REPUBLIQUE DU SENEGAL

MINISTERE DU DEVELOPPEMENT RURAL

INSTITUT SENEGALAIS
DE
RECHERCHES AGRICOLES

IMPROVEMENT OF NITROGEN LEVEL IN RUMINANT'S DIET :

The problem of dissemination of research results on utilization of urea and browses as nitrogen sources in Sahelian feeding systems

Communication presented at the PANESA/ARNAB workshop
Malawi - December 5-9 th 1988

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INTRODUCTION

Bioclimatic contraints are still the main limiting factor to food availability for ruminants in the sahel.

The dissemination of available research results wich propose well adapted solutions to those difficulties is of particular urgency.

Cereals as well as high energy and nitrogen concentrates remain costly with additionna1 problems of transport and livestock is in competition with others alternative usages. Some high nutritive value agro-industrial by products are exported;thus their availability is poor.

So in sahelian countries ruminant feeding systems are naturally based on natural pastures and low quality roughages like cereal straws witch are good sources of cellulose but low in digestible nitrogen(see table 2).Chemical and/or physical treatment including nitrogen,energy and minera1 supplementation are indispensable for optimal utilisation of low quality roughages.

Among nutritionnal constraints,protein deficiency appears to be one of the most important.Protein sources are expensive and some proposed solutions involving utilisation of oil meals and cereal brans seem to be of poor apliability at the great scale of extensive livestock.For that purpose urea and browse plants could be of a good help as locally available and cheaper nitrogen sources.

Over more than 50 past years,research works on protein

ruminant nutrition have identified urea as the most promising chemical for cereal straw quality improvement and non protein nitrogen supplementation(Jackson 1979 , Sunstol 1984).However research results have been of poor dissemination in African traditionnal livestock.

Rrowse plants are other source of protein readily available in pastures.During the dry season they can reach 50 per cent of the cattle diet while they represent the basis of small ruminants nutrition(around 80 per cent of their diet) (Guerin et al 1985),in grazing conditions.Available informations describe the nutritive value of trees and shrubs;their high protein content and aptitude to enhance nitrogen level of ruminants diet is emphasized (Rivière 1978,in Le Houerou 1980,Kone 1984,Kone 1987,Fall 1988)

So urea and browses give good possibility to limit nitrogen deficiencies in sahel and improve livestock productivity.

Our objectives is to highlight several considerations linked with practical dissemination of research results,to identify constraints and propose some solutions able to make easy nitrogen supplementation of low quality fodder using urea and browses at the farmer level and find out some on farm-research areas in relation with urea and browses usage witch need to be investigated in priority.

1. Constraints to urea on farm utilisation in sahelian countries

1.1. Urea for nitrogen supplementation of ruminants diet

1.1.1. Urea availability (See table 1)

In most of the sahelian countries urea is not locally produced.This chemical is imported and widely used as fertilizer.In Senegal around 10,000 tons per year are imported and manufactured for fertilizer production.This quantity is bellow the national requirement for soil improvement and urea usage in livestock feeding could increase the deficit.

Governement contribution to urea cost is decreasing from a year to another.The objective is to suppress this contribution for priva-te initiative resulting in a decrease in urea distribution.

So availability and cost of urea is a major constraint to it's popularization.More quantity is required for both livestock an soil produtivity improvement.

The question is weather urea supplementation is feasible and profitable in the conditions of extensive livestock or not.On-farm trials and economics could help to prove it.

1.1.2.2 Caracteristics of urea added diets.

To optimize urea digestive usage a good supply of energy, true proteins and minerals is needed.

- Easily digestible source of energy is needed.Molasses and cereals are good supports of urea.The first is available in areas of sugar cane prodution while the second suffers for monogastric (including human) nutrition competition.

-Urea mixture in the diet has to be the most homogenous possible to ensure a progressive consumption by the ruminant. This aspect involving the diet preparation may be constrainting for farmer since urea is sold in pearl form.It has to be solubilized in water before to be mixed with the other components of the diet.This imply a good water supply but also a blendor or a hand mixer like fork to impregnate forage with urea solution.

-In addition to urea supplement,true proteins are required for a well balanced rations.According to NRC (1976) estimates urea level should not be above 30 to 40 per cent of the protein requirement of the animal.So urea cannot solve the whole problem of nitrsgen requirement in protein deficient diets.

-Minerals specially calcium and phosphorus(in a well balance)including sulphur and cobalt are required for optimal activity of rumen microbes the true users of urea.

It puts the problem of availability of mineral supplements

in acceptable price in rural area.A practical solution has not been reached yet at the large scale of traditionnal livestock.

-The water availability in the sahel is the most important constraint to urea utilisation.The watering of urea given animals should be as regular as possible and it is advisable to give water at libitum.This is almost impossible in the sahelian traditionnal system.

Temporary water points dry in the early dry season. Drillings have a hard problem of maintenance;they do not work often and the distance between them in ferlo area is too high(See figure 2 Gaston et al 1987) So herds use to be watered once every two days.In this system water supply does not satisfy ruminants requirements;those conditions do not seem to allow urea introduction.

Beef fattening workshops around agglomeration where water supply is correct offer best conditions to spread research results involving urea usage in ruminants diet.

-Poor palatability of urea added diets may be a constraint to it's acceptance by ruminants.Molasses and/or salts are excellent supports for improvement of urea added diets palatability

Caracteristics of urea based diets summarizes some rules to be respected in order to ensure a good absorption and prevent ammonia intoxication.Farmers need to be aware of them.

1.2. Improving nutritive value of low quality roughages by urea processing

1.2.1. Urea versus other chemical or physical methods of straws quality improvement.

A major limiting factor to straws utilisation is their bulkiness and low concentration in digestible nutrient.Their nitrogen poverty specially has a negative effect upon their digestibility.

Several methods have been used to improve intake and digestibility of straws.

Physical treatment by chopping or milling has the drawback that they may be costly in energy and need some equipment.Rice straw is less rough and does not need to be chopped on farm.Hand cutting with a chopper is suitable for sorghum and milled straw to make them easily edible.

For chemical treatment of low quality roughages,several alcaline or acid reagents are proposed.Among them the ammoniation by urea offers greater promise in the viewpoint of feasibility,with an added advantage that it supplies non protein nitrogen(Jackson 1979,Sundstol 1984,Fall et al 1987), and that it is more accessible at the farmer level compared to other chemicals.Urea is three times cheaper than sodium hydroxide wich is not available in rural zones in Senegal for

example.However his usage is not without any constraint.

1.2.2. Technical constraints to dissemination of urea treatment of cereal straws

In addition to urea availability and potential toxicity of ammonia as described previously,there is a need tu select an adapted technical procedure in tropical conditions.

1.2.2.1. The method of straw trsatment

available methods (Jackson 1979) are based on the mixture of straw and urea at the level of 5 per cent.

In the dry procedure,urea is injected in the straw using high pressure.After injection temperature raising seems to give best forage quality(Jackson 1979).The cost and availability of the needed equipment makes that technology out of reach for sahelian farmers at the large scale.

The second way involves a small quantity of water.A 5 per cent urea solution is spread over the straw at the proportion of 1 liter of solution per kilogram of straw to make it reasonnably humid (see Fall et al 1987).The urea-straw mixture is kept in a silo and left for incubation for two (in tropical climate)or six weeks(in cool climate).This way seems to be advisable in drought conditions of sahel.In addition it prevents from risk of environment pollution.

Urea ensiling leads to improvement of intake

digestibility and nitrogen content of poor quality roughages (see table 3).However it should represent a restricted proportion of the ruminant diet to avoid risks of ammonia toxicity for beef cattle or transmission of toxic compounds in milk for dairy cattle(Perdock and Leng 1987,Preston and leng 1987).In north Europe treated straw does is usually above 30 per cent of the diet(Preston and leng 1987).More research work are needed to evaluate accurately the daily optimal consumption of urea treated straws for sheeps and cattles in Africa.

Urea ensiling method seems ta be of easy application;however some adaptations to rural conditions are needed.

1.2.2.2. Adaptation of urea ensiling method te rural conditions.

Availability of suitable equipment in traditionnal livestock areas is a serious constraint to popularization of straw ammoniation by urea treatment.One should try to use locally available tools.

-**Straw** physical treatment

Before urea ensiling long cereal straws have to be chopped in order to make them easy to handle and the reagent reach the cell wall.Most of the choppers are more or less sophisticated and working with electricity witch may not be available in rural areas.

Fe of a good help.Total isolation of the silo is a problem. With local tools it may suffer for some gas ammonia escape.On

The chopping process may be done by hand with a hatchet. Rice straw is less rough and does not need a reduction of length.

-Tools of treatment.

Urea solution can be sprinkled by watering cans.

Instead of big containers made of metal like it is used in North Europ,straw can be urea ensiled in a silo hollowed out of soil and covered with a lay of cernent or clay.

After urea solution-straw mixture the silo can be covered by a polyethylen tarpaulin wich can be non available in certain zones.In this case banana or palm trees leaves can be of a good help.Total isolation of the silo is a problem. With local tools it may suffer for some gas ammonia escape.On farm trials should precise the negative effect of loosing ammonia through the silo.

-Ensiling time.

Although the treated straw may be of long conservation in the technical viewpoint,ensiling time may be a constraint for small scale farmers.They may not have capacity to treat a great quantity of straw once,and prefer to treat the required amount each week.Reported optimum ensiling time are from 10 days (in warm climate) to six weeks (in temperate countries). Reseach efforts should be directed to studies about the influence of decreasing ensiling time upon in the extend of straw quality improvement.

1.2.3. Cost of urea treatment of straw

As discussed previously, the cost and availability of urea in rural areas are the major constraint to its utilisation.

An estimate of treatment cost in the area of rice production leads to triplicate it's price witch goes from 15 to 45 CFA per kilo.

Trials involving the study of milk or liveweigt gain cost in the case of urea ensiled straw usage are scarce in sahelian countries.

Economics of straw ammoniation by urea should be a major on farm research work in order to precise the profit and convince farmers about the reliability of the technic.

1.3. Conclusion,

Ability of urea to enhance nitrogen level of ruminant's diet either as supplement or as chemical reagent for low yuality roughages improvement has been proved for many years.

In sahelian countries dissemination of available research results is limited by, a lack of suitable equipment, the poor availability of urea in rural area, it's high price and potential toxicity by quick ammonia intra rumina1 release.

More on farm research could find solutions to technical constraints and propose feasible adaptations in rural areas.

Farmers training is one of the first problem to solve before urea introduction in sahelian feeding systems.

II. Constraint to browse plants utilisation in ruminants diet in the sahel.

Recent results have shown the importance of trees and shrubs in ruminants feeding in africa(in Le Houerou 1980). In natural pasture they can reach 70 to 30 per cent of sheep and goat's diet during the dry season(Guerin et al 1935).

Leaves,flowers and fruits of browses are well known for their high level of nitrogen witch improves ruminant's protein supply (in Le Houerou ed 1980,Kone 1984,Kone 1987,Fall 1933).

Consumed browses involve around 100 species(Le Houerou 1980).In the senegalese sahelian ferlo area the main genus are **Acacia,Balanites,Calotropis,Guiera,Boscia,Zyziphus** and combretum.

Nutritive value,harvesting and manadgement constraints can be a limiting factor to browse usage at the farmer level.

2.1. Nutrive value of browse plants,

2.1.1 Chemical composition.

Chemical composition of browses may be a limiting factor

to their digestibility.Their high maturity explains the high proportion of cell wall witch plays a negative role upon digestibility.Part of the proteins may be imprisoned in lignocellulose and make them unreachable by protein microbes (Guerin et al 1938) .So the total protein may not be available.It depends on the degree of lignification,the age and part of the plant.

Occurence of tannins in browses has been mentionned by Mc Leod (1974),Diagayete (1983) and Reed et a1 (1985).Those antiquality factors have a negative effect upon digestibility and protein metabolisme specially.

Research efforts should try to identify the best period of harvesting according to the stage of developpement and part of the plant witch nutrient can be really available.

2.1.2. Intake and toxicity.

Limiting factors to browse intake are in relation with chemical composition.Some species can be rich in digestible nutrient but not interesting in the pastoral viewpoint because they are unpalatable.

Tannins and other toxic compounds play a negative role on trees and shrub's palatability.Most of them remain to be identified,their toxicity and seasonnal variations studied. However browse intake varies according to the season and year.In case of drought when food is scarce,ruminant are hardless to please and accept some bad taste species.

A long period of adaptation seems to improve browses intake.

2.1.3. Digestibility and intra-rumina1 degradation.

A high proportion of cell wall and lignin fraction contribute to lower digestibility of browses.The poor intra-rumina1 solubility at a short time of incubation explains in part,the low intake of some speeies (Fall 1988).Some research work could try to find out a feasible method of browse ensiling to limit the negative role of cell wall.

2.2. On farm utilisation of trees and shrubs.

2.2.1. Browse harvesting.

Most of the sahelian countries do not have a legislation witch specify the way of natural pasture utilisation.This judicial lack should be filled to allow farmer to be really involved in range manadgement.

In addition the moving of herds looking for water and food makes difficult a planification of pasture utilization. So browse are used freely in pasture.Some species are over-grazed while others are not touched.Stocking rates are often too high and bush fire is still destroying a great part of pastures.

To avoid those constraints,for a well planed utilisation of available feed ressource farmers have to cut and save

trees and shrubs for the hard period of dry season.

Technics of exploitation have been reviewed by Piot (1980).Sometime trees are entirely cut down.That method do not help regeneration and protection of environment.It should be advisable to cut the upper leaves and allow regeneration of trees.

2.2.2. Storage of trees and shrubs.

In the sahel storage of browses as a fodder reserve is a necessity.

Sun drying is easily applicable.This method is utilized for most of the harvested Acacia fruits in west Africa. However this procedure may have a negative effect upon nutritive value of some species.

Ensiling with salt,used to store Alzadirachta indica leaves(Hentgen 1985) seems to be a promising method.However training of farmers is suitable before introducing that technology.

2.2.3. Supplementation of ruminanta.

More investigations are needed to measure weight gain or milk production allowed by supplementation of ruminants with browses.Their secondary productivity measurment is of urgent importance,to help to precise recommandations about their utilisation.

2.3. Browses manadgement in pasture.

A whole methodology of hrowse exploitation has to be defined.It would include a time table and method of browses harvesting ,species to be protected,storage and distribution to ruminants as supplement.The case of direct utilisation in pasture needs more research work to precise and control the optimal stocking rate.

So browses manadgement must take in account all constraints witch are technic and social particularlly.

Harveeting: In addition to the problem of methodology , browse plants usage puts a problem of species collection and optimal period of harvesting.

It is not easy to define a methodology of harvesting appliable to all genus.Variations in phenological behaviour justify a particular study of each genus or specie.The goal is to exploit and allow browses to regenerate.Cutting leaves and small branches seems to be a good method of harvesting (Piot,1980).

Some species are high in nutritive while others are uninteresting as ruminant fodder.An association of çhemical and secondary production criteria should allow a definition of species to be protected or introduced in pasture.

The choice of browse harvesting period is of major importance.One must bear in mind that too early cutting can break the process of development of reproductive parts

(flowers and fruits).A too late cutting can lead also to an excess of lignification and a decrease in nutritive value of trees and shrubs. Species variation in development cycle suggest an adoption of different periods of harvesting according to their phenology witch good knowledge is required.

.Storage of harvested bromes: A good storage of leaves or fruits of trees and shrubs can overcome bioclimatic constraints like fire,drought,wind and insect or birds parasitism.So they can contribute to limit under-nutrition and mortality of ruminants in the Sahel.

The depressive effect of sun drying upon nutritive value suggests that ensiling should be tested with local tools.

, **Direct utilisation in pasture**:The free choice method does not help in manadgement improvement in the present conditions of sahelian livestock with large movement of herds during the dry season,resulting in a disordered natural pasture exploitation.Some species may be menaced for suppression because of over-grazing,encouraging development of uninteresting others.

Determination and control of adequate stocking rate could minimize the constraints to direct utilisation of browses in pasture.

2.4. Conclusion

Some browses are of high digestible protein level and

are available in areas of traditionnal livestock in the sahel.

Constraints to their optimal utilisation at the farmer level involve variation in nutritive value, range management as well as farmer low level of education.

Research about browse plants need to be intensified in order to answer questions involving species choice and collection including their secondary productivity.

CONCLUSION

Protein under-nutrition is the main constraint to livestock productivity in the sahel.

Usual protein sources like oil meals or seeds,cereal treatment by-product or brans of animal origin are sometime expensive and not available in the area of production.

Research workers must face now the on-farm practical utilisation of lower cost protein sources like browses or urea.

The ability of urea to improve nitrogen level of ruminants diet has been highlighted for many years.In sahelian developping countries urea utilization at the farmer level could help in protein supply and improvement of low quality roughages.However research results are of poor dissemination.

Constraints to introduction of that new feed technology in traditionnal livestock involve risks of toxicity,water deficiency,cost and availability of urea in rural areas,as well as lack of equipment and low level of farmer education.

Farmers preliminary education is needed to teach them appropriate feeding management for maximizing the profit of urea diets supplementation.

Some resarch area need to be carried out on-farm to precise recommandations about locally available tools

usage,urea-straw ensiling time and economics of urea on-farm utilisation as a new feeding technology in rural zones.

Optimal utilisation of browses requires a better knowledge of their nutritive value,technic of harvesting and secondary productivity.In addition to those technical constraints the problem of range management needs to be investigated.On-farm research efforts should be directed on farmer education for environment preservation.

SUMMARY

Studying the problem of protein supply of traditionnal livestock in the sahel,constraints to urea and browse plants usage at the farmer level has been highlighted.

In the case of urea utilisation either as non protein nitrogen source or reagent for low quality roughage treatment ,emphasized constraints involve it's unavailability as well as difficulties in handling this potentially toxic compound. Other limiting factors are water deficiency and low level of farmers education in the sahel.

The main constraints to browse utilisation are in relation to optimal range management and environment preservation.Some technical points like species to be selected their secondary productivity and toxicity,remain to be clarified by more research work.

Farmers education appears to be of major importance in

the introduction of thuse new feeding technics.

Key words: Protein supply,ruminants,urea,browses,constraints

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Table 1: Urea availability and cost in Senegal (Tons)

	YEAR		
	1986	1987	1988
Total requirement * for soil improvement: (tons)	-	17000	17000
Imported quantities** (tons)	-	10000	8000
Price(Tax free) * CFA/Kg	60	60	60
Government contribution CFA/Kg *	24	6	8
Dakar price ** CFA/Kg	70	70	70
Rural market price CFA/Kg	75	75	75
Requirement for ruminants supplementation (tons	-	-	171550

Sources: * Ministry of rural development
** Senchim
*** our estimation: 20g per head of small ruminant
200g per head of cattle

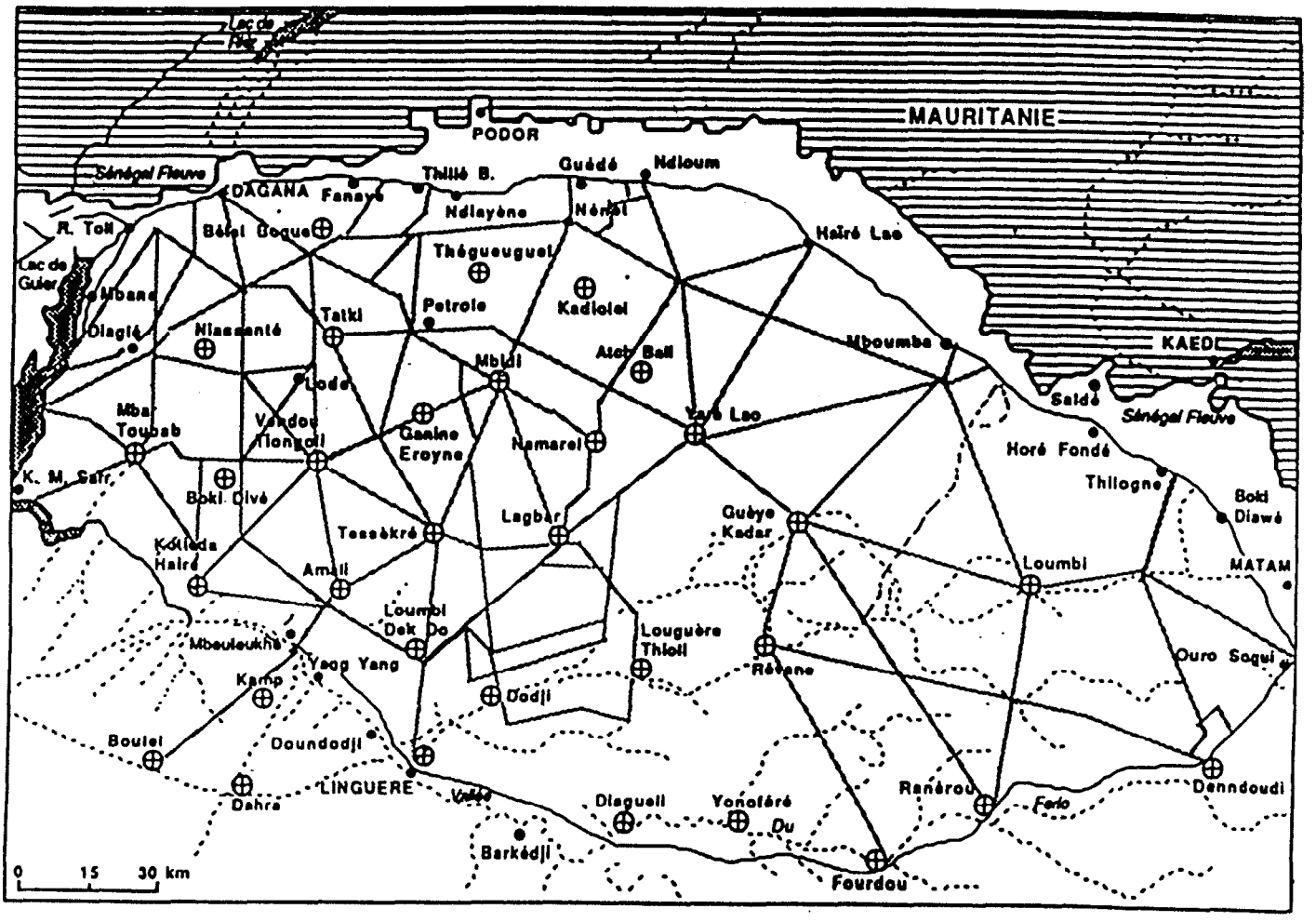
Table 2: Nutritive value of cereal straws (Fall et all 1987)
* g/Kg dry matter

Chemical composition, digestibility and intake.	Rice straw (N)	Maize straw(N=1	Millet straw (N)	Sorghum straw(N=3)
Organic matter *	827±19(29)	751	886±43(5)	914±29
Crude protein *	25±13(29)	36	60±15 (5)	39±9
Crude fiber *	360±34(29)	251	397±55(5)	344±31
NDF *	555 (1)	618	814±83(3)	708±36
ADF *	428 (2)	316	518±57(3)	438±26
Lignin *	62 (2)	55	96±19 (3)	58±5
Silica *	-	107	43±41 (4)	32±13
Calcium *	1.9 (2)	1.1	3.1±2.2(5	2.7±0.2
Phosphorus *	0.7 (2)	0.5	1.8±1.1(5	0.46±0.12
Magnesium *	-	0.9	4.1±0.1	3±0.4
Potassium *	-	0,4	93±98 (3)	8.2±3.1
Cobalt ppm		0.76	0.6±0.1 "	0.34±0.07
Copper ppm		17.9	6.5±1.7 "	3.1±0.6
Zinc ppm		76.5	29.4±5.0"	18.1±7.5
Manganese ppm	-	50.3	107.8±13.3	195±27
Sodium ppm	-	2525	575±414	757±307
Dry matter digestibility(sheep) p100	49+3 (15)	48 (1)	37 (10)	44
Organic matter digestibility (sheep) p100	58	39	38	46
Intake g/Kg po.75				
sheep	48	-	34	39
cattle	74	-	-	-

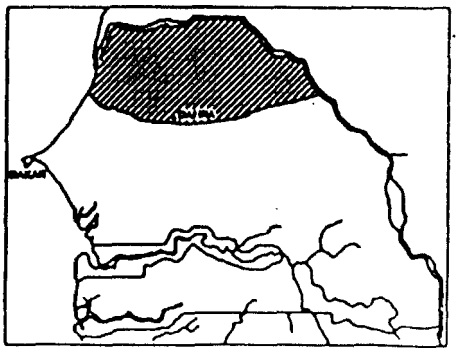
Table 3: Effect of urea treatment on straws nutritive value
(Source Fall et al 1987)

		Crude protein g/Kg DM	Dry matter Digestibility p100	Dry matter intake p100
Rice straw	Urea 5p100: ensiled	79	54+4 (N=6)	61+10 (N=6)
	Control	45	43+4 (N=6)	48+3 (N=5)
	ensiled urea 5p100	149	57+5 (N=6)	53+10 (N=6)
Maize straw	Control	39	49+2 (N=6)	40+5 (N=6)
	ensiled: urea 5p100	141	59+6 (N=6)	56+3 (N=4)
Millet straw	Control:	84	39+6 (N=5)	31+7 (N=4)
	ensiled: urea 5p100	146	65+3 (N=6)	68+3 (N=6)
Sorghum straw	Control:	42	47+5 (=2)	50+6 (N=5)

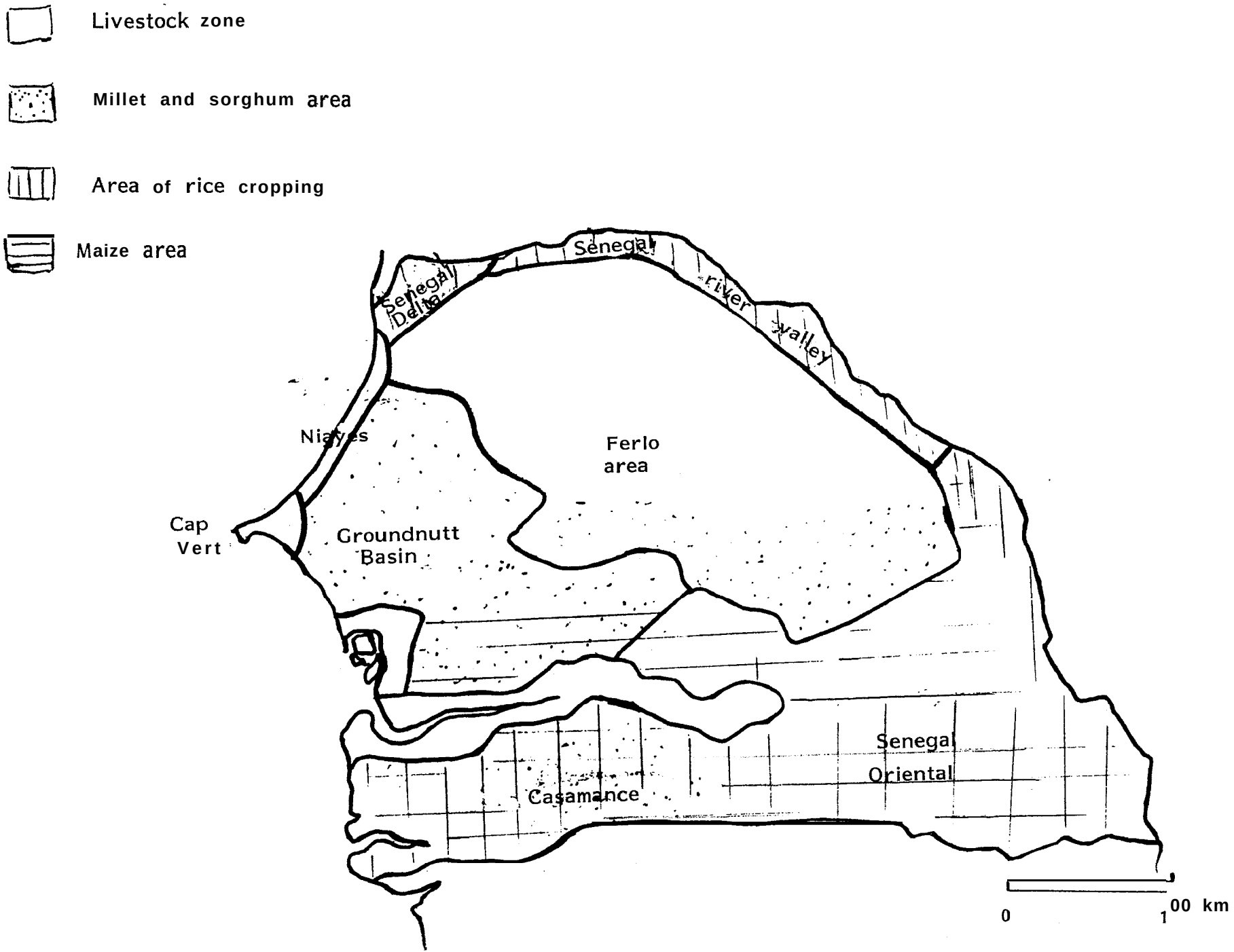
Sahelian Ferlo area : drilling distribution in Senegal



drilling



Source : Gaston 1987


Livestock zone
Millet and sorghum area
Area of rice cropping
Maize area
Senegal
Senegal Delta
river valley
Niayes
Ferlo area
Cap Vert
Groundnutt Basin
Casamance
Senegal Oriental
0
100 km