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CLUB DU SAHEL

C.I.L.S.S.

Search Areas for New Lands in the Sahel

Zones d' Exploration pour les Terres Neuves du Sahel

Part 1. ----- La Carte Principale

Part 2. ----- Tchad

Part 3. ----- Niger

Part 4. ----- Haute-Volta

Part 5. ----- Mali

Part 6. ----- Senegal

John M. Hunter
Michigan State University
for DOS/AID/AFR/SFWA/SDP
November 17th, 1977

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FOREWORD

This report has been prepared under constraints of time and also limitations of information and of opportunities for adequate field observation. The writer collected cartographic and other information in Paris 9-11 November 1976, and in Rome on 12 November 1976, whilst on his way to attend a meeting of the Drylands Group of CILSS in Ouagadougou on 20 November 1976. Other documents were subsequently examined in New York and Washington.

Responsibilities then intervened to prevent the writer from engaging in the study prior to the spring of 1977. At that time an arrangement was made with a counterpart geographer, Dr. R. Rochette, who was also to work as a new lands consultant. The writer and Dr. Rochette attended a Drylands Group meeting in Ouagadougou 24-26 March 1977. At the meeting it was recognized that a synthesis report on the new lands was urgently required before 15 April 1977. Accordingly, Dr. Rochette visited Senegal, Mali, Upper Volta and Niger; whilst Dr. Hunter visited Senegal and Upper Volta; and a synthesis report on the new lands, jointly compiled by Rochette and Hunter, was completed and duly delivered in Paris on 15 April.

In addition, the writer had agreed to prepare some preliminary maps of search areas for new lands utilizing existing and available data. Not being able to visit each country personally, arrangements were made for others to assist in collecting population census, cartographic and other information in March and April, 1977. In large measure, however, and for various reasons, this was not done. The consequence has been considerable variation in available detail among the countries. It is hoped, nevertheless, that the present findings will provide a sufficient basis from which to proceed satisfactorily to subsequent phases of development planning.

The preparation of the maps and the area calculations have been delayed by the writer's ongoing responsibilities in academic administration, and by teaching duties. Apologies are offered for inconveniences caused by the delay.

The writer hopes to prepare a report on the principles of new land settlement which will be an expansion of the report prepared in April as a working document for the meeting with Dr. Rochette, from which the new land synthesis report emerged.

ERRATA

A few uncorrected minor errors of labelling have occurred in some of the maps portraying agricultural potential categories. These are readily observable inconsistencies and may be corrected by comparison with the principal map given in Section 1.

Search Areas for New Lands in the Sahel

Zones d' Exploration pour les Terres Neuves

Part 1. La Carte Principale

2. LEGENDE DE LA CARTE DES APTITUDES ET DES POTENTIALITES A LA CULTURE ET AU PATURAGE DES SOLS DU SAHEL

Sur cette carte figurent, peur une région déterminée:

1) Le sol dominant symbolisé par deux lettres, selon la nomencleture de la Carte mondiale des sols FAO/UNESCO;

2) La classe d'aptitudes et de potentialités à la culture, indiqués par un chiffre arabe;

3) La classe d'aptitudes et de potentialités au pâturage, indiquée par un chiffre romain;

4) Des zones climatiques basées principalement sur la pluviosité.

d'àpres J. RIQUIER, AGL, FAO, Rome

2.1 ZONES CLIMATIQUES

A' - D' pour le paturage
A - D pour la culture

Les zones climatiques ont été basées sur les travaux de J. Cochemé et P. Franquin (1967) et de D. Garcia (1974).

ZONE A' entre 0 et 200 mm de pluviométrie annuelle moyenne, la productivité du pâturage est très faible.

ZONE B' entre 200 mm et la limite des cultures, le pâturage est meilleur mais la culture est encore impossible.

ZONE C'/A pour le pâturage (= A pour la culture) entre la limite extrême des cultures et l'isohyète 350 mm à probabilité de 90 pour cent (c'est-à-dire que, au nord de cette ligne, le risque d'avoir moins de 350 mm de pluie est supérieur à 1 fois tous les dix ans); donc relativement satisfaisant pour le pâturage extensif mais trop aléatoire pour la culture.

ZONE D'/B pour le pâturage (= B pour la culture) entre les isohyètes 350 et 600 mm à probabilité de 90 pour cent.

ZONE C pour la culture entre les isohyètes 600 et 800 à probabilité de 90 pour cent. Bon pour la culture mais cette derniere isohyète coincide approximativement avec l'apparition de la tsé-tsé et nous n'avons pas cartographié les pâturages au sud de cette isohyète.

ZONE D pour la culture >800 mm de pluie avec probabilité de 90 pour cent.

Le tableau suivant, d'après D. Garcia, donne les principales cultures et les cultures secondaires pour chaque zone climatique:

Zone climatique	Pluviometrie annuelle	Cultures principales	secondaires
B	350 - 600 mm (P 90)	Millet C - M	Sorgho C Niebé
C	600 - 800 mm (P 90)	Millet M - L Sorgho C - M Arachide C - M	Millet C Niebé
D	>800 mm (P 90)	Millet C- M Sorgho M - L Arachide M - L Coton	Millet C Sorgho C Niebé Tubercules

C - M - L indiquent des cycles de croissance court, moyen et long.

2.2 DEFINITIONS DES CLASSES POUR L'AGRICULTURE

Classe 1 - Sols irrigables

Région de faible altitude, presque plane, disposant d'une bonne disponibilité en eau d'irrigation, comprenant une dominance de sols (plus de 50 pour cent de la surface) de bonne qualité agricole. Ces sols sont en général capables de produire un haut rendement de cultures adaptées au climat et à un prix raisonnable si on fait abstraction des dépenses d'eménagement car le drainage ou le protection centre les inondations sont parfois nécessaires.

Classe 2 - Sols de bonne potentialité pour les cultures sèches

Région où, pour des raisons géographiques, l'irrigation est difficile ou impossible, donc vouée aux cultures sèches. Par contre, les sols nécessitent peu d'engrais, sauf peut-être engrais azotés, se travaillent facilement et ont donc une bonne rentabilité en culture traditionnelle sans aménagement coûteux.

Classe 3 - Sols de moyenne potentialité pour les cultures sèches

Les sols ont soit une fertilité chimique faible soit trêp peu de matière organique, ou présentent des contraintes agricoles telles que présence de pierres en surface, de nappe de cailloux ou de concrétions en profondeur, ou encore sont trop argileux, donc difficiles à travailler. Ils ont en général un rendement moindre ou nécessitent des aménagements plus coûteux qu'en Classe 2.

Classe 4 - Sols de potentialités marginales pour les cultures sèches

Région marginale pour les cultures sèches parce que les sols sont de fertilité chimique médiocre, sont trop sableux ou trop lessivés, présentent une pente exigeant des travaux anti-érosifs ou ont des facteurs limitants tels que mauvais drainage, un horizon durci ou une cuirasse à faible profondeur. Les sols sont de faible rapport ou ne sont utilisables que pour un nombre limité de cultures.

Classe 5 - Sols inutilisables pour la culture mais propices à l'élevage extensif, au reboisement, au tourisme, etc.

Sols non cultivables par suite d'une pente trop forte, de la présence de sels, d'un excès de sodium ou d'acidité, trop secs, trop érodés ou même sols pratiquement inexistants : roche nue, débris de roches, cuirasse affleurant en surface. Certains de ces sols peuvent servir de pâturage extensif, de zones à reboiser ou de zones touristiques.

L'Annexe, intitulée "Classement des sols de la Carte mondiale FAO/Unesco en cinq classes d'aptitudes et de potentialités pour la culture", explique la méthodologie utilisée pour obtenir les classes à partir des indications de la carte des sols.

Ces classes expriment à la fois l'aptitude à l'irrigation, à la culture sèche, à certaines cultures plus ou moins exigeantes, et la potentialité, c'est-à-dire la productivité du sol (décroissante lorsque le numéro de la classe augmente).

Les influences climatiques, socio-économiques, n'interviennent pas sur le choix de la classe ou tout à fait indirectement : l'interprétation doit donc en tenir compte.

Cette carte a été établie pour connaître les surfaces cultivables par classes de potentialité et par zones climatiques. Les surfaces mesurées sur la carte doivent être multipliees par un coefficient d'utilisation variant avec le sol et la zone climatique. Ce travail a été exécute pour l'Etude prospective du Sahel de la FAO et a fourni une bonne estimation des surfaces encore disponibles pour l'agriculture.

2.3 DEFINITIONS DES CLASSES POUR LE PATURAGE

I. Pâturage produisant plus de 5 000 kg de matière sèche à 1'hectare et par an. Un hectare doit nourrir 1 UBT (un bovin tropical moyen de 250 kg).

II. 1 650-5 000 kg de matière sèche à 1'hectare et par an ou 1,1-3 ha pour 1 UBT.

III. 1 000-1 650 kg de matière sèche à 1'hectare et par an ou 3,1-5 ha pour 1 UBT.

IV. 500-1 000 kg de matière sèche à 1'hectare et par an ou 5,1-10 ha pour 1 UBT.

V. $<$ 500 kg de matière sèche à 1'hectare et par an ou $>$ 10 ha pour 1 UBT.

Ces classes sont basées sur la productivité annuelle du pâturage sans tenir compte de la variation saisonnière qui impose le nomadisme.

Le calcul des surfaces peut se faire do la même manière que pour les cultures, mais en soustrayant la surface occupée par les cultures.

L'Annexe,intitulée "Classement des sols de la Carte mondiale FAO/Unesco en cinq classes de potentialité pour le pâturage", expose la méthodologie utilisée.

Centrairement aux classes agricoles, elles intègrent la pluviométrie qui est le facteur principal de la productivité des pâturages.

2.4 ANNEXE

CLASSEMENT DES SOLS DE LA CARTE MONDIALE FAO/UNESCO

EN CINQ CLASSES DE POTENTIALITE POUR LE PATURAGE

Les données de différents instituts sur l'élevage (notamment l'IENVT) et du Land Resources Survey of O.A.D., ont été résumées par S. Risopoulos dans son mémorandum du 2 janvier 1975 "Esquisse pastorale de la zone sahélienne". La productivité des pâturages est exprimée, dans ce texte, suivant 4 zones climatiques <200 mm de pluie moyenne annuelle, 200-400, 400-600, 600-800, et d'après 5 types de sols: sols concrétionnés (Co), sols sableux (S), sols sablo-limoneux (SL), sols limono-argileux (LA), sols inondés (H).

Les zones climatiques ont été identifiécs avec les zones A', B', C', D', déjà décrites dans le texte et nous avons fait correspondre les unités, les phases, les textures de la légende mondiale FAO/Unesco avec les types do sols de S. Risopoulos, d' où le tableau à double entrée indiquant la classe de potentialité du pâturage en fonction de la pluviométrie et du sol. La pente ainsi que certaines phases ont été négligées car sans importance pour ce type d'utilisation des sols et il n'a été tenu compte que des sols dominants.

Tableau

Unités, phases et texture de la carte FAO/Unesco	Sols de S. Risopoulos	A' 0-200	B' 200-400	C' 400-600	D' 600-800
I	Co	V	V	IV	IV
lithique	Co	V	V	IV	IV
pétrique	Co	V	V	IV	IV
pétroferrique	Co	V	V	IV	IV
pierreuse	Co	V	IV	IV	IV
Qc	S	V	IV	III	III
Ql	S	V	IV	III	III
dunes	S	V	IV	III	III
- 1 texture grossière	S	V	IV	III	III

Unités, phases et texture de la carte FAO/Unesco	Sols de S. Risopoulos	A' 0-200	B' 200-400	C' 400-600	D' 600-800
Qf	SL	V	III	III	III
Lf	SL	V	III	III	III
R	SL	V	III	III	III
Y	SL	V	III	III	III
X	SL	V	III	III	III
B	SL	V	III	III	III
- 2 texture moyenne	SL	V	III	III	III
N	LA	V	II	III	III
Lg Lp	LA	V	II	III	III
V	LA	V	II	III	III
W	LA	V	II	III	III
Bv	LA	V	II	III	III
Af	LA	V	II	III	III
- 3 texture fine	LA	V	II	III	III
J	H	III	II	I	I
G	H	III	II	I	I
S))	sols pour cure salée	V	III	III	III
Z)		V	III	III	III

2.5 ANNEXE

CLASSEMENT DES SOLS DE LA CARTE MONDIALE FAO/UNESCO

EN CINQ CLASSES D'APTITUDES ET DE POTENTIALITIES POUR LA CULTURE

Introduction

Ce classement résulte d'une interprétation des données de la Carte mondiale des sols FAO/Unesco au 1/5 000 000. Plusieurs suppositions ont été faites qui seront précisées dans la suite, certains fact urs de la productivité sont implicitement ajoutés aux données de la carte (surtout pour les classes conditionnelles) suivant les connaissances que l'auteur possède de la région, enfin certaines interprétations sont subjectives.

Le climat n'intervient pas dans l'aptitude aux différentes cultures. Il n'intervient qu'indirectement dans les potentialités des yermosols et des aérosols, qui sont déjà définis par leur régime hydrique.

Methodologie

Une unité géographique de la Carte mondiale des sols est définie soit par une unité de paysage : glacier, dune, etc., soit par une association de sols comprenant un sol dominant, des sols associés (occupant plus de 20 pour cent de la surface de l'unité) et des inclusions (moins de 20 pour cent), une texture et une phase pour le sol dominant, une pente moyenne pour l'association.

Chacune de ces caractéristiques présente des contraintes à l'utilisation agricole. La phase, en particulier, est basée sur des critères significatifs pour l'utilisation et l'aménagement de la terre; la phase pierreuse, par exemple, indique que le sol contient une quantité suffisante de pierres pouvant gênor la culture, la phase saline une teneur en sels pouvant nuire aux plantes sensibles ou occasionner une salure nocive par concentration de sels.

L'unité de sol elle-même est l'expression de certaines caractéristiques qui sont des limitations à l'utilisation de ces sols. Un gleysol possede en général un mauvais drainage, une mauvaise aération du sol, un solonchak une teneur en sels nocive, un podzol une acidité forte, une faible capacité d'échange et une fertilité chimique insuffisante, etc.

La plus forte de ces contraintes ou de ces limitations entraine le classement de l'unité géographique dans une des 5 classes d'aptitudes et de potentialités.

Le tableau No 1 indique par le signe - l'incompatibilité des contraintes de la pente, de la phase, de la texture et du sol lui-même avec la classe envisagée dans la même colonne; le signe + au contraire signifie que les contraintes sont faibles ou nulles, ne faisant pas obstacle au choix de cette classe. La classe de l'unité géographique est donc celle qui correspond à la dernière croix à droite, c'est la classe maximum rendue possible par la limitation la plus sévère due soit au sol, à la pente, à la phase ou à la texture.

L'unité géographique étant en général composée de plusieurs sols, la convention suivante a été adoptée : l'unité est placée dans la classe autorisée par le sol dominant, sa phase, sa pente et sa texture, mais une deuxiéme classe est ajoutée à la première (1) si 2 sols associés ou si un sol associé et une inclusion ont la même classe, (2) si le sol dominant lui-même peut
dont l'une est commune avec un sol associé (la classe conditionnelle 1 par exemple).

Le premier chiffre indique la classe dominante dans la région considérée.

Exemples :

Qc17-1a association composée d'arénosol cambique (Qc) dominant (de classe 3), de solonetz (S) de classe 5 et de planosol solidique (Ws) de classe 5. L'association est classée 3 + 5.

Je31-23a association composée de fluvisol eutrique dominant (Je) de classe 1, de luvisol ferrique associé (Lf) de classe 3 et de deux inclusions, gleysol (G) et luvisol gleyique (Lg), tous deux de classe 3. L'association est classée 1 + 3.

Lg33-12a association composée de luvisol gleyique (Lg) de classe 3 ou 1 conditionnelle, de deux sols associés, fluvisol eutrique (Je) de classe 1 et luvisol ferrique (Lf) de classe 3, l'association est classée 3 + 1.

Discussions

La classification dans la classe 1 est un peu arbitraire. Certains sols, tels que les fluvisols, sont pratiquement tous dans les vallées, donc faciles à irriguer. Par contre, un nitosol, un ferralsol ou un luvisol se trouve plutôt sur les collines, sur les hautes terrasses, donc demande soit une élévation de l'eau d'irrigation ou une amenée par un canal long et coûteux, ce qui n'est pas envisageable en culture traditionnelle. L'irrigation par aspersion est toujours possible localement, même sur des pentes fortes, mais cette solution a été écartée sur les grandes surfaces cartographiées à l'échelle du 1/5 000 000. Par contre, certains sols gleyiques ou à gley sont déjà mal drainés par suite d'une topographie plane et de leur présence dans un fond de vallée, et ils ont été mis en classe 1 conditionnelle, donc irrigable si le drainage est possible, si on dispose de suffisamment d'eau pour irriguer, etc.

Les potentialités des sols en culture sèche doivent être considérées en fonction des investissements possibles, des ressources du fermier, des possibilités de transport, etc. La classification actuelle suppose l'emploi des méthodes traditionnelles de culture, pratiquement sans engrais et avec des moyens mécaniques très limités. Au contraire, pour l'irrigation il a été admis que l'Etat ou les organisations internationales pourraient exécuter les travaux nécessaires qui ne seraient donc pas à la charge du paysan.

La classification n'est valable qu' avec les conventions adoptées, avec le niveau de généralisation admis et évidemment en fonction de l'exactitude des renseignements de base. Elle peut donner une grossière évaluation des régions cartographiées en vue de leur utilisation agricole si on fait intervenir par la suite les facteurs climatiques, économiques et le niveau technologique de l'agriculteur.

Tableau

Limitations dues à / Classes d'aptitudes et de potentialités		1	2	3	4	5
Pente	a 0-8°	+	+	+	+	+
	b 8-30°	-	+	+	+	+
	c >30°	-	-	-	-	+
Texture	1 grossière*	-	→	→	→	
	2 moyenne	+	+	+	+	+
	3 fine	+	+	+	+	+
Phase	pierreuse	-	→	→	→	
	lithique	-	→	→	→	
	pétrique	-	→	→	→	
	pétrocalcique, pétrogypsique, pétroferrique	Ajouter la classe 5 a la classe obtenue pour le sol dominant				
	à fragipan	-	→	→	→	
	à duripan	-	→	→	→	
	saline	-	→	→	→	
	sodique	-	→	→	→	
Paysages	Dunes	-	-	-	-	+
	Sable mobile	-	-	-	-	+
	Lac salé	-	-	-	-	+
	Débris de roches	-	-	-	-	+

* sauf arénosol

→ marque un déclassement vers la classe suivante

Limitations dues à / Classes d'aptitudes et de potentialités		1	2	3	4	5
Unités de sol (liste limitative pour la zone sahélienne)	Ao	-	-	+	+	+
	Af	-	-	+	+	+
	Ah	-	-	+	+	+
	Ap	-	-	-	+	+
	Ag	-	-	-	+	+
	Be	-	+	+	+	+
	Bd	-	-	+	+	+
	Bh	-	-	+	+	+
	Bg	(+)	-	+	+	+
	Bk	-	-	+	+	+
	Bc	-	-	+	+	+
	Bv	-	+	+	+	+
	Bf	-	-	+	+	+
	E	-	-	+	+	+
	Fo	-	-	+	+	+
	Fx	-	-	-	+	+
	Fr	-	-	+	+	+
	Fh	-	-	+	+	+
	Fa	-	-	-	+	+
	Fp	-	-	-	+	+
	Ge	(+)	+	+	+	+
	Gc	(+)	+	+	+	+
	Gd	(+)	-	+	+	+
	Gm	(+)	+	+	+	+
	Gh	(+)	-	+	+	+
	Gp	-	-	-	+	+
	I	-	-	-	-	+
	Je	+	+	+	+	+
	Jc	+	+	+	+	+
	Jd	+	-	+	+	+
	Jt	(+)	-	-	-	+

(+) Classe conditionnelle à interpréter suivant d'autres conditions : disponibilité en eau, possibilité de drainage, etc.

Limitations dues à / Classes d'aptitudes et de potentialités		1	2	3	4	5
Unités de sol (suite)	Lo	-	+	+	+	+
	Lc	-	-	+	+	+
	Lk	-	+	+	+	+
	Lv	-	+	+	+	+
	Lf	-	-	+	+	+
	Lp	-	-	-	+	+
	Lg	(+)	-	+	+	+
	Ne	-	+	+	+	+
	Nd	-	-	+	+	+
	Nh	-	-	+	+	+
	De	(+)	(+)	+	+	+
	Od	(+)	-	(+)	(+)	(+)
	Po	-	-	-	+	+
	Pf	-	-	-	+	+
	Pp	-	-	-	+	+
	Pg	-	-	-	+	+
	Qc	-	-	+	+	+
	Ql	-	-	+	+	+
	Qf	-	-	-	+	+
	Qa	-	-	-	-	+
	Re	-	+	+	+	+
	Rc	-	-	+	+	+
	Rd	-	-	+	+	+
	So	-	-	-	-	+
	Sm	-	-	-	-	+
	Sg	-	-	-	-	+
	Vp	(+)	-	+	+	+
	Vc	-	-	+	+	+
	We	-	-	+	+	+
	Wd	-	-	-	+	+
	Wm	-	-	+	+	+
	Wh	-	-	+	+	+
	Ws	-	-	-	-	+

Limitations dues à / Classes d'aptitudes et de potentialités		1	2	3	4	5
Unités de sol (fin)	Xh	(+)	-	-	-	+
	Xk	(+)	-	-	-	+
	Xy	(+)	-	-	-	+
	Xl	(+)	-	-	-	+
	Xh	(+)	-	-	-	+
	Yk	(+)	-	-	-	+
	Yy	-	-	-	-	+
	Yl	(+)	-	-	-	+
	Yt	-	-	-	-	+
	Zo	-	-	-	-	+
	Zm	-	-	-	-	+
	Zt	-	-	-	-	+
	Zg	-	-	-	-	+

Tableau 1.

Zones Climatiques du Sahel: Superficie

pour la culture: A - D
pour le pâturage: A^1 - D^1

a) Hectares (approximation)

Zone	Mauritanie	Senegal	Mali	H. Volta	Niger	Tchad
A^1	74 210 000	-	67 601 000	-	82 368 000	64 652 000
B^1	19 686 000	-	11 405 000	590 000	18 055 000	9 438 000
C^1 A	7 009 000	2 210 000	8 094 000	629 000	14 507 000	14 571 000
D^1 B	2 165 000	7 689 000	14 988 000	8 791 000	11 010 000	14 121 000
C	-	4 295 000	7 642 000	9 005 000	760 000	16 333 000
D	-	5 478 000	14 289 000	8 405 000	-	9 285 000
Total	103 070 000	19 672 000	124 019 000	27 420 000	126 700 000	128 400 000

b) Proportions

Zone	Mauritanie	Senegal	Mali	H. Volta	Niger	Tchad
A^1	72.0	-	54.5	-	65.0	50.4
B^1	19.1	-	9.2	2.1	14.3	7.4
C^1 A	6.8	11.2	6.5	2.3	11.4	11.3
D^1 B	2.1	39.1	12.1	32.1	8.7	11.0
C	-	21.8	6.2	32.8	.6	12.7
D	-	27.9	11.5	30.7	-	7.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: d'après le planimétrage sur les cartes 1:5,000,000 et 1:2,500,000

/ ... Suite

Tableau 1 ... Suite

C) Total hectares pour les six pays : Mauritanie, Senegal, Mali, Haute-Volta, Niger et Tchad

Zone		Pour	Pluviométrie	Hectares	Percent	Cumulative	
A[1]		le pâturage	<200 mm moyenne	288 831 000	54.5	54.5	100.0
B[1]		le pâturage	200 mm à limite des cultures	59 174 000	11.2	65.7	45.5
C[1]	A	pâturage et culture	limite des cultures à 350 mm P.90	47 020 000	8.9	74.6	34.3
D[1]	B	culture et pâturage	350-600 mm P.90	58 764 000	11.1	85.7	25.4
	C	la culture	600-800 mm P.90	38 035 000	7.2	92.9	14.3
	D	la culture	800 + mm P.90	37 457 000	7.1	100.0	7.1
				529 281 000	100.0		

Tableau 2 : Terres a vocation agricole selon les classes des aptitudes des sols (en milliers d'hectare)

		Sénégal	Mauritanie	Gambie	Mali	Haute-Volta	Niger	Tchad	Total
Zone A - Classes	I	212	479		1 923		890	710	4 214
Classes	II & III	514	737		468	376	4 226	2 302	8 623
Classes	IV	16	130		249			184	579
		(742)	(1 346)		(2 640)	(376)	(5 116)	(3 196)	(13 416)
Zone B - Classes	I	180	175		1 787	137	757	722	3 758
Classes	II & III	1 473	574		1 875	2 328	4 364	2 330	12 944
Classes	IV	453	-		517	21	10	170	1 171
		(2 106)	(749)		(4 179)	(2 486)	(5 131)	(3 222)	(17 873)
Zone C - Classes	I	190	-	266	121	286	103	2 521	3 487
Classes	II & III	757	32	50	993	1 803	330	4 701	8 666
Classes	IV	234	-	32	826	495	96	347	2 030
		(1 181)	(32)	(348)	(1 940)	(2 584)	(529)	(7 569)	(14 183)
Zone D - Classes	I	242		106	206	225		1 682	2 461
Classes	II & III	1 706		162	3 991	2 999		4 024	12 882
Classes	IV	352		-	1 242	219		85	1 898
		(2 300)	-	(268)	(5 439)	(3 443)	-	(5 791)	(17 241)
Ensemble Zones A-B-C-D									
Classes	I	824	654	372	4 037	648	1 750	5 635	13 920
Classes	II & III	4 450	1 343	212	7 327	7 506	8 920	13 357	43 115
Classes	IV	1 055	130	32	2 834	735	106	786	5 678
Total		6 329	2 127	616	14 198	8 889	10 776	19 778	62 713
Répartition	I	13,0	30,7	60,4	28,4	7,3	16,2	28,5	22,2
en %	II & III	70,3	63,2	34,4	51,6	84,4	82,8	67,5	68,7
	IV	16,1	6,1	5,2	20,0	8,3	1,0	4,0	9,1

N.B. Classe I - Sols irrigables
II & III - Sols bons et moyens aptes à la culture en sec
IV - Sols marginaux pour la culture en sec

Source: d'apres le planimétrage sur la carte des sols à 1 = 5 000 000.
Source: d'après F.A.O., Étude Prospective ... Vol. II p.7, Rome, 1976

4. Observations

4.1 The purpose of the report is to identify new lands or, at least, search areas for new lands in the Sahel. The principal document used in this report is the map of potentialities for agriculture and for pastoralism in the Sahel, produced by J. Riquier, AGL, FAO, Rome. (See copy of map attached.) For the countries of the Sahel, stretching from Mauritania and Senegal in the west to Chad in the east, the map shows three sets of information. They are a) rainfall probability zones; b) soil types; and c) potentialities for agriculture and for pastoralism. Detailed explanations of these map categories are given in Section 2, above.

4.2 As indicated in Table 1, page 14 above, area measurements, both absolute and proportional, are given for six countries of the Sahel. For each country, there is a division into zones suitable for pastoralism (A' through D') and zones suitable for agriculture (A through D). Where the categories overlap, as in C'A and D'B, the zones are suitable for both agriculture and pastoralism South of Zone D', that is in Zones and C and D, tsetse infestation generally precludes cattle raising.

4.3 There are new lands in the northern dry areas of the Sahel, that have first class, irrigable soils and therefore a good potential for economic development. However, this report concentrates on the Southern new lands, that is to say on those lands lying on the southern margins of the Sahel, in the better watered areas which receive more rainfall, and also enjoy greater reliability of rainfall. These are located in Zones D'B, C and D.

4.4 As indicated in Table 1, Part C, Zone D'B receives between 350 and 600 mm of rainfall, with a probability of 90 percent (P. 90). P. 90 indicates that the indicated amount of rainfall will fall nine years out of every ten. That is a very high probability. Zone C receives 600 to 800 mm rainfall, nine years out of ten, and Zone D receives more than 800 mm rainfall nine years out of ten.

These three well watered zones collectively comprise about 25 percent of the surface area of the Sahel. In particular, Zone D'B covers nearly 59 million hectares, or approximately 11 percent of the Sahel, Zone C covers 38 million hectares, or 7.2 percent of the Sahel (Table 1, c).

4.5 Table 2 is taken from the FAO Prospective Study of the Sahel. It

indicates classes of land for four major climatic zones in seven countries. The figures in Table 2 do not correspond with those of Table 1 for the following reasons: Table 1 is concerned with total surface area for pastoralism, as well as agriculture, whereas Table 2 shows only the agricultural zones; it also excludes Class V agricultural land.

4.6 The report that follows focuses upon those five countries which enjoy the greatest extent of southern new lands. If we consider only those areas receiving more than 350 mm of ranfall (P. 90), then, as indicated in Table 1, part a, Tchad is foremost, with nearly 40 million hectares, followed by Mali with 37 million hectares, Upper Volta with 26 million hectares, Senegal with 17 million, and Niger with less than 12. For the best watered areas, with over 600 mm of rainfall (P .90), that is Zones C and D combined, Tchad leads with nearly 26 million hectares, followed by Mali with 22, Upper Volta with 17, and Senegal with just under 10. Niger has only 760,000 hectares in this wetter zone. Mauritania has no land in the Zones C and D.

4.7 A more detailed characterization of the southern zones is given separately for each of the following countries: Tchad, Niger, Upper Volta, Mali, and Senegal. Wherever possible, maps are presented at scales corresponding with those of each country's administrative maps, such as, 1:1 million, 1:1.5 million or 1:2.5 million. This arrangement, although cumbersome, is used, in preference to photographic reduction, in order to facilitate use of the maps as practical working documents for agricultural planning. For reasons of simplicity, symbols indicating soil categories, which are given in the principal map, and in the legend, are omitted from the maps prepared for individual countries.

Search Areas for New Lands in the Sahel

Zones d' Exploration pour les Terres Neuves du Sahel

Part 2. TCHAD

1. Liste des Tableaux

2. List des Cartes

Tchad Tab. 1. Superficie des Zones Climatiques

pour le pâturage: A′, B′, C′, D′
pour la culture: A , B , C , D

Zone	Hectares	Percent
A^1	64 652 000	50.4
B^1	9 438 000	7.4
C^1/A	14 571 000	11.3
D^1/B	14 121 000	11.0
C	16 333 000	12.7
D	9 285 000	7.2
Total	128 400 000	100.0

Source: d' après le planimétrage sur la carte
à 1:5,000,000 pour les zones A^1, B^1, C^1/A; et
à 1:1,500,000 pour les zones D^1/B, C, D.

Tab. 2. TCHAD -- POPULATION DENSITY BY PREFECTURE

Prefectures	Area in km2	Population estimate - 1970	Density per km2
SAHARA			
B.E.T.	600,350	81,000	0.1
SAHELIEN			
Batha	88,800	324,000	3.6
Biltine	46,850	141,000	3.0
Chari-Baguirmi	82,910	461,000	5.6
Guéra	58,950	174,000	3.0
Kanem	114,520	188,000	1.6
Lac	22,320	127,000	5.7
Ouaddaï	76,240	340,000	4.5
Salamat	63,000	90,000	1.4
SOUTH			
Logone occidental	8,695	241,000	27.7
Logone oriental	28,035	268,000	9.6
Mayo-Kebbi	30,105	533,000	17.7
Moyen-Chari	45,180	410,000	9.1
Tandjilé	18,045	262,000	14.5
TOTAL	1,284,000	3,640,000	2.8

Source: Enfance et Jeunesse - Plan de Développement, November 1971.

(Bird, 1974)

Tchad Tab. 3. Surface Area by Climatic Zone and by Administration Area in Southern Tchad
Tchad Sud: Superficie par Zone Climatique et par Limite Administratif

T C H A D Secteur Administratif Préfecture/Sous-Préfecture	Population Densite 1970 Hbts/Km2	Superficie Total Hectares	Zone D 800 + mm P.90 Hectares	Zone C 600-800 mm P.90 Hectares	Zone D1/B 350-600 mm P.90 Hectares	Other Zones Hectares
MAYO KEBBI	17,7	3 010 500	1 179 900	1 823 400	7 200	
Bongor		1 140 800	7 200	1 126 400	7 200	
Fianga		286 300		286 300		
Gounou Gaya		156 200	108 500	47 700		
Pala		947 100	874 800	72 300		
Léré		480 100	189 400	290 700		
TANDJILÉ	14,5	1 804 500	1 522 900	281 600		
Lai		1 290 500	1 008 900	281 600		
Kélo		514 000	514 000			
LOGONE OCCIDENTAL	27,7	869 500	869 500			
Beinamar		224 300	224 300			
Mondou		413 200	413 200			
Benoye		232 000	232 000			

(Continued)

Tchad Tab. 3. ..... Suite 2

T C H A D Secteur Administratif Préfecture/Sous-Préfecture	Population Densite 1970 Hbts/Km2	Superficie Total Hectares	Zone D 800 + mm P.90 Hectares	Zone C 600-800 mm P.90 Hectares	Zone D1/B 350-600 mm P.90 Hectares	Other Zones Hectares
LOGONE ORIENTALE	9,6	2 803 500	2 803 500			
Doba		644 000	644 000			
Bebedjia		176 800	176 800			
Goré		1 093 300	1 093 300			
Baibokoum		889 400	889 400			
MOYEN CHARI	9,1	4 518 000	2 909 100	1 608 900		
Sarh		1 948 100	1 318 400	629 700		
Kyabé		1 389 900	410 700	979 200		
Koumra		587 700	587 700			
Moissala		592 300	592 300			
CHARI BAGUIRMI	5,6	8 291 000		3 069 000	3 216 900	2 005 100
N'Djamena		787 400			509 700	277 700
Bousso		1 492 500		1 492 500		
Massenya		3 136 100		1 457 400	1 678 700	
Bokoro		1 608 500		119 100	943 100	546 300
Massakory		1 266 500			85 400	1 181 100

(Continued)

Tchad Tab. 3. ..... Suite 3

T C H A D Secteur Administratif Préfecture/Sous-Préfecture	Population Densite 1970 Hbts/Km2	Superficie Total Hectares	Zone D 800 ≠ mm P.90 Hectares	Zone C 600-800 mm P.90 Hectares	Zone D1/B 350-600 mm P.90 Hectares	Other Zones Hectares
GUÉRA	3,0	5 895 000		3 653 100	2 241 900	
Melfi		2 960 100		2 960 100		
Bitkine		1 017 500		379 400	638 100	
Mongo		821 500		205 400	616 100	
Mangalmé		1 095 900		108 200	987 700	
SALAMAT	1,4	6 300 000		5 375 400	924 600	
Abou Deia		931 400		784 500	146 900	
Am Timan		2 995 000		2 513 800	481 200	
Haraze Mangueigne		2 373 600		2 077 100	296 500	
OUADDAI	4,5	7 624 000		521 900	5 805 600	1 296 500
Goz Beida		2 672 700		521 900	2 150 800	
Am Dam		1 903 000			1 903 000	
Adré		1 135 200			950 700	184 500
Abeche		1 913 100			801 100	1 112 000

(Continued)

Tchad Tab. 3. ..... Suite 4

T C H A D Secteur Administratif Préfecture/Sous-Préfecture	Population Densite 1970 Hbts/Km2	Superficie Total Hectares	Zone D 800 + mm P.90 Hectares	Zone C 600-800 mm P.90 Hectares	Zone D1/B 350-600 mm P.90 Hectares	Other Zones Hectares
BATHA	3,6	8 880 000			1 924 700	6 955 300
Ati		6 089 400			1 099 600	4 989 800
Oum Hadjer		2 790 600			825 100	1 965 500
TOTALS	-	49 996 000	9 284 900	16 333 300	14 120 900	10 256 900

Source: d'après le planimétrage sur la carte à 1:2,500,000.

3. Observations

3.1 The climatic zones of Tchad, arranged by rainfall probability, are given in Map 1, and the surface areas corresponding with these zones are indicated in Table 1. It will be seen that nearly 40 million hectares, comprising 31 percent of the surface area of Tchad, lie in the better watered, southern zones: D'B, C, and D.

3.2 Administrative boundaries together with capital cities and towns, are shown in relationship to climatic zones in Map 2.

3.3 Estimates of population density are given in Table 2, and Map 3, together with the distribution of population and the boundaries of the climatic zones.

Map 3 focuses on the southern half of Tchad. It will be seen that population density ranges upwards from 1.6 h/km2 for Mayo in the northwest and 1.5 h/km2 for Am Timan in the southeast. The latter is a very low population density for a Zone C environment. Peak densities of 27.7 and 14.5 are found in the west of Zones D and C.

In general terms, Map 3 shows extensive unoccupied lands in Zone C, and some empty areas in the eastern parts of Zone D, with scattered low density areas of more limited extent in Zone D'B.

3.4 The distribution of tsetse fly in the south of Tchad is indicated in Map 4, together with the major patterns of transhumance. It can be seen that the entire extent of Zone D, and the greater part of Zone C, as well as smaller areas in D'B and C'A are tsetse infested, and not available for pastoralism. Of particular note is the fact that nomadism systematically occupies extensive areas of Zones B', C'A, D'B, and C. This means that a latitudinal extent of land ranging over some 400 km is seasonally utilized for pastoralism. Therefore, any estimates of the availability of new lands must take into account this important utilization of the natural resource space by pastoralists. This would be most true for Zone D'B.

3.5 The phenomenon of annual flooding in the south of Tchad is represented in Map 5. Flooding is extensive in those drainage systems flowing northwards into Lake Tchad. It ranges through Zones D'B, Zone C and, to a lesser extent, Zone D. An equally large area of flooding, however, occurs in the eastern part of Zone C. At its maximum extent, this flood zone is some 400 km from north to south.

The phenomenon of annual flooding is clearly an obstacle to development; however, if properly harnessed with some measure of control of the rise, and also of the retreat, of flood waters, much development could occur in fishing, rice farming, irrigation, and cattle fattening.

3.6 Zone D. Maps 6, 7, 8 and 9 illustrate the situation in Zone D. They respectively show administrative boundaries, zones which are occupied or unoccupied, flood areas, and agricultural potentialities, respectively. In addition Table 3 shows the surface area in hectares for Zone D, calculated for prefectures and sous-prefectures. For example, Table 3 shows that there are over 9 million hectares in Zone D, of which 3 million lie in Moyen Chari, 2.8 million in Logone Orientale, and so on. The surface area in hectares of each administrative unit, or part of a unit, marked on Map 6, is given in Table 3.

Careful comparison of the four maps (numbers 6-9) will indicate the best areas in which to search for new lands, the extent of environmental phenomena to be considered, and the potentialities for agriculture. Map 7 shows that there are exploration zones west of Kelo, south of Moundou, north of Doba, south of Doba and, extensively, north and south of Sarh. Flooding, as a problem, is extensive to the east and north of Doba and particularly in the area of Lai (Map 8).

Potentialities for agriculture are indicated in Map 9. This map requires careful study but, by way of illustration, one can identify an extensive area of Class 1, irrigable land together with Class 3, average agricultural land (as a minor component in the soil complex) in the area extending from Maro to Sarh, and further in a northerly direction. There are also complexes of Class 1, irrigable land with third Class 3, average agricultural land in the Lai area. In the eastern part of the Lai area irrigable land predominates in the complex. In the Doba area there is an extensive complex of average agricultural land together with first class irrigable land. In the Moundou area there is an extensive occurrence of first class irrigable land flanked by third class average agricultural land. Average third class agricultural land occurs extensively in the Gore area. In the Baibokoum area there is superior Class 2 agricultural land in the north with an admixture of very poor Class 5 land.

A careful analysis of the geographical boundaries of the search areas indicated in Map 7, and of the agricultural-potential zones of Map 9 should

be made. Comparisons may be drawn for each sous-prefecture. The surface area of each sous-prefecture by climatic zones is given in Table 3 so that estimates of the extent of first class, second class and third class agricultural lands can be readily made.

Criteria for selecting favorable search areas for new lands would include the following: unoccupied land, or land occupied or utilized with a very low population density; land with heavier and more reliable rainfall; and land with superior agricultural potentialities, that is to say, Class 1, irrigable land, Class 2, superior agricultural land, or Class 3, average agricultural land.

Areas with extensive occurrences of Class 4 and Class 5 land clearly hold less favorable prospects for new lands development.

3.7 Zone C. In Zone C, with 600-800 mm of rainfall, P. 90, there are 16 million hectares (Table 3). As is evident in Map 11, much of the land is unoccupied. The administrative units of Zone C are shown in Map 10. Huge search areas are evident in Map 11; and zones which are subject to seasonal flooding are shown in Map 12. Given the great extent of flooding, it is apparent that control of water in the environment will be a paramount goal of agricultural development. Potentialities for agriculture are indicated in Map 13. In the Haraze Mangueigne area there are very extensive occurrences of Class 1, irrigable land. South of Am Timan there is much Class 3, average quality agricultural land. [This land is further sub-divided by soil type, but symbols of soil type are not indicated on the map for reasons of simplification. However, the missing symbols are given on the principal map in Section 1.] In the area extending between Bousso and Kyabe there are extensive occurrences of Class 1, irrigable land, and also third Class 3, average agricultural land. East of Melfi there is Class 2, superior agricultural land but with an admixture of Class 5, unfavorable land.

A careful analysis of Maps 11 and 13 will indicate potentially the best areas for searching for new lands. The surface extent in hectares of each sous-prefecture in Zone C is indicated in Table 3, so that estimates can readily be made of the extent of different land categories. To repeat, there are large, extensively unoccupied lands in Zone C. Also noteworthy is the remarkable extent of seasonal flooding as an environmental obstacle to be overcome in development plans.

3.8 Zone D'B. This climatic zone with 350-600 mm of rainfall (P. 90) covers a total area of approximately 14 million hectares. Administrative boundaries are shown in Map 14 whilst the area of each sous-prefecture, or part of a sous-prefecture, within the climatic zone, is given in Table 3.

Compared with the Zones to the south, this area is rather extensively occupied. However, there are search areas for new lands, evident in Map 15, lying between N'Djamena and Massenya, between Massenya and Bokoro, also east of Bokoro, around Goz Beida, and east of Am Dam

There is some seasonal flooding south of Goz Beida as indicated in Map 16. Seasonal flooding is very extensive in the western part of this climatic zone, especially south of N'Djamena, and between N'Djamena and Massenya; as well as to the north of Bokoro. Flooding is an environmental phenomenon which must be taken carefully into account when planning the development of new lands.

Potentialities for agriculture and also for livestock raising are indicated in Map 17. A comparison of the search areas marked in Map 15 with the areas of agricultural potentialities indicated on Map 17, together with a comparison of the area calculations given in Table 3, will reveal the location and areal extent of potential new lands. In the east, around Goz Beida, there is a complex of Class 3, average agricultural land, intermingled with Class 5, very poor agricultural land. To the south of Goz Beida, there is an extent of first class irrigable land. West of Adre there is an extensive occurrence of first class irrigable land. Elsewhere in the east of this climatic zone soils range in quality from Class 3, average, to Class 5, very poor.

In the areas of Mongo and Mangalme there is a complex of Class 2, superior agricultural land, with Class 5 land. This is true also of Bitkine. North of Bitkine, north of Mongo, and west of Oum Hadjar, there are extensive Class 3, average, agricultural lands.

In the west of the climatic zone, there is a considerable distribution of Class 1, irrigable, land. This is most extensive immediately south of N'Djamena, but it also occurs east of N'Djamena intermingled with Class 5 land and Class 4 land; as well as intermingled with Class 3 land to the southeast of N'Djamena. There is also some irrigable land east of Massenya, intermingled with Class 4 land. The approximate areal extent of these lands can be estimated, in hectares, by comparing Map 17 with the information in Table 3.

4. Recommendations

Recommendation 1. Reconnaissance Ground Survey. It is recommended that after careful analysis of the maps submitted with the report, together with an analysis of any supplementary materials that may be obtained, that rapid reconnaissance surveys be made for each of the southern three climatic zones of Tchad, namely, Zone D, Zone C, and Zone D'B. The purpose of these rapid, ground-truthing surveys will be to confirm areas of occupancy and of non-occupancy, to sample soils on a very limited basis, to study vegetation cover as an indicator of occupancy and also of soil fertility, and generally to identify the distribution of potential areas for new lands settlement. These reconnaissance surveys would utilize sampling techniques, rather than comprehensive survey. Their findings would confirm, correct, and modify the preliminary distributions as indicated in the maps provided here. Recent air photography where available would also be very helpful in this regard.

Recommendation 2. Health Risks Profile. It is recommended that a sample survey of major health risks in the three climatic zones be made. Medical and entomological teams would identify the major parasitic and infectious diseases, their habitats and prevalence, and major features of man-environment relationships that will effect the transmission of diseases. Observations on nutritional status, both seasonal and sex and age related, should also be included in the health profiles. It is recommended that a health profile be drawn separately for each of the three zones. In particular, the health profiles should include observations on the health risks of settlement and economic development of the new lands. Animal disease profiles should also be included. The major problem, of course, is Nagana or bovine trypanosomiasis. However, there are other diseases of domestic animals that may be important, and possibly special problems related to seasonal flooding. These health profiles, and assessments of health risks of resettlement, will provide basic planning data for the Government as it develops it policies toward economic development of the south.

Recommendation 3. Flood Control. As shown in the series of maps, seasonal flooding is a major environmental phenomenon of Tchad. It is suggested, however, that this phenomenon can be turned to economic advantage in the form of fish farming, rice farming, cattle fattening, irrigation, and other economic activities. An essential prerequisite for economic planning of the flood

zones would be an intimate knowledge of flood hydrology. Essentially this would call for information on the extent, duration, and depth of flood waters; the geographic patterns of the rise of the floods; and the geographic patterns of their diminution. Knowledge of this nature could be obtained from specially-flown air photography, synchronized seasonally, and by geographic area. An accurate indication of topography, with perhaps a contour-interval of 12 inches or less (~30cm) would also be needed.

When the hydrology data are collected, the parameters of the natural phenomena will be known, and it will then be appropriate to design a range of potential interventions. These may be minor, peripheral, diversions of flow as waters accumulate or retreat, in particular areas. An accelerated or controlled rate of drying out of some areas may be advantageous. Alternatively, a retention of the water cover in certain other areas may favor an agricultural activity. Larger interventions may include big barrage schemes. The design of all proposed hydrological interventions should be very closely correlated with their proposed agricultural purposes. There should be the closest integration between hydrological design and agricultural production.

The aforegoing three recommendations should be implemented immediately so that the Government will have available an adequate information basis for planning for several decades to come.

Recommendation 4. Integrated Regional Planning. When the results of the three surveys (ground truthing, health profiles, and hydrology) are available, the information should be utilized in the design of regionally integrated development plans for southern Tchad. These regional plans would include the development of new lands, where it deemed appropriate, together with intensification of agriculture in presently settled areas. Potential settlers for new economic development schemes could identified in pockets of high population pressure. Given that these are uncommon in Tchad, it would be expected that economic opportunity in the new lands would be the main incentive for movement and resettlement, rather than land hunger in the homelands.

With particular regard to the health profile, and to health risks of resettlement, it is strongly recommended that the economic costs of health maintenance be build into the infrastructural costs of each agricultural development project. Programs of health maintenance would include screening of migrants, ecological awareness of disease transmission cycles, treatment of migrants,

and adequate health services in the new lands. An identical philosophy of preventive medicine would also apply to animal diseases and to animal health.

As the integrated regional development plans are being prepared, a need will arise to integrate planning information relating to all other sectors of the economy. The reports and findings of the C.I.L.S.S. working groups on human resources, transportation, irrigation, marketing, pricing, storage, and pastoralism should be incorporated. In summary, the findings and recommendations of this report on new lands should not be viewed as entities separate from the considerations of the other working groups. It is argued in conclusion for Tchad, as well as for the other Sahelian countries, that the new lands constitute an arena or a sphere of activities open to and essentially belonging to the activities of all of the vertical and horizontal working groups of C.I.L.S.S. It would be dysfunctional to regard the new lands as the sole province of the C.I.L.S.S. dry-lands working group.

Search Areas for New Lands in the Sahel

Zones d' Exploration pour les Terres Neuves du Sahel

Part 3. NIGER

1. Liste des Tableaux

2. Liste des Cartes

Niger Tab. 1. Zones Climatiques:

pour le paturage: A^1 B^1 C^1 D^1

pour la culture: A B C

Zone	Hectares	Percent
A^1	82 368 000	65.0
B^1	18 055 000	14.3
C^1/A	14 507 000	11.4
D^1/B	11 010 000	8.7
C	760 000	.6
Total	126 700 000	100.0

Source: d'après le planimétrage sur la carte à 1:5,000,000

Niger Tab. 2. Superficie par Zone Climatique et par Arrondissement

Zone D^1/B (West): 350-600 mm P.90

Departement/Arrondissement	Superficie Total Hectares (approx.)
NIAMEY (part)	4 152 400
Téra (S.)	809 900
Tillabéry (S.)	131 200
Ouallam (S.)	356 800
Filingué (S.)	771 300
Niamey	803 700
Say (N.)	1 279 500
DOSSO (part)	2 265 600
Birni N'G. (N)	377 700
Dosso (N)	655 000
Loga	282 100
Dogon D. (S)	916 800
Gaya (N.)	34 000
Zone Total	6 418 000

Source: d'après le planimétrage sur la carte à 1:2,500,000

Niger Tab. 3. Superficie par Zone Climatique et par Arrondissement

Zone C: 600-800 mm P.90

Departement/Arrondissement	Superficie Total Hectares (approx.)
NIAMEY (part)	174 300
Say (S.)	174 300
DOSSO (part)	656 900
Birni N'G (S.)	59 400
Dosso (S.)	240 900
Gaya (S.)	356 600
Zone Total	831 200

Source: d'après le planimétrage sur la carte à 1:2,500,000

3. Observations

3.1 As indicated in Map 1 and Table 1, Niger has 11 million hectares in climatic Zone D'B, amounting to a little under 9 percent of the total surface of the country. Zone C is much smaller, covering only 760,000 hectares, or approximately 0.6 percent of the total surface area. Niger has no land at all in Zone D and is therefore the least favored among the Sahelian countries, in the possession of southern rain lands, excluding Mauritania.

3.2 Boundaries of departments and of arrondissements are indicated in relationship to climatic zones in Map 2. It can be seen that much of the Departments of Niamey and Dosso lie in Zone D'B, which enjoys rainfall of 350-600 mm (P. 90). A small area in the south of the Departments of Niamey and Dosso lies in climatic Zone C with over 600 mm of rainfall (P. 90).

3.3 When analyzed at the level of the arrondissement, it can be seen that population density in Zone D'B and C generally exceeds 10 h/km2 (Map 3). Notable exceptions to this are the Department of Say, and the southern portions of the Departments of Tillabery, Ouallam, and Filingue. In these areas the mean population density, as indicated in Map 3, ranges between 2 and 10 h/km2. Within such areas of relatively low density, therefore, one might expect to find sparsely occupied zones of very low population density and, indeed, unoccupied areas. Zone D'B, east, is densely occupied from Maradi to Magaria with no prospects for new lands.

3.4 In Tera, Niamey and Birni, in Zone D'B, west, cattle densities are in the order of 15-20 per km2 (Map 4). In Say the average is 5-10 per km2. Small ruminants in Say range from 20 to 40 per km2, but are less than 10/km2 to the north, in Tera, in climatic Zone D'B (Map 5).

3.5 Administrative boundaries and capital towns of southwest Niger are indicated in Map 6, together with the boundaries of climatic zones.

For the Department of Niamey only, Map 7 indicates that there are exploration areas for new lands in the west and south of Say, and also south of Tera. There are also apparent search areas immediately east of Tillabery, as well as southeast and southwest of Filingue. These are largely unoccupied areas.

There are also areas with under 25 h/km2 indicated on the map, and it is likely that some of these will be unoccupied on underutilized. Each square on Map 7 approximately measures 7x7 km, equalling 50 km2.

Major zones of exploration are indicated in Map 8. Apart from a national park which occupies the entire empty area in the west of Zone C, it will be seen that there are extensive search areas west of the river Niger, in some areas northeast of Niamey, and in other areas lying between Dogondoutchi and Filingue.

Inspection of Map 8 suggests that there may be overspill zones for local population resettlement, in some areas such as southwest of Birni - Ngaore. However, generally speaking, the largest areas for exploration for new lands lie in the Departments Tera, Niamey and Say.

3.6 For climatic Zone C one can recognize, in Map 9, first class and also second class grazing lands in Gaya, southern Dosso, and southern Birni-Ngaore. There is first class irrigable land in the eastern part of Gaya, whilst in the western part of Zone C there is a complex of Class 2, superior agricultural land predominating over Class 5, very poor land.

For climatic Zone D'B the following observations and generalizations may be made. In the arrondissement of Niamey there are Class 3, average agricultural lands and Class 3, average grazing lands. The same may be said for the southern part of Ouallam within this climatic zone. In Tera, within climatic Zone D'B, there are extensive areas of Class 2, superior agricultural land, as well as Class 3, average grazing land. For the central areas of the arrondissement of Say, there are Class 3, average agricultural lands and Class 3 grazing lands. In the northwest of the arrondissement of Say, however, there is a complex with Class 2, superior agricultural land predominating. There is also a similar complex in the south of Say within this climatic zone.

Table 2 shows the surface areas in hectares by department and arrondissement for climatic Zones D'B, west, and for Zone C. Climatic Zone D'B, east, is excluded because of its high population density.

Careful comparison between Map 9 and Table 2 will show the approximate extent in hectares of the areas of each administrative unit, within a climatic zone, classified by potential for agriculture and for pastoralism.

4. Discussion

4.1 Whereas it is true that the extent of moist lands in Niger are limited especially when compared with those in Tchad and Mali, yet prudent

development of the new lands of Niger could bring considerable economic benefit to the country.

4.2 It is recognized that the Department of Niamey, especially in the arrondissement of Say, is well advanced in regional plans that include the control of onchocerciasis and associated resettlement of new lands. The writer cannot comment upon these plans since he does not have any detalis.

4.3 Apart from Say, however, it is apparent that there is a potential for new land which should be explored in other areas such as Tera and Niamey. Even portions of the arrondissements of Dosso, Birni-Ngaore and Dogondoutchi should be explored.

5. Recommendations

Recommendation 1. Ground Survey. It is recommended that a rapid reconnaissance ground truthing survey be implemented for climatic Zones D'B and C. On a very limited sample basis this will explore areas of occupation and areas of sparse settlement. There should be some limited soil survey sampling and some assessment of vegetation cover as an index of soil fertility as well as an index of human occupancy. Given the importance of Zone D'B in the livestock industry, particular attention should be paid to the utilization of the natural resources of the zone by pastoralists. The reconnaissance survey will demarcate possible areas of new land settlement.

Recommendation 2. Health Risks Profile. A survey of the prevalence of major parasitic and infections diseases of southwest Niger should be made. Human and animal diseases should be included. Already in the case of onchocerciasis, spraying activities are under way in the southwest, and cognizance should be taken of the effectiveness of these programs. Other possible health hazards associated with resettlement activities should be taken under consideration.

Recommendation 3. Source Areas of New Land Settlers. It is recommended that potential source areas for the recruitment of new land settlers be identified through a process of mapping high population density areas, areas with high ratios of population per unit area, and per unit area of cultivable land. These will be the areas of land hunger in which the psychological climate for the recruitment of settlers will be favorable.

Recommendation 4. Integrated Regional Planning. It is recommended that when

the findings of the ground survey, the health risks profile together with the identification of target recruiting areas are available, the information for southwest Niger should be integrated in the context of a regional development plan. Thus, new lands settlement schemes should not be promoted except in the general context of regionally integrated economic development. In particular, the findings of the various C.I.L.S.S. working groups in livestock and range management, in human resources, in the transportation, pricing, marketing, and storage, and in irrigated agriculture should be carefully synthesized in the preparation of regional economic plans. The economic development of the new lands, where deemed appropriate by the Government, should be fully integrated with local, regional, and national economies.

Search Areas for New Lands in the Sahel

Zones d' Exploration pour les Terres Neuves du Sahel

Part 4. Haute-Volta

1. Liste des Tableaux

2. Liste des Cartes

(Continued)

Part 4. Haute-Volta (Continued)

Tab. 1. Haute Volta : Zones Climatiques :

pour le pâturage: B^1, C^1, D^1

pour la culture: A, B, C, D

Superficie en Hectares

Zone	Hectares	Percent
B^1	590 000	2.1
C^1/A	629 000	2.3
D^1/B	8 791 000	32.1
C	9 005 000	32.8
D	8 405 000	30.7
Total	27 420 000	100.0

Source: d'après le planimétrage sur la carte à 1:5,000,000

Haute-Volta :
Tableau 2. Densité par Cercle, 1972

H. VOLTA O.R.D./Cercle	Superficie Km2	Population 1972	Densité Hbts/Km2
SAHEL	36 895	264 273	7.2
Dori	12 495	121 244	9.7
Djibo	14 000	97 423	7.0
Oudalan	10 400	45 606	4.5
EST	49 992	287 110	5.7
Fada	28 664	131 667	4.6
Diapaga	14 780	68 779	4.6
Bogande	6 548	86 664	13.2
SUD-OUEST	18 393	183 600	9.9
Banfora	18 393	183 600	9.9
BOBO-DIOULASSO	28 297	332 929	11.8
Bobo	12 222	133 171	10.9
Boromo	3 518	61 384	17.4
Hounde	4 250	35 374	8.3
Orodara	8 307	103 000	12.4
VOLTA NOIRE	29 588	488 981	16.5
Dedougou	6 924	95 710	13.8
Nouna	13 177	160 222	12.2
Toma	2 623	68 666	26.2
Tougan	6 864	164 383	23.9
BOUGOURIBA	17 448	359 952	20.6
Diebougou	7 087	171 227	24.2
Gaoua	10 361	188 725	18.2

Suite 1 Tableau 2 - Densité par Cercle, 1972

H·VOLTA O.R.D./Cercle	Superficie Km2	Population 1972	Densité Hbts/Km2
KOUDOUGOU	26 324	733 667	27.9
Koudougou	4 138	297 740	72.0
Leo	13 736	106 681	7.8
Reo	1 759	86 102	48.9
Tenado	3 406	61 361	18.0
Yako	3 285	181 783	55.3
N. du P. MOSSI	21 578	528 669	24.5
Barsalogho	3 610	45 035	12.5
Boulsa	7 555	141 005	19.7
Kaya	4 718	175 988	37.3
Kongoussi	4 017	125 796	31.3
Pissila	1 678	40 845	24.3
CENTRE EST	9 039	277 786	30.7
Koupela	1 627	94 676	58.2
Tenkodogo	5 989	113 403	18.9
Garango	1 423	69 707	49.0
OUAGADOUGOU	24 179	973 122	40.2
Bousse	1 912	101 933	53.8
Kombissiri	2 908	92 434	31.8
Manga	2 847	99 662	35.0
Ouagadougou	1 708	242 080	141.7
Po	3 121	22 803	7.3
Sapone	1 871	72 237	39.6
Tiebele	722	49 958	69.2
Zabre	2 227	77 116	34.6
Ziniare	2 776	127 657	46.0
Zorgho	4 087	87 242	21.3

Suite 2

Tableau 2 - Densité par Cercle, 1972

H. VOLTA O.R.D./Cercle	Superficie Km2	Population 1972	Densité Hbts/Km2
YATENGA	12 297	475 150	39.6
Gourcy	2 003	104 800	52.3
Ouahigouya	4 891	201 550	41.2
Seguenega	1 519	105 450	69.4
Titao	3 884	63 350	16.3

Source: Annuaire de Statistiques Agricoles, 1972

Haute Volta Tab. 3. Summary Table

Surface Area by Climatic Zone, Population Density and by Administrative Boundaries. Superficie par zone climatique, par densité de population, et par limite administratif : le Sommaire

Zones Climatiques by Admin. Areas	Hectares by Population Density: hbts/Km^2			
	0-5	5-15	15+	All Densities
D OUEST: 800 + mm P.90	1 082 900	2 807 700	2 171 400	6 062 000
D EST: 800 + mm P.90	920 200	176 900	716 900	1 814 000
Zone D Totals	2 003 100	2 984 600	2 888 300	7 876 000
C: 600-800 mm P.90	nil	4 532 500	4 408 200	8 940 700
D'/B: 350-600 mm P.90	610 400	3 541 200	5 394 700	9 546 300
C'/A: less than 350 mm P.90	nil	546 900	nil	546 900
B[1]: more than 200 mm Mean	nil	493 100	nil	493 100
Totals	2 613 500	12 098 300	12 691 200	27 403 000
Total Area of H. Volta in Hectares				27 403 000

Notes:

1. The figure representing the total area of H. Volta (27,403,000 hectares) is the one used by the Services Statistiques Agricoles, 1972. It differs from the total of 27,420,000 hectares used on the 1:5,000,000 map.
2. For convenience of data management, the climatic and population density areas, analysed in this and following tables, have been adjusted to fit administrative boundaries; they therefore do not exactly coincide with the climatic lines. Calculated areas differ accordingly with zone totals represented on the 1:5,000,000 map.
3. Surface areas are those provided by the Services des Statistiques Agricoles, 1972, and by additional planimeter measurements (planimétrage).

Haute Volta Tab. 4. Superficie: ZONE D OUEST

ZONE D (OUEST): 800 + mm P.90

(See maps for boundaries of named units)

Population Density: 0 - 5 h/Km2

Cercle/Subdivision/Arrondissement	Superficie Total Hectares (approx.)
Banfora/Sideradougou/Tiefora /Mangodara /Sideradougou	1 082 900
Total for 0 - 5 h/Km2 areas	1 082 900

Population Density: 5 - 15 h/Km2

Banfora/Niangoloko/Niangoloko	275 900
Gaoua/Batie	341 600
Orodara/Ndorola/Samoro Souam /Ndorola	543 000
Hounde	425 000
Bobo Dioulasso/Bobo D./Fo /Bobo D.	996 500
/Toussiana	225 700
Total for 5 - 15 h/Km2 areas	2 807 700

(Continued)

ZONE D (OUEST)..... Suite 1.

Population Density: 15 ≠ h/Km2

Cercle/Subdivision/Arrondissement	Superficie Total Hectares (approx.)
Banfora/Sindou/Sindou /Loumana	223 700
Banfora/Niangoloko/Soubakaniedougou	119 600
Banfora/Banfora/Banfora	137 200
Orodara/Orodara/Orodara /Koloko	287 700
Diebougou/Diebougou/Diebougou /Dissin /Tiankoura	401 600
Diebougou/Dano	307 100
Gaoua/Gaoua/Gaoua /Doudou /Loropeni	410 800
Gaoua/Kampti	204 400
Gaoua/Naku	79 300
Total for 15 ≠ h/Km2 areas	2 171 400
Grand Total for Zone D OUEST: all densities	6 062 000

Haute Volta Tab. 5. Superficie: Zone D EST

Zone D (EST) 800 + mm P.90

(See maps for boundaries of named units)

Cercle/Subdivision/Arrondissement	Density Range hbts/Km^2	Superficie Approx. Total Hectares
Fada N' Gourma/Pama	0- 5	767 700
Fada N'Gourma/Comin Yanga	0- 5	152 500
Total for 0-5 h/Km^2 areas	0- 5	920 200
Tenkodogo/Ouagaye/Ouagaye	5-15	
Sangha	5-15	
	5-15	176 900
Total for 5-15 h/Km^2 areas	5-15	176 900
Tenkodogo/Tenkodogo/Tenkodogo	15 +	
Bittou	15 +	
	15 +	422 000
Zabre/Zabre/Zabre	15 +	
/Zonse	15 +	
/Combou	15 +	
	15 +	222 700
Tiebele	15 +	72 200
Total for 15 + h/Km^2 areas	15 +	716 900
Grand Total for ZONE D EST: all densities		1 814 000

Haute Volta Tab. 6. Superficie ZONE C

ZONE C: 600 - 800 mm P.90

(See maps for boundaries of named units)

Population Density: 5 - 15 h/Km2

Cercle/Subdivision/Arrondissement	Superficie Hectares	Total (approx.)
Nouna/Solenzo/Solenzo		
/Tansilla		
		613 100
Leo/Fara/Fara	202 200	
/Ouessa	58 500	
		260 700
Leo/Leo/Leo	506 000	
/Sapony	239 400	
/Gao	367 400	
		1 112 900
Po		312 100
Fada N'Gourma/Fada N'G/Diago		61 300
/Fada N'G (S.)		
/Bilanga (S.)		
/Matiakoali(S.)		
		993 200
Diapaga/Diapaga/Diapaga		
/Logobou		
		867 600
Dedougou/Safane/Safane	157 600	
/Tcheriba	154 000	
		311 600
Total for 5 - 15 h/Km2 areas		4 532 500

ZONE C ..... Suite 1.

Population Density: 15 + h/Km^2

Cercle/Subdivision/Arrondissement	Superficie Total Hectares	
Nouna/Nouna/Nouna		295 900
Dedougou/Dedougou/Dedougou	191 700	
/Ouarkoye	189 100	
		380 800
Toma/Toma/Toma		
/Koungny		
/Ye		
		262 300
Boromo/Boromo/Boromo		
/Bagassi		
		351 800
Tenado/Tenado/Tenado		132 200
/Pouni		208 400
Reo/Didyr/Didyr		104 700
/Reo/Reo		
/Kordie		
		71 200
Yako/Samba		71 200
Koudougou/Koudougou		71 200
/Sabou		122 000
/Kindi		68 100
/Nanoro		98 600
/Kokologo		53 900
Bousse/Bousse/Bousse		
/Nyou		
		191 200

ZONE C ..... Suite 2.

Population Density: 15 + h/Km^2

Cercle/Subdivision/Arrondissement	Superficie Total Hectares
Ouagadougou/Ougadougou	116 900
/Tanghin Dassouri	53 900
Sapone/Sapone/Sapone	
/Komsilga	
/Kayao	
	187 100
Ziniare/Ziniare/Ziniare	
/Zitenga	
/Dapelgo	
/Loumbila	
	277 600
Kombissiri/Kombissiri/Kombissiri	
/Doulougou	
/Toece	
	290 800
Manga/Manga/Manga	
/Nobere	
	284 700
Garango	142 300
Zorgo/Zorgo/Zorgo	
/Meguet	
	408 700
Koupela/Koupela/Koupela	
/Gounghin	
/Tensobentenga	
	162 700
Total for 15 + h/Km^2 areas	4 408 200
Grand Total for ZONE C: all densities	8 940 700

Haute Volta Tab. 7. Superficie: Zone D^1/B

ZONE D^1/B: 350 - 600 mm P.90

(See maps for boundaries of named units)

Population Densité: 0-5 h/Km^2

Cercle Subdivision/Arrondissement	Superficie Total Hectares (approx.)
Diapaga/Kantchari	610 400
Total for 0-5 h/Km^2 areas	610 400

Population Density: 5-15 h/Km^2

Fada N'Gourma/Fada N'G/Fada N'G (N.) /Bilanga (N.) /Matiakoali (N.)	891 700
Dori/Sebba /Dori/Dori /Dani /Yatako /Falagountou /Gorgadji	615 200
	634 300
Djibo/Aribinda /Djibo/Djibo /Kelbo Foulbes /Tongomayel /Baraboule	379 000
	1 021 000
Total for 5-15 h/Km^2 areas	3 541 200
Grand Total for ZONE D^1/B (excluding 15 + h/Km^2 areas	4 151 600

ZONE D^1/B .....Suite 1.

(See maps for boundaries of named units)

Population Densité: 15 + h/Km^2

Cercle	Superficie Total Hectares
Nouna (part)	408 700
Tougan	686 400
Yako (part)	257 300
Gourcy	200 300
Ouahigouya	489 100
Seguenega	151 900
Titao	388 400
Kongoussi	401 700
Kaya	471 800
Pissila	167 800
Boulsa	755 500
Bogande	654 800
Barsalogo	361 000
Total for 15 + h/Km^2 areas	5 394 700
Grand Total for ZONE D^1/B: all densities	9 546 300

Haute Volta Tab. 8. Superficie: Zones C^1/A et B^1

Population Densité: 5-15 h/Km^2

Zones Climatiques	Cercle /	Hectares
Zone C^1/A:		
Less than 350 mm P.90 (à limite des cultures)	Oudalan (S.)	546 900
Zone B^1:		
More than 200 mm Mean	Oudalan (N.)	493 100
Total Hectares		1 040 000

3. Observations

3.1 Some 96 percent of the surface area of Upper Volta receives more than 350 mm of rainfall each year, with a probability of 90 percent (P. 90) (See Table 1). There are almost 9 million hectares in Zone D'B receiving 350-600 mm rainfall (P. 90); 9 million hectares in Zone C receiving 600-800 mm (P. 90); and, approximately 8.4 million hectares in Zone D with more than 800 mm of rain (P. 90) (See Map 1).

3.2 The boundaries of the cercles of Upper Volta are indicated on Map 2 in relation to climatic zones.

3.3 Average population density for each cercle is indicated on Map 3 in relation to climatic zones. It will be noticed that some of the cercles, such as Nouna, Fada - N'Gourma, and Diapaga extend over more than one climatic zone.

The surface area of each cercle, together with its population and its population density are given in Table 2. Population density ranges from 142 inhabitants per km2 (h/km2) for the Cercle of Ouagadougou, and 72 h/km2 for the Cercle Koudougou, down to 5 h/km2 for several cercles in the eastern and northern parts of the country.

The search for new lands is likely to be more successful where there is a favorable conjunction of low population densities and high rainfall.

3.4 Population density by arrondissement and by climatic zone is indicated in Map 4. Low population density zones, 0-5 h/km2, are revealed south of Banfora in the southwest of the country, in Zone D, in the south of Fada N'Gourma, in the southeast of the country, also in climatic Zone D; in the north of Diapaga; and in the general vicinity of Leo in climatic Zone C.

3.5 Map 5 shows the distribution of population by proportional dots and by climatic zones. This map should be used in conjunction with Map 4 to determine areas of settlement, areas of occupation, and areas of limited or no occupation. It will be noted that even in areas which apparently have moderate population densities, there are indeed empty or uninhabited zones. These zones typically are empty river valleys, vacant because onchocerciasis. This would be most apparent in the White Volta and Red Volta Valleys to the south and southeast of Ouagadougou. Extensive new lands may be observed in the Cercle of Banfora, the Cercle of Fada N'Gourma, and also Diapaga.

In the series of maps which follow, areas are identified first by climatic zones; second by level of population density; and third, by search areas for new land settlement; together with the boundaries of agricultural potential zones.

3.6 Map 6 shows the administrative boundaries of the arrondissements in climatic Zone D, west, that have population densities less than 5 h/km2. Agricultural potentialities of this area are indicated in Map 7. It will be seen that there are extensive third class average lands in Tiefora and Mangodara, whereas in Siderabougou there is much Class 4 and 5, poor agricultural land. All together, the three arrondissement shown on Map 7 cover an area of just over 1 million hectares (see Table 3 and 4). Because of soil potential, search areas for new lands should focus in the west and south of this area.

Climatic Zone D, west, within the population density range 5-15 h/km2 is shown in Maps 8, 9, and 10, with surface area measurements available in Table 4. Search areas for new lands are indicated in Map 10. It will be seen that these search areas cover large areas of each arrondissement. Agricultural potential is shown in Map 9. For the most part, the search areas are Class 3, average land, with a mixture of Class 5, very poor land. There is, however, some Class 2, superior land in the Batie area, and in Hounde.

In the high population areas (15+ h/km2) of climatic Zone D, west, one would not expect to find extensive search areas for new lands (see Maps 11, 12, 13). However, in Map 12 one can identify distinct linear zones which are not occupied by settlement. These are, of course, river valleys deserted because of onchocerciasis. Given satisfactory control of the disease, these empty river valleys could be utilized for local, overspill resettlement programs. Surface areas are given in Table 4, and agricultural potentialities are shown in Map 13. A careful comparison of Maps 12 and 13 will reveal the agricultural potentialities of the unsettled vacant areas. Sindou, Soubakanie, Banfora, Loumana, Orodara, and Koloko have some first class, irrigable land, Class 2, superior agricultural land, and Class 3, average land. West of Diebougou, and east of Dano there is Class 2, superior agricultural land in the empty zone. The extent of these empty lands may be estimated by comparing the figures given in Table 4 with the areas represented in Maps 12 and 13.

3.7 Climatic Zone D, east, covers 1.8 million hectares, of which some 900,000

hectares have a population density of less than 5 h/km2 (see Table 5).

Cartographic representation of Zone D, east, is given in Maps 14, 15, 16, and 17. On Map 15 it will be seen that the lowest population densities occur in the arrondissements of Pama, Comin-yanga, Sanga, and Ouagaye. However, as revealed in Map 16, even areas with higher population densities do have unoccupied zones. Agricultural potential of Zone D, east, is given in the Map 17. Particularly noteworthy is the extent of first class irrigable land in the eastern portion of Pama. There is, in addition, much Class 3, average agricultural land that could potentially be developed. Elsewhere in the arrondissement of Pama there are large areas Class 5, very poor agricultural land.

3.8 In climatic Zone C, with 600 to 800 mm (P. 90), there are 4.5 million hectares in the population density range of 5-15 h/km2 (see Table 6 and Maps 18, 19, and 20). A comparison of Maps 19 and 20 will indicate both search areas for new lands and agricultural potentials. The extent of the agricultural potential zones in hectares and by arrondissement may be estimated from Table 6.

The search areas in Gao, Leo, Sapouy, and Po are mostly Class 5 and Class 4 agricultural lands. They are of very poor quality and offer scarcely any prospects for resettlement activities, (see Map 20). In the Diapaga and Logobou areas, in contast, there is first class irrigable land, Class 2, superior agricultural land, and extensive occurrences of Class 3, average land; so that prospects for new land activity are favorable in this area. Also in the Fada N'Gourma area marked on Map 20 one can observe Class 2, superior agricultural land as well as Class 3, average agricultural land that offer propspects for settlement activity.

In the west of this climatic zone (see Map 20) there is Class 2 and Class 3 agricultural land with, in some areas, an add mixture of Class 5 land. These are the areas of Tcheriba, Safane, Solenzo, and Tansilla.

The higher population density areas of Zone C (15+ h/km2) cover 4.4 million hectares (see Table 6), and are represented in Maps 21, 22, and 23. A comparison between Maps 22 and 23 will reveal agricultural potential as well as potential for livestock development in the unoccupied zones. It is recommended that these comparisons be made arrondissement by arrondissement. Estimates of surface area in hectares may be obtained by comparison with

Table 6.

Those new lands search areas marked on Map 22 east and south of Ouagadougou are, of course, the Red Volta and the White Volta presently being developed by the Volta Valley Authority (AVV). Other relatively extensive occurrences of new lands search areas may be identified west of Tenado, west of Pouni, south of Fara, south of Boromo, and in the area of Ouarkoye and Nouna. An inspection of Map 23 will show Class 3, average agricultural lands in these areas together with some first class irrigable land, all of which could be used for local overspill resettlement projects.

3.9 In climatic Zone D'B with 350 to 600 mm (P. 90) there are 600,000 hectares with a population density of 0-5 h/km2, and 3.5 million hectares with a population density of 5-15 h/km2. (see Table 7 and Map 24).

This zone possesses a high suitability for pastoralism and, accordingly, any evaluation of new land potential should include a combination of agricultural and livestock activities. A cartographic representation of the areas with lower population density is given in Maps 24, 25, and 26. Map 25 shows that the greater part of this area is apparently unsettled; but one should note that there is extensive livestock utilization of the natural resources of these areas. Again, the need to integrate agricultural with livestock planning is apparent here.

Potentialities for agriculture and pastoralism are indicated in Map 26. One sees very extensive occurrences of Class III, average grazing land. There are also fairly extensive occurrences of Class 3, average agricultural lands, as well as some mixture of Class 5, very poor land. Some first class irrigable land, together with Class 2, superior agricultural land, will be observed in the arrondissements of Tongomyel, Aribinda, Gorgadji, Dori, and Dani, especially in the latter area.

The extent of these areas may be estimated by comparison with Table 7. The areas given in the Table 7, as for all the tables, 3 through 8, correspond with the boundaries of the arrondissements as given on the maps.

3.10 The Cercle of Oudalan covers approximately 1,000,000 hectares, of which about 550,000 hectares lie in Climatic Zone C'A, and the remainder in Climatic Zone B' (see Table 8 and Map 27). The average population density of this cercle is 4.5 h/km2 (Table 2) and there are no important areas of search for new lands.

4. Discussion

Among all the countries of the Sahel, Upper Volta occupies a special place because of the high level of activity of its ongoing resettlement programs organized by the Volta Valley Authority (AVV). Programs are well underway for the valleys of the White Volta and the Red Volta, and a beginning has already been made in part of the Black Volta. For the areas surveyed by the AVV, far more detailed information is available than is presented in this series of maps. It would be redundant to duplicate this; however, for the areas outside the perimeters of the AVV, it is suggested that the present set of maps and area calculations will serve a useful function in identifying search areas for new lands. These areas are considerable. In the southwest of the country and in the southeast there are suitable areas for agricultural development, in climatic Zones D and also C. Furthermore, opportunities for integrated agricultural and livestock new land development, especially in Zone D'B, should not be ignored. The present findings, therefore, should be regarded as complementary to and supplementary to the ongoing work of the AVV.

5. Recommendations

Recommendation 1. Ground Survey. A rapid reconnaissance is recommended, using sampling techniques, to confirm the availability of areas of low levels of population density, and of underutilization, such areas being potentially suitable for resettlement activities. The potential new lands, so identified, would of course be additional to those within the perimeter of the Volta Valley Authority (AVV).

Recommendation 2. Health Risks of Resettlement. A sample survey of the health risks of the identified new lands should be conducted by climatic zones. For each climatic zone, the major parasitic and infectious diseases, as well as nutritional problems, should be identified. Disease prevalences should be determined, as well as major foci of disease. At the same time, the health risks of resettlement programs should be evaluated. Recommendations should be made for the health maintenance of new land settlers. It is anticipated that the major health problems will be onchocerciasis, both in the southeast and southwest of the Upper Volta. In both areas, the World Health Organization (WHO) is presently spraying against the black fly (Simulium damnosum), but other health hazards should be identified and evaluated. Animal health

should importantly be included with particular reference to bovine trypanosomiasis.

Recommendation 3. Source areas for Migrants. The resettlement of new lands requires identification of potential migrants. These may be located by geographic area through the process of plotting population density for small unit areas, if data are available. Map 3 shows the cercles of highest population density in which one should expect to find a larger number of people psychologically predisposed to new land settlement activities. On a smaller scale, on Map 4, arrondissement of very high densities, in some cases over 50 h/km2, and even over 80 h/km2, are identified. These would be prime target areas for recruiting campaigns. A perusal of Map 5 would further refine target areas for recruiting campaigns. It is recommended that field sampling be conducted to further identify geographical areas of population pressure and land hunger in which recruiting campaigns for families wishing to occupy new lands would have the best likelihood of success.

Recommendation 4. Integrated Regional Planning. When the new lands have been fully identified, as under the first recommendation above, and when health risks are evaluated with major source areas of migrants determined, as under recommendations 2 and 3 above, integrated regional development plans should be developed for resettlement activities.

It is recommended here that new land settlement should not be regarded as a discrete, separate, and isolated economic activity; rather, new lands development should be integrated concurrently with the economic development of the surrounding areas, and a regional framework for such economic development should be established. The merit of this proposal is apparent if one considers the distribution of the new lands as approximately indicated in the various maps of the search areas. One sees that the new lands may form linear patterns within areas of settlement, may form interstitial patterns in areas of settlement, as well as, thirdly, occupying large blocks of territory. Given the extensive intermingling of the new lands with occupied territories, it is obviously more rational to integrate their development with the development with the development of surrounding regions.

Search Areas for New Lands in the Sahel

Zones d' Exploration pour les Terres Neuves du Sahel

Part 5. Mali

1. Liste des Tableaux

2. Liste des Cartes

Mali Tab. 1. Zones Climatiques

pour le pâturage: A^1, B^1, C^1, D^1
pour la culture: A, B, C, D

Zone	Hectares	Percent
A^1	67 601 000	54.5
B^1	11 405 000	9.2
C^1/A	8 094 000	6.5
D^1/B	14 988 000	12.1
C	7 642 000	6.2
D	14 289 000	11.5
Total	124 019 000	100.0

Source: d' après le planimétrage sur la carte à 1:2,500,000

Mali Tab. 2. Regions et Cercles : Superficie en Hectares par Zones Climatiques

M A L I Region/Cercle	Dec. 76 Densité Hbts/Km^2	Zone A[1]	Zone B[1]	Zone C1/A	Zone D[1]/B	Zone C	Zone D	Superficie Total Hectares
KAYES					4,069,569	3,754,800	4,156,931	11,981,300
Kayes	9.1				902,149	1,194,739	121,912	2,218,800
Bafoulabe	5.0				231,687	926,749	854,064	2,012,500
Keniebe	6.7						1,400,000	1,400,000
Kita	5.2				110,733	1,633,312	1,780,955	3,525,000
Nioro	8.7				2,250,000			2,250,000
Yelimane	12.8				575,000			575,000
BAMAKO				240,071	3,776,455	1,765,836	3,227,638	9,010,000
Bamako	39.4					136,568	1,493,432	1,630,000
Banamba	10.9				482,032	287,968		770,000
Dioilla	12.8					136,594	1,163,406	1,300,000
Kangaba	9.2						470,000	470,000
Kolokani	9.9				464,494	705,506		1,170,000
Koulikoro	16.6					499,200	100,800	600,000
Nara	3.7			240,071	2,829,929			3,070,000

(Continued-next page)

Mali Tab. 2. (Suite 1)

M A L I Region/Cercle	Dec. 76 Densite Hbts/Km2	Zone A1	Zone B1	Zone C1/A	Zone D1/B	Zone C	Zone D	Superficie Total Hectares
SIKASSO						743,315	6,904,674	7,648,000
Sikasso	18.5						1,537,500	1,537,500
Bougouni	9.4						1,910,000	1,910,000
Kadiolo	15.1						537,500	537,500
Kolondieba	10.1						920,000	920,000
Koutiala	20.5					662,426	680,574	1,343,000
Yanfolila	10.0						880,000	880,000
Yorosso	14.4					80,889	439,111	520,000
SEGOU				1,150,289	3,083,894	1,378,517		5,612,700
Segou	33.7				653,763	621,237		1,275,000
San	26.8				315,773	403,027		718,800
Massina	17.0				656,300			656,300
Niono	5.6			1,150,289	1,156,011			2,306,300
Tominian	17.0				302,047	354,253		656,300

(Continued-next page)

Mali Tab. 2. (Suite 2)

M A L I Region/Cercle	Dec. 76 Densite Hbts/Km^2	Zone A^1	Zone B^1	Zone C^1/A	Zone D^1/B	Zone C	Zone D	Superficie Total Hectares
MOPTI				4,817,279	4,057,921			8,875,200
Mopti	22.0			342,623	591,377			934,000
Bandiagara	20.7			92,949	632,051			725,000
Bankass	18.8				687,500			687,500
Djenne	24.1				456,300			456,300
Douentza	6.1			2,331,200				2,331,200
Koro	16.5			46,706	1,046,994			1,093,700
Niafunke	11.9			1,537,500				1,537,500
Tenenkou	8.0			466,301	643,699			1,110,000
GAO		67,600,986	11,404,832	1,886,182				80,892,000
Gao	4.2	913,750	1,773,750					2,687,500
Ansongho	3.6	83,100	2,198,200					2,281,300
Bourem	2.2	3,079,725	1,026,575					4,106,300
Dire	44.7		21,000	154,000				175,000
Goundam	1.1	6,951,600	1,248,234	1,068,966				9,268,800

(Continued-next page)

Mali Tab. 2. (Suite 3)

MALI Region/Cercle	Dec. 76 Densite Hbts/Km2	Zone A1	Zone B1	Zone C1/A	Zone D1/B	Zone C	Zone D	Superficie Total Hectares
GAO (Cont.)								
Kidal	.2	15,143,000						15,143,000
Gourma-Rharous	2.1	3,857,784		642,216				4,500,000
Menaka	.6	3,990,650	3,990,650					7,981,300
Tombouctou	.2	33,581,377	1,167,423					34,748,800
MALI TOTAL	4.1	67,600,986	11,404,832	8,093,821	14,987,839	7,642,468	14,289,243	124,019,200

Source: d' après le planimétrage sur la carte à 1:2,500,000

3. Observations

3.1 Some 30 percent of the surface area of Mali covering 37 million hectares receives more than 350 mm of rainfall with a probability of 90 percent (Table 1). There are 15 million hectares in climatic Zone D'B, with 350-600 mm of rainfall (P. 90), approximately 7.6 million hectares in climatic Zone C, with 600-800 mm (P. 90), and 14.3 million hectares in climatic Zone D, with 800+ mm (P. 90). Mali is comparable with Tchad in the extent to which it is favored by large areas of well watered southern lands.

The distribution of climatic zones is represented in Map 1 together with the boundaries of the administrative regions and of the cercles. The most favored regions of Mali with regard to rainfall amounts and reliability are Regions 1, 2, 3, and 4.

Average population density for each cercle is indicated on Map 2 together with the boundaries of the climatic zones. In climatic Zones C and D, the cercles with the lowest population densities are Kita, Bafoulabe, and Kenieba with an average density of about 5 h/km2. These are followed by Yanfolila, Kangaba, and Kolondieba with about 10 h/km2. Within these areas, therefore, one might expect to find search areas for new lands deve-opment.

3.2 Unfortunately the writer was not able to obtain detailed census statistics or maps indicating the boundaries of the arrondissements. Therefore, the following analysis is conducted only at the level of the cercle and must be cautiously interpreted, merely a preliminary indication of possibilities. Search areas for new lands are not shown.

3.3 Map 3 gives the boundaries of the administrative regions and of the cercles for climatic Zone D, and the boundaries of the agricultural potential zones. A comparison of Maps 2 and 3 will indicate which cercles have the lower population densities in relation to soil potential.

Areas of cercles are given in Table 2 arranged by climatic zones. It can be seen in this table that climatic Zone D covers a total of 14.3 million hectares of which there are 4.2 million in the region of Kayes, 3.2 million in the region of Bamako, and 6.9 million in the region of Sikasso. The area of each cercle, or each part of a cercle lying within climatic Zone D, is also given. Therefore, a comparison of Maps 2 and 3 together with Table 2 will give a preliminary indication of the extent of agricultural zones within

cercles by mean population density.

Considering Map 3 it can be seen that very poor Class 5 agricultural land and also Class 4 mixed with Class 5 land predominates in the west of Zone D in Region 1. In Region 2 there is some first class irrigable land east of Dioila and in the Kangaba area. Apart from some Class 3, average agricultural land in the cercle of Bamako, other areas have mostly very poor Class 5 agricultural land. Generally speaking, therefore, Regions 1 and 2, within climatic Zone D, seem to have very low agricultural potentialities.

In Region 3 there are extensive occurrences of Class 3, average agricultural land. In addition there is a complex of Class 2, superior agricultural land in the west of the Cercles of Sikasso and Kadiolo, and in the east of the Cercles Kolondieba, in particular. Such land quality would favor colonization activities; however, it should be noted that population densities are above average for this area, when viewed in Map 2. Only a more detailed spatial analysis would indicate the availability or otherwise of new lands in this part of Zone D.

3.4 As indicated in Map 4 and Table 2, Zone C, which receives 600 to 800 mm of rainfall (P. 90), covers a total surface area of 7.6 million hectares, of which 3.8 million are located in the region of Kayes, 1.8 million in the region of Bamako, 1.4 million in the region of Segou, and about 700,000 hectares in the region of Sikasso. The area of each cercle, or part of a cercle, in climatic Zone C, is given in Table 2.

Considering climatic Zone C, it can be observed in Map 2 that only the western portions, which are in Region 1, have low densities in the order of 5 h/km2, compared with densities in the order of 17 to 20 in the central and eastern portions of the zone.

In the cercle of Kita, within climatic Zone C as shown in Map 4, the land is of poor quality: Class 4, Class 5. This is also true of the southern part of Bafoulabe and south of Kayes. There is, however, an extensive belt of Class 3, average agricultural land extending through the Cercles of Kayes and Bafoulabe and extending into the Cercle of Kita; but the degree to which these lands are presently occupied cannot be determined from the information presently in the hands of the writer.

It is noteworthy that the eastern half of climatic Zone C, which is an area

of substantially higher population densities, also contains extensive poor, Class 4 and 5 agricultural lands. If these eastern lands are not subject to overcultivation, and are not ecologically deteriorating, then one might suggest that there are some possibilities for intensification of settlement in the more sparsely populated western half of this climatic zone. This, however, is no more than tentative speculation.

3.5 Zone D'B, which receives 350-600 mm of rainfall (P. 90), covers a total area of 15 million hectares of which there are 4 million in the region of Kayes, 3.8 million in Bamako, 3 million in the Region of Segou, and 4 million in the Region of Mopti (see Table 2). The area of each cercle or part of a cercle included in the climatic Zone D'B, is given in Table 2.

On Map 2 one can observe a low population density of 3.7 h/km2 in the Cercle of Nara, and 5.6 in the Cercle of Niono. In these areas, therefore, one might expect to find potential new lands, within the D'B zone. There may also be possible search areas for new lands in the cercles to the west, including the north of the Cercles of Kayes and of Yelimane, although this would have to be verified by more detailed population settlement mapping. In the eastern half of climatic Zone D'B, there appear to be much higher population densities in the order of 20 h/km2, as is clearly indicated on Map 2.

The western part of Zone D'B, with low population densities, and possibly some search areas for new lands, contains extensive Class 3, average agricultural land, as well as Class III average livestock grazing lands. In contrast the eastern half of this region contains much better soils. There are large occurrences of first class irrigable land as well as some complexes of Class 3 plus Class 1 land. In addition, there are areas of first class grazing land, as well as second class grazing land. In summary, the agricultural potential of this eastern area is very high indeed, although one must repeat that existing population densities are relatively high, and one cannot ascertain from the information available to this writer whether in fact new lands for agriculture do exist. The possibilities for the development of new irrigation, and the extension of present irrigation practices in this region, which seem to be favorable, are appropriately the focus of a special investigation of the working group on irrigation in the Sahel.

It should be remarked that plans for agricultural development in climatic Zone D'B should include the integration of agriculture with livestock development. That is to say there should be a synthesis of all the findings and recommenda-

tions of the livestock group, the agriculture group, and the irrigation group.

3.6 There is a total of 8 million hectares in climatic Zone C'A. Details of areas are given in Table 2; and potentialities for agriculture and for livestock are indicated in Map 6.

The analysis of Map 6 will in particular be of interest to members of the C.I.L.S.S. livestock group and those of the irrigation group. The potentialities for irrigation in an extensive area in the center of this zone are indicated as well as potentialities for the livestock industry. As for Zone D'B to the immediate south, it is apparent that there must be a very close integration in planning the two economic activities of irrigated agriculture and livestock raising.

3.7 Climatic Zone D' covers an area of 11.4 million hectares (Table 2). Seasonal grazing grounds are mostly rather poor Class IV and Class V (see Map 7). There are apparently areas of Class 2 and Class 3 agricultural land, but of course water supply is a servere problem in this zone, which is well beyond the limits of dry land farming.

4. Discussion

4.1 Mali is remarkable for the very considerable extent of well watered southern lands. At the same time there is not a widespread problem of population pressure in Mali so that one would not expect to find the Government, through reasons of population pressure, being actively inclined towards the development of policies for new lands settlement.

4.2 Customarily the Government of Mali has developed a strong focus on irrigation and livestock rearing, and therefore the development of the southern new lands for agricultural purposes does not claim a high priority among planning resources. Expressed another way, the population "push" factors for resettlement planning are not particularly strong in Mali. However despite a possible lack of interest, or the according of a low priority to the development of southern new lands, it would be appropriate at this time to begin to develop an information base that would support the development of policies for the possible future development of the southern new lands of Mali. Information gathering for longterm planning purposes is recommended.

5. Recommendations

Recommendation 1. Preliminary Map Analysis. It is recommended that another

new lands report be prepared based upon more detailed population information than is available to the writer. This would produce a more accurate identification of search areas. When accomplished, the following recommendations could be considered.

Recommendation 2. Ground Survey. It is recommended that rapid reconnaissance surveys be made of the southern climatic zones of Mali and, on a sample basis, verify the distribution of occupied and unoccupied lands, test a few selected soils for suitability for agriculture, and examine the natural vegetation cover as an index of fertility and of human occupancy. Such a survey would positively identify new lands and also suggest potentialities for agricultural, livestock and other economic development.

Recommendation 3. Health Risks Profile. Sample surveys should be conducted within the climatic zones to identify the prevelance of major parasitic and infectious diseases. These studies should also make an assessment of the health risks of the resettlement. It is understood that one of the major environmental problems, particularly of Zone D, in the south is onchocerciasis. In the eastern part of this zone, the World Health Organization (WHO) is presently engaged in a spray program against the black fly (Simulium damnosum). Other health hazards in colonization, including nutrituion problems, should be identified, and recommendations should be forthcoming on health maintenance of the settlers in the new lands. Animal health problems including bovine trypanosomiasis should be included in the survey.

Recommendation 4. Integrated Regional Planning. It is strongly recommended that the colonization of new lands should be implemented within a framework of integrated regional planning. The new lands should not be viewed as separate entities but rather as functioning economic units within economic regions. That is to say, their development should be related to the development of the surrounding areas. Furthermore, the development of the new lands should not be regarded as the sole province of dry land agriculture. All forms of agricultural production, namely, dry land farming, irrigation, livestock rearing, as well as forestry, should be incorporated in the regional plans. The joint availability of the new lands survey, with evidence from ground truthing, and the health risk profiles, should collectively support the preparation of integrated regional plans. Within these plans, arrangements for transportation infrastructures and for the implementation of policies

of pricing marketing and storage, would be included, as well as policies for the development of human resources.

Search Areas for New Lands in the Sahel

Zones d' Exploration pour les Terres Neuves du Sahel

Part 6. Senegal

1. Liste des Tableaux

2. Liste des Cartes

TABLEAU 1

SENEGAL: ZONES CLIMATIQUES
POUR LA CULTURE: A B C_1 D
POUR LE PATURAGE: C^1 D^1

ZONE	RAINFALL	HECTARES	PERCENT
C^1/A	< 350 mm P.90	2 210 000	11.2
D^1/B	350-600 mm P.90	7 689 000	39.1
C	600-800 mm P.90	4 295 000	21.8
D	> 800 mm P.90	5 478 000	27.9
TOTAL		19 672 000	100.0

Note: See Senegal Carte 2

TABLEAU 2

SENEGAL: SEARCH AREAS FOR NEW LANDS:
LOW POPULATION DENSITIES WITHIN
RAINFALL PROBABILITY ZONES

Population	SURFACE AREA IN HECTARES				
Density	Zone C[1]/A	Zone D[1]/B	Zone C	Zone D	
h /Km2	<350	350-600	600-800	>800	TOTAL
<2	nil	1,249,000	2,104,000	705,000	4,058,000
2-5	593,000	2,825,000	1,358,000	1,166,000	5,942,000
6-10	excl.	nil	1,171,000	510,000	1,681,000
11-15	excl.	excl.	95,000	636,000	731,000
	593,000	4,074,000	4,728,000	3,017,000	12,412,000

ote: 1. Calculated by arrondissement hence inexact correspondence with zones of Tab. 1. Excluding National Park.

2. See Senegal Cartes 3 and 4.

TABLEAU 3

SENEGAL: SUMMARY OF POSSIBLE EXTENT AND CAPACITY OF NEW LANDS

Zone	Total Area of Zone Hectares	ESTIMATED POSSIBLE NEW LANDS				
		Total Hectares	For Forestry, Pasture and Future Use Hectares	For Agricultural Production and Settlement Hectares	Agricultural Settlement Density P/Km2	Possible Settlers Population
A/C[1]	2,210,000	*	--	--	--	--
B/D[1]	7,689,000	2,894,000	1,447,000	1,447,000	10	144,660
C	4,295,000	3,754,000	1,877,000	1,877,000	20	375,350
D	5,478,000	2,094,000	1,047,000	1,047,000	20	209,360
TOTAL	19,672,000	8,742,000	4,371,000	4,371,000	--	729,370

Notes: *1. Possible new lands for cattle raising and irrigation in Zone C[1]/A have not been identified in this table. Refer to Livestock Group and to Irrigation Group.

2. This table is derived from Senegal Tables 1, and 4-7. See Senegal Cartes 5 - 12.

TABLEAU 4

SENEGAL: SEARCH FOR NEW LANDS:
ZONE C^1/A < 350 mm P.90

Region de Diourbel

Departement	Arrondissement	Km^2	Population	Pop/Km^2
LOUGA	KEUR MOMARSARR	2,727	13,618	5.0

Region du Fleuve

Departement	Arrondissement	Km^2	Population	Pop/Km^2
DAGANA	DIAGLE	2,132	15,408	7.2
	ROSS-BETHIO	3,076	19,275	6.3
PODOR	CASCAS	3,098	32,860	10.6
	NDIOUM	3,901	24,400	6.3
	SALDE	2,743	17,499	6.4
	THILLE BOUBACAR	3,205	14,527	4.5
MATAM	THILOGNE	1,851	25,038	13.5
GRAND TOTAL		22,733	162,625	7.2

Note: See Senegal Cartes 5 et 6.

TABLEAU 5

SENEGAL: SEARCH FOR NEW LANDS:
ZONE D[1]/B 350-600 mm P.90

			Total Arrondissement			Possible New Lands				
						Assumption #1		Assumption #2		
Region	Departement	Arrondissement	Km^2	Pop.	P/Km^2	Km^2	Pop.	Km^2	Km^2	Pop.
DIOURBEL	LINGUERE	BARKEDJI	12,490	21,099	1.7	10,380	103,800	5,190	5,190	51,900
		DAHRA	7,622	32,334	4.2	4,389	43,890	2,195	2,195	21,950
		Total				14,769	147,690	7,385	7,385	73,850
FLEUVE	MATAM	KANEL	6,044	24,335	4.0	3,610	36,100	1,805	1,805	18,050
		OURPS-SOGUI	14,579	40,262	2.8	10,553	105,530	5,277	5,277	52,770
		Total				14,163	141,630	7,082	7,082	70,820
		ZONE TOTAL				28,932	289,320	14,466	14,466	144,660

Note: 1. See Senegal Cartes 7 et 8.

2. First assumption is mean density of 10 p/Km^2.

3. Second assumption is that one half of possible new land is reserved for forest, grazing and future use; the remaining half is settled at 10 p/Km^2.

TABLEAU 6

SENEGAL: SEARCH FOR NEW LANDS

ZONE C: 600-800 mm P.90

			Total Arrondissement			Possible New Lands				
						Assumption #1		Assumption #2		
Region	Departement	Arrondissement	Km^2	Pop.	P/Km^2	Km^2	Pop.	Km^2	Km^2	Pop.
SINESALOUM	FOUNDIOUGNE	NIODIOR	948	11,595	12.2					
	KAFFRINE	KOUNGHEUL	4,262	32,810	7.7	2,622	52,430	1,311	1,311	26,220
	KAFFRINE	MALEME HODDAR	4,935	46,365	9.4	2,617	52,335	1,309	1,309	26,170
		Total				5,239	104,765	2,620	2,620	52,390
ORIENTAL	TAMBACOUNDA	KOUSSENAR AND								
	TAMBACOUNDA	KOUMPENTOUM	9,340	29,384	3.1	7,871	157,416	3,936	3,936	78,710
	TAMBACOUNDA	MAKA	2,513	18,094	7.2	1,608	32,166	804	804	16,080
	TAMBACOUNDA	MISSIRA	8,475	17,299	2.0					
	TAMBACOUNDA	MISSIRA excl. PARK	4,238	17,299	4.1	3,373	67,461	1,687	1,687	33,730
		Total				12,852	257,043	6,427	6,427	128,520
ORIENTAL	BAKEL	BALA	8,882	12,229	1.4	8,271	165,420	4,136	4,136	82,710
	BAKEL	GOUDIRY	8,054	13,922	1.7	7,358	147,160	3,679	3,679	73,580
	BAKEL	SANSANDE	4,099	5,688	1.4	3,815	76,300	1,908	1,908	38,150
		Total				19,444	388,880	9,723	9,723	194,440
		ZONE TOTAL (excl. Niodor)				37,535	750,688	18,770	18,770	375,350

Note: 1. See Senegal Cartes 9 et 10.

2. First assumption is mean density of 20 p/Km^2.

3. Second assumption is that one half of possible new land is reserved for forest, grazing and future use; the remaining half is settled at 20 p/Km^2.

TABLEAU 7

SENEGAL: SEARCH FOR NEW LANDS
ZONE D: OVER 800 mm P.90

			Total Arrondissement			Possible New Lands				
						Assumption #1		Assumption #2		
Region	Departement	Arrondissement	Km^2	Pop.	P/Km^2	Km^2	Pop.	Km^2	Km^2	Pop.
CASAMANCE	BIGNONA	DIOULOULOU	1,883	22,741	12.1	746	14,920	373	373	7,460
	KOLDA	DABO	2,434	30,778	12.6	895	17,900	448	448	8,950
		MEDINA-YOROFOULA	4,687	20,706	4.4	3,652	73,040	1,826	1,826	36,520
		Total				4,547	90,940	2,274	2,274	45,470
	SEDHIOU	BOUKILING	2,830	27,797	9.8	1,440	28,800	720	720	14,400
		DJINDE	2,047	25,435	12.4	775	15,500	388	388	7,750
		Total				2,215	44,300	1,108	1,108	22,150
	VELINGARA	BOCONTO	2,836	16,804	5.9					
		BOCONTO excl. PARK	2,269	16,804	7.4	1,429	28,580	715	715	14,290
ORIENTAL	KEDOUGOU	BANDAFASSI	5,750	10,604	1.8					
		BANDAFASSI excl. PARK	2,875	10,604	3.7	2,345	46,900	1,173	1,173	23,450
		FONGOLIMBI	2,126	10,029	4.7	1,625	32,500	813	813	16,250
		SALEMATA	1,970	7,542	3.8	1,593	31,860	797	797	15,930
		SARAYA	7,050	12,273	1.7	6,436	128,720	3,218	3,218	64,360
		Total				11,999	239,980	6,000	6,000	119,990
		ZONE TOTAL				20,936	418,720	10,468	10,468	209,360

Note: 1. See Senegal Cartes 11 et 12.

2. First assumption is mean density of 20 p/Km^2.

3. Second assumption is that one half of possible new land is reserved for forest, grazing and future use; the remaining half is settled at 20 p/Km^2.

3. Observations

3.1 The rainfall gradient of Senegal runs from north to south. There is a mean rainfall of 400 mm in the north of the country increasing to a mean of 1,500 mm in the south; see Map 1. In contrast, however, the population gradient stretches from west to east with high population densities on the west diminishing rapidly towards the east. This also is evident in Map 1.

Taking rainfall probability into account, one may observe in Table 1 and Map 2 that 89 percent of the surface area of Senegal receives more than 350 mm of rain with a probability of 90 percent (P. 90). This area covers 17.5 million hectares. There are 7.7 million hectares in climatic Zone D'B, 4.3 million hectares in climatic Zone C, and 5.5 million hectares in climatic Zone D (see Table 1 and Map 2).

It can be seen in Map 3 that there are very high population densities in western Senegal, from the coast stretching inland for a distance of 100-150 kilometers, with densities exceeding 50 h/km2. Beyond 200 kilometers from the coast, however, the mean population density falls very sharply to less than 5 h/km2. This eastward gradient of population density is found in each of the four climatic zones of Senegal; modified only by a linear band of higher population density along the banks of the Senegal River in the northeast.

The boundaries of each arrondissement in relation to the boundaries of the climatic zones of Senegal are indicated in Map 4. The map also shows average population density per arrondissement. One may observe densities of 72.0 h/km2 in the arrondissement of Lambay, 69.2 in Bambey, and 72.2 in Niakhor. These are in climatic Zone D'B; but, in the eastern ranges of the same climatic zone, one finds densities of 2.8 in Ourossogui, and 1.7 h/km2 in Barkedji. In climatic Zone C there is, for example, a high density of 41.9 h/km2 in Wack-N'Gouna, in the west, and a low density of 1.4 in Bala in the east. Climatic Zone D similarly shows a range from 45.5 h/km2 in the Diattacounda, in the west, to 1.7 in Saraya in the east.

3.2 A matrix indicating the amount of land in each climatic zone arranged by population density is given in Table 2. It should be noted that the surface areas are calculated by whole arrondissements, to facilitate identification of boundaries. Thus there is no exact correspondence with the areas represented in Table 1; and, furthermore, lands with a population density in excess of 15 h/km2 are excluded from the table.

Other things being equal, new lands will be found where there is highest level of rainfall coinciding with the lowest population density. This conjunction is evident in Table 2 where one can see that there is 705,000 hectares in climatic Zone D with more than 800 mm of rainfall (P. 90) at a population density lower than 2 h/km2. Similarly, below the same density threshold of 2 h/km2, there is over 2 million hectares in climatic Zone C receiving 600-800 mm of rainfall (P. 90). In Zone D'B receiving 350-600 mm of rainfall (P. 90), there is 1.2 million hectares with a population density of less than 2 h/km2.

Generally speaking the carrying capacity of agricultural land increases with higher levels of rainfall and better reliability of rainfall; therefore, it may be more worthwhile to focus on Zones C and D in searching for new lands. These two zones cover 7.7 million hectares, of which 5.3 million hectares are occupied at densities below 5 h/km2 (Table 2). Even the areas with a higher population density, in these two zones, (2.4 million hectares) may contain new lands.

3.3 The boundaries of the arrondissement of climatic Zone C'A are indicated in Map 5 together with average population densities. Surface areas in hectares are given in Table 4. It will be seen that there are approximately 23,000 km2 in this area which receives less than 350 mm of rain (P. 90). Population density ranges from 4.5 h/km2 Thille-Boubacar to 13.5 in Thilogne.

As is evident in Map 6 there are good potentialities for agriculture and pastoralism in this zone. There is Class III grazing land and Class 3 average agricultural land, as well as extensive occurrences of first-class irrigable land. Given the low rainfall of the area, it is appropriate to consider potentialities for irrigation and for livestock raising, rather than for dry land agriculture.

3.4 In climatic Zone D'B with 350-600 mm of rainfall (P. 90), there are four arrondissements of very low population density. These cover a total area of 4 million hectares (see Map 7).

The potentialities of these areas for agriculture and pastoralism are indicated in Map 8. In Dahra there is Class 3, average agricultural land and Class III grazing land. In Barkedji there is Class 4, poor agricultural land in the east, but in the west there is Class 3, average agricultural land, and

Class III grazing land. In the southwest of this arrondissement there is an occurrence of first-class irrigable land. In Ourossogui and Kanel, there are very extensive occurrences of poor Class 5 agricultural land, and Class IV grazing land. Only in the northeast of these two arrondissements does one find Class 3, average agricultural land, together with riverine deposits of first class irrigable land.

The areas of these agricultural zones in hectares may be estimated by a comparison of Map 8 and Table 5.

3.5 If one hypothesizes that the identified arrondissements of this climatic Zone D'B have a mean carrying capacity of ten person per km2 then a comparison with existing population densities reveals a possible extent of new lands amounting to 2.9 million hectares. (See Table 5). Using the same hypothesis this would indicate a possible population of 289,000 new settlers (Table 5).

One may argue that the hypothesized average population density of 10 h/km2 is too great considering the variation in land quality with extensive outcrops of Class 4 and Class 5 land. Therefore, one may propose a second hypothesis whereby one-half of the possible new land is set aside for purposes of forestry, for grazing, and for use in the future, and that the remaining half of the new land is settled at an average population density of 10 h/km2. This is Assumption 2 in Table 5. It can be seen in the table that an area of 1.4 million hectares would be settled potentially by an estimated 145,000 new settlers. These calcultations under both assumptions are, of course, purely speculative and would need to be verified by ground truthing as indicated in the recommendations to follow.

3.6 The low population density (<15 h/km2) arrondissements of climatic Zone C with 600-800 mm of rainfall (P. 90) are given in Map 9. These areas cover 4.7 million hectares and range in population density from 12.2 h/km2 in Niodior, in the west, to 1.4 in Sansande in the east. Map 10 indicates the agricultural potential of this area excluding Niodior and the Parc Nationale. In Maleme Hodar there is Class 3, average agricultural land in the north and poorer quality Class 4 land in the south. In Koungheul there is Class 3, average land in the north and Class 2 superior land in the south, in a complex that includes Class 5 land; and these two areas are separated by a middle belt of Class 4, poor agricultural land. In the south of Koumpentoum there is some Class 2, superior land mixed with Class 5, very poor quality land. In the north there is Class III grazing land. The arrondissements of Maka and Missira

contain complexes of Class 2, superior agricultural land, Class 3, average land and Class 5, very poor land. Generally speaking, Bala and Goudiry contain superior Class 2 lands and average quality Class 3 agricultural land together with some occurrences of Class 5 land. In Sansande and extending northwestwards into Goudiry there is a complex of Class 5 land including some first class irrigable land.

In Table 6 some estimates are made as to the possible extent of new lands and the possible carrying capacity of those new lands. If one hypothesizes that this area with 600-800 mm of rainfall (P. 90) has a mean carrying capacity of 20 h/km2, then a comparison with existing population densities, which are much lower than this, would suggest that there are some 3.8 million hectares potentially available for resettlement. These would support some 750,000 new settlers.

If, however, one assumes that the carrying capacity of 20 h/km2 is unrealistic, and if one sets aside one-half of the possible new lands for the purposes of forestry, for grazing activities, and for use in the future then, as indicated in Table 6, there would be about 1.9 million hectares of new land available for agriculture and this land would support a population of 375,000 new settlers. These figures are, of course, purely speculative and would be subject to verification as indicated in the recommendations to follow.

3.7 In climatic Zone D with more than 800 mm of rainfall (P. 90) there are ten arrondissements of low population density ranging from 12 h/km2 in the west to 1.7 in the east. (See Map 11). These cover a total area of about 3 million hectares, excluding the Parc Nationale. There is average Class 3 agricultural land in the arrondissements of Diouloulou, Boukiling, Djinde, and Dabo. Medina-Yorofoula, however, contains only poor Class 4 land; as does Boconto. Salemata contains Class 1, irrigable land, Bandafassi has some Class 2, superior land; and Saraya some Class 3, average land. There are, however, extensive outcrops of Class 5 virtually unfarmable land in these areas of the southeast. Generally speaking from Boconto westwards there is Class 3, average agricultural land whereas to the east there are extensive occurrences of Class 5, very poor land.

In Table 7, the first working assumption that these areas could sustain an average population density of 20 h/km2 is probably not agriculturally sound; although clearly much intensification of agriculture, including the development of semi-permanent tree crops on Class 4 and Class 5 land is possible.

Given the second assumption, that one-half of the possible new lands is set aside for purposes of forestry, and future use, then one can estimate that about one million hectares of new land could be settled by about 200,000 new settlers (see Table 7).

If one accepts as a working hypothesis, the second assumption for Zones D'B, C, and D (excluding Zone C'A) then one can estimate that there are about 8.7 million hectares of potential new land in Senegal, of which 4.4 million hectares may be settled by a total of about 730,000 new settlers. These calculations are derived from Tables 5, 6, and 7 and are summarized in Table 3. Again it should be emphasized that these figures and assumptions are entirely speculative and would depend upon adequate verification by ground-truthing as indicated in the recommendations to follow.

4. Discussion

Both Tchad and Mali have very extensive new lands but probably no areas of great population pressure that would create a strong planning impetus in favor of resettlement schemes. In contrast, however, both Upper Volta and Senegal have areas of high population pressure, and also available new lands, so that in these two countries both the need and the opportunity for resettlement programs exist. Indeed, progress is already being made in resettlement in these two countries in the activities of the Volta Valley Authority (AVV) and the Society des Terres Neuves (STN).

If one compares rainfall probability with population density for Senegal in Map 3, it is apparent that there ought to be widespread opportunities for resettlement activities in the eastern part of each climatic zone. This statement is based upon the assumption that each zone has a population absorption capability in the east where, at present, densities are less than 5 h/km2.

5. Recommendations

Four major recommendations are proposed here:

Recommendation 1. Ground Surveying. It is recommended that rapid reconnaissance surveys be made within each climatic in order to verify the distribution of population, to identify search areas for new lands and, by sample survey, to verify the agricultural potential zones. These surveys would include the use of air photography, and the identification of natural vegetation cover as an index of soil fertility and as a measure of intensification

of land use and of occupancy.

Recommendation 2. Health Risk Profiles. It is recommended that for each climatic zone a sample survey be made to identify the major infectious and parasitic diseases and also to identify major nutritional problems. In particular an assessment will be made of the health risks to potential new lands settlers. It is recognized particularly in the eastern part of Zone D that onchocerciasis is a major problem, and appropriate recommendations would have to be made in this regard. Animal diseases including bovine trypanosomiasis should be considered.

Recommendation 3. Recruiting Zones. It is recommended that a study be made that will identify geographically the pockets of population pressure. These will be the areas of greatest land hunger with the most unfavorable man land ratios, the areas where there is the least per capita cultivable land available. Such areas are identified in a preliminary way on Map 4 as the arrondissements with the highest rural population densities. All other things being equal one would expect these areas to have the largest supply of settlers looking for opportunities to migrate to the new lands. In this way geographical target areas for the recruiting of settlers can be identified and this will facilitate program efficiency in recruiting. In addition, recruiting by target areas will also favor social coherence in the resettled zones because of social homogenity reflecting identity with the same homelands.

Recommendation 4. Integrated Regional Development Planning. It is recommended when the rapid reconnaissance ground truthing survey is completed and when the health profiles are available, as well as the report on recruiting zones, that all the information be synthesized within a framework of planning for regionally integrated development. In this way, new lands policies, when they are formulated by the Government, will be functionally integrated with the economic development plans for the major regions of the country. The dangers of implementing new land settlement separately, without coordination in the regional and national economy, should be avoided. Effectively this means integrating the findings and recommendations of all C.I.L.S.S. sectoral and production groups with the emerging regional plans of the Government.