observation should be made concerning land use in the Sahel.

If it were not used under extremely well adapted systems of production, no other production would be possible, as there is no agriculture because of the inadequacy of the water supplies needed for food crops (except in wadis and in the marginal areas of the South) and livestock production alone makes it possible to exploit these extensive areas and provide food for the populations concerned. The output is admittedly small but the efficiency in energy terms is excellent, as almost the only inputs are those of the administrative services and water supply works, and the same holds true when the surplus is marketed.

This last remark is significant in the context of the present energy crisis.

> The pastoral area of the Sahel countries provides the only production that is possible over 150 million hectares for a cost in renewable energy that is negligible at the present time. This will be one of the assets of the Sahel if the price of energy, and hence of the inputs needed for livestock production in the developed countries, continues to rise.

The population of those areas, although it is beginning to develop modern monetary economic systems, has socio-economic occupations which are mainly dependent on herds and what those herds produce.

2.1.1 The role of milk

Milk, whether consumed in its raw state or after processing into curds, cheese, butter, etc., is an extremely important food element in the Sahel countries. In selecting male or female animals the criterion of milk production is always predominant.

Milk is produced by four species: cows, goats, sheep (ewes) and camels. The first two are the most important, camel's milk in particular being used only in the areas of the Sahel bordering on the Sahara and the semi-desert areas.

Milk used for human consumption accounts for approximately 13 per cent by value of production. An estimate of consumption is given in Table 23.

This production, unlike that in developed countries, does not require specialised stock. The animals are used for all they can produce: meat, leather (for tents, cords, ladles), manure (for fertilizing the fields) and milk.

Any female animal giving milk, whatever the level of its production, is regarded as a dairy animal, and part of its production is for human consumption to the detriment of its young.

The farmers' diet is based on milk and competes with that of the young animals before weaning. Additional food for the young animals would enable more milk to be taken for human food, and so increase the production of meat by reducing the mortality of young animals.

Production is at a very low level and is very dispersed. In the bush areas it is used by the farmers themselves and their families. Near the towns, collection, though difficult, makes it possible to sell production to town-dwellers, but there are a number of problems involved in this:

(i) In the dry season production falls considerably and is barely enough to feed the young animals, this being the time of transhumance which brings the farmers close to the centres of consumption.

(ii) In the rainy season, production is more abundant and might help to supply the towns, if the herders were not dispersed so as to make the best use of pastures inaccessible in the dry season and thus too far from the town centres, and if they had a suitable technology.

Low individual output, and the need to feed young animals to increase meat production, make it impossible to envisage an appreciable reduction in imports of milk products (14 billion CFA francs in 1977) without creating special dairy-farming areas close to the towns.

2.1.2 Meat

Meat production is very often regarded as being the main function of livestock in Africa. In fact, apart from a few specialised modern establishments such as ranches or intensive fattening units, and some of the still rare peasant fattening farms (in Niger and Senegal), meat is still often a by-product of other livestock activities on traditional farms.

In 1977 meat production accounted for 70 per cent of the value of animal products, in which only those that are comparatively easy to identify are taken into account: meat, milk, eggs, hides and skins, without including all the other products and services resulting from livestock. Beef accounts for 56 per cent, meat from small ruminants 35 per cent, pig-meat 3 per cent and that of other species (dromedaries and poultry) 6 per cent.

With cattle and small ruminants, which account for 90 per cent of meat production, a distinction should be made between what is consumed on the spot and what is marketed.

Animals consumed by those who raise them are almost always those that are slaughtered in extreme circumstances because of disease or exhaustion.

Animals slaughtered on ceremonial occasions, or to meet social obligations (visits by foreigners, for example), are included with those that are marketed.

Apart from barter or sale of breeding stock (breeding males, heifers, female calves), the animals that are marketed come into the following categories, in order of their availability:

1. older males, fully-grown and heavy;
2. culled females; older females considered to be past their reproductive age, females regarded as sterile because they have given no milk for several years or because they have not yet reproduced at a certain age (6 or 7 years in the case of cattle), females with defective udders;
3. young males still growing;
4. young females for breeding.

Females in condition for breeding are not offered for sale as the possibilities of reproduction are so small that they are kept for increasing the size of the herd.

The proportion of these two types of farm is difficult to discern as it depends on special situations which vary greatly.

Overall, Sahel meat production in 1977 was 16 kg. of meat and offal per head, and consumption 13 kg. Production was estimated at 148 billion CFA francs, 25 per cent of which was exported.

2.1.2 The role of other outputs

The animals in the Saharan zone and the pastoral zone are used for transport and for raising water. The animals most frequently used are cattle, generally in good condition, camels and, more rarely, donkeys (except for family transport).

The ease with which water can be raised depends on the depth of the well. From a well 70 metres deep, a "délou" can be filled in 8 minutes, and an average family herd of 50 UBT(1)

(1) UBT = Unité Bétail Tropical (tropical livestock unit), a theoretical reference animal weighing 250 kg. /The abbreviation UBT is used hereafter in the English text/

each drinking 30 litres, can be watered in five hours by two men and a child. It is understandable that this amount of hard work in the sun is a major constraint, which Sahel herders will try to avoid.

Apart from the use of cow or camel-dung as a source of heat energy or building material, animal droppings are used to fertilize crop-growing land.

This is done in two ways:

- South of the pastoral zone, the herds are always assembled at the same place and the accumulation of their droppings makes it possible to try to prepare a millet field in the rainy season;

- The animals grazing on harvest residues in the crop-growing areas (stubble, millet and sorghum straw), by leaving their droppings on the ground, transfer fertility to the crop-growing area.

For the latter there may be "manuring contracts" between crop-growers in the Sudano-Sahel zone and transhumant herd owners in the Sahel zone; the latter are entitled to allow their animals to graze on the remains of the harvest in exchange for the manure delivered.

Production of hides and skins for marketing originates in the slaughterhouses for the most part and also from slaughtering that is done in the countryside. After processing (drying, arsenic treatment), hides are then used either by craftsmen, who make a wide variety of leather goods in the Sahel countries, or by companies which export the hides and skins in their original condition or sell them back to local processing companies.

Hides and skins from animals consumed by the farmers are used by craftsmen or by the farmer himself to make a variety of objects: tents, "délous", shoes, bags, cords, etc.

2.1.4 The social role

The social role of livestock varies with the ethnic group, but speaking very generally, two functions may be discerned: one, to provide a way of forging family links, and the other to make it possible to reduce the risks inherent in the hard nature of the environment by providing a means of mutual help.

The family ties begin to be formed at the birth or baptism of a child, who receives animals from his close relatives; he may continue to receive them during adolescence. When engaged to be married he gives his future parents-in-law animals in payment for the maintenance of his fiancée. On

marriage, the wife has a personal herd, all or part of which she contributes to the new household. On the death of a member of the family, the animals are again divided among the various relatives.

The farmer often lends animals to relatives, friends, or poor or unlucky people whose herds have been weakened by theft, animal diseases, drought, etc. The methods of repayment vary greatly (one gives back all or part of the increase); in all cases the use of milk makes survival possible. It was thanks to this system that the consequences of the recent drought were less damaging than they would otherwise have been.

Generally speaking, therefore, animals are the property of individuals, but the owners of a herd may be a number of people.

It is reckoned that on the average a family of six must own a herd of 30 to 40 UBT to survive without needing to do other work.

The system of exchange and dispersal of the animals is a mutual guarantee against risks and is in itself a genuine system of social insurance.

"Dollar worship", which is synomymous with power, consumption and security, does not involve the social interplay that is found in "herd worship" in the Sahel, which represents solely the prestige enjoyed by the owner of a large herd because of the respect his equals feel for his security and the opportunities that it gives him to help other families.

2.2 Role of livestock in agro-pastoral areas

Whereas in a typical pastoral area in the Sahel the main limiting factor is water for the herds, the main factor in the Sahelo-Sudanese and Sudano-Sahelian zones, whose system is agro-pastoral, is very often the availability of animal feed. This is a zone with a dense human population in which the area under cultivation has been increasing to a point where fallow land has sometimes disappeared, and which often already supports large herds.

Livestock as an activity carried on by individuals thus still exists, and here has a mainly savings function; because of this influence, however, it is becoming increasingly integrated in crop-growing activities through:

- animal traction;
- production and use of manure on part of the crop-growing land;
- finishing of livestock by peasants.

2.2.1 Livestock as a method of saving

The ways in which this is done vary enormously from one region to another; we shall nonetheless try to indicate its main features.

Stock-rearing is a secondary activity among sedentary farmers. The family herd is rarely very large, and the time devoted to it is small, which is why the large animals are usually entrusted to a shepherd or, more rarely, to the children. The conditions of keeping, using and marketing the animals are different from those encountered among the pastoral societies.

In present farming conditions, however, stock-rearing ensures that certain needs of the sedentary farmer are met. Small animals provide an appreciable supplement to resources, especially for the poor crop-growers, and are the capital that is always available for settling a large item of expenditure, or for buying food through a difficult period. The production of small ruminants resembles a cash reserve to meet general consumption requirements. Stock-rearing also allows uncultivated land to be used and provides a supply of manure.

Moreover, although the sedentary farmer rids himself of the task of maintaining his herd by entrusting it to a shepherd, he nonetheless has control over most of the outlets for livestock products, he being the only one carrying on the trades which ensure that animals and their by-products can be sold.

The development of stock-rearing among the settled farmers is a recent phenomenon for which a number of factors are responsible:

(i) increased control over the main animal diseases which made livestock an uncertain activity;

(ii) the development of a standard of living and a level of incomes among certain sections of the population which make it possible to keep a part of their savings in the form of livestock and to increase local demand for animal products, meat in particular.

All types of animals are represented in the sedentary farmers' herds, but their importance varies.

Cattle rearing encounters the constraints of limited resources for feeding, watering and minding the herd. Its density thus varies from region to region depending on how severe these constraints are, but also in accordance with social habits and history. The density nonetheless seems to be higher where agricultural output is intensively marketed, and there is a tendency towards the well-known "cotton cycle",

as in certain regions of East Africa: the crop-growers invest their income in livestock up to the limit of what the land will bear; the smallest failure of climate then decimates the herds, and the crop-growers then grow more cotton to replace their livestock but at the same time further diminish the area of grazing land.

The originality of the method of rearing the small ruminants lies mainly in the way in which it is carried out. It is, as everywhere, a so-called "extensive" method.

Sheep and goats (especially the latter) are easy to maintain because they can find their own food in fallow land or from food scraps in villages. The fact that the work needed to maintain them is minimal and not highly skilled makes them ideal animals, as the main activity of the villager is agriculture, and stock-rearing does not form part of his traditional store of knowledge.

The only unavoidable constraints are the tending of the herds to protect the fields from damage during the crop-growing period and before the harvest, and ensuring that the herds are kept watered during the dry season.

This requirement to mind sheep and goats at crop-growing times, together with the need to provide them with food, is a hindrance to the peasant preoccupied with agricultural work.

The peasant accordingly is not usually very active in rearing livestock, hardly pays any attention to the feeding or health of small animals, and is not usually aware of the need to make better use of the outputs of the herd.

A special diet is nonetheless provided for certain categories of small ruminants: the sheep that are "part of the household"; goats or ewes that produce milk where the population consumes it; and animals that are seriously ill.

These animals temporarily receive extra food based on bran, leaves, dried grass, kitchen refuse, and salt or natron.

The real "household" sheep, however, kept in an enclosure for systematic fattening, are rare except in strongly Islamic areas and among townspeople.

The method of stock-rearing of which the general features have just been described allows for many variations of detail in the ways in which the farmer treats the animals. There are parts of the sub-Sahelian zone, in particular, (with a tradition of better-established stock-rearing), where herds are often minded throughout the season and the animals enjoy better conditions.

Another feature of village stock-breeding is the small size of the herds and the manner in which they are shared among a large number of people. In Chad, for example, among herds averaging from 14 to 17 sheep or goats, there may be from 5 to 13 owners per flock, depending on the locality. Here one is justified in speaking of extreme fragmentation of property, in contrast to conditions in the Sahelian zone where the herds usually number from 30 to 50 and may be as large as 250 to 500 among the nomads (Peuls).

Cattle have, especially in agro-pastoral areas, a short and medium-term savings function, while the small ruminants, although a secondary activity insofar as the peasants give them little time or attention, are an essential part of the family economy, being a liquid form of savings as well as a product which may be consumed directly.

2.2.2 Animal traction

Animals are used for work, in pastoral zones for transportation, but the integration of animals for work in agriculture is more important; animal traction, after stagnating for many years, has been developed rapidly in recent years, mainly in regions which grow cash crops.

The general studies that have been made on the performance of animal traction have shown that their overall efficiency (the quantity of energy produced by the animal and available for work, divided by the quantity of energy contained in its food ration), over a long period of work, is of the order of 0.12 for a man, 0.10 to 0.12 for a horse, and 0.09 to 0.10 for cattle.

The efficiency of comparatively high-powered mechanical engines, calculated in the same way, is known to be as high as 0.15 or even 0.30.

From an energy point of view, if animal traction has the drawback of having a lower efficiency than mechanical traction, it has the advantage of consuming a form of energy (fodder) that is renewable and often free (natural pasture and fallow land), and of providing in addition a free substitute (manure) for increasingly expensive mineral fertilizers.

No overall statistics are available of the number of cattle or other animals at present being used for traction. Piecemeal estimates give figures of 128,000 for Chad in 1977 and 100,000 for Southern Mali. In the experimental units at Siné Saloum in Senegal the number of yoked cattle increased fourfold between 1970 and 1976.

Cattle predominate among traction animals but donkeys and horses may also be found.

Farmers use the animals best suited to their region, determined in the main by the presence or absence of tsetse flies: zebu in the North and oxen in the South.

For good results it is necessary to have strong animals. The crossing of zebu and oxen gives a breed whose hybrid vigour (heterosis) produces animals of large size, which inherit the dimensions and speed of the zebu and the better shape and muscle structure of the ox. All this has been perceived by the peasants, who are planning the production of such hybrids in their herds (the Mere in Mali, and the Djakore in Senegal). The size of the cattle produced on farms is accordingly tending to increase. Mainly males are used, although females are of some value and are beginning to be used in certain regions.

The advantages of animal traction lie in:

(i) Reduced fatigue: the basic reason for the success of animal traction is to be found in the reduction of the human physical effort needed to work the land. Although African animals are light and consequently not strong, their main use everywhere is ploughing. Weeding is often done by hand; most members of the family can help in this, since work on the surface of the soil does not call for such great strength.

In certain areas the lightening of tasks done by women with the help of hand-carts (transport of water, wood, etc.) is also a fundamental reason why animal traction has become established.

(ii) Reduction in length of the working day: in Senegal, in areas where groundnuts are grown, the work needed per hectare is reduced by one-third if animal traction is used, which frees manpower and makes it possible either to cultivate a wider area or to have more leisure time.

(iii) Better use of manpower: if the output of one man's working day is valued at 100 for entirely manual cultivation, it is worth 118 with partly motorised cultivation and 158 with animal traction.

(iv) Higher yeilds: the use of animal traction ensures that the soil is better worked, which can help to increase yields. Animal traction is, however, only one factor among many others, and its contribution is not always obvious.

(v) Increase in areas cultivated: this is one of the most tangible consequences of the use of animal traction, which is to increase the area that can be tilled by one worker and consequently by a family. With hand cultivation, one worker generally attains a maximum of 0.5 hectares per year, and a family farm is usually between one and two hectares. On the other hand income per hectare is not always increased, as other factors enter into the output (dates of sowing, weeding, fertilizing, etc.). The advantages of animal traction may then be concealed by the negative contribution of the other factors.

(vi) Meat production by draught cattle: draught cattle must be broken in early, usually at between two and three years of age. The weight of the animals at that age is seldom more than 200 kg (250 kg for the large breeds of zebu like the Gobra).

If cattle are used for four years or more they will reach a weight of more than 300 kg for the small breeds and nearly 400 kg for the large.

The increase in weight is from 100 to 150 kg per animal, the gain in value being greater because the price of the young animal is some 15 per cent lower than that of the adult, and because working animals have, through their functional exercise at work, a good muscle structure and better shape and are thus preferred by butchers. If the purchase price of a young ox is fixed at 100 the resale price is 172.5 for the light or heavy breeds.

(vii) Production of manure: the droppings of draught cattle in the stable or on their grazing land can be collected and kept for use as fertilizer.

(viii) Hiring out of draught animals: draught animals provide labour for peasant farmers, but they also earn income when their services are let out for hire. A day's work in harness may earn as much as 1,000 CFA francs. If we remember how debts can be incurred in buying tools, and especially a cart, we can understand that those who have done this will try and repay those debts by various kinds of work.

Draught animals also facilitate trade when provided for special transport or on hire.

In the agro-pastoral zones, animal traction, which consumes a renewable source of energy, increases the productivity of labour by making it possible to cultivate larger areas, improve yields, and reduce working hours and fatigue. It also contributes to the production of meat and organic fertilizers.

The costs connected with animal traction are many; the principal ones being:

(i) Purchasing the animals: if a peasant takes steers for breaking in from his own herd there is no cost layout under this heading. But this is not a common case, and the cost of buying a couple of young animals may be 70,000 CFA francs. If the purchase is coupled with the sale of a pair of old culled oxen, however, the peasant may make a profit of as much as 50,000 CFA francs.

(ii) Breaking in the animals: young oxen have to be broken in at approximately three years. The breaking-in period varies with the animals and those breaking them in. One month is usually necessary to obtain the minimum of training compatible with setting them to work.

Breaking-in is an important task for the peasant. For this reason, when he has well-trained animals and bonds of affection have been created between him and them, he is reluctant to dispose of them for economic reasons.

(iii) Feeding costs: additional food is often given to draught oxen at the end of the dry season and during the working period. This usually takes the form of grass, straw and branches of trees, which cost only the work of collecting them. Some additional food may however be purchased, such as cottonseed and by-products of cereals (millet, rice, etc.); they are always given in limited quantities and their cost never exceeds (2,000 to 3,000 CFA frs., sometimes less.

(iv) Cost of accommodation: the accommodation of oxen does not usually involve any additional cost, as they live with the other animals or are given a simple thatched shelter which does not involve much monetary expenditure.

(v) Agricultural equipment: locally manufactured more and/or less suitable articles sometimes make it possible to obtain tools at relatively low prices. The fol owing were some estimated prices in 1977:

cart .....90,000 CFA francs

plough ..... 8,000 CFA francs

three-pronged cultivator ..... 6,000 CFA francs

root crop lifter ..... 5,000 CFA francs

seed drill .....25,000 CFA francs

The cart is by far the most expensive item. On the other hand it is the one which can be used most often for various transport jobs: harvest, fertilizers, domestic water, wood, etc. It may be expected to do 1,000 hours of work a year.

The costs of animal traction are many and are a financial burden on the farmer wishing to make such an investment. Some suitable credit facilities should therefore be available.

2.2.3 Production of organic fertilizer

Apart from the uses mentioned in the paragraph on the pastoral zones, there are two uses peculiar to the agro-pastoral zones:

(i) Collection of manure from the farmyard for spreading mainly on garden crops: here a mixture of earth and dried dung is usually used, sometimes with the addition of household refuse.

(ii) Manufacture of high-quality manure: this requires suitable quarters and a supply of bedding for the animals, and a special storage area. It is not yet common under traditional systems as it requires considerable investment and transport facilities (for transporting bedding straw, and transporting manure from the stable to the manure heap and from the manure heap to the fields).

It has often been recommended that the by-products of the harvest: stems, leaves and stalks of cereals or pulses, should be returned to the ground and buried in order to maintain an adequate proportion of organic matter and restore the minerals which these by-products contain, to avoid having to replace them by costly and acidifying fertilizers.

The peasants usually take these by-products away from the fields to feed animals (stems of pulses, and in some cases of cereals) and for bedding, firewood (sorghum straw) or roofing. Ploughing under cereal straw also involves technical difficulties in the present state of the farmers' equipment.

The use of crop residues as food and bedding for animals, and their return to the fields in the form of manure, appears to be the most acceptable and practical way for peasants to maintain a positive mineral balance in their soil, with limited additions of minerals in the form of fertilizers.

This method also makes it possible, in areas where land which cannot be cultivated exists alongside cultivated land, to transfer fertility from the latter to the former.

2.2.4 Fattening on the farm

We saw in connection with animal traction that it helped to produce additional meat, though the process could not be described as fattening. Similarly, some traders carry out a very partial second rearing of almost adult cattle, which they keep for a few months to bring them into good condition, with a view to selling them without any special feeding other than the natural resources and a few additional by-products, all of which does not amount to finishing.

Finishing by farmers is final fattening on traditional lines; it is a small-scale activity using simple techniques, and is mainly practised in Niger and Senegal. Trials of systematic fattening of culled draught cattle were recently carried out in Upper Volta and Chad. The technical and economic results attained deserve to be studied in greater detail to ascertain the precise advantage of this type of operation.

The advantages of fattening by farmers are: the small investment that is needed; the fact that the operation can be performed outside the period of major agricultural tasks; the low operating costs (most of the food comes from the by-products of the farm); the difference between the buying and the selling prices yielding an additional profit; and the income which it brings to the farm at the end of the dry season, making it possible to bridge a gap.

Another example of fattening by farmers is that of the "household" sheep which are marketed at the time of the Moslem religious festivals.

Here we must note that the use of dromedaries as pack animals is declining as a result of the building of roads or tracks in or across the Sahara.

This activity might with advantage be replaced by the production of animals for meat, for which there is a big demand in North Africa, or possibly oriented towards milk production.

3. ROLE OF LIVESTOCK IN URBAN AND SEMI-URBAN AREAS

African towns are the main centres for consumption of livestock products because of the number of inhabitants, their higher income, and their eating habits, which call for a very much higher consumption of animal products than the national averages.

3.1 Importance of milk

Production of reconstituted milk from imported dried milk has developed in most African towns. Imports of milk and milk products from developed countries accounted for 14 billion CFA francs in 1977, or more than one-third of the value of meat exports.

There is also a local output. Fresh milk, which is generally distributed in the form of curds, comes from the small farms within the towns or on the edge of them. The system of production closely resembles that for goat's milk cheese: the animals are the same, and so are the feeding techniques except possibly for the addition of a small supplement (chopped grass, millet bran, etc.).

The milk is usually despatched by the producers themselves and sold to customers placing regular orders.

The quantities distributed in this way are small. Clearly they will vary with the size of the centre but they rarely exceed a thousand litres a day.

Attempts have sometimes been made to organise the collection of this milk by traditional methods, for the purpose either of rationalising the distribution or of providing part of the supply for the dairies that have been built: the addition of a little fresh milk to reconstituted milk would appreciably improve its flavour.

The collection systems, usually employing modern methods (carts, lorries), have, in many cases, encountered major problems in view of the small output of the farms and the distances between them.

In the rainy season when production is high, large quantities of milk are lost (cows are milked to prevent mastitis, and surplus milk thrown away) and might be recovered for town consumption when suitable methods of preservation or storage have been devised.

Much more rarely, attempts have been made to provide extension services and to organise producers so as to rationalise and expand their output.

Mention may be made of the experiment in the peasant sector of Kirkissoye, near Niamey, which is the first attempt to set up intensive dairy units run by farmers who benefit from being in a small area, and of the experiment at Sangalkam near Dakar, where a scheme for intensified production is also being worked out.

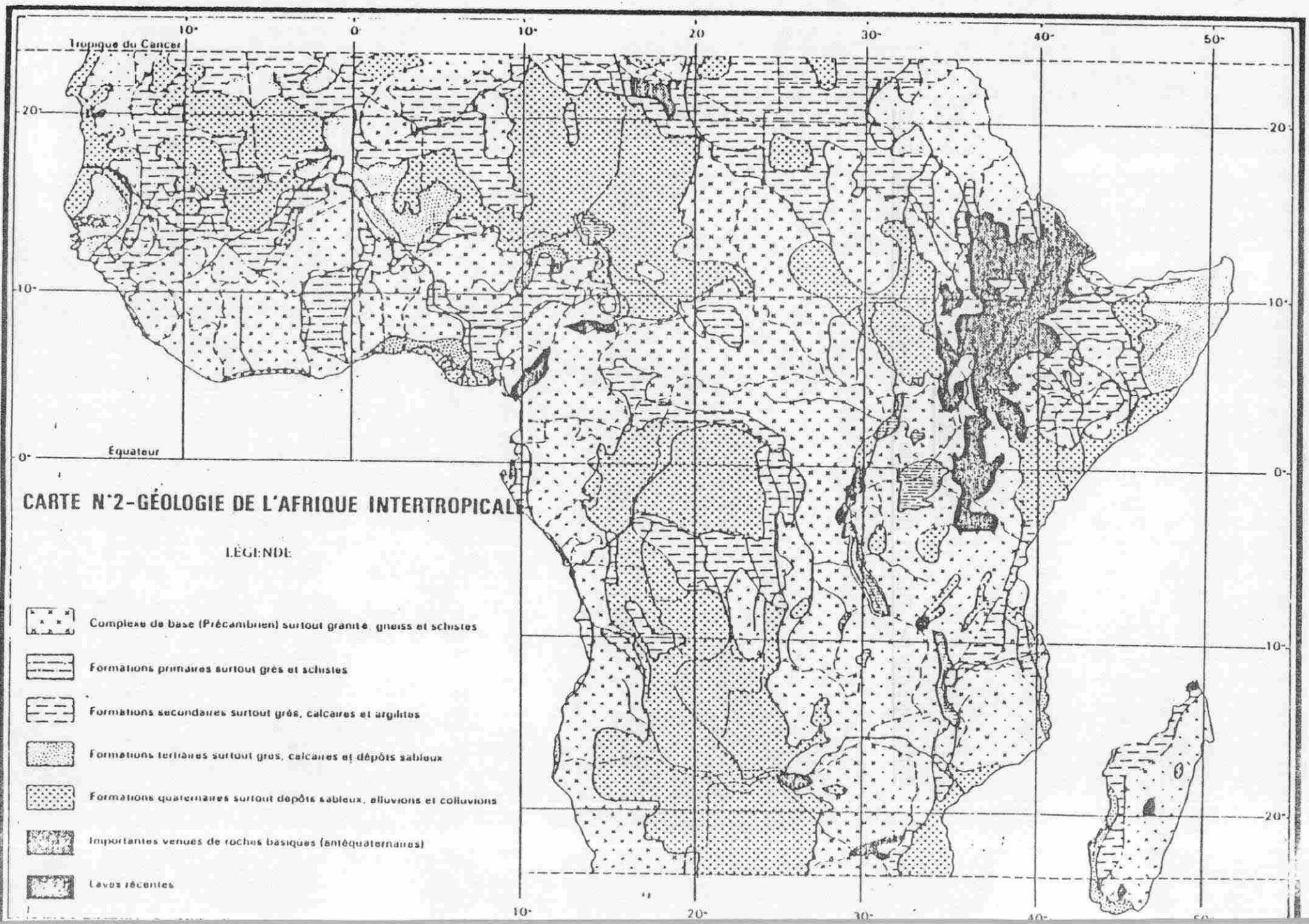
There is a very great shortage of dairy products in the towns, which might be partly overcome if production in and near the towns were rationalised, and suitable techniques devised for storage and preservation to make it possible to use the surplus output which the rural areas produce in the rainy season.

3.2 Importance of meat

Fairly exact figures for meat consumption in the large towns can be obtained from the statistics of the slaughterhouses despite the undeclared slaughtering, especially of the small ruminants, that still takes place. Recent figures are comparatively scarce, but it may be estimated that the consumption of meat is between two and three times higher in towns than in the country. Production in towns is almost nil except for a few domestic sheep, pigs and poultry.

CHAPTER II

ASSESSMENT OF THE SITUATION AND CURRENT POTENTIALITIES



CARTE N°2-GÉOLOGIE DE L'AFRIQUE INTERTROPICALE

LÉGENDE

- Complexe de base (Précambrien) surtout granité, gneiss et schistes
- Formations primaires surtout grès et schistes
- Formations secondaires surtout grès, calcaires et argilites
- Formations tertiaires surtout grès, calcaires et dépôts sableux
- Formations quaternaires surtout dépôts sableux, alluvions et colluvions
- Importantes venues de roches basiques (antéquaternaires)
- Laves récentes

CHAPTER II

ASSESSMENT OF THE SITUATION AND CURRENT POTENTIALITIES

1. PRODUCTION FACTORS

1.1 Natural resources

1.1.1 Physical factors

GEOLOGY

Old geological formations of hard crystalline rocks occupy the greater part of tropical Africa (Map 2).

During the later geological periods (secondary, tertiary, quaternary) these rocks were rarely covered by oceans and most of the sedimentary rocks are of continental origin, formed by winds or lakes.

GEOMORPHOLOGY

Vestiges of the old surface relief still remaining consist of plateaux of old rock which have resisted subsequent erosion cycles.

At present the West African plateau slopes gently from the South-East to the North-West, and large tectonic basins, very wide but shallow, break the monotony of the plateau as in Niger and Chad.

In the present stage of evolution of the relief, the formation of the various individual types of soil is influenced by the topography, with:

(i) high areas in which, through scouring and removal, only metamorphic material remains;

(ii) low-lying, badly-drained areas with an accumulation of solid sediments and comparatively loose constituents (soluble salts, colloids, etc.);

(iii) transitional areas, where the gradients are adequate to prevent silting but too gentle to permit erosion.

SOIL

Soil is the result of the decomposition and transformation of underlying rock through the action of physical, chemical and biological agents.

The parent material or original soil substance may be the result of weathering of the rock on the spot or may be a mixture of products of weathering brought from elsewhere, so that the nature of the products of the breakdown of the parent material greatly depends on the evolution of the relief, its geological origin and its topographical position.

Skeletal type soils, or lithosols, are thin, of the order of 30 cm., and often include large pieces of debris from the breaking away of ironstone, and ferruginous gravels. These are mainly found on the upper slopes.

They usually occur on the outcrops of precambrian crystalline bedrock, on the sandstone and pudding-stone in the primary, the intercalated continental in the secondary, and the terminal continental in the tertiary.

Clay loam soils are found in colluvial deposits at the foot of slopes. They result mainly from the breaking down of shale, from argillaceous sediment, or from clay formed by decalcification, and are therefore mainly to be found on outcrops of the primary, secondary and tertiary.

Sandy soils come from deposits of sand formed by wind (dunes of the quaternary), or alluvial deposits, also of the quaternary.

WATER AND ITS USE

The development of livestock in the tropics is unthinkable without a plan for water supplies. The need for access to wells or sweet water points has always given rise to struggles for their possession.

Clearly, the watering of animals at ponds in the open air is the easiest and quickest method, even for large herds. It is unfortunately not common, and livestock herders often have to draw water from wells, which represents a considerable amount of work. There is therefore no need to stress the interest which they show in improved water supplies.

The availability of ground water is closely connected with the nature of the subsoil. The knowledge acquired of underground hydrology in West Africa is now being brought up to date by the BRGM (Bureau de Recherches géologiques et minières) in the form of maps on the scale 1/1,000,000, indicating the flow from wells, and the cost and quality of the water.

The geological map already gives some indication of these water resources.

The substratum of crystalline rocks is impermeable and contains water deposits of limited area held in depressions in its surface. Output from wells may be as much as 3 litres when the water is drawn close to sound rock at the level of granite that is weathered but not kaolinised.

Continuous large high-yield water-tables are found only in the secondary and tertiary formations and are usually tapped by deep wells, as follows:

- those in the intercalated continental and upper senonian in the secondary formations; and
- those in the terminal continental in the tertiary formations.

Except in areas where the substratum comes to the surface, pasture land can be used only in the rainy season, with the help of temporary ponds. There are thus possibilities of finding water in the Sahel.

More than 10,000 wells have been counted and identified, and their water analysed. The number of large wells is smaller, only several hundred.

Except on the edges of the water deposits, where the water is drained off, water in the Sahel may have quite a high mineral content, though not such as to make it unusable for watering animals. Only exceptionally is it impossible to use it for human consumption.

During the great droughts it was believed that pastures disappeared because they were over-grazed through the concentration of sedentary herds made possible by the creation of permanent water points, often with a large flow.

This view may be justified so far as some regions are concerned, but it is the management of grazing space that is at fault and not the creation of water points. In no way could it be a reason for abandoning the pastoral water supply policy pursued for several decades; on the contrary it can only reinforce the need to take all possible steps to rationalise the management of pasture land.

1.1.2 Biological factors

(a) The major ecoclimatic units

For the eight CILSS countries, a rising humidity gradient can be followed from North to South (Map 3) and the severe traditionally recognised ecological zones can be grouped as follows:

(i) A desert zone (the Sahara), in which rain is uncertain, with an annual average of less than 100 mm. This is exclusively grazed by nomadic herds.

(ii) The Sahelian zone, a climatic belt bordering the desert, where the annual average rainfall is low, between 100 and 400 mm, in a short season of summer rains lasting from 1 to 2 months (between July and September). This is the area of transhumance.

(iii) A transitional zone, between the Sahel and the Sudan, combining the dry Sahelo-Sudanese (Sa3) and Sudano-Sahelian (So1) zones on Map 3, where the annual average rainfall is between 400 and 800 mm, falling in a rainy season of from 2 to 4 months. This is the area in which transhumant and sedentary herds and agriculture all co-exist.

(iv) The Sudanese zone, in which the average annual rainfall is between 800 mm and 1,300 mm (1,500 mm in Casamance) in a rainy season of from 4 to 7 months (between May and October). This is an area in which agriculture and sedentary herds are found together.

(b) Natural vegetation and its products

This varies from one ecoclimatic unit to another, and with the types of soil (skeletal, colluvial, sandy). The main features of tropical grazing land are given in Table 4.

The estimate of areas (Table 7) was made by plotting between isohyets for typical rainfall, on Map 2, on the assumptions that:

(i) The crystalline bedrock bears skeletal soils;

(ii) The outcrops of primary give rise to 75 per cent of skeletal and 25 per cent of colluvial soils;

(iii) The outcrops of secondary and tertiary give rise to 50 per cent of skeletal and 50 per cent of colluvial soils;

(iv) The outcrops of quaternary carry sandy soils.

The estimate of the potential herd density (Table 7) in UBT is calculated taking into account the production of forage by the land (1/3 of the biomass is assumed to be edible) and the quantity eaten (6.25 kg of dry matter per day for a 250 kg animal).

In this situation no account is taken of the day-to-day satisfaction of needs in energy and nitrogenous matter, as the value of forage available varies with the season and the state of growth of the plant concerned (Table 5). Thus grasses (granimeae) provide nourishing forage in the rainy season but must be supplemented by ligneous forage in the dry season, to meet the needs of the UBT evaluated at between 2.7 and 3.1 UF and 150 g of digestible nitrogenous matter per day.

THE SAHARA DESERT

With an annual rainfall below 100 mm, the Sahara Desert receives intermittent rain, tropical in the hot season (summer) and oceanic in the cold season (winter). These local rains enable short-cycle plants (a few weeks) to grow, with the occasional addition of perennial grassy pasture on suitable subsoils and with the help of an additional water supply (collection of run-off).

The vegetation is reduced to a few trees and shrubs in the drainage channels, with tufts of perennial and annual gramineae which grow when there is rain.

Owners of livestock move about in this area as rain and wells are available, with herds of camels, goats and sheep.

The potential herd density in the area is estimated at 75 hectares per UBT on colluvial soil.

The Sahel

The vegetation is again concentrated on sites where run-off water collects, in a semi-desert area bounded by the isohyets of 100 to 200 mm average annual rainfall.

In the typical Sahel area between the 200 and 400 mm isohyets and corresponding to the Sahelo-Saharan climate of Aubreville (1949)*, the vegetation is a steppe consisting mainly of annual gramineae and sparse ligneous thorn vegetation.

On skeletal soils, the vegetation is a contracted shrub steppe with vegetation in patches on shoulders, ledges and small depressions between layers of outcropping rock. The potential herd density is estimated at 70 hectares per UBT.

On the colluvial slopes, the ligneous cover is mixed and in places constitutes low open woodland (2 or 3 m high). The potential density is estimated at 8 hectares per UBT, and these stretches are all the more useful as they are an essential

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(*) AUBREVILLE, A. - 1949 - Climats, forêts et desertification de l'Afrique tropicale - Paris, Soc. Edit. marit. et colon.; 351 p.

seasonal link in the food chain, as the species consumed there do not present any harmful infructescence as is the case in the sandy stretches.

On sandy soils, the ligneous cover does not exceed 5 per cent. The herbaceous cover is not continuous, and there are many stretches of hard sand laid bare with the topsoil worked into wavelets. The potential density is estimated to be 8 hectares per UBT on the average.

The transitional zone

This represents the greater part of the Sahelo-Sudanese climate mentioned by Aubreville (op.cit.) with a rainfall of between 400 and 800 mm, areas in which annual species strongly predominate and in which much of the soil is taken up with temporary crops.

On skeletal soils the ligneous cover, often varied, may tend towards low open woodland towards the North. Vegetation often takes on a "striped" appearance, resembling a contracted steppe in which the bushy strips more or less coincide with the depressions and elevations of the microrelief, while the slopes are bare, with stones at the top and silt at the bottom. The herbaceous vegetation is contracted. The potential density is estimated at 17 hectares per UBT.

On colluvial soils, the ligneous cover becomes thicker and the patchy savannah is increasingly dominated by Andropogon gayanus. The potential density is estimated at 4 hectares per UBT.

On sandy soils, the ligneous cover increases from North to South (from 5 to 30 per cent with broad-leaved deciduous species). Pennisetum grows in the shade (of the trees), while the sunny areas carry a mixed savannah with annual and perennial gramineae growing together. The potential density is estimated at 6 hectares per UBT.

The Sudanese Zone

This extends from the 800 mm isohyet to the southern frontiers of the CILSS States.

On skeletal soils the vegetation is still similar to that of the transitional zone, and the potential density is estimated at 17 hectares per UBT.

On colluvial soils, the herbaceous cover is mainly Adropogon gayanus, and the potential density is estimated at 3 hectares per UBT.

On sandy soils the ligneous vegetation may cover as much as 40 per cent of the land, and tend towards open woodland. The herbaceous ground cover is still mainly of annual gramineae, despite the presence locally of perennials in sunny patches. The potential density is estimated at 4 hectares per UBT.

(c) Derived vegetation and its production

Year-to-year variations in production

The vegetation in the Sahelian area is especially unstable, and its flora and production may be altered by changes in rainfall and the effects of grazing. The risk of accidental fires is always considerable but becomes more so as soon as straw production exceeds one tonne per hectare.

Fires may destroy the feedstock constituted during the rainy season, and there will then remain only such new shoots as may appear. To estimate the effect of fires, two hypotheses have been considered (Table 9):

- an upper density limit not taking into account material destroyed by fire;
- a lower density limit assuming that fires have been checked only slightly or not at all:

  on skeletal soils, in the Sahelian and transitional zones, growth continues because it is insufficient to enable the fire to spread;

  in the Sudanese zone it is assumed that 50 per cent of growth is destroyed;

  on colluvial soils, production is not affected in the Sahara but is reduced by half in the Sahel and transitional zones, the same being true of sandy soils.

On these soils in the Sudanese zone, fires are expected to destroy everything during the dry season. Production for consumption is reduced to new shoots and the density to 10 hectares per UBT.

Harvest residues are also assumed to be preserved on the ground and available to the herds to an extent which may be as much as 25 per cent of colluvial and sandy soils in the transitional zone and 50 per cent of those soils in the Sudanese zone.

Fluctuations in rainfall result in very marked changes in the annual production of the land. An estimate of the changes in production has been made (Table 8) for an average annual rainfall of 400 mm and an average production of 4 kg per hectare of dry matter per millimetre of rainfall for this climatic area(1).

The effect of cultivation (harvests residue and fallow land)

Toutain(2) considers that cultivated land makes up 12 per cent of the total area of the transitional zone in Upper Volta, with an extension of crops of 2.25 per cent over the last 20 years. While from the point of view of the quantity of feed available for livestock, a good crop is equivalent to pasture in normal condition (2.4 to 4 tonnes per hectare of millet stems and leaves compared with 2 to 3 tonnes per hectare of grass stems), the period in which it can be used is closer to the dry season, thus increasing the value of the feed as a timely supplement.

Where pulses, and groundnuts in particular, are grown, production of leaves varies from 500 to 1,000 kg and the feed obtained is balanced and of excellent quality if properly harvested and stored. It is often sold in bunches for horses and for fattening sheep. The residues of the cotton and sugar-cane harvests are often not easily accessible to animals, but the agro-industrial by-products obtained are very useful for intensive rearing (oilcake, cotton-seed, molasses).

Production of rice straw may be as much as 500 to 2,000 kg per hectare, but it is a very unbalanced feed which cannot be put to good use except with an additional nitrogen ration. If an irrigated crop is badly tended and is invaded by graminaceous weeds (Paspalum obiculare) the pasture obtained after the harvest is excellent; a crop that is well-tended and without weeds reduces the local pastoral resources all the more, as rice crops are grown in basins and valleys that can to some extent be flooded, and are thus valuable for the dry season. The shortage will be accentuated if the ricefields occupy marshy ground with Echinochloa stagnina, on which the potential density for the dry season often exceeds 0.5 hectares per UBT for the six months of the dry season.

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(1) Boudet, G., "Etude de l'évolution d'un système d'exploitation sahélien au Mali", Paris, IEMVT/DGRST, ACC Lutte contre l'aridité en milieu tropical 1979 (48 pp).

Diarra, L., "Composition floristique et productivité des pâturages soudano-sahéliens sous une pluviométrie annuelle moyenne de 400 à 1,100 mm", Bamako, Ecole normale supérieure, 1976 (95 pp).

(2) Toutain, B., "Situation de l'élevage dans le Sahel voltaïque face à l'extension de l'espace agraire". Actes du Colloque ORSTOM/CVRS, Ouagadougou, 4th-8th December, 1978 (pp. 159-162).

Except for ricefields that are often invaded by wild rice with rhizomes (Oryza longistaminata), the fallow land preserves a potential for pasture that is very close to that of its original state. The plants taking over, however, are always based on annual gramineae, and the perennials (Andropogon gayanus) do not become established until after three or four years in the Sudanese zone.

Degraded vegetation

In the Sahelian and transitional zones the dry periods can cause ligneous plants and perennial gramineae to die, prevent the germination of the annual gramineae and encourage the drifting of surface deposits, bringing about actual desertification. On colluvial soils, exposure of the soil may accentuate erosion in layers on the return of the rains, bringing about silting and hardening of the soil which will prevent any subsequent germination.

In the Sudanese zone, the dry periods merely reduce grass production and any death of ligneous plants does not result in quasi-irreversible degredation of the substratum as in the Sahel. On the other hand an excessive density of livestock without any rest period will result in destruction of the traminaceous cover, that is often replaced by scrub.

Intensified forage production

The extension of irrigated perimeters which will take place once the big dams have been constructed should be coupled with a forage crop programme. Table 10 shows the areas concerned in each country.

Full scale experiments, with a change of livestock, have shown that it is possible to maintain 4 tonnes of live weight cattle per hectare with a fodder crop of perennial gramineae (Panicum maximum) grazed monthly, irrigated to compensate for water deficit and heavily dressed with several applications of mineral fertilizer (300 units nitrogen, 210 units phosphorus, 250 units potash). During experiments, 15 UBT/ha were maintained; 8 UBT/ha for farmers receiving technical support would thus be a reasonable expectation.

In respect to dry farming, various Sahelian countries are attempting extension work on the enrichment of fallow land by planting feed crops, and fodder fallow should make it possible to maintain livestock at 2 ha/UBT in transition zones and 1 ha/UBT in the Sudanese zone.

For colluvial and sandy soils it might thus prove possible to enrich a quarter of the transition zones and half the Sudanese zone. An estimate of land already reclaimed and left fallow can be made on the basis of the FAO 1977 census

(Table 11) by excluding from the areas cleared those under dry farming (millet, sorghum, groundnuts, other legumes, cotton), and crops on low-lying ground, irrigated to some extent (rice, sweet potatoes, tobacco, manioc, sugar cane).

In some countries, for instance, Upper Volta, the areas reclaimed are larger than those estimated with respect to colluvial and sandy terrain; this implies growing crops in fine-gravel (skeletal) soils.

1.2 Other resources: agricultural and agro-industrial by-products

(a) Agricultural by-products

Agricultural by-products consist of:

- first, crop residues: cereal straw (rice, millet, maize) and pulse haulm (groundnuts, cowpeas), whose use has already been considered in the previous paragraph, concerning harvest residues;

- second, domestic wastes after preparation of cereals: rice, millet or maize bran left after pounding. The quantities produced are difficult to estimate, but they are certainly substantial; they are already entirely consumed by animals kept near dwellings: poultry, small ruminants, pigs, tethered calves, lactating females (suckling or milked). If it is considered that 1 kg of cereal provides 5 per cent, i.e. 50 g, of bran and flour at 0.6 forage units (FU), the overall number of FU thus produced in 1977 in the countries under study would be some 150 million or, in other words, to give some idea of the quantity involved, one year's feed ration for 180,000 UBT - about 1 per cent of the total livestock population.

(b) Agro-industrial by-products

The main agro-industrial by-products are:

- grain offal from flour mills

- grain offal from rice mills

- oil cake from groundnuts

- cotton seed or cotton seed oil cake

- sugar cane residue.

The quantities theoretically produced in 1977, estimated from the 1977 FAO Production Year Book, are shown in Table 13.

But the quantities actually available for cattle feed do not bear much relation to these figures.

Only a small proportion of the paddy harvested - some 10 per cent - goes to the rice mills; most of it is processed on the spot, by the housewife or in the village, and the bran recovered is already used to feed small animals.

A recent study carried out in Senegal shows that 89 per cent of groundnuts grown go to the oil mills and produce oil cake; a small fraction (2 per cent) is processed as peanuts to be eaten as such; another fraction (almost 9 per cent) is eaten or processed on the spot by farmers. A large proportion of the oil cake produced is, moreover, exported (almost 100 per cent in 1977, 85 per cent in 1978).

Cotton seed may be used either as it is or in oil cake form after oil has been extracted. The proportion of seed used locally for cattle feed is certainly very small; most of it is exported either as seed or in oil cake form, or is used as fuel to run the factories (in seed or husk forms).

Molasses is difficult to transport and is not exported. But its use as cattle feed - for intensive fattening, for example - has to compete with other uses, particularly the manufacture of alcohol.

There are many breweries, and the dross from them is only partially used. The problem of keeping it - and therefore drying it - is difficult to solve because of ever-rising energy costs.

Little is as yet known about the real availabilities of cattle feed from agro-industrial by-products, because of the absence of reliable statistics. The figures presently available do not, without further surveys, permit cross-checking of the various data.

As a result, it is difficult to project trends over time, which will depend on two essential factors:

- trends in cereal, oilseed and textile fibre production in each country;
- the priorities decided for their use:

  export or local use,

  cattle feed or industrial uses (molasses, cotton seed).

It would be essential that the use of agro-industrial by-products be planned in each country since it is obviously impossible to launch livestock industries if feed supply is not assured.

1.3 Animals

1.3.1 Wild fauna

The present situation of wild fauna in the Sahelian countries is serious; this seriousness varies, however, in degree.

In some countries (Senegal, Mali, Upper Volta, Niger) the situation has almost reached the point of no return, and drastic safeguard measures are imperative. In Chad, things are a little better, and while conditions for the conservation of wild fauna are not always ideal, the results obtained and the efforts being made are encouraging.

In all countries, the herds of large herbivores are greatly depleted, and their numbers are far from being as great as they were only twenty or even ten years ago.

Moreover, it is only in or near the big nature reserves or national parks, where protective regulations are properly enforced, that herbivores are present in any numbers.

The grave risks to wild fauna in the region are of two kinds. They threaten individuals (traditional and "industrial" poaching, excessive illegal and uncontrolled hunting), or the natural environment, often seriously damaged by land clearance and the changes brought about by human occupation (farmers, herdsmen). Ultimately, the wild fauna have to compete with the cattle for grazing.

Utilisation of wild fauna as a source of protein

The idea of making rational use of wild herbivores in this way is not new.

It has to be said, however, that while this technique is already advocated and practised in East Africa, it has scarcely been contemplated in the Sahelian countries.

Yet its application is rightly considered to be a good way of utilising and restoring tropical environments, many of which have been modified and deteriorated by man.

The advantages offered by wild fauna in the use of available vegetation are based on the fact that wild herbivores are perfectly adapted to the natural environment, morphologically, anatomically, physiologically and ethologically.

Rational management of these animals might be considered as a method allowing the regular culling of animals of various species while keeping up optimum numbers and without upsetting the balance of the ecosystem.

Do the right conditions for such an enterprise exist in Sahelian Africa? Certainly there is no doubt of the need to protect and reconstitute impaired natural environment and depleted wildlife.

But if the operation is to succeed, the various ways of using the wild fauna must be backed up by ecological and economic considerations which are still little or imperfectly known in these regions. Moreover, this kind of management depends, initially, on the presence of an abundant stock of wild animals, and such stocks do not exist everywhere.

The first aim of the projects already set up (Mali, Upper Volta), or which might be envisaged, must be to reconstitute depleted herds of wild animals and to persuade and inform local populations so that they accept the idea of safeguarding wildlife through rational use.

Such moves are desirable and should be undertaken little by little. The aim should not be to husband game at the expense of cattle, but to bring it to a level where it would supplement meat production, making the most of marginal zones and restoring the natural environment.

1.3.2 Domestic animals

The various species and breeds and their distribution

Each species is represented by a number of breeds which are, in fact, more or less homogeneous ethnic groups, found in the various geographical zones and related to a few main types of breed, rather than separate breeds in the strict sense of the term. Their geographical distribution is indicated in the table below.

(a) Cattle

Oxen are found in the South Sudanese fringe of Senegal, Mali, Upper Volta and Gambia.

Their principal characteristic is their trypanotolerance, which enables them to survive in Glossinae (tsetse) infested zones provided there is enough food.

Other distinctly different cattle, not trypanotolerant, live in the islands and swamps of the Lake Chad basin: these are the Kouri, whose numbers are estimated at some few thousand head.

(b) Zebu

Zebu live in the Sahelian semi-desert zones, whether of Sahelian or Sahelo-Sudanese type.

The Sudanese zone constitutes a transition area where both the zebu populations of the North and the cattle of the South are found.

A distinction can be made between:

- the Sahelian shorthorn zebu, whose distribution area roughly covers the Sahelian semi-desert and Sahelian type zones;

- the Peul lyrehorn zebu, whose distribution area roughly covers the Sahelian and Sudanese zones.

(c) Crossbreeds

Crossbred populations (ox x zebu) are found in the Sudanese zone.

(d) Sheep

Wool sheep are represented by one breed only, the Macina sheep, which now lives mainly on the inner delta of the Niger, in Mali. It is found along the Niger as far as Niamey.

Coarse hair sheep comprise two main types:

- the large Sahelian sheep which live in the Sahelian semi-desert, Sahelian type, Sahelo-Sudanese zones;

- the small Djallonké sheep, which live in the South-Sudanese zone from Seneral to Chad.

(e) Goats

There are two main types:

- the large Sahelian goat, whose distribution area is the same as that of the Sahelian sheep;

- the Fouta-Djallon or Guinea goat, whose distribution area is the same as that of the Djallonké sheep.

(f) Horses

The area where horses are found is confined practically to the Sahelo-Sudanese and North-Sudanese zones. Further north, horses are replaced by dromedaries. Further south, tsetse fly infestation is a major obstacle to horse breeding.

(g) Donkey

The donkey is found in the Sahelian semi-desert, typical Sahelian, Sahelo-Sudanese and North-Sudanese zones. Its habitat extends a little further south than that of the horse.

(h) Dromedaries

The distribution area of the dromedary extends as far south as the Sahelian semi-desert and typical Sahelian zones. The Kel Aïr have a proverb: "Where millet grows, the camel cannot live". This saying, however, must now be qualified; since the drought, camels are found much further south.

(i) Pigs

Few pigs are reared in the zones where consumption of pork is forbidden for religious reasons. Local breeds are small. When climatic conditions are not too severe, it is quite possible to raise European breeds, and many improved breeds have been introduced into Africa; the Large White is one of the most widely used.

(j) Poultry

Various kinds of poultry are raised: guinea fowl, ducks, sometimes geese. But the commonest species, found everywhere except in the Sahelian zone where only ruminants can be raised, is the chicken.

Many breeds or strains of European or American origin have been introduced and have done well when conditions for breeding were satisfactory: the Sussex, the New Hampshire and the Rhode Island are among those most widely used.

Species - Breeds - Geographical distribution

Species	Breeds	Geographical distribution
Cattle (Oxen)	N'dama Baoulé Hybrid N'dama x Baoulé	South-Sudanese or Sudano-Guinean fringe of Senegal, Mali, Upper Volta
	Kouri	Niger, Chad
Zebu	Sahelian short-horn zebu:	
	Moorish	Mauritania, Senegal, Mali
	Tuareg	Mali
	Azawak	Niger
	Arab	Chad
	Peul lyre-horn zebu:	
	Gobra	Senegal, Mali
	Peul Sudanese	Mali, Upper Volta
	Djelli	Niger
	M'Bororo	Niger, Chad
Cross-breeds	Djakoré - Méré - Bambara, etc.	Sudanese zone
Sheep	Macina wool sheep	Mali
	Coarse hair sheep:	
	- Sahelian sheep (Moorish, Tuareg, Peul)	From Senegal to Chad
	- Djallonké sheep	South-Sudanese or Sudano-Guinean fringe of Senegal, Mali, Upper Volta, Chad
Goats	Sahelian goats	From Senegal to Chad
	Guinean goats	South-Sudanese or Sudano-Guinean fringe of Senegal, Mali, Upper Volta, Chad
Camels		Sahelo-Saharan and Sahelian type zones of Mauritania, Mali, Niger, Chad
Horses Asses		Sahelian zone, transitional zone, Sudanese zone
Pigs		Limited distribution, for religious reasons
Poultry		Transitional zone, Sudanese zone

Quantity

The quantities of each of the main domestic species raised in the various countries concerned are shown in Tables 16 - 20.

These figures are those published by FAO for 1977 and are based either on information provided by the country concerned or on estimates when no statistics were available.

All the figures indicated should be considered merely as estimates whose reliability is practically impossible to establish, since none of these countries is adequately equipped, statistically, to provide an exhaustive census of its livestock population.

The number of cattle has declined significantly in comparison to the 1968 estimates (16.7 million as against 21.3 million).

The number of goats has gone up again to reach the same figure as for 1968 (19 million), while the figure for sheep has increased considerably as compared with that of 1968 (17.3 million as against 15.2 million).

The number of camels is the same as for 1968, while the number of horses has increased and that of donkeys decreased.

There are still few pigs, although proportionately their numbers have increased to a considerable extent.

In value terms (Tables 21 and 22), the livestock population of the Sahel countries represents a capital of 743.2 billion CFA francs, broken down by species in the following manner:

- cattle	67.5 per cent
- small ruminants (sheep and goats)	19.7
- dromedaries	6.4
- horses and donkeys	5.0
- pigs and poultry	1.4

Health status

Even though livestock health status was fairly satisfactory in 1977, it must continue to be watched very carefully.

(a) Infectious diseases

The main infectious diseases diagnosed in most countries of the zone are:

- rinderpest
- contagious cattle pleuropneumonia
- pulmonic diseases of small ruminants
- foot and mouth disease
- anthrax
- tuberculosis
- brucellosis

Rinderpest affects in all regions. It has lost its epizootic, epidemic, character and now occurs only in limited centres of infection affecting, almost exclusively, animals under two years old. After the vast international vaccination campaign covering some 80 million head of cattle spread over 22 countries, the incidence of the disease has been so far reduced that it should now be possible to maintain a high immunity rate for herds simply by vaccinating young animals and by carrying out sustained vaccination campaigns to eliminate any residual centres of infection.

Contagious cattle pleuropneumonia is endemic in all cattle-raising regions. Its economic incidence varies enormously from one region to another. Preventive medical campaigns using modern live vaccines are nevertheless necessary in all the infected zones.

Pulmonic diseases of small ruminants: these include contagious goat pleuropneumonia and respiratory syndromes whose etiology is complex. Many laboratories are at present working to determine the etiology of these diseases so as to develop an effective vaccine.

Foot and mouth disease is endemic throughout the African intertropical zone, in a fairly primitive clinical form. The African continent is the reservoir for serotypes SAT_1, SAT_2 and SAT_3, which infect many regions and against which no stock of vaccine is available in Europe (as in America and Asia) to combat this virus in the event of its being brought from Africa; for this reason, the export of meat from the Sahelian zone is prohibited.

The two forms of anthrax, bacteridian (B. anthracis) and symptomatic (Cl. chauvoei) are enzootic. Systematic vaccination has done away with practically all the losses due to these two infectious diseases.

Bovine mycobacterioses (tuberculosis, farcy) do occur, but up to the present their incidence has been negligible or has been disregarded.

Brucellosis is a widespread affection, but the fact that infection frequently goes unnoticed, and the rarity of clinical accidents, explain why there have not, as yet, been any organised preventive medical campaigns to combat it.

(b) Internal parasitoses

Internal parasitoses are mainly due to helminths and coccidia. The distribution of these parasites varies according to ecological conditions.

Their pathological impact varies. The most serious, and the most common, is strongyle diarrhoea affecting calves, lambs and kids, often with the complication of coccidiosis: the majority of young animals is affected, with mortality of between 5 and 15 per cent. Animals which survive are left in a weakened state and do not prosper, so that their future economic value is compromised. Other parasitoses are ascaridosis affecting calves, bovine fasciolosis and moniezias stilesioses in the dry zones.

(c) External parasites

The main external parasitical affections are mange and ticks.

Mange: the most serious form affecting West Africa, is sarcoptic mange in camels, which sometimes covers the animal's entire body and causes its death. Other types of mange do occur, but are generally less serious.

Ticks: Many species of ticks are present on cattle, varying according to zone. All these species play a direct morbific role by preying on the animals' blood and injecting salivary toxins. Nearly all of them also serve as a reservoir or vector for various rickettsioses, theilerioses, piroplasmoses.

Performance and productivity

The productivity of domestic animals depends on several factors:

- reproductive and growth performance,
- mortality.

(a) Reproductive and growth performance

Reproduction

Sex ratio

It would seem that the birth of a male or female animal is equiprobable. No significant difference has been discovered, although some survey reports have mentioned a predominance of females.

Age at first parturition

This is the age at which a female reproduces for the first time.

The following table shows average age at first parturition, according to species:

Oxen (cattle)	3 years
Zebu	4 years
Sheep	1 year
Goats	1 year
Horses	3 - 4 years
Donkeys	3 - 4 years
Dromedaries (camels)	4 years
Pigs	1 year

The main factor causing variation in age at first parturition in a tropical environment is certainly the animals' nutritional state.

Observations made during experimental attempts to bring out the genetic potential of the Gobra zebu, carried out at the Dahra Zootechnical Research Centre in Senegal, showed that heifers placed from birth in optimal feeding conditions could calave for the first time at 31 months, whereas heifers of the same age and breed, raised in extensive breeding conditions but with some supplementary feed, had their first calf at 40 months, and those raised traditionally in the Ferlo region at 53 months.

Pathological factors intervening either directly, or indirectly, by inducing nutritional deficiencies, may also retard first parturition.

Fecundity

This is the capacity of a female to reproduce young animals. It is usually shown by the fecundity rate, which the annual number of live births, in proportion to the average number of females of reproductive age over the same period.

The fecundity rates generally observed in traditional breeding conditions are the following:

Oxen (Cattle)	60 to 80 per cent
Zebu	50 to 70 per cent
Sheep	90 to 150 per cent
Goats	100 to 170 per cent
Dromedaries	37.5 - 50 per cent

The fecundity of African sows is often good and it is not unusual for litters of 12 piglets to be farrowed three times every two years.

African hens lay between 30 and 100 eggs a year, depending on conditions.

The nutritional state has a very important influence on the fecundity level. This has been shown frequently, and is true of all the various domestic species.

It was, for instance, observed in Senegal when an experiment on the genetic potential of the Gobra zebu was carried out.

The fecundity rate of Gobra cows bred in the traditional manner in the Ferlo is, like that of most female zebu bred in similar conditions, a fairly modest one: some 55 per cent. In modernised extensive breeding conditions, with rational rangeland management, ensuring better feeding of the animals, the fecundity rate was found to reach 85 per cent. And when the same female Gobras are given excellent feeding conditions from birth, the fecundity rate oscillates around 95 per cent.

In traditional breeding, there is no special season for service, since the males are left with the females all the time. But it has been found that where females of continuous-type sexuality are concerned, parturitions seem to be grouped at particular times of the year, which vary considerably from one region to another.

Pathological influence on dams' fertility has often been masked, in tropical zones, by other factors, especially nutritional factors, since its economic incidence, usually fairly low as compared with other causes of infertility or decreased fertility, makes it hard to detect.

Longevity

Longevity, a concept which usually refers to length of life, is a term often used to define the length of a dam's reproductive life.

Unless she dies, a dam's reproductive life usually comes to an end only when the farmer takes the decision to cull her. After the drought, it was noticed that farmers were tending to keep their aged females for as long as possible because they wished to reconstitute their herds.

In traditional African husbandry, it is hard to say with any accuracy what the average age for culling is; nevertheless, some idea may be gained from the surveys on herd structures which have been carried out:

- about 10 - 12 years for zebu;
- about 12 - 14 years for oxen (cattle);
- about 7 years for sheep and goats.

Milking and maternal qualities

So far as cattle raising is concerned, wherever it is, milk is taken from nursing cows for human consumption, although there is no attempt to specialise production.

Humans and calves are thus competing for milk. In most cases, this competition is keen, for several essential reasons:

- the cows have only a modest genetic potential: Azawak cows from Toukounouss, in Niger, the only African breed which has been subjected to selective processes in order to improve milk yield, have produced almost 2,000 kgs in 350 - 380 days when well fed. Animals at research stations (between 1938 and 1951), given very little supplementary feed (1 or 2 kgs of cowpea haulm when grazing was too poor) produced an average yield of 450 - 600 kgs in 290 days;
- in traditional husbandry conditions, coverage of nutritional needs is provided only by natural grazing, grass or sometimes shrubs, and remains well below genetic potential, especially late in the dry season when the nutritive value of the grass is greatly diminished.

Animal growth in weight and size

Growth in weight, the increase in live weight which occurs as the animal grows to adult size, depends on genetic factors (sex, genetic type) and on external factors, of which feeding is one of the most important.

In domestic ruminants of whatever breed or genetic type, males are always heavier than females at a given age. The relative difference increases as the animal grows, to reach some 15 to 25 per cent in the adult animal.

As a corollary, the male growth rate is faster than the female.

There are differences between breeds as regards growth and size. These differences are usually not very clear, because the animals often live in widely differing maintenance and feeding conditions, so that it is difficult to compare the weights noted at various ages (Tables 62, 63, 64).

Among the environmental factors affecting growth, that of food - itself in turn highly dependent, in the Sahelian zone, on climatic factors - is one of the most important.

Feed level effects on the speed of growth came out particularly clearly in an experiment on the genetic potential of the Gobra zebu carried out at the Dahra Zootechnical Research Centre in Senegal, during which the growth of a sample of male and female Gobra zebu whose rations were supplemented by unlimited quantities of a high-energy feed was compared with that of a control sample of animals of the same age which was given only the grazing available in the extensive herding conditions usually practised on the station.

The weights noted between birth and 24 months were considerably higher in the experimental than in the control sample.

Weights were distinctly higher from the age of 6 months onwards in both males and females, and the difference became even more marked as the animals grew older; at 24 months, the weights of the experimental animals, as compared with those of the control sample, were 1.9 times higher in the males (490 kgs as against 260 kgs) and 1.75 times in the female (388 kgs as against 220 kgs).

Seasonal variations in the fodder value of grazing, which is at its highest at the end of the rainy season and at its lowest at the end of the dry season, affects the animals' growth curve; when food is scarce, the animals' growth will progress only in steps separated by stationary periods, or there may even be loss of weight (stepped or zig-zag growth curves).

Such periods are generally followed by a resumption of growth which continues at a high rate during the last weeks of the rainy season, compensating for the previous lack of growth so that the animals' growth curve continues to rise naturally at the same rate as before the stationary period or setback. This phenomenon of compensation raises the question of making up for the loss of weight suffered during the dry season by animals raised for meat: this question always has to be looked at in all its aspects: cost of feed, cattle prices, time of sale, etc.

It is, however, important to remember that the first months of an animal's life are crucial for its later growth; once weaned, animals which have been well fed up to that time will use available grazing to the best advantage, prospering better than others and reaching the best market weight much sooner.

(b) Mortality

Mortality rates among animals are extremely variable; in a year with normal climatic conditions, it is usually the young animals which suffer most heavily.

Cattle mortality is frequently as high as 25 to 45 per cent in the first age group, from 0 to 1 year.

It then diminishes in the following age groups and is of the order of 5 to 15 per cent in the 1 - 2 year group, 2 to 8 per cent in the 2 - 3 year group and 2 to 4 per cent above that age.

Surveys on herd structures show that there are less males than females aged 0 to 1 year: this disparity seems to be attributable to a higher mortality in males, although the surveys were not able to show any significant difference in the male and female mortality rates, since it is difficult to distinguish between losses due to mortality and those due to slaughter for food purposes or to sales.

As regards sheep and goats, recent surveys in Upper Volta, Mali and Chad have shown mortality rates of some 20 to 53 per cent for the 0 - 1 year age group, 9 - 25 per cent for the 1 - 2-year-olds, 4 - 17 per cent above that age.

These considerable variations relate to several factors, among which the climatic factor is one of the most important.

There are, of course, many causes of mortality:

- accidental (wild carnivores, snake bite, deaths by drowning, crushing, etc.);
- pathological (epizootic, enzootic or sporadic diseases, hematozooses, parasitoses, etc.);
- nutritional (underfeeding and undernourishment).

Among young animals which are the principal victims, the main cause, whether determinant or simply incidental, is the state of undernourishment or malnutrition which results from the combination of several factors:

- the small quantities of milk produced by lactating females, aggravated at the end of the dry season by food deficient in both quantity and quality;
- the amount of milk taken for human consumption, which means that calves have to compete directly with humans;

- food which is insufficient and ill-adapted to the animals' needs at the time of weaning, especially when this takes place at the end of the dry season: the only food available is grass which is scarce and gives very little nourishment. The long distances animals have to travel in order to find food makes matters even worse. This undernourished state may be a direct cause of death. More often than not it lays the animals' organisms open to microbial or viral intercurrent affections or to parasitic diseases which deteriorate their health even more rapidly and sooner or later cause death.

Poor feeding of young animals seriously hampers production development.

It could be improved by:

- an increase in the quantity of milk produced by lactating dams. In the long run, this would lead, first, to an improvement in feeding conditions, and then to improved genetic potential;

- distribution of supplementary fodder: tests carried out so far have always shown that extra feed given to young animals before and during weaning brought an often appreciable drop in mortality.

(c) Production levels

The indicators generally employed to calculate production levels are the offtake rate and productivity in terms of weight.

The offtake rate is the number of animals removed annually from the herd unit to be marketed (this also includes animals bartered or offered as gifts) or slaughtered for the farmer's own consumption, in relation to the average number of animals in the herd unit concerned.

The farmer will keep part of the herd's production (usually the females) in order to increase its numbers; these animals represent natural increase in stock, and their number, in relation to the average number of animals in the herd, constitutes the natural increase rate.

The rate of yield is the sum of the offtake rate and the natural increase rate.

The offtake rate essentially depends, following complex principles, on the zootechnical and socio-economic parameters governing the life of the herds: fecundity rate in the various age groups, mortality rate, the farmer's marketing policy.

Productivity in terms of weight is the quantity of meat produced, sold or used for own consumption annually in relation to the average number of animals in the herd unit. It thus depends, for one thing, on the zootechnical and socio-economic parameters determining the offtake rate, and for another on the animals' weight at the time of sale or slaughter for on-the-spot consumption.

Present production levels are generally low.

The offtake rate ranges between 6 - 14 per cent for cattle, 20 - 35 per cent for small ruminants, and 8 - 12 per cent for dromedaries.

Productivity in terms of weight ranges, for cattle, between 7 - 14 kgs net, for small ruminants between 3 - 6 kgs net, and for dromedaries (camels) between 11 - 16 kgs net.

Table 65 summarises some production level values noted in surveys of the cattle population in various Sahelian countries.

2. PRODUCTION SYSTEMS

In this section, the various production systems are distinguished one from another in order to describe them clearly; it should not, however, be forgotten that they constantly interact.

2.1 Traditional systems

In what may be termed the South-Sahelian countries, stockbreeding is entirely of the sedentary type (the whole of Gambia, rather less than half of Senegal). The farther north one goes, the more transhumant the herds are. Sedentary stockbreeding accounts for not more than one-quarter of the cattle population in Mali, about one-fifth in Upper Volta, one-tenth in Niger, one-twentieth in Chad; in Mauritania, stockbreeding is wholly nomadic or transhumant.

2.1.1 Sylovo-pastoral systems

Water resource and range use in the Saharan and even the Sahelo-Saharan zone is nomadic; in the Sahelian zone, livestock is transhumant.

Whereas nomadism depends on rainfall and wells, transhumance is a complex phenomenon allowing optimum use of ecosystems and differing in its characteristics according to the species of animals bred, the amount of rainfall, etc.

(a) Water constraints and animal water supply problems

Water is the main constraint on nomad and transhumant stockbreeding.

Livestock water requirements vary in the course of the year according to differences in temperature, humidity and availability of water.

The distance/watering point/grazing constraint is of prime importance in the dry season, since the animals have to travel long distances to find food. Watering every two days then becomes preferable.

To this distance constraint must be added those of a hydraulic device's rate of flow and the amount of labour needed for pumping.

The following sources of animal water supply may be considered:

- natural ponds, whose period of use will depend on whether or not they dry up;
- improved ponds and small dams, rarely seen in Sahelian Africa because of the many obstacles to their construction that have to be surmounted (evaporation, seepage, operational difficulties and cost of equipment for deepening and maintenance);
- small draining wells redug every year on low-lying ground: thse can be used for short periods (from a few weeks to a few months), and raise no particular problems;
- large traditional dry season wells, which do pose a number of problems: difficulty or impossibility of boring, insufficient flow, short lifespan (1 to 5 years), shaft-sinking accidents;
- modern, cemented wells which reduce the above-mentioned disadvantages but call for better-adapted surface facilities and more regular maintenance, especially when they are deepended and the surrounding terrain becomes unstable;
- drilling of wells or pumping stations, more costly but necessary when the underground water level is 80 - 100 m or more deep, since below that depth it is impossible to pump the water by hand.

The contribution of pastoral hydraulics through the creation of permanent watering points has brought about some changes in production systems:

- new pastures have been opened up; this has permitted better distribution of livestock, but has also led to overgrazing in certain countries when free access to water did not allow efficient rangeland management;

- there has been more or less extensive settling of herders around the wells sunk in Senegal and Niger; this has led to deforestation and modification of the flora around these wells;

- herd management has been modified, because:

  removal of pumping difficulties at the wells means that herders can send children to supervise the watering of animals; this stretches human-animal relations, detracting from the quality of herd management;

  the concentration of livestock around wells facilitates veterinary health and welfare work.

Modern pastoral hydraulic projects have done away with many constraints and made it possible to improve livestock production; at the same time, production systems have been modified to some extent.

(b) Socio-economic constraints

- The areas reserved for transhumant pastoralism are tending to shrink because of agricultural pressure in the south of the sylvo-pastoral zone;

- long distances and poor tracks complicate the work of administrative services (health, education, etc.), and necessitate transport which sends up consumer goods prices while keeping the price of the goods produced low.

- almost all transactions take place at the markets situated on the borderline between the agricultural and pastoral zones, where the herders buy the agricultural produce they need. The prices of this produce rise steadily after the harvest, while the herders' needs increase because their animals produce less milk once the rainy season is over;

- merchants bring consumer goods to certain wells and sell them at high prices, while purchasing stock very cheap from the herdsmen.

The different access to pastoral zones, with its attendant consequences, is a major constraint.

(c) Livestock species and herd composition

The role of the species which make up the livestock population varies according to ethnic groups, their ways of life, the need to make the most of the different ecosystems and the spread risks.

Cattle often predominate over the other species; camel breeding is less widespread towards the South; some herdsmen may possess only small ruminants.

In the present state of knowledge, it seems that no general rule can be deduced. Certainly the ethnic groups have their various preferences (cattle for the Peuls, camels for the Tuaregs), and specialised stockbreeding does exist (camels for certain nomad groups, oxen for the M'bororos, sheep for the Peuls); but the trend is towards diversification - with, however, since the drought, a bigger proportion of small ruminants which will probably make it possible, later, by substituting one species for another, to reconstitute herds.

It is noteworthy that since the drought the number of small herds has increased many times, resulting in two opposing influences on the improvement of livestock. The first is that herdsmen affected are much more aware of the methods which can improve herd productivity; the second is a decline in the quality of stock, since poor herdsmen are often obliged to sell, in order to survive, animals which would be needed for better herd management.

To achieve optimum pastoral production systems, it would be necessary to find the inter- and intra-species structures which would make it possible to deal in the best possible way with the constraints related to availability of feed, water and labour and, at the same time, to meet the herdsmen's food needs (milk and meat) as well as their monetary needs and their obligations in social terms.

(d) Production factors

Livestock, food resources and water are the main production factors.

Labour is another important factor; labour is needed to look after the herds, to draw water and for milking.

A herdsman's apprenticeship starts when he is very young (a child will tend small ruminants at seven years of age, and cattle when he is a little older); this largely explains the

reluctance of pastoral societies to send their children to school. The labour force available is often not enough to cover all herd-tending needs, especially for small ruminants, and it is often necessary to have recourse to paid hands (shepherds).

Drawing water in the dry season calls for a great deal of very hard work (it takes two adults and a child 5 hours to water 50 UBT).

Milking, which is less exhausting work, can be shared by several members of the household and involves fewer constraints than drawing water or minding animals. All this is very far from the idea of the "idle shepherd".

Protective measures against the main contagious diseases is a production factor which is usually free for the herdsman, but costs the national economy money.

Other veterinary treatment, usually at the herdsman's expense, is rare, but will become more common if meat prices, as seems to be the present trend, make it worthwhile.

Purchases of salt, natron, supplementary feed and other dietary needs are further costs which have to be borne by the herdsman, but it is not easy to calculate the amounts involved.

Labour requirements, in the present sylvo-pastoral system, are an obstacle to children's schooling.

2.1.2 Agro-pastoral systems

These are production systems where agricultural and pastoral activities coexist and may sometimes be associated with other activities unconnected with agriculture. Such systems exist only in regions where water supply (adequate rainfall, irrigable areas) makes agriculture possible.

Since they are much more diverse in character than the essentially pastoral systems, it is not easy to give a general, summary description of them.

In most instances, livestock and agricultural activities are separate and simply take place side by side; in certain zones, however, there is some overlap, since animal traction for transport and ploughing, production and use of manure, and livestock fattening by farmers are tending to be developed.

In the Sahelo-Sudanese and Sudanese zones, where agro-pastoral systems predominate, the main limitative factor is often fodder availability.

These zones are much more densely populated, and almost everywhere more and more land is being brought under cultivation; thus fallow land is shrinking and sometimes disappearing altogether, whereas the livestock population is often excessively high.

Thus, for instance, in Upper Volta, the Sahel ORD, it has been calculated that cultivated land is increasing, at the expense of rangeland: out of a total area of 5.5 million hectares, cultivated land, which in 1955 accounted for 466,000 ha (8.5 per cent of the total land area), covered 774,000 ha in 1974 (14 per cent). In 19 years, cultivated land was thus multiplied by 1.66, i.e. an average yearly progression of 2.7 per cent.

In particular, because this zone has, unlike the typical Sahelian zone, more abundant rainfall, more ponds and streams, better ground water supplies, the watering of animals is no longer the main factor limiting the development of livestock production; this is not to say, however, that acute difficulties may not arise in some circumstances due, especially, to geological substrata.

More and more often, major problems are arising because ricefields, for instance, or crops sown after flood subsidence, are being installed in the immediate neighbourhood of watering points, causing violent social conflict between farmers and herdsmen.

In the Sudano zones, where agro-pastoral systems predominate, the main factor limiting livestock is often feed availability. The extension of agriculture, related to demographic pressures, is exacerbating the problem.

For the sedentary farmers, livestock is a secondary activity. The family rarely possesses a large herd, and the time devoted to management of stock is minimal. Operation, utilisation and marketing conditions differ from those found in pastoral societies.

Nevertheless, as operated at present, livestock does provide for some of the sedentary farmer's needs. Small livestock, in particular, brings poor farmers appreciable supplementary resources and finances requirements of consumer goods.

Moreover, while the sedentary farmer rids himself of the maintenance work involved by employing a herdsman, he still controls most stockbreeding outlets, since he is the only one engaged in the occupations which provide outlets for livestock and its by-products.

Stockbreeding by sedentary farmers is a recent development and is due to a number of factors:

- regression of the major epidemics which made stock-breeding a risky activity;

- rising living standards and incomes, which make it possible to invest a part of production in livestock and lead to increased local demand for livestock products, especially meat.

All categories of livestock are represented, to varying degrees, in the sedentary herds.

. Since cattle breeding often comes up against fodder constraints, and sometimes problems of water supply and herd-tending, its density will vary from one region to another, according to the extent of these constraints, but also according to social and historical customs. Density does, however, seem to be higher where agricultural production is intensively marketed (the trend is towards the well-known "cotton cycle", as in some East African regions: farmers invest their income in livestock, keeping as many as the grazing can possibly take - whereupon the slightest climatic incident will decimate the cattle population, and the farmers will then grow still more cotton in order to be able to reconstitute their herds, thus, at the same time, reducing the area available for grazing).

. The novelty of small ruminant breeding lies essentially in the way it is conducted. As everywhere else, the method used is that known as "extensive".

Sheep and goats (especially goats) are easy to keep, because they can forage for themselves on fallow land or among village refuse. These, therefore, since they give the least trouble for their keep, are the ideal animals for the villager whose main occupation is agriculture and who has not acquired knowledge and experience of stockbreeding practices from past traditions.

The only compulsory constraints are to keep herds from ravaging cultivated fields while crops are growing and before the harvest, and to see that they have water during the dry season.

Having to mind and feed sheep and goats while crops are growing inconveniences the farmer, who has other work to do in his fields.

It is exceptional, therefore, for farmers to spend much time on stockbreeding; they pay little attention to providing food for the small livestock and looking after its cleanliness and health, and are usually quite unaware of the need to turn their livestock production to better account.

Some small ruminants do, however, enjoy privileged treatment: the sheep known as "household" sheep, she-goats, ewes when their milk is consumed by the population, and animals which are seriously ill.

For a time, these animals are given extra food (bran, leaves, haulm, refuse, salt or natron).

It is rare, however, to find true "household" sheep, kept in pens for systematic fattening, except in strongly Moslem areas and in towns.

The kind of stockbreeding broadly outlined above allows, when broken down in detail, for many variants in the way the breeder manages his animals. There are, for instance, some regions in the Sub-Sahelian zone where herding traditions are more solidly implanted and where animals are minded throughout all seasons, and better looked after.

Another feature of village stockbreeding is the small size of the herds and the fact that the livestock population is shared between a large number of individuals (head of family, wife, parents, children). In Mossi country, for example, in 70 per cent of cases where small ruminants are owned, the average herd consists of 12 goats and 8 sheep. In Chad, where average herds are of 13 to 17 head of sheep/goats, there are between 5 and 13 owners per herd, depending on the locality. It is possible to speak of fragmentation of property, in contrast to the Sahelian zone, where herds are of 30 to 50 head and may reach 250 to 300 head for nomads (Peuls).

. Traditional poultry keeping, related to settlement and the availability of agricultural sub-products, is practically non-existent except in the agro-pastoral systems.

For farmers, small-scale livestock, seen as a subsidiary activity insofar as the animals are given only limited time and attention, is a "necessary evil", since it does play a vital part in the family economy, providing an easily convertible means of saving and a product ready for direct consumption.

2.2 Modernised systems

2.2.1 Sahelian and Sudano-Sahelian ranches

The idea of setting up ranches in the Sahelian and Sudano-Sahelian regions stemmed from two main observations:

- rangeland must be rationally managed if it is to be used without deteriorating it;

- Sahelian herd productivity is seriously hampered by the slow rate at which young animals grow, particularly during the two years following weaning: hence the idea of taking young males out of the traditional herd for "growing out" in more rational conditions, thus improving their economic profitability.

Ranches have been installed in zones little used by herdsmen because of insufficient water; this difficulty has been overcome by taking the necessary measures, usually drilling wells.

The present schemes have not been as economically successful as had been hoped, largely because:

- a great deal of costly investment, too heavy an economic burden, is required (fencing, fire breaks, buildings, equipment);

- rainfall is uncertain;

- urban consumer centres are long distances away.

Even though ranching is an activity well adapted to marginal zones with little forage potential, the profit-making ability of ranches has, up to now, proven uncertain.

2.2.2 Livestock fattening

Fattening, an operation which consists of finishing animals by providing them with the right food prior to slaughter, may be done in several ways.

(a) Fattening by farmers

The existence of this practice in Africa has only recently been discovered, although it doubtless goes back to ancient times.

It is often carried out during the dry season, after the harvest, when inexpensive fodder can be used (groundnut or cow-pea haulm, bourgou, cereal waste, third-grade cotton seed).

Speculation in fattening by farmers, since it allies low production costs with often substantial differentials in the purchase and sale price of the animals concerned, is economically very satisfactory. Profits are frequently quite high, and in Niger in 1977 were seen to reach between 11,000 and 26,000 CFA francs per animals.

Fattening by farmers fits perfectly into Sudanese peasant systems, but the practice has its limits:

- availability of low-cost fodder;
- the farmers' financial situation, which makes it necessary for them to seek loans.

(b) Industrial fattening

Industrial fattening makes it possible to finish animals and increase their value.

Experience has shown that an industrial fattening centre can be profitable as long as fodder costs are kept down.

For the moment, the necessary conditions exist only in the Sudano-Guinean zone, where rainfall makes sugar cane cultivation possible, so that molasses is produced in large quantities and is inexpensive.

In the Sudano and Sahelo-Sudano regions, industrial fattening lacks plentiful and inexpensive fodder (insufficient cheap agro-industrial by-products, fodder production in river-watered systems too limited and in irrigated systems too expensive).

Industrial fattening has not been developed in regions where the dry season is long because of the absence of adequate quantities of inexpensive agro-industrial sub-products.

2.2.3 Peri-urban milk production

The population of African towns in the Sudanese region has increased, in recent years, with the arrival of rural people who are accustomed to consuming dairy products. A market has thus grown up for milk from the bush; the importance of this market is often surprising when one considers the low milk potential of the cattle concerned.

Milk is collected by dairies within a radius of anyting up to 60 kms (N'Djamena), and sold packed in plastic sachets (N'Djamena, Niamey, Dakar) or processed as yoghourt (N'Djamena, Niamey).

Milk may also be collected by private individuals who sell it direct, without processing, more cheaply than the dairies (N'Djamena).

A peri-urban market gardening and dairy system is growing up, based on the combined production of vegetables and milk. The cows produce manure, which is vital to vegetable growing.

2.2.4 Poultry farming

It is hoped that poultry farming will provide means of making up for some part of the deficit in food of animal origin which affects the countries of the Sahelo-Sudano zones.

As for modernised beef production (ranches, fattening), the development of modern poultry farming depends on availability of fodder and its prices. It would be an illusion to expect any notable growth in poultry farming unless surplus cereals were available. The development of poultry farming will therefore depend on a general increase in agricultural production.

Three systems are being used to modernise poultry farming.

(b) Improvement of traditional poultry farming by means of "operation rooster"

Under this procedure, male birds of an improved (Rhode Island type) variety are distributed in the villages to replace local cocks, which are eliminated.

This system leads practically to a first-generation cross, since many farmers keep their local cocks. When this procedure is followed, live weight increases, growth is faster, heavier eggs are laid.

(b) Modernised poultry farming and industrialised farms

Modern poultry farming implies the adoption of a number of techniques and the introduction of a wider variety of stock than those traditionally kept. Improvements will cover genetics, rearing methods, prophylaxis, packaging and marketing of produce.

This modernised poultry farming may be on a private, co-operative or national basis (poultry farming centres). If the farms are State-run, they aim to produce and distribute stock; if they are commercial undertakings, they concentrate on producing eggs for consumption, or chicken meat. Industrialised firms, however, are still rare.

It will soon prove vital to substitute meat produced through poultry farming for beef in some cases. This will call for a considerable effort of organisation all along the production line.

2.3 Complementarity of the different systems and production stratification

The production systems described above, far from being incompatible, can be complementary.

The nomads, who cultivate no crops, buy millet or other grain from the farmers at the market. In exchange, they sell the farmers milk or melted butter; while the quantities involved have never been measured exactly, they are certainly far from negligible in some instances.

For example, Chad was able to export over 1,000 tonnes of butter annually for several years.

Where the beef production chain is concerned, it is tempting to contemplate organising it rationally by:

- reserving the typically Sahelian regions for use as production zones for young cattle, by means of economical, extensive breeding;

- seeing to it that young bull calves are taken over through other structural arrangements (yet to be defined) under which they could be reared to adult age in better conditions than in the Sahel, thanks to certain availabilities of fodder;

- using these young animals for traction purposes in agriculture;

- sending the adult animals, later, for fattening, either by farmers or industrially, in the more southern regions where agro-industrial by-products are available;.

- continuing the chain right up to the slaughter of high-quality animals in the large towns.

In reality, however, the setting up of such a system encounters many obstacles.

There is no economic advantage, for the herdsman, in marketing very young animals, which he has to sell cheap. Prices depend on butcher's meat values, and from this point of view young animals are of no interest. For that reason, their price per kilo is lower than for adult animals. The herdsmen therefore hold on to their cattle as long as possible, and this attitude is unassailable from the economic viewpoint, all the more so since the main early mortality dangers are past and the risks involved in keeping animals at this stage are considerably diminished. The idea of "growing out", therefore, still has to

be put into practice, and how this is to be done is as yet undefined. Animal traction is developing, and might play a positive role, but it could affect only a very small part of the Sahelian livestock population. What is more, the oxen used for traction would have to be sent for fattening after they had worked for two years, and experience has proved that a farmer who has well-trained, fully grown oxen which are at the peak of their strength and to which he is used will be extremely reluctant to let them go until he has worked them for four or six years. This thus takes away from the role of traction animals in "growing out" zones.

Finally, large-scale industrial fattening can only be carried on in more humid areas where agro-industrial by-products exist in great quantities, whereas the Sahelian countries want to achieve maximum added value on their national production in their own country. This has sometimes led to exports being blocked, with consequent flooding of the domestic market and a drop in cattle prices. This policy is advantageous for town-dwellers, who can go on buying meat at moderate prices; but it is extremely prejudicial to the herdsmen, who feel very strongly about it.

Stratification of production would be desirable, but would require price structures such that everyone, all along the line, could take his share of the profits. This would mean intervening in the meat trade so that the market, still governed by price structures taking no account of stratification, would allow for it henceforward; and as regards foreign policy, it would call for the conclusion of inter-State agreements which would permit fair remuneration of both partners.

3. MARKETING SYSTEMS

3.1 The structures

3.1.1 Markets and traders

Livestock produced by the traditional sector are usually sold via a series of markets located at different points between production areas and consumption centres.

The first-stage markets for livestock from the typical Sahelian areas are situated on the edge of the pastoral and agro-pastoral zones. These markets are attended by a large number of small-scale buyers, who buy either direct from the producer or through a recognised middleman. The livestock are driven on foot to larger second-stage markets where they are resold to a smaller number of large-scale livestock traders.

These traders usually belong to ethnic groups which have specialised in this form of trade. They employ herdsmen to drive the animals on foot to the terminal markets or they may arrange for shipment by truck or by rail if such facilities exist.

Livestock is often sold to butchers on a short-term credit basis.

The producer is paid cash and the trader's net margin is not very high in relation to the capital outlay (e.g. in Chad in 1975, cattle purchased at 35,700 CFA francs provided a profit margin of only 4,570 CFA francs).

The traditional market for livestock on the hoof is a particularly complex system which, being well suited to local conditions, enables the assembling of livestock from several million production units scattered over millions of square kilometres.

3.1.2 Livestock trails and the movement of animals

Once they have been assembled on the markets located on the edge of the grazing zone, the livestock intended for human consumption are, in most cases, driven on foot along traditional routes to urban slaughterhouses or frontier posts.

Some of these trails have already been equipped with facilities for watering the livestock at each stage and sufficient grazing to prevent excessive weight loss during the journey. Moreover, since these are officially recognised trails, this avoids possible conflict with the local farmers.

Moving these animals on foot is still the method most commonly used. Rail transport, when it is available, is however no more expensive.

Transport of livestock by truck or by water is more costly.

Over long distances (600-1,000 km) modern methods of transporting carcass meat, including air freight, are apparently competitive on certain routes.

The moving of livestock on foot from the areas of production to the centres of consumption is a fairly expensive method, but in many cases the only one available. There is however a growing tendency, wherever such facilities exist, for it to be replaced by truck or rail transport which makes for shorter journeys and easier inspection.

3.1.3 Slaughterhouses

In camps and small villages, slaughtering is done on the ground and in doubtful conditions of hygiene.

At the larger centres (i.e. the main town in a district or region) there are small slaughterhouses with a cement area, water, hooks and more often than not a kiln and an arsenic vat for hides and skins.

Larger centres (prefectures, sub-prefectures) have covered slaughterhouses sometimes with cold-storage rooms.

The major towns in all the Sahel states now have large slaughterhouses with deep-freeze equipment for the export of carcasses. At present, the capacity of these large slaughterhouses is often under-utilised.

3.2 Marketing and related problems

There are several special aspects involved in the marketing of livestock and meat:

- livestock products are fragile, require delicate handling and care and an elaborate technique if they are to be stored for long periods;
- the value of these products is directly related to the quality delivered to the consumer and this quality deteriorates rapidly;
- the marketing operation must continue throughout the year, whereas production tends to be cyclical.

The peculiarities of the livestock and the meat trade all constitute obstacles to production:

- the constraint in all African villages of not being able to keep meat in cold storage means that the butcher has to choose a size of slaughter animal equivalent to his potential sale for the day, hence the slaughtering of young animals which could easily put on another 100 kg or more;
- the price of livestock under present conditions is based on the price of meat on the terminal market which, for political reasons, is usually an official price kept deliberately low, with the result that the price quoted to the producer does not always come up to his expectations;
- this price constraint is made more serious by the fact that it takes no account of quality; the impossibility of keeping livestock, together with the seasonal pattern

of production, causes a drop in prices during the good season (from November to February) particularly if producers, anticipating a difficult transitional period for feed supplies at the end of the dry season, decide to reduce their herds;

- lastly, the markets on the coast are affected by competition from meat from non-African sources which is often available at a very low price.

The traditional marketing system works efficiently under present conditions, but it is unable to prevent seasonal interruptions in supply for some urban centres.

The drawing up of a fair and efficient policy regarding the marketing of livestock products means defining a number of somewhat conflicting and incompatible priorities:

- priority for domestic consumption in order to improve the population's protein intake;
- or priority for export to improve the trade balance;
- keeping consumer meat prices low so that the maximum number of people can afford it;
- or taking action with regard to producer prices so as to encourage stock farmers to produce more.

3.3 Trends in prices for livestock products, their significance and relative level

An analysis of prices should not be confined to the price of beef. Prices, in the context of a market economy, should be used to indicate trends in the trading conditions and purchasing power of producers.

Hence the need to know over a long timescale:

- the relative prices for different types of livestock;
- the relative prices for livestock products and farm produce;
- producer prices and retail prices.

Prices vary from year to year as the result of fluctuations in supply and demand. However, over a long period there is evidence of relative stability in the relationship between livestock and cereals (5/6 kg of millet being equivalent to 1 kg of meat).

Meat prices are more often than not kept "low" as a political measure in the interests of urban consumers, which at the same time would appear to be contrary to the interests of producers.

In recent years, prices for Sahel meat in the major coastal towns were higher even than world prices. This seems however to have been a cyclical phenomenon and in the future a balance should be achieved, making Sahel meat competitive. Alignment with world prices would however seem the best guarantee of a ready market in the coastal countries.

4. ROLE OF THE STATE

4.1 Administrative role

The State has welcomed the tendency for nomads to settle following the drilling of boreholes, since this enables it to fulfil its role (health, education, etc.) more easily and more effectively. Although, from this point of view, it may be desirable that part of the herder's family is settled, the system of transhumance cannot be abandoned, since this is the only possible way of using the grazing lands.

Disputes between crop farmers and herders (over the destruction of crops, use of water resources etc.) are usually decided in the farmer's favour. (It was estimated that the Peuls paid out on average the equivalent of 7.5 kg of meat per person per year in fines for damage to crops caused by their livestock.)

In the grazing zone, the absence of a set of rules and regulations is an obstacle to efficient use of pasture; in the southernmost part, the cultivation of millet is becoming increasingly common and pre-empting some of the best grazing land.

In the areas of settlement, millet can even be seen growing in the midst of livestock tracks, which is tantamount to holding the herder for ransom.

4.2 Technical role and means implemented

4.2.1 Staff

Currently, average staffing ratios in the Sahel states are as follows:

- 1 veterinarian per 228,000 UBT (Gambia 90,000; Niger 583,000);

- 1 agronomist specialising in animal husbandry per 60,000 UBT;
- 1 expert in applied animal husbandry per 56,000 UBT;
- 1 senior technician, assistant supervisor per 58,000 UBT;
- 1 veterinary assistant per 19,000 UBT.

These ratios are still far below those in developed countries; what is more, only rarely does the staff have the resources to perform its tasks properly.

4.2.2 Training

The staff is trained in schools and universities of an international standard. With the opening of the Inter-State College of Veterinary Science and Medicine in Dakar, the problem of providing high-level training in an African context has been resolved, assuming that each country will send its students there.

As far as middle-grade and field staff are concerned, recruitment is in some cases not sufficiently rural, which explains why some workers are completely at a loss when they arrive to take up their first assignment. In addition, training is in many cases given to staff who are too old and it is not sufficiently geared to real conditions in Africa.

Field staff are often without work except during vaccination programmes, which is detrimental both to herders interests and staff morale.

The training of middle-grade staff and field workers is not always programmed in relation to needs. Insufficient emphasis is placed on practical training for the most frequent forms of extension activity.

4.2.3 Extension activities

Few training and extension activities aimed at getting herders to participate in and progressively become responsible for the development process have so far been undertaken.

4.2.4 Research

Basic research is carried out in foreign or international institutes; its cost could not at present be borne by the Sahelian countries.

Applied research, which is closely linked to development problems, is primarily the task of agricultural research centres and laboratories in the Sahelian countries.

Many of the current Sahel development projects provide for "accompanying research" which enables them to solve specific problems and at the same time build up a scientific data base.

"Learning as you go" makes for a faster pace of development.

4.3 Organisational role

Animal health is one of the main points on which government action to encourage livestock production is focussed. An essential condition for the success of any logical policy for developing livestock production is the setting up of a comprehensive and sound health protection programme. However, these countries' budget is more often than not meagre as far as the department of animal husbandry is concerned, which explains the obsolescence of the veterinary vehicle fleet and equipment as well as the almost total lack of drug supplies.

One of the governments' objectives at present is to organise production on the basis of a more logical management of pasture. All the projects are based on a dense extension service, sometimes working in conjunction with a livestock producers' association or co-operative, to disseminate technical information and advice.

The marketing system in the private sector has already been described but, in each Sahel country, the government has set up (or is in the process of setting up) national organisations for developing livestock resources and marketing livestock products.

In this case in particular, there is a need to define more clearly the role which these organisations will be called upon to play in the future in promoting government policy in this area.

The role of these organisations is primarily to enable the State to achieve some form of balance between, on the one hand, direct intervention in the various phases of production and marketing and, on the other, co-operation with the private sector which will need to be improved or supplemented, perhaps even assisted, but never supplanted.

4.4 Incentive role

Through its policy with regard to taxation, subsidies, credit and prices, the State can encourage activities likely to further the objectives which it has set out to achieve.

The increasing number of taxes, allied to the divergent fiscal policies of exporting countries and importing countries has often hampered the development of the livestock sector as a whole.

> The system of taxation has often hindered the development of a logical marketing system for livestock products.

The number of free veterinary services provided by the departments of animal husbandry, and which are more numerous in some countries than in others, must be considered as a form of subsidy. The same is true of feed and drugs sold at a loss.

The abolition of the livestock tax following the drought and the redistribution of income which this meant has given some fresh incentive to herders.

The current policy of keeping consumer prices at a fairly low level handicaps the livestock producer and, although he is partially compensated by the system of subsidies mentioned above, the consequent redistribution of income is certainly far less radical than in the case of crop farming.

Generally speaking, the systems of credit which have been set up operate only in the crop farming area. The main problem is recovering the loan and this is difficult in the case of nomadic or migratory herders. No attempt has been made to find a solution adapted to the problems of livestock production and the only credit operations have been concerned mainly with small-scale feedlots, animal traction and occasionally the raising of small livestock.

CHAPTER III

PROSPECTIVE TRENDS IN SUPPLY AND DEMAND (1977-2000)

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The potential capacity for feeding livestock is the vital factor in determining what development strategy can be adopted.

Ensuring the potential feeding capacity for livestock depends upon overcoming a number of constraints, the most important of which is a political constraint linked to the problems of the structure of the occupation itself, land use, and also the will to implement legislation (aid to grazing units, extension services, training and dissemination).

Without underestimating the other technico-economic constraints which will have to be overcome (e.g. land improvement by means of a water resources policy, fire control measures, regeneration and improvement of pastures, rational use of crop residues and agro industrial by-products, health measures, better marketing arrangements etc.), there is good reason to think that these could be solved easily if all those concerned in the development of livestock production were convinced of the need to do so.

1. DEMAND TRENDS

The supply of livestock products will need to match total demand, which is made up of internal demand, i.e. consumption, and external demand, i.e. export.

Internal demand

Total internal demand has been calculated without taking into account regional and seasonal variations, or the differences between herdsmen, crop-growers and town dwellers. There are too few surveys on consumption for it to be possible to differentiate various social categories without becoming involved in guesswork.

Consumption levels, which in 1968 were from 17.2 kg per head per year of meat and offal(1) and from 54.8 kg per head per year of fresh milk equivalent, declined seriously in 1977. They dropped to absolute minimum levels of 12.5 kg and 53.6 kg respectively, corresponding to an aggregate level for all the CILSS countries of 365,000 tonnes of meat and 1,520,000 tonnes of milk and milk products.

(1) In what follows, the term "meat" will be used to include offal.

The trends up to the year 2000 were calculated using the forecasting norms adopted by the FAO(1) which, using a simplified model, assume an annual increase of 1 per cent in household expenditure as the result of a slight rise in income and increasing urbanisation.

It was assumed that the consumption patterns for meat and offal would vary only slightly, as shown in the following table.

Meat	1968	1977	2000
Cattle	52.4	50.4	49.4
Sheep and goats	34.3	31.0	31.7
Pigs	1.7	3.9	4.3
Poultry and other livestock	11.6	14.7	14.6
	100	100	100

Domestic demand for milk and milk products has been calculated on the basis of production figures which are very approximate (based on the output from cows in milk which ranges from 600 kg per year in the Cape Verde Islands to 300 kg per year in Mauritania and 150 kg per year in Niger) and on the figures for net imports. In recent years, the increase in imports has been substantial (an annual growth rate of more than 22 per cent from 1968 to 1977!).

Several problems were encountered in making these projections:

- There is a very marked difference between urban consumption and rural consumption and it would have seemed reasonable to assume that imports are intended (at least partially) to satisfy the first of these, whereas the second is satisfied by local production. It did not seem reasonable to extrapolate the 1968-1977 trend to urban consumption, which would have implied multiplying imports of dairy products by more than one hundred.

- Applying the urban growth rate (even without taking into account any increase in consumer expenditure and demand elasticity involves tripling imports, which hardly seems feasible.

As in the case of meat therefore, the forecasting norms used by the FAO in the report already referred to were adopted.

(1) Prospective study on agricultural development in the Sahelian countries, 1975-1990. FAO, 1976.

Two hypotheses, which take the above-mentioned factors into account, were adopted in forecasting the trend in per capita consumption (these hypotheses are explained in Figure 28).

HYPOTHESIS I (low): present average per capital consumption would undergo only a slight annual increase resulting from growth in consumer expenditure and urbanisation. It would reach, in this hypothesis, 16.4 kg per head per year of meat and 53 kg per head per year of milk by the year 2000.

HYPOTHESIS II: average per capita consumption would, by the year 2000, reach the level that should be attained according to a normal progression from its 1968 level according to the norms projected by the FAO. This takes into consideration the re-absorption of the setback caused by the drought.

According to this hypothesis, by the year 2000 domestic demand for meat would augment to 24.1 kg per head per year and for milk to 54.8 kg.

Average per capita consumption of meat should increase at an annual rate of 2.75 per cent so that by the year 2000 the forecast level, in the absence of drought, will have been reached.

Taking into account the high demographic growth rate from 1.5 to 3 per cent, depending upon the country, by the year 2000 the total demand will reach:

- in consumption hypothesis I: 823,000 tonnes of meat and 2,665,000 tonnes of milk and milk products;
- in consumption hypothesis II: 1,218,000 tonnes of meat and 2,775,000 tonnes of milk and milk products.

Thus the internal demand will be multiplied, according to the hypothesis adopted, by 2.25 or 3.34 for meat and 1.75 or 1.83 for milk.

External demand

The demand for meat products in the non-Sahelian seaboard countries continues to increase, and domestic production will fall far short of being able to satisfy this demand by the year 2000. It would therefore seem desirable that these countries, members of regional organisations (ICBC, UDEAC, CEBV, CEAO, etc.), should be able to continue to purchase at least part of their

requirements from the Sahelian countries, provided prices remain competitive. Countries with chronically unfavourable trade balances could hardly get along without this.

In view of this requirement it was assumed that the pattern of exports per country and per livestock type would remain the same.

The export levels adopted were:

- in the case of Hypothesis I: maintenance of the level recorded in 1977 of 3.9 kg per head per year.
- in the case of Hypothesis II: maintenance of the level recorded in 1978 of 5.1 kg per head per year.

In order to satisfy the demand for exports added to internal requirements, meat production for all the Sahelian countries will by the year 2000 have to reach 1,020,000 tonnes in the case of Hypothesis I or 1,492,000 tonnes in the case of Hypothesis II. Meat production, estimated at 447,000 tonnes in 1977, will have to be multiplied by 2.28 or 3.34 respectively.

In order to satisfy the increase in both internal and external demand, resulting from an increase in per capita consumption and population growth, livestock production in the Sahelian countries as a whole would need to rise by the year 2000 from its 1977 constant franc value of 211.6 billion CFA francs to:

- a value of 432.9 billion CFA francs if consumption and export are to maintain their 1977 levels, which would imply an annual increase in production of 3.2 per cent;
- a value of 594.2 billion CFA francs if consumption and export are to regain their 1968 levels, which would imply an annual increase in production of 4.6 per cent.

2. PERSPECTIVES FOR PRODUCTION ASSUMING A CONSTANT LEVEL OF PRODUCTIVITY

Livestock products have been divided into two categories: those from herbivorous animals, most of whose nutritional requirements are derived from the improved or unimproved pastures, and those from pigs and poultry which rely on agro-industrial by-products or foodstuffs on which man has a rival claim.

In the case of herbivorous animals there are two possibilities to consider according to the capacity of the grazing lands:

- countries whose pastures since 1977 are at the limit of their capacity or already over-grazed: it is assumed that the stock-carrying capacity has reached its peak and that the breakdown between different species remains unchanged;

- countries whose pastures are still under-utilised: it is assumed that the breakdown between different species will remain what it was in 1968 when optimal capacity is reached. This will allow:

  assurance of complimentarity between species in use of resources,

  response to the accepted social function of each species for the various ethnic groups,

  satisfaction of economic needs (production for own consumption or for the market, animal traction).

In forecasting production it was only assumed that the yield per animal would remain unchanged, whereas better pasture management should result in improved nutrition and therefore an increase in these yields(1).

Production forecasts for the year 2000 are based on two scenarios, both depending on animal feed availability.

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(1) For beef the yield per animal is estimated at 15.7 kg of meat and offal with an offtake rate of 11.1 per cent and a growth rate of 3 per cent. This growth rate would progressively drop to zero once the limit of capacity was reached which would gradually raise the yield per animal to 19.9 kg.

For small ruminants the yield per animal is estimated at 3.8 kg of meat and offal with an offtake rate of 26.7 per cent and a growth rate of 2.8 per cent. For the same reason as in the case of cattle the yield will reach 4.2 once the size of the herd ceases to grow.

In the case of pigmeat, since the Sahelian countries are predominantly Moslem, it is assumed that production would remain low and adjust very rapidly to internal demand.

In the case of poultry and other types of poultry as well as egg production it is also assumed that supply would automatically adjust to the demand. Moreover, poultry could fill a part of the shortfall between supply and demand, or even act as a substitute for other types of meat on the domestic market, thus making other meats available for export.

In the case of milk production and dairy products, only the traditional system was considered. It was assumed for the same reasons as in the case of meat that the yield per animal would remain unchanged; production increase being derived only from the increase in livestock.

A first case which would be imagined but which has not been considered likely is one in which, for social reasons, the countries would not succeed in controlling their livestock population, nor in maintaining it nor reducing it this side of the overstock point already reached in certain countries.

This situation could be acceptable only if there is transhumance and even transfrontier migration, or if measures are taken to improve the management of grazing tracts and increase their capacity.

It should be noted that in this case the livestock is completely at the mercy of the five-year risk of a 31 per cent decrease in the biomass which reduces the stock carrying capacity from 27 million to 19 million UBT with an obvious risk of high mortality, there being no reserve feed available for these animals.

Failure to institute a livestock policy would inevitably result in a worsening of the situation in the more vulnerable countries which could only become more serious as the years went by, culminating once again in another catastrophe and a situation increasingly difficult to reverse. Such inaction is unthinkable due to the dire consequences that would result.

The first scenario retained (Scenario I) assumes that all the grazing land is usable (which implies a water resources programme); that as a result of an appropriate management organisation the present number of fires is reduced by 50 per cent; and that one fifth of the pastureland is kept in reserve. This last point ensures, through a sensible rotation of lands withheld from grazing use, the restoration of forage potential and a reserve for use in a bad year.

A possible capacity of 27 million UBT which could be maintained without deterioration to the eco-systems is envisaged in this scenario. If this livestock population and its production figures are identical to the previous ones, the basic difference lies in the preservation and even improvement of the eco-system.

Rationalisation the management of grazing lands does not permit an increase in animal population, bu does ensure the protection, the perenniality and the improvement of the eco-system.

The second scenario (Scenario II) retains all the hypotheses of the preceding scenario, but it assumes that the fallow areas could be enriched by forage plants. Twenty per cent of these areas, i.e. close to seven million hectares, could

be involved. This would allow the maintenance of an additional 5.3 million UBT for the eight countries. Obviously the need for these improvements will be felt to different degrees by the countries depending upon the amount of pressure on national pastures. (e.g. Chad in particular will not experience a need as intense as other countries.) Consequently the considered increase in capacity has been limited to 3 million UBT.

This scenario also envisages the use of feed crops grown in irrigated perimeters. It was assumed that a cultivation programme involving 5 per cent of the irrigated land, i.e. about 88,000 hectares by the year 2000, would provide additional capacity equivalent to 705,000 UBT. These irrigated crop lands would be reserved for intensive livestock production, fattening and milk production, particularly since other agro-industrial by-products would be available in the irrigated perimeters. Moreover they could serve as an emergency reserve for livestock raised in extensive conditions in case of an exceptional drought. With the help of permanent teams to monitor these pastures it will be possible to have early warning of exceptional dry periods thus permitting reduction of intensive livestock production and the transfer of fodder output made available to livestock being raised in extensive conditions.

Taking into account these hypotheses regarding the growing of feed crops on non-irrigated (cultivated fallow) and on irrigated land, the number of herbivorous livestock which could be supported on natural pastureland and on fallow land will amount to 30.2 million UBT by the year 2000.

The more intensive fodder production foreseeen in this scenario only permits a 12 per cent increase in feeding capacity.

In the hypothesis regarding maintenance at their present levels of yield per animal and milk production in the different species, increase in production will only follow from increase in the number of livestock resulting from improved nutrition brought about by the implementation of one or the other of these scenarios.

In Scenario I production in all the Sahelian countries will reach about 770,000 tonnes of meat and approximately 1.5 million tonnes of milk by the year 2000.

In Scenario II it will reach approximately 820,000 tonnes of meat and 1.7 million tonnes of milk.

3. COMPARISON OF THE PROJECTIONS FOR SUPPLY AND DEMAND

Irrespective of the production scenario and the consumption hypothesis adopted, it is assumed that production of pig-meat, poultry and eggs will adjust itself rapidly to domestic demand, in view of the relatively low level of consumption of these products and the fairly substantial ability to adjust these livestock populations.

On the other hand, as far as meat from ruminants, milk and dairy products are concerned, the gaps which occur between supply and demand are in some cases substantial, depending upon the country.

If the yield per head of livestock remains at its present level, and if it is assumed that average per capital consumption and exports are maintained at their 1977 levels (consumption Hypothesis I), the implementation of Scenario I for improving livestock production will not prevent a shortfall by the year 2000 in the Sahelian countries of 260,000 tonnes of meat(1), and 1,100,000 tonnes of dairy products in terms of fresh milk equivalent. In value terms (constant 1977 francs) this shortfall will amount to close to 130 billion CFA francs.

The implementation of Scenario II, which involves a greater degree of intensification of livestock production, would bring the shortfall to 210,000 tonnes of meat(2) and 1,000,000 tonnes of dairy products. In value terms the shortfall would be approximately 108 billion CFA francs.

The shortfalls increase substantially under consumption Hypothesis II.

In the case of Scenario I the shortfalls reach 720,000 tonnes of meat(3) and 1,225,000 tonnes of dairy products, representing an aggregate value of 295 billion CFA frans.

In the case of Scenario II the shortfalls are not more than 670,000 tonnes of meat and 1,120,000 tonnes of dairy products. They represent an aggregate value of 273 billion CFA francs.

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(1) Composed of 110,000 tonnes of beef and 150,000 tonnes of meat from small ruminants.

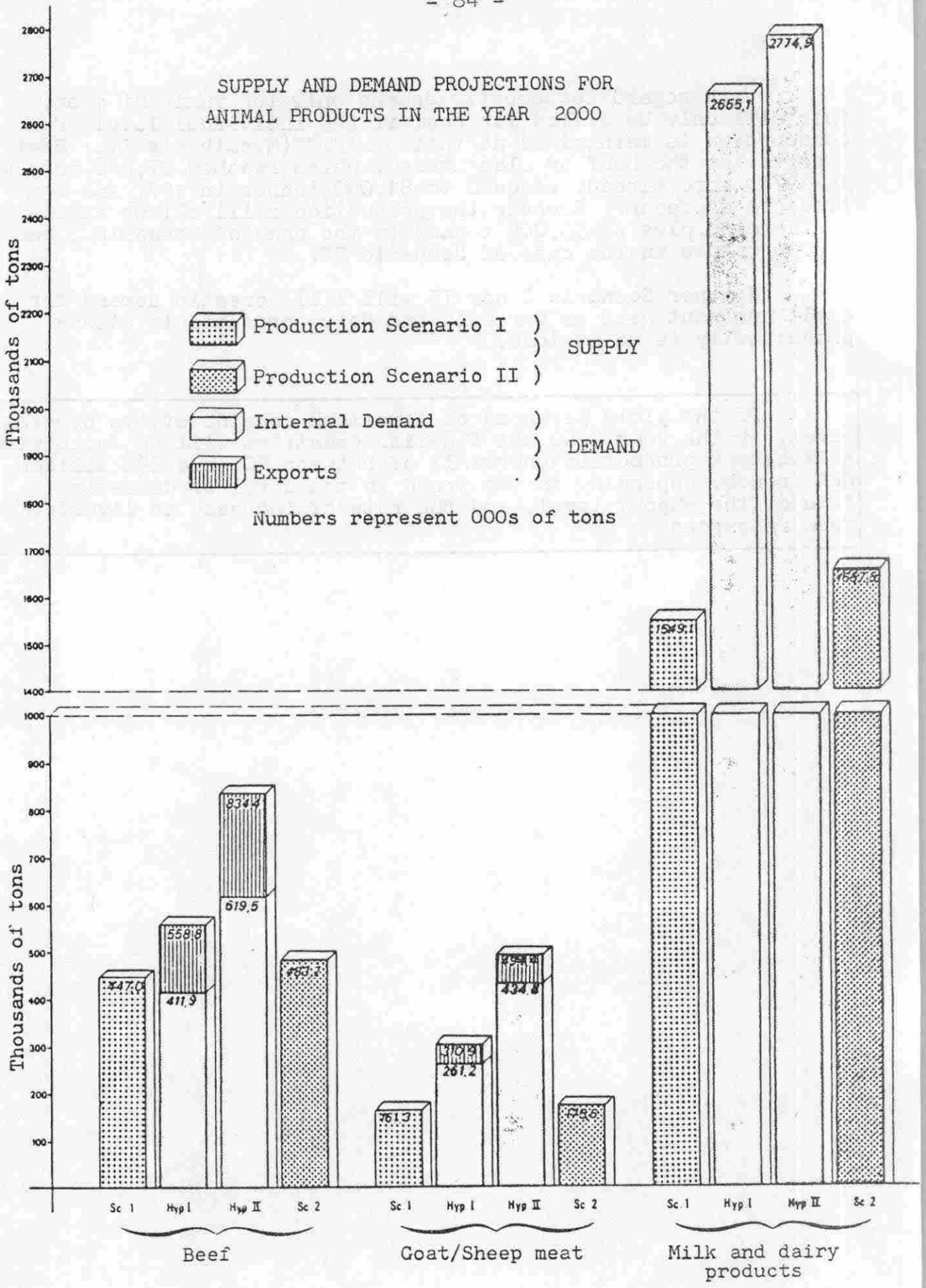
(2) Composed of 75,000 tonnes of beef and 135,000 tonnes of meat from small ruminants.

(3) Composed of 387,000 tonnes of beef and 330,000 tonnes of meat from small ruminants.

With regard to domestic demand only for ruminant meat, this will only be filled for beef if the individual level of consumption is maintained at that of 1977 (Hypothesis I). Beef exports, on the hoof or slaughtered, which reached 87,000 tonnes in 1978, were already reduced to 81,000 tonnes in 1977 and continue to decrease. However the production still allows an exportable surplus of 36,000 tonnes in the case of Scenario I and 72,000 tonnes in the case of Scenario II.

Neither Scenario I nor II will fill domestic demand for small ruminant meat or for milk and dairy products if steady productivity is maintained.

If the yield per head of livestock remains at its present level, by the year 2000 the Sahelian countries will be faced with a livestock production shortfall of between 108 and 295 billion CFA francs, depending on the trend in the level of domestic demand, the export level, and the rate of increase in livestock feed resources.


SUPPLY AND DEMAND PROJECTIONS FOR
ANIMAL PRODUCTS IN THE YEAR 2000
Thousands of tons
Production Scenario I
Production Scenario II
SUPPLY
Internal Demand
Exports
DEMAND
Numbers represent 000s of tons
2774,9
2665,1
1549,1
834,4
619,5
558,8
411,9
447,0
434,8
261,2
761,3
Sc 1
Hyp I
Hyp II
Sc 2
Beef
Goat/Sheep meat
Milk and dairy products

4. MEASURES REQUIRED TO MAKE UP THE SHORTFALL

4.1 Description of the measures

By the year 2000, with a sustained level of exports and whatever hypothesis is adopted for the growth in consumption, merely increasing the number of livestock by implementing programmes to improve the management of grazing land and to augment feed production to a level which will ensure maintenance of the balance and continuity of resources will, under no circumstances, enable production to match demand. To achieve increased production, livestock productivity levels must be increased.

In the case of beef production, the productivity level in the most favourable case i.e., Scenario II, needs to be increased by 2.9 kg or 13.6 kg, depending on whether one adopts Hypothesis I or Hypothesis II with respect to the consumption trend.

In the case of meat production from small ruminants, the yield will need to increase by 3.2 kg or by 7.6 kg, depending on the consumption hypothesis adopted.

In other words, the annual growth in yield will have to be between 0.6 and 2.4 per cent in the case of cattle and between 2.5 and 4.6 per cent in the case of small ruminants. These figures are high and getting anywhere close to them will require substantial efforts.

By comparison, in Europe over the past 25 years the cattle productivity has increased at an annual rate of 2.5 per cent (the highest rate in the world) as the result of substantial progress in genetics, nutrition and health, made possible by vast research and capital investment programmes, sustained by a high overall level of economic growth. It would seem difficult to achieve such results in so short a time in the Sahelian countries. Over the past 25 years, the progress made throughout the world in the case of small ruminants has always been less than that for cattle.

However, since present yields are very low due to various diseases, nutrition, etc., one could hope for a relatively faster rate of progress, at least during the initial years, than that achieved in Europe.

An increase in productivity could be achieved:

- either by means of projects to develop traditional livestock production (grazing units, development activity, etc.). In this case, the factors which would receive attention would be the fertility of females, the death rate among younger animals in particular, the growth and possibly the size of livestock.

Forecasting models show that, by planned development, it would be possible to increase yields within the space of about ten years by 5 kg (carcass and offal) in the case of cattle and by 2 kg in the case of small ruminants.

The proportion of the national or regional livestock population which would need to be involved in order to obtain a 1 kg increase in yield would be 20 per cent in the case of cattle and 50 per cent in the case of small ruminants.

- Or by fattening under intensive conditions (fodder crops, agro-industrial by-products). In this case, the focus would be on only one factor in improving yields i.e. growth. The previous results obtained from intensive fattening show that it is possible to obtain a net gain of about 60 kg (carcass and offal) per head of cattle fattened and about 10 kg per small ruminant fattened compared with the average yield for animals from traditional livestock production.

This represents an increased yield for the herd:

- of 600 g in the case of cattle, when the number of animals fattened is equivalent to 1 per cent of the total;

- of 100 g in the case of small ruminants when the number fattened is equivalent to 1 per cent of the total.

- Or by introducing milk production, meat production being a natural by-product of milk production. A livestock unit comprising a dairy cow and its offspring, male or female, produced during the three previous years, provides an annual output, assuming 1,200 kg of milk per lactation and taking fertility and mortality into account, of about 850 kg of milk and 62 kg of meat (carcass and offal).

In the case of dairy products, total production will need to increase by between 3.7 and 3.9 per cent per year in order to meet demand; the increase in the number of livestock will provide about 1.3 per cent of this, but the yield will need to increase by between 2.1 and 2.6 per cent per year overall (although these rates vary widely for individual countries, ranging from 0 in the case of Chad to 8.2 for the Cape Verde Islands). Assuming a constant level of productivity, the shortfall in milk and dairy products would amount to between 1,000,000 and 1,200,000 tonnes, i.e. equivalent to total production in 19.7. Over the past 25 years, the world milk yield has increased by 1 per cent per year (it increased by as much as 2.5 per cent in the United States, which enabled the United States to stabilize and even reduce the number of livestock, but the techniques used and the progress achieved would not appear to be within the reach of the Sahelian countries between now and the year 2000).

However, because of the division in the consumer market, it will be possible to satisfy only a small part of urban consumption from rural peri-urban areas. Since urbanisation is expected to continue at an annual rate of 4.8 per cent and assuming the pattern of consumption remains unchanged the shortfall and the level of imports are likely to be much higher than the estimated figures. It would seem therefore that an essential option would be the creation of "dairy zones" around the major towns, where suitable feeds could be found for the livestock. This would also involve technological research to help solve the problems of transport and conservation and provide products suited to consumer tastes.

4.2 The cost of these measures

The cost of increasing meat production can be estimated on the basis of the various development projects which have been formulated in recent years:

- Improvement of the traditional system of livestock production: for one UBT the annual capital outlay is reckoned at 2,000 CFA francs over a period of 5 years, two-thirds of this being for pasture hydraulics. Operating costs amount to 700 CFA francs per UBT per year, including working capital. The extra yield increases progressively up until the tenth year when it reaches 6.7 kg i.e. a yield of 33.2 kg (carcass and offal) per UBT (all livestock types combined). The internal rate of return, all activities included (i.e. training, extension work, etc.) would amount in this case to 5 per cent (on the basis of 400 CFA francs per kg of meat). If no hydraulics investment is required, the internal rate of return becomes 12 per cent and may even be as high as 15 per cent.

- Cattle fattening: the cost per FU from feed crops varies between 10 and 50 CFA francs depending on the system of cultivation (non irrigated, irrigated, type of irrigation, etc.).

Fattening produces a gain of 60 kg net (carcass and offal) representing a total value of 24,000 CFA francs, based on 400 CFA francs per kg. Since feed represents about 70 per cent of production costs, this item must not be allowed to exceed 12,600 CFA francs if marketing costs are reckoned at 25 per cent. Since approximately 650 FU (10 FU per kg) are required to produce this 60 kg live-weight gain (corresponding to about 65 kg vif), the cost per FU produced must stay below 19 CFA francs. Beyond this figure fattening becomes a losing operation.

In the case of fattening done by the farmer, in a self-sufficient family economy the price of agricultural by-products used (niebe) are generally market prices tied to the law of supply and demand, appreciably less than production costs. In most cases this justifies farmer fattening operations.

Added to these operating costs is the capital investment which the peasant farmer cannot provide because of lack of funds - it is reckoned that a working capital of 45,000 CFA francs is required per animal fattened.

The cost of setting up a dairy livestock unit is estimated at 200,000 CFA francs with annual operating costs for the government (primarily staff) of 17,000 CFA francs per year.

4.3 Case study

The country chosen as an example is Gambia where the per capita meat shortfall is one of the highest (6.7 kg per year in Scenario II, Hypothesis I; that is, 6,079 tonnes).

This shortfall could be overcome by intensive fattening of cattle and/or improvement of the traditional system.

Fattening: Gambia will have 316,000 head of cattle of which a maximum of 25,000 males could be fattened per year. All of the males could be taken for fattening because the fodder crops, which would provide 32 million FU, would in theory enable 50,000 beef cattle to be fattened and the agro-industrial by-products, providing a potential 51 million FU, would in theory enable 85,000 beef cattle to be fattened. We are therefore making the very optimistic assumption that 25,000 males will be fattened.

This represents an additional output of 1,500 tonnes of meat and offal, but these 1,500 tonnes will only partially make good the shortfall leaving 4,600 tonnes (6,079 - 1,500 = 4,600) which will have to come from the improvement of the traditional system of livestock production.

Traditional livestock production: If all livestock is considered, production will be increased by 6.7 kg per UBT. To make up the shortfall of 4,600 tonnes, 687,000 UBT would have to be affected by the projects. This is impossible since Gambia would have less than half that number of livestock.

What is more, assuming that all the by-products and feed production are used, Gambia would have, after fattening, an unused surplus (theoretical and optimistic) of 68 million FU.

A dairy LU (Livestock Unit) made up of a dairy cow and its offspring (calves born during the three preceding years) consumes 3,300 FU and produces 850 kg of milk and 62 kg of meat per year.

The available feed would therefore support 22,000 LU with an output of 19,000 tonnes of milk and 1,400 tonnes of meat.

The additional output of meat would thus be:

- fattening	1,500 tonnes
- traditional livestock production	1,800 tonnes
- dairy farming	1,400 tonnes
	4,700 tonnes

This still leaves a shortfall of 1,400 tonnes.

This highly optimistic programme would make good the milk shortfall and even provide a surplus.

This case study is of course completely theoretical, but it illustrates the whole problem of increasing productivity to any substantial degree.

The cost of setting up this programme would amount to:

- fattening ..... 1.1 billion CFA francs (working capital)

- traditional livestock production:

  . capital outlay ..... 2.7 billion CFA francs

  . operating costs ..... 0.2 billion CFA francs per year

- dairy farming:

  . capital outlay ..... 4.4 billion CFA francs

  . operating costs ..... 0.4 billion CFA francs per year

i.e. a total capital outlay of .. 8.2 billion CFA francs.

On the basis of the total cattle population in 1977, this amount represents an additional outlay of 38,000 CFA francs per UBT and, in relation to the human population in 1977, an expenditure of 15,500 CFA francs per head between now and the year 2000, solely in the form of capital investment.

CHAPTER IV

OPTIONS FOR THE DEVELOPMENT STRATEGY

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The grazing lands of the Sahel have so far, primarily through the use of extensive methods of stock farming, been able to supply the needs of the domestic market, though admittedly not in large quantities, and also satisfy some external demand.

The foregoing analysis of the present situation and the prospects for development up to the year 2000 have shown that, in some of the countries, the number of livestock had already exceeded the limits of the existing production systems and was threatening the broad natural equilibria. What is more, operations aimed at increasing grazing potential by rational development and use of pasture, in conjunction with intensive feed production in certain suitable areas on non-irrigated or irrigated land, would per se (without there being a substantial increase in livestock yields) be quite unable to satisfy total demand for livestock products, whatever consumption hypothesis is adopted.

This could be achieved only by a radical reform of existing production systems.

But such reform would not be possible, and still less successful, unless a number of essential factors can be completely controlled i.e.:

- maintaining the livestock population at a level geared to feed resources, which implies detailed knowledge and constant surveillance of livestock numbers and feed resources;

- optimal use of feed resources, which implies rational exploitation of pasture with the co-operation of stock farmers, intensification of production using appropriate modern agricultural methods and optimal use of agro-industrial by-products;

- constant improvement of livestock yields, which implies thorough control of animal health and nutrition, which is an essential condition for the success of any policy for the genetic improvement of livestock.

This will require:

- a sufficient staff of extension workers, technically qualified and with adequate resources to perform their tasks;

- incentives in the area of taxation and prices;

- easy sale and profitable prices for livestock products, facilitated by the organisation and modernisation of the marketing, processing and distribution systems.

This chapter will examine, in relation to different hypotheses regarding production objectives, what actions would be required to implement a policy of this kind.

1. ACTION ON PRODUCTION FACTORS

1.1 Maintenance of current potential

The minimum target is to maintain current potential, whatever degree of intensification and modernisation of livestock production is adopted.

In this case, action on livestock production factors will need to take into account the close inter-relationship between livestock, pasture and water points, with a view to making more rational use of these.

1.1.1 Action on natural resources

The objective will be to guarantee the permanence of natural resources and in particular the renewal of those which are annual. Priorities may differ depending on whether the areas concerned are pastoral or agro-pastoral.

(a) Pastoral areas

The development of pasture areas will include:

- the distribution and volume of water resources, the control of which during the dry season to a large extent governs the use of grazing tracts;

- the maintenance of the migratory system (transhumance in particular) which is the only way of making use of a highly dispersed natural feed production;

- protection of the regenerative capacity of plants (seed production areas and controlled stocking levels);

- protection of pastures against bush fires.

Livestock drinking water

One of the most serious problems for Sahelian stock farmers is watering their livestock.

Experience over the past 20 years has shown that, judging by the condition of the grazing areas, a plan to regulate the use of water points, based on their capacity, must be drawn up so as to avoid over-stocking of the grazing area concerned.

This stock capacity is related to the duration and seasonal variations in the grazing period.

Surplus water capacity results in a deterioration of the pasture by encouraging over-stocking, particularly if there is an uninterrupted supply of water throughout the year. Moreover, capacity of this kind often encourages settlement and even the creation of villages. The pressure on such a fragile environment soon has disastrous consequences: the natural regenerative capacity is no longer able to prevent desertification.

The deterioration and subsequent disappearance of herbaceous vegetation, and the elimination of ligneous plants, very soon leads to degradation of the soil, a process which can become irreversible.

Per se, the creation of water points is not a factor in pasture deterioration. On the contrary, if users agree to regulate their use, a series of water points are a way of splitting the livestock load and rationalising the use of pastures.

In addition, steps will be taken to improve (or create) natural seasonal water points (marigots, sumps) which automatically limit the duration of the grazing period. Since these water points require little or no pumping, livestock can therefore be watered ad lib and grazed over a wider area, which helps during the period of plant regrowth (the rainy season).

Maintenance of the migratory system

The migratory movement of livestock in the Sahel region is the only way of using the grasslands which enables benefit to be derived, without direct costs, from the region's only resource - its natural vegetation.

The dispersal of this resource, with its low yield, over a wide area means that it cannot be utilised in any other way except direct grazing.

In some cases, the seasonal variations in the value and accessibility of certain pastures will even make large migrations a necessity, failing which it would be impossible to make use of this natural asset.

Herd mobility over more or less great distances characterises transhumance which is a method of land use well adapted to arid regions. The necessary technical facilities (water points), economic facilities (supplying the population, marketing systems), and social facilities (schools, dispensaries) need to be planned so that the transhumance system can be maintained.

Plant regeneration potential

In other contexts, the creation of water points has demonstrated the advisability of closing off part of the grazing areas by introducing appropriate regulations (e.g. governing the use of certain water points). This closure of pastureland is justified on three counts:

- assurance against five-year climatic hazards;
- it provides uncut reserves of hay in the event of any unforeseen need occurring before the next rainy season e.g. the destruction by fire of other pasture areas, an influx of livestock not normally grazed in the area, etc.;
- it means that seed-growing areas can be set up to produce the seed required for renewing the grassland.

The annual withdrawal of one-fifth of the pasture area from use of grazing land will provide a reserve of uncut hay for use in case of need (e.g. over-stocking, accidental fire) and will help in the maintenance and regeneration of the herbaceous and ligneous fodder potential.

Fires and fire-breaks

The destruction of the natural grasslands of the Sahel by bush fires is as serious a risk as fluctuations in rainfall amounts. It is not uncommon for immense grazing areas to be destroyed in a matter of hours by a fire which is impossible to extinguish. But fire is neither spontaneous nor inevitable and, since pastures in the Sahel are composed of annual plants (i.e. no possibility of regrowth) fire destroys the entire year's fodder stock.

Fire prevention is therefore essential. The various methods used so far have shown that none of them is entirely satisfactory on its own and that the most effective solution is a combination of:

- informing and educating the local population so that they take care to avoid causing fires, participate actively in fighting fires, support strict penalties for arsonists etc;

- setting up fire-fighting teams comprising a nucleus of trained staff with basic equipment, which is easy to handle, and able to call on the assistance of the local inhabitants when necessary. If this trained staff are permanent, they could be employed outside the periods of fire alert on other extension or information tasks;

- constructing fire-breaks (which require annual maintenance) by mechanical or manual means - expensive in either case.

To maintain present pasture potential means eliminating bush fires. The recommendation therefore would be for concerted action in the area of fire-prevention, information-education and actual fire-fighting which would need to be geared to the physical and human resources of the region concerned.

(b) Agro-pastoral zones

Development of the grazing land in the agro-pastoral zones must focus on:

- the balance between farmland and pastureland;

- making better use of crop residues;

- regulating the use of fires.

The balance between farmland and pastureland

As a result of the difference in rainfall amounts, the Sahel region is divided into a Northern and Southern zone by a "crop limit" i.e. a line North of which the traditional cereal crops do not provide a steady worthwhile return. This boundary corresponds more or less to the 400 mm isohyet, which marks the beginning of what has been termed the "transition zone".

North of this limit there is too great a risk of insufficient rainfall - hence the two sub-zones:

- The nomadic zone to the North, where the activity is livestock production. The hardy, nomadic breeds of ruminants can make full use of the natural vegetation and, by virtue of their mobility, adapt to wide variations in its availability.

- The sedentary zone to the South where rainfed farming is possible, which means that both crop farming and stock farming are practised. This can result in a certain degree of competition for use of the land - this is true in the case of some low-lying land (the best in terms of water balance) which is being gradually reclaimed for crop farming, thus depriving stock farmers of what were the best pastures during the dry season. Thus, although the grazing area may diminish very little, the feed chain looses one of its essential links.

As a general rule, the best land is taken for crops and although these cover only a small part of the total area (except in the densely populated regions) stock farmers are obliged to adopt "intensive" methods of some kind, on a seasonal, periodic or permanent basis.

However, except in a few special cases, competition between stock farming and crop farming is more theoretical than real. In practice, many crop farmers try to increase their output by adding livestock production to their activities, while some livestock producers seek to ensure their fresh food supply by cultivating cereals.

In the agro-pastoral zone, livestock represent not only a factor in maintaining soil fertility (manure), but also a working implement (draught animals), a source of food (small livestock in particular) and a way of investing surplus income.

Making better use of crop residues

The use of crop residues for fodder, either in the field (millet and sorghum stalks) or after they have been gathered in (groundnut and bean foliage) is common practice and a major factor in livestock nutrition during the dry season.

The grazing of livestock on cereal stalks in the field, after harvesting, has the added advantage of delaying grazing on the grass of the pasture tracks which then have time to scatter all their seed. In addition, in the case of certain plants such as the cenchrus biflorus ("cram-cram") this respite means that the livestock can graze the stalks once the plant has lost its sharp spikelets.

Grazing on crop residues also provides direct fertilization for the field (dung) and this may even involve a transfer of fertility if part of the feed ration is derived from neighbouring pastures.

Improvement in this area will therefore involve regulating the use of uncut crop residues as feed and in the case of cut residues (legume foliage in particular) on developing simple and efficient techniques for gathering in, drying and storing these residues so that they retain all their nutritional value.

The use of these residues as fodder in feedlots (at village level) comprising just a few livestock (cattle and sheep) and for short periods (less than six months) is a highly profitable operation providing it forms part of an organised production chain.

One of the normal objectives of development must therefore be to provide appropriate marketing channels to facilitate the operation of selling these high-quality livestock products at a profitable price.

Regulating the use of fires

In the agro-pastoral zone, the damage to natural grassland caused by fire is no different from that in the North, but these fires are generally less extensive because they are contained by a number of barriers e.g. crops, roads or tracks, marigots, etc.

On the other hand, if fires are one of the techniques used either for land clearance, denshering or cleaning land prior to replanting, the farmers take care that such fires do not spread. The most disastrous fires are those which occur at the beginning of the dry season (October to December) which are frequently caused by poachers, travellers or other strangers to the area.

It follows that, if the grazing potential of this agro-pastoral region is to be maintained, steps will have to be taken to make the local population aware of the need for fire-prevention, dealing with fires immediately they start (organising teams of volunteers with their own fire-fighting equipment) and severe penalties for arsonists.

Over the longer term, the development of appropriate methods of ploughing-in vegetable residues instead of burning them will improve the soil's humus content, prevent the destruction of valuable fertilizing substances and reduce the risk of fires.

1.1.2 Strategy for using agro-industrial by-products

In the Northern zone, where stock farming is the sole activity, agricultural by-products are rarely to be found (except where hydro-agricultural improvements have been made) - groundnut cake, seeds and cake made from cotton seed, molasses and sugar cane tassels, rice meal or other by-products from less important crops all come from the crop farming zone. Their use in the nomadic zone would therefore mean probably very high transport costs.

Consequently, in the North, the partial feeding of livestock on by-products would, aside from all the practical difficulties, involve the stock farmer in a capital outlay which he will not regard as necessary, except when it is a question of the life or death of his animals or when he is certain to make a worthwhile profit on the sale of his livestock or their products.

In the crop farming zone, the shorter distances between factory and consumer and the better transport facilities will mean more acceptable costs. Nevertheless, because of their price, these products will be used only as supplementary feeds and solely for livestock likely to provide a rapid return on investment e.g. dairy cows, cattle in the terminal fattening stage, weaners etc.

A structure for the control and management of by-products could be envisaged.

The use of by-products at the national or regional level is imperative during dry periods in order to insure the survival of the nation's livestock.

From a practical standpoint, it is essential to disseminate modern techniques for harvesting, storage and, above all, optimal use of by-products for the various types of livestock given supplementary feed. It will be necessary to devise information campaigns of this kind for stock farmers.

1.1.3 Action involving livestock

The drought during the early 1970s seriously disrupted the structure of the livestock population and profoundly altered the proportion which each species represented of the total, thereby clearly demonstrating the complementary role that each plays. This complementarity manifests itself in several ways:

- cattle, sheep, goats and camels are not present to the same extent in every zone and do not use the grazing tracts in the same way, both in terms of what and how they eat and the way they procure this;

- each type of livestock has a specific socio-economic role and serves different purposes;

- small ruminants, because of their resistance, their ability to survive and their short reproduction cycle, have been a major element in the rebuilding of the livestock population.

Striking a balance between species of livestock in relation to the zone, vegetation and fodder resources, the risk of a catastrophe (drought), stock farmers' needs and market requirements will promote optimum use and stocking of grazing areas and will provide the herder with a minimum safeguard against climatic hazards.

Animal health is, and will remain, the cornerstone of any programme for developing livestock production.

Incessant vigilance and constant intervention will be required in implementing such a programme, if whatever progress is achieved in animal husbandry, marketing, etc. is not to be lost.

Disease prevention and treatment need to be part of a two-pronged effort to protect livestock from the major deadly contagious diseases capable of decimating the livestock population in one fell swoop. Control needs to be in the hands of the central authorities and programmes must be national or international.

In the development areas, these activities will need to be backed up by more specific measures to prevent chronic infectious and parasitic diseases i.e. detection of infected animals and the formulation, organisation and implementation of appropriate preventive and remedial measures(1).

Animal health protection, which is essential to the development of the livestock industry, has a triple objective:

- to protect livestock from the major epizootic diseases and prevent losses;
- to improve their physiological condition so that they can achieve their target reproduction and growth rates;
- to provide the health guarantees essential to any growth in export trade.

1.1.4 Action involving the production systems

Livestock production systems in the Sahelian countries are primarily based on making use of natural vegetation. Only these systems enable full benefit to be derived from this natural asset, whilst at the same time providing man with a means of existence in the hostile climate of the Northern Sahel.

(1) Not to mention, in the Sudanese regions, disinfecting those zones infested with tsetse fly.

Moreover, these traditional pastoral systems are generally the most suitable way of using the grazing land, in view of the substantial environmental constraints (physical, climatic, biological and human) and the level of traditional techniques.

(a) Traditional systems

The traditional systems need to be improved, but any action in this area will need to be carefully thought out and thoroughly tested before any attempt is made to introduce them on a wide scale - which should only be done once stock farmers had been given detailed information. All too often sound traditional methods have been eliminated in hasty and ill-considered ways making the situation worse than it was before.

Aside from actions involving the upstream sector of livestock production (particularly those concerned with the need to reward efforts to improve production), and in order to maintain the existing systems' potential, action is required primarily on two levels:

- Changes in systems for management of pastoral and agro-pastoral lands so that the use of pastures can be organised in such a way as to make the herdsmen responsible for the manner in which this common asset is used. The creation of "grazing units" is one possible solution.

- Retaining the methods of managing and utilising the environment which have proved their unique ability to derive full benefit from the grazing tracts, before gradually modernising these through the introduction of "grazing regulations" i.e. essential actions such as maintaining the migratory stock farming system, assigning grazing rights, putting a stop to outsiders' using these pastures etc.

(b) Modern systems

As far as the production of beef or meat from small ruminants is concerned, these modern systems mainly take the form of ranches and terminal fattening operations.

The Sahelian and Sudano-Sahelian ranches

Provided they achieve faster growth rates with livestock supplied by the traditional stock farming system and which they keep for only a short time (about one to two years), these ranches should increase substantially the yield per animal in terms of both quality and quantity. Their economic viability however, depends very much on minimal capital outlay and operating costs. For the sake of sound management, these latter costs need to be very clearly differentiated from those of the downstream activities (i.e. slaughtering and marketing of the carcasses), and vice versa.

On the other hand, only extensive stock farming can provide the "breeding ground" because, having practically no operating costs, only it can afford mediocre performance levels.

The complementarity between the traditional system and modern production methods is obvious. It will be difficult to implement however, as long as there is no appropriate pricing policy which would allow "breeding" herdmen to get a fair return from selling off young livestock.

Terminal fattening

Rural (i.e. on the farm) or semi-industrial cattle or sheep fattening operations also get their animals for the most part from the traditional herder. Aside from making profitable use of a number of fodder residues and by-products, these operations result in improved meat yields.

Traditional or rural fattening in certain countries (Niger, Senegal) is frequently an intermittent operation (Tabaski sheep, culled draught oxen, etc.), but it should be possible to develop it by improving marketing arrangements for fattened livestock, providing technical assistance via a competent extension force (selection of livestock, duration of fattening period, better use of feed supplements etc.) and setting up a credit system.

"Growing out" and terminal fattening in the modern operations require:

- a choice of livestock with sufficient fattening potential and in sufficient numbers to ensure a regular supply;
- a guaranteed supply and proper use of fodder supplements and by-products;
- profitable outlets for quality products.

These two systems are therefore highly dependent on traditional stock farming for their supply of livestock, on the agricultural and agro-industrial sectors for their fodder supplements, and on organised local and national markets to absorb their output. They can develop harmoniously only within the framework of a modernisation of the entire food chain.

1.2 Increasing productivity

The various actions undertaken to maintain current levels of productivity discussed in the foregoing paragraphs constitute the essential preconditions for any attempt to intensify

production methods. Such intensification will be the outcome of a series of technical interventions on environmental factors, livestock and production systems.

Whether or not surpluses will be available for export will depend on the scale of such improvement.

1.2.1 Action concerning the environment

(a) In the pastoral zone

To increase the resources derived from stock farming involves action which more often than not requires, in addition to very substantial technical and financial inputs, the active participation of herders themselves.

As a first phase, the resources employed in restoring degraded pasture must be sufficient to allow vast areas to be dealt with. Basically, this will involve the total and periodic withdrawal of pastures requiring renovation, together with strict control of the stock levels on those still in use.

At the same time, it will be possible to improve productivity by introducing foreign plants or multiplying good local varieties of plants on limited areas of pasture land where fertility is high (deep soils in most cases). To derive full benefit from pasture land means disseminating appropriate methods for its use and in particular for dealing with bush fires, and ensuring at all times the best balance between livestock levels and pasture growth.

A second phase would involve improvement of the flora on a sufficiently extensive scale of the Sahelian pastures, in conjunction with the actions mentioned earlier, once "research" has identified suitable species for increasing the feed potential and perfected efficient sowing or planting techniques.

One way of doing this would be to carry out acclimatisation trials on a large number of species from the dry tropical regions.

It is essential that the amount of research on plants suited to climates with a long dry season should be substantially increased.

(b) In the agro-pastoral zone

The limits on the development of the traditional pastoral system's productivity means that intensifying livestock production has to begin in areas where this is possible. One method is

to introduce fodder fallow using legumes or grass varieties suited to the environment and systems of farming. This will firstly require research to identify the most suitable plants and secondly, a substantial modification of crop farming systems to make provision for the introduction and cultivation of feed crops. An increased use of animal traction should help in this respect. It has been estimated that between now and the year 2000, twenty per cent of the fallow could be sown with feed crops.

A second method would be to introduce feed crops on the irrigated perimeters. It has been estimated that five per cent of the irrigated areas could be set aside for such crops, which by the year 2000 would amount to about 80,000 ha for the Sahelian countries as a whole. Full-scale experiments have shown that it is possible to support a stock level of four tonnes live weight per hectare i.e. 16 UBT on perennial grass (Panicum maximum), irrigated, manured and used in rotation. The forecasts which have been made have been based on a stock level of half this amount i.e. 8 UBT/ha, which should be easy to achieve in a traditional environment densely staffed, as will be the case in the irrigated perimeters.

In any case, the intensification of feed production, however necessary this may be, can only be successful as part of an overall intensification of crop farming in which restoring and maintaining soil fertility will be a priority aim.

For the agro-pastoral zone as a whole, there is an urgent need to decide on and implement methods for protecting, rejuvenating and using the natural grasslands, as well as techniques for creating and exploiting cultivated grasslands in order to maintain and thereafter increase the feeding potential.

1.2.2 Action involving livestock

Efforts to increase livestock yields will need to focus on three essential points, i.e., increased health protection, better nutrition and improvement of livestock breeds.

Increased health protection will primarily involve the control of chronic infectious diseases and parasitic diseases. The approach will need to be two-fold: firstly, intervention covering more and larger areas (areas more densely staffed, modernisation of operations etc.) and, secondly, increased measures of protection, prevention and treatment designed, if not to eradicate disease and create disease-free areas, at least to improve livestock health significantly.

As this health programme, under the aegis and control of the state, increases in scope and intensity, veterinary attention for individual livestock will become increasingly feasible and increasingly vital in view of the increased value of these animals as the result of their better genetic quality.

An improvement in animal nutrition will to a great extent result from the increase in availability of feed, whether in the form of properly managed natural pasture, feed crops introduced in the crop farming systems or more and better utilised agricultural or agro-industrial by-products.

Aside from this purely quantitative aspect, the quality of livestock nutrition will assume even greater importance since breeding performances, milk production and growth rates will be higher.

There could be an infinite variety of ways for achieving balanced livestock feeding, depending on the system of production involved: this could range from periodically supplementing pasture intake for certain categories of livestock (e.g. females with their young, young animals before and during weaning, females at the end of their pregnancy etc.) to the indoor feeding of livestock in permanent stabling (e.g. intensive milk production in the urban periphery, terminal fattening etc.).

This will mean drawing up a precise inventory of the actual availabilities of agro-industrial by-products, the building of suitable storage facilities, the possible creation of processing plants or plants to manufacture livestock feeds and organising systems for transporting these feeds from the producer to the consumer.

The genetic improvement of livestock will be an important factor in increasing yields, but proposals for selective breeding or cross-breeding with high yield species will have a real chance of being successful only if they take full account of the different environments in which they will be applied, not only in terms of the health environment or nutritional level, but also in terms of stock farmers' technical ability.

1.2.3 Action involving the systems

Where the traditional systems of livestock production are concerned - and where new land tenure systems and grazing regulations have been adopted in agreement with those concerned and with a promise of active support on their part - the creation of a competent technical field staff will enable the level of production to be raised. In particular, it is vital to provide producers with information to help them to adapt their traditional methods of stock farming to the market economy in which they have to operate.

In practical terms, this means setting up an effective zonal stratification of the different phases in the livestock production chain, without however harming the interests of any one category of producers.

Such stratification has not been possible hitherto because it works to the disadvantage of initial producers (breeders) and favours those farther along the chain and particularly those at the end of it. However, some of the modern systems, such as ranches, can carry out this kind of integration and thus try out ways of introducing such stratification.

In the pastoral zone, improvements to the traditional system can be based on the development of simple but effective techniques for creating fodder reserves for the dry season or providing agro-industrial by-products for seasonal feeding, or other methods for the periodic supplementary feeding of certain categories of livestock e.g. the balance of the feed ration during the season when only poor quality straw is available can be improved by providing supplementary nitrogenous substances. The low protein content in Sahelian straw reduces its digestibility and the amount consumed. Supplements in the form of (digestible) nitrogenous substances increases the amount of spontaneous consumption and can reduce, or even overcome, weight loss during the dry season.

In the agro-pastoral zone, the same type of action, in conjunction with the division of livestock into lots with similar requirements, can also make a definite improvement in yields by making it possible, to some extent, to match the value of the feed ration to the animal's requirements.

2. ACTION ON MARKETING SYSTEMS

2.1 Organising the marketing sector

All the Sahelian countries are aware of the need to organise the marketing sector so that it can fulfil its proper economic function in the context of changing marketing needs.

(a) The status of traders

The standard of professional conduct needs to be raised and the status of each specialist clarified i.e. wholesale traders, wholesale and retail butchers; this trading code should define each specialist's sphere of activity, specify the qualifications required, the appropriate type of technical training and a form of professional organisation to protect their interests, improve the service rendered and the income they receive from their work - all this of course in co-operation with the traders and not just decided on at government level, as is too often the case.

(b) Encouragement of private investment

Once their status has been more clearly defined, traders should be encouraged to undertake improvements which would make them more competitive not only in terms of price, but also in terms of quality and reliability.

(c) Credit

In addition, this sector should be assisted by the provision of special credit facilities for meat traders, wholesale butchers and certain exporters covering operations such as:

- feeding livestock in holding pens;
- short-term loans for cash purchases of livestock from stock farmers;
- increasing storage capacity (holding pens, warehousing for hides and skins) so as to avoid interruptions in supply;
- credit facilities to purchase equipment.

2.2 Increased activity on the part of national bodies for the development of livestock resources and the marketing of livestock products

In almost every case the role which these bodies will be called upon to play in promoting government policy needs to be more clearly defined.

Their role can range from either extensive or, more usually, semi-intensive or intensive production operations, either independently or in conjunction with stock farmers, to marketing operations, e.g. intervention purchases on the market, slaughterhouse operations, processing, storage, the distribution and sale of livestock, meat and by-products (such as hides and skins) on both the domestic (possibly at subsidised prices at critical periods) and export markets.

Government bodies concerned with livestock marketing should be strengthened, but not to the detriment of the private sector.

2.3 Improving the marketing system

(a) Offtake of young livestock

The offtake of livestock is regarded as essential because it should be a way to increase the productivity of migratory livestock and gradually transform them into "breeding stock". This however will require:

- adequate facilities (feedlots, areas for growing-out and terminal fattening) either in the Sahelian countries, whenever feed availabilities will allow this and when it is certain to be profitable, or in countries poor in meat but rich in agricultural by-products;

- agreements between the countries for a fair distribution of profits and expenses;

- incentives for stock farmers to sell their livestock i.e. prices for young animals which are sufficiently high to provide an inducement to sell.

(b) Better information

The effectiveness of market information in determining a fair level of prices is considerably reduced by the difficulties and distances involved in taking livestock from one market to another, except where rapid means of transport by road or rail are available. However, it would be useful if, via the media or other methods, information could be given on prices so that stock farmers could enjoy the benefits of a free and competitive market situation and be less at the mercy of livestock traders.

(c) Organising the domestic market

Domestic needs must be satisfied before any moves are made to encourage exports.

Suggestions for possible changes in these livestock marketing systems at the stage closest to the consumer include the following:

- evening out the supply of livestock to urban markets by setting up reception points in regions accessible to livestock merchants and butchers;

- encouraging contractual agreements between buyer and seller;

- facilitating the movement of animals (livestock tracks, collecting centres with grading pens).

(d) Organising the channels for export

It is important in this connection to assess competition from non-African meat products on the coastal urban markets. To counter this competition, the seaboard states must be able to count on a reliable supply in terms both of quality and quantity whether on the hoof or slaughtered. The latter form must be widely developed since all the Sahelian countries want to realise maximum value for their livestock which presupposes local slaughter.

This entails:

- Improving the entire transport operation for livestock from collection to deliv ry. Co-operation with the importing countries is essential with the object of providing sufficient rolling stock and well-equipped holding pens, simplifying the formalities and various export levies and introducing a visa system for suitable livestock.
- Organising all the administrative and health procedures in such a way as to eliminate the various petty formalities which hinder the movement of livestock.

Marketing organisations will need to focus their attention on aiding the private sector while continuing to intervene directly, whenever necessary, in production and marketing areas.

2.4 Pricing

Meat and livestock prices are very difficult to fix because of the strong influence of the consumer on the market and the variations in price from one year to another as the result of the supply/demand relationship, which is in turn linked to the present system of production.

A study should be carried out to assess the feasibility of setting up a system of price stabilization on a regional level, and a national fund to assist livestock production and increase productivity.

If, for political reasons, meat prices have to be kept at a reasonable level in the urban areas within the exporting countries, they should nonetheless not penalise producers. Stock farmers could be compensated in the form of subsidised prices for supplementary feeds, veterinary products etc.

The solution to the problem caused by the presence of non-African meat on the coastal markets is a purely political one and lies in the long overdue renewal of co-operation between these countries and in the improvement of production systems so as to increase the available supply of meat.

3. THE ROLE OF THE STATE

3.1 Administrative role

(a) Setting up appropriate systems of land tenure

In most of the CILSS countries, the system of land tenure has undergone changes during the twentieth century in the hands of the colonial and then the national legislatures.

In what was formerly French West Africa, the Decree of 1906 allowed land owners, by registering their tenure, to secure legal protection of their rights.

In 1925, a decree set up a method for establishing property rights in preparation for the transition from common law tenure to a system of freehold.

The Decree on property and State lands of 20th May, 1955 recognised "common law rights exercised collectively or individually to lands not assigned under the forms of the Civil Code or the system of registration" i.e. it recognised common law property rights without exception and provided an insurance against arbitrary eviction.

With the exception of registered property, these common law rights were concerned mainly with rights of use, which the occupant of the land did not possess because, according to common law, land belonged to the community. Since Independence, most of the CILSS countries have extended this concept to all land, pasture and water, users having only a right of usufruct.

The State has therefore acquired a dominant role, and is now responsible for ensuring proper utilisation of land and water by farmers and herders.

For example, the Mali Forestry Act (Law 68.8 of 17.02.1968) states that "all forest land (with the exception of areas cleared by farmers for agricultural production) shall constitute the State forest domain".

State intervention will therefore be necessary almost everywhere as far as improvements to pastoral and agro-pastoral areas are concerned - improvements which are vital if livestock production targets are to be attained.

(b) Formulating and applying grazing laws

The systems of land tenure in the CILSS countries make it necessary to draw up a code of grazing laws. Since there is no private ownership of farmland, appropriate legislation needs to be enacted to govern the use of pastoral and agro-pastoral land, similar to the laws governing forests.

Grazing laws should be a reflection of the political choice of the country concerned with regard to its society. They should define the stucture of its rural society of pastoral and agro-pastoral farmers, regulate the use of land either on an individual or communal basis and define:

- a regional and national master plan;
- the composition of pastoral and agro-pastoral communities and their representative and decision-making bodies, which would have some jurisdiction over land tenure and land utilisation, i.e. be responsible for:

  defining the areas controlled by local communities and the State lands controlled by the government's technical services (forestry, animal husbandry);

  drawing up a land use plan for the different areas;

  planning livestock levels and pasture reserves;

  the prevention of bush fires;

  controlling the use of feed or non-feed plants.

(c) Drawing up a policy for pasture water resources

Since grazing land is practically everywhere the property of the State, the stock farming community is increasingly abandoning responsibility for its development with the result that the government's technical services have been obliged to take over this task rather than try to make the users responsible.

Successful pasture land management depends on well-distributed livestock watering facilities, and here, again, the government is having to assume most of the responsibility since satisfactory pasture land improvement means a satisfactory distribution of watering facilities.

(d) Pricing policy

World prices for livestock products, and meat in particular, fluctuate a great deal. Moreover, they do not accurately reflect production costs because of the effect of various official or hidden subsidies.

In the CILSS countries, when import barriers are removed, the low price of non-African meat can sometimes ruin local producers, and conversely, when world prices are high, the African consumer is the one who suffers.

If consumer demand is to be met, governments cannot put a total ban on imports, but they should discourage them by various measures such as taxes.

Some system of quotas on imports of non-African meat is essential if a modernised system of production is to be introduced in the Sahel.

3.2 Technical role

3.2.1 Staff, training, extension

Generally speaking, training in livestock production needs to be better geared to needs and to put more emphasis on practical instruction.

In this connection, it is essential:

1. To gather sufficient data on the requirements to be met so as to find solutions and formulate policies.

But what has to be done first of all is to:

- broaden existing staff's scope for action (by increasing the resources at their disposal and their technical ability);
- make use of the complementary function of existing staff in other areas of rural development (Agriculture, Water and Forestry Resources) by giving them additional training;
- improve the training methods and curricula of existing training courses;
- progressively reduce the number of tasks carried out by extension staff by preparing the way for more of these to be assumed by the producers themselves.

Staffing ratios should not be defined arbitrarily but after detailed analysis of the specialist tasks to be performed and the resources available.

2. To increase the efficiency of training establishments at a national and regional level.

(a) External factors affecting training must be taken into account:

- by creating the basis for a dialogue between the various bodies responsible for training staff for livestock production operations;
- by looking at ways of making the criteria for government service less restrictive;
- by planning for the future as far as budget allocations for staff training and operating costs are concerned.

(b) Teaching aids need to be developed so as to facilitate the task of training (e.g. information for teachers, setting up a "bank" of documents etc.).

(c) The full-time teaching staff should be increased on a selective basis.

At present, most of the instructors are employed on a freelance basis and do not have the time to spend preparing improvements in teaching methods.

(d) Scholarships for training abroad should be awarded regularly both for trainee instructors and for specialised training for planning staff in the livestock production sector.

3. To ensure good relationships between organisations involved in livestock production.

(a) Between individual training institutions.

(b) Between training institutions and rural development operations.

(c) Between rural development operations and producer groups.

4. To expand substantially the training programme for livestock producers.

The extension services have an important role to play in communicating to producers the methods they should use so that they participate more directly in their own development, which involves the fundamental task of providing basic education for nomadic and migratory populations.

3.2.2 Organising the sectors involved in livestock production

(a) Organising the veterinary and animal production services

Governments should devise means for increasing the capacity of existing services or make such improvements as are necessary to implement effective animal health programmes.

This involves:

- the maintenance and standardization of veterinary equipment;

- a regular supply of drugs and vaccines;

- creating additional facilities or increasing the scope of existing facilities.

To accomplish this it will be necessary to endow these services with adequate budgets which, unfortunately, is not often the case at the present time.

Governments should draw up plans for reorganising these services in order to prepare them for changes in the system of livestock production and make it possible to broaden the scope of operations including community development (animation).

In order to do this:

(a) Veterinary services will need to be restructured so as to relieve them of certain tasks which can be performed by stock farmers themselves (e.g. administering essential drugs).

(b) Governments will need to see to it that these services have adequate financial and material resources.

(c) Since most of the staff are usually concentrated in the capital, Governments should provide incentives for them to move out into the field.

(d) Lastly, Governments should co-ordinate their activities in the areas of vaccine manufacture and disease prevention campaigns.

(b) Organised livestock producers

The organisation of livestock producers in co-operative or pre-cooperatives would seem to be an important step for promoting progress in the development of livestock resources. Such co-operatives, well organised and well managed, will spearhead operations undertaken.

The improvement of livestock production methods, health protection campaigns, regular mass treatment of livestock and access to credit could all be organised at their level. They could also play an effective role in purchasing, transporting, and distributing supplementary feeds required by livestock throughout the year.

Setting up co-operatives would pose more problems in the grazing zone than in the crop farming zone where such structures already exist. The same is true of credit facilities (it being more difficult to recover loans from livestock owners because of their migratory movements).

Initially, the most important function of co-operatives will be to supply production inputs to stock farmers; subsequently, once the necessary studies have been carried out, they could be responsible for the various livestock marketing operations.

3.2.3 Research

Research should always be considered as the responsibility of Governments, whether they conduct the research themselves or delegate this task to specialized organisations.

The development of livestock production is often hampered by the fact that it is difficult to introduce changes in existing socio-economic systems and adapt modern technologies to local conditions. Research in the sociology of pastoralism therefore, must really be geared to the producer level so that it can provide herders with acceptable models which will serve as the basis for development projects.

Concrete examples of supporting research exist which clearly demonstrate the value of this method.

Aside from this accompanying research for on-going projects, the Government should devise programmes of applied research as a preliminary to more intensive development, which would involve:

- adequate infrastructures (laboratories and experimental stations);
- the training of local research staff;
- co-operation between the different countries.

In view of the financial resources of the CILSS countries, basic research would still need to be carried out in the developed countries, but applied research, conducted by the Sahelians themselves in conjunction with foreign universities and colleges of technology, will contribute enormously to progress.

"No progress is possible without development, without technical innovation, without intervention and hence without research".

(L. SENGHOR)

CONCLUSIONS

The years of drought which struck the Sahelian countries at the end of the 1960s and during the early 1970s substantially undermined their livestock production capacity.

With the population growth continuing at a steady rate, this resulted in a marked decrease in per capita consumption of meat, which dropped from 17.2 kg in 1968 to 12.9 kg in 1977 and was accompanied by a decline in exports.

In all the countries the livestock population is being reconstituated.

However, the unfavourable climatic conditions which characterise the Sahel region, and which limit the potential feed supply, mean that the livestock population cannot exceed a certain limit, beyond which the broad ecological balances would once again be at the mercy of the slightest variation in rainfall.

Once this limit has been reached, any increase in meat production can only be the result of increased livestock yields.

An analysis of the prospective trends in demand, both to satisfy domestic consumption and maintain a certain level of exports, shows that by the year 2000 demand could increase to as much as three times the 1977 estimate of production, under the combined effect of increased per capita consumption and population growth.

It will be impossible to achieve this target, which implies an annual increase in production of about 5 per cent, unless substantial efforts are made by everyone at every level.

This will mean steering a traditional and essentially extensive system of production, in constant precarious balance with its own environment, towards an intensive system by bringing about radical changes in outlooks, habits and ways of life.

But whatever resources are brought to bear, whatever techniques are proposed, livestock production will never achieve the necessary development targets unless there is a clearly stated and constantly reaffirmed political intent on the part of the Government. This intent must first of all be expressed in the way the national priorities assigned to the development of livestock production are defined. It must then be embodied in a clear and public statement of the technological and social means to these ends. And finally, within the framework of a long-term plan, it must ensure continuity not only in these priorities and technological options but also in the mobilisation of resources, whether these be local resources or assistance from outside.