Crop Production System Zones of the IGADD Sub-Region

IGADD Early Warning and Food Information System for Food Security
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Crop Production System Zones

of the IGADD Sub-Region

Harry van Velthuizen and Luc Verelst

in collaboration with

Paolo Santacroce
Chief Technical Adviser

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The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of IGADD, FAO or the Italian Government concerning the legal or constitutional status of any land or sea area or concerning the delineation of frontiers.

Any part of this Crop Production Systems Zones database may be updated and modified in the light of additional data or new knowledge. This database is developed to enhance crop monitoring and forecasting procedures of regional and national early warning units. Procedures employed in the compilation and customization of the database are expected to be refined with use.

FOREWORD

Drought and Development are the core of the preoccupations which led to the establishment of the Inter-Governmental Authority on Drought and Development (IGADD), where more than any other semi-arid area of the world, weather vagaries constitute a real constraint on a sustainable agricultural development of the sub-region.

Agricultural impact assessments require a good knowledge of both the agricultural system being affected and the negative environmental factors, of which drought, flood, and pest infestation are among the most common in the sub-region.

After the IGADD/FAO Early Warning Food Information System for Food Security (EWFIS) was established in 1989, it soon became obvious that insufficient information was available on crop and livestock production systems to properly analyze some of the advance indicators provided by environmental satellites or by agrometeorological analyses. This led to a multi-annual effort the results of which I am most pleased to present herein to the users.

This publication on IGADD Crop Production System Zones is a comprehensive compilation of detailed agricultural and environmental information on all the IGADD Member States, and I am confident it will become a most valuable reference in this field.

This has been achieved through the dedicated collaboration between IGADD, FAO, and National Experts under the EWFIS project. The financial assistance of the Government of Italy to implement this project is gratefully acknowledged.

Djibouti, November 1994

Dr. David Muduuli
IGADD Executive Secretary

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CHAPTER 1 INTRODUCTION

1.1 Presentation

The study here presented was undertaken in the IGADD Early Warning and Food Information System (project GCPS/RAF/256/ITA) after it was realized that insufficient background information was available to assess crop condition and food production prospects. In particular, satellite-based Normalized Difference Vegetation Indices could not be interpreted properly due to insufficient knowledge about actual farming practices in the region. Also agrometeorological monitoring in the region suffered from lack of appropriate agronomic data for basic crop monitoring activities.

A database and a map of IGADD Crop Production System Zones, with a detailed description of the IGADD physical and biological environment constitute the core of this publication. The volume itself serves merely the purpose of presenting methodological aspects and other detail of codes, definitions, etc.

It was considered that for planning purposes, and to ensure the compatibility with other background data (such as demography and agricultural statistics), the information had to be presented according to geographic units largely following administrative boundaries. The region was therefore subdivided into 1220 homogeneous map units which correspond to administrative units, or subdivisions thereof whenever steep ecological gradients occur. These map units constitute the basic elements shown in the maps and the database alike.

For each of the map units, up to 502 variables describing the physical and biological environment, as well as the prevailing agricultural practices (including livestock) have been assembled. Based on the above mentioned variables, 44 relatively homogeneous Crop Production System Zones (CPSZ) were defined using mainly statistical clustering techniques.

It is essential to observe that the Crop Production System Zones describe actual farming in the region, not potential crop zones. The main subdivisions, as described in chapter 5 and shown on the enclosed map, are (i) arid and hyper-arid areas, (ii) marginally productive lowland, (iii) productive lowland, (iv) marginally productive highland, (v) productive highland and (vi) irrigated areas.

Class (i) covers mainly desert and pastures. Additional subdivisions of classes (ii) to (v) are according to the main crops grown, the number of growing periods and other environmental characteristics.

The CPSZ Database Viewer software gives the user a more direct access to the actual data. In addition to displaying the mapped data on the screen, it also permits to extract data for further processing.

A set of companion volumes to this publication is also available from IGADD, by countries. The CPSZ Summary Sheets list the most significant information by map unit. The variables covered include general geographic information, phenology of the main crops, climatic hazards, etc. Only a limited number of Summary Sheets was printed as the information is also accessible using the CPSZ database viewer.

1.2 Structure of the report

Chapter 2 broadly covers methodological aspects; it lists the variables which were used and the steps which led to the outputs presented in chapter 5.

Chapter 3 provides more information on the agroclimatic inventory which was carried out, together with some conventions and definitions adopted in the definition of the Crop Production System Zones. The end of the chapter lists the codes used to characterize the agroclimatic conditions prevailing in the Crop Production System Zones in terms of temperature conditions, moisture availability and number of growing periods.

Chapter 4 gives additional detail on the structure of the IGADD Crop Production System Zones database, including the coding of some of the variables and an assessment of their quality. The chapter also indicates which techniques were applied to convert the variables to fit the map units and, where applicable, the procedures followed to derive them from the raw input data.

As indicated above, the main outputs of the present study are given in chapter 5 and in the enclosed maps and software: the chapter provides the full definition of Crop Production System Zones, an overview of the CPSZ Database Viewer and a description of the Summary Sheets by map unit.

Additional information is provided by a short glossary and 4 appendices, which are mainly meant for a more advanced use of the database.

Appendix 1 supplements the IGADD Crop Production System Zones Map by providing, for each map unit, its name, agroclimatic code and CPSZ identifier, while appendix 2 lists in detail the contents of the CPSZ database according to categories, i.e. General Data, Crop Information, Physical Data, Agronomic Data, Livestock Data, Environmental Hazards and Pest and Disease Hazards. Appendix 3 summarizes the codes and classifications used in the database.

Appendix 4 is the user's manual for the CPSZ Database Viewer. It provides full detail about installation and operation of the software, as well as the file information which may be required by the more advanced users.

1.3 Acknowledgements

A considerable amount of work was invested in the present publication and database. In addition to the authors (Harry van Velthuizen, Luc Verelst and Paolo Santacroce), all IGADD and FAO staff of the IGADD Early Warning and Food Information System for Food Security contributed directly with data collection and preparation, screening, checking, and with the material arrangements which had to be made.
They deserve to be mentioned here by name : Ahmed Habbane and Ali Saleem of IGADD management staff; Samuel Zziwa, Estifanos Tekle, John Mwikya, Alain Castermans, Abdel Zahran of the IGADD and FAO technical staff; Ms Anne Maria Comin for the administrative support, and Aisha, the Project Secretary.

Significant inputs, as well as verification of national data sets were provided by the national consultants recruited by the Project to ensure the accuracy of country data, in particular Adipala Ekwamu (Uganda), Fitsum Ghebreyohannes (Eritrea), Mohammed Osman Hussein (Sudan), Mohammed Ibrahim (Ethiopia) and Benson Mochoge (Kenya). Mr Khalifa assisted the authors with Somalia which unfortunately could not be covered at the same level of detail as the other countries.

Specialized technical inputs were provided by Peter Hoefsloot (then at the SADC Regional Remote Sensing project in Harare) with the spatial interpolating of rain, potential evapotranspiration and crop yield, as well as Prof. Silvio Griguolo (University of Venice) who developed the IGADD version of ADDAPIX, a multivariate statistical analysis software which was used extensively throughout this study. Elena Zotskyna assisted with data entry and digitising work.

The assistance of the heads of the national Early Warning Units in the IGADD member states is also acknowledged: Tedlah Desta (Ethiopia), Wahab Ahmed (Sudan), Desire Lubega (Uganda) and Anthony Mungai (Kenya).

Freddy Nachtergaele, of the FAO Soil Resources Management and Conservation Service (AGLS) provided valuable help with soil data, and Ms Marina Zanetti (FAO Geographic Information System) dedicated a fair amount of her time to the preparation of the cartographic material.

Nico Van Leeuwen, Senior Country Project officer, kept reminding those involved about budget and other constraints, thereby ensuring the timely completion of the present Document.

The interest of Dr. D. Muduuli, IGADD Executive Secretary was a permanent, and sometimes needed encouragement.

Finally, the work could not have been carried out without the financial assistance provided by the Government of Italy under project GCPS/RAF/256/ITA (jointly formulated by the Government of Italy, IGADD and FAO) and the Government of Belgium for financing two Associate Professional Officer posts.

(R.G., Nov. 1994)

CHAPTER 2 OVERALL METHODOLOGY

2.1 Introduction

The Crop Production System Zones (CPSZ) inventory, integrated with detailed infrastructure data, was designed to bring together information on physical environment, agronomy, livestock and occurrence of biotic and abiotic hazards to agricultural production. One of the main purposes for the compilation of the CPSZ database was to enable interfacing statistical data by administrative units with geo-referenced physical, agronomic and livestock data.

2.2 Input data

The CPSZs represent homogeneous zones in terms of agro-ecological conditions and current distribution of agricultural land use. The definition of CPSZs is based on crop climatic adaptability characteristics and current occurrence of crops. Basic elements for the definition of CPSZ are:

- dominant crops including information on cropping pattern, crop management calendar and frequency of occurrence and severity of invasion/infestation of major pests and diseases;

- cropping density (cultivation intensity);

- agroclimatic conditions including thermal regime and frequency of occurrence and severity of climatic hazards, and

- soil and terrain conditions including soil fertility, readily available soil moisture and terrain slope characteristics.

Further, the CPSZs are made up of combinations of the lowest administrative subdivisions (or parts of these) for which agricultural, socioeconomic and demographic statistics are available.

In summary, the combination of the CPSZ database, the District Profile database (see box below) and Infrastructure data provides:

~ Information on Crops

- current distribution of crops
- agricultural systems under which crops are grown
- crop management calendars
- crop phenology
- average crop performance in terms of achieved yields
- ecological conditions under which the crops are grown
- frequency of occurrence and severity of environmental hazards
- frequency of occurrence and severity of invasion/infestation by pests and diseases

~ Information on Livestock and Pasture

- current livestock systems
- pasture availability for livestock
- dependence on livestock for food security
- importance of livestock versus crop production

~ Information on Agricultural, Socio-economic and Demographic Statistics

- area, yield and production of crops
- agricultural inputs
- livestock production
- income, health etc.
- rural and urban population distribution
- fertility and mortality

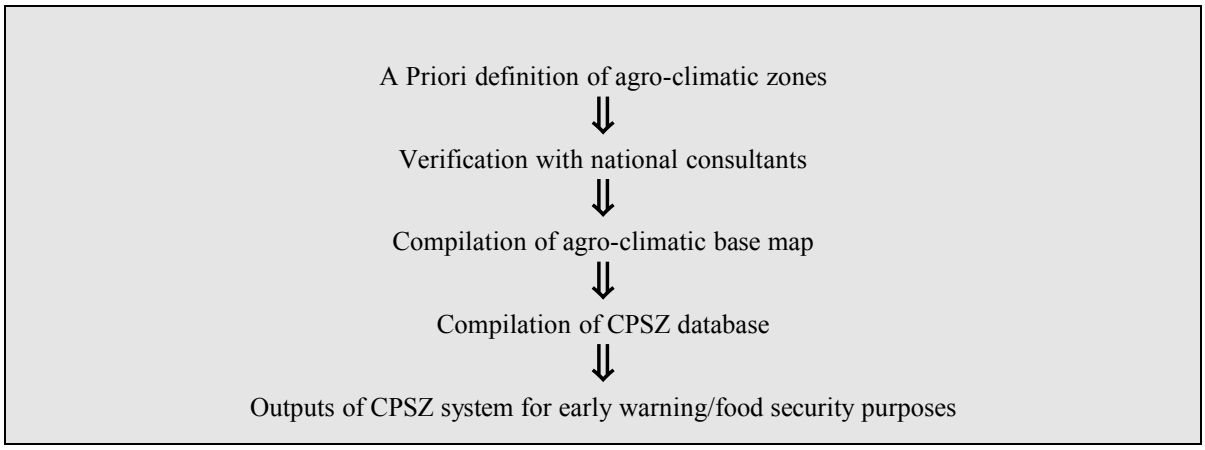
~ Information on Infrastructure

- road and railway network, and rivers
- population centra

2.3 Procedures

The overall methodology followed for the definition and compilation of the CPSZ inventory and database comprised the following activities (Figure 1):

Figure 1 **Schematic representation of methodology**



A priori definition of agroclimatic zones

(i) formulation of the definition of agroclimatic zones;

(ii) compilation of administrative units map to be used as basis for agroclimatic zone inventory;

(iii) collation of the available administrative unit profiles (District Profiles);

(iv) formulation of classifications for thermal and moisture regimes that reflect the distribution of crops and pasture and compilation of thermal zones and moisture zones inventories on the basis of the administrative unit base map (from ii);

(v) compilation of agroclimatic regions inventory and identification of provisional agroclimatic map units;

(vi) establishment of a provisional agroclimatic map unit database (from iii and v);

Verification and cross-verification with national consultants

(vii) verification of provisional agroclimatic map units (iv) by national consultants through adjustment of the provisional delineation of agroclimatic map units vis-a-vis provisional CPSZ database (vi) and current agricultural land use;

Compilation of CPSZ database

(viii) collection, calculation and verification of physical parameters by agroclimatic map unit including:

- interpolation of average monthly rainfall and potential evapotranspiration meteorological station data (Hoefsloot, 1994);

- derivation of growing period parameters such as start, end and length and number of growing periods from climate data, NDVI data and reported crop calendar data where available;

- GIS overlay of the agroclimatic inventory and FAO/Unesco Soil Map of the World (FAO, 1990) and extraction and classification of agroclimatic map units in terms of inherent soil fertility, readily available soil moisture, terrain slope characteristics;

(ix) collection, verification and classification of data on agronomic, environmental hazards, pest and diseases hazards and livestock for each CPSZ map unit (by national consultants).

(x) compilation of CPSZ database made up of the following data matrices (from viii and ix)

- general data
- crop and pasture occurrence data
- physical environmental data
- agronomic data
- livestock data
- environmental hazards data
- pest and disease hazards data

(xi) integration of infrastructure data in CPSZ database i.e. roads (three levels), towns, villages, railways and main rivers;

Outputs

(xii) development of IGADD CPSZ database viewer (i.e. CPSZ database VIEWER software package for interactive mapping and tabulation of individual parameters of the seven CPSZ data matrices and infrastructure data).

(xiii) compilation and publication of IGADD CPSZ inventory Sheet at 1:5 million scale including inset maps of cropping density, livestock/crops ratio, soil fertility and potential moisture storage capacity, number of growing periods, start of main growing period and growing period days;

(xiv) compilation and publication of CPSZ Summary Sheet Country Annexes for Eritrea, Ethiopia, Kenya, Sudan and Uganda which highlight the major parameters from the data matrices by CPSZ map units, and

(xv) compilation and publication of graphical representations of moisture balance by each CPSZ map unit.

IGADD District Profile Database

Since the inception of the IGADD Early Warning project, one of its priorities has been the regular collection and collation of agronomic and socio-economic information by administrative unit. This includes data on calendars, production, area planted and yield for the main crops, as well as more general information concerning socio-economic and demographic characteristics at the smallest administrative level available.

Data is organized in three categories: demographic, socio-economic and agronomic data and is stored in Lotus worksheets.

The purpose of the collation of "District Profiles" was to assist the regional and the national early warning units in their monitoring activities and in particular:

- to improve the interpretation of remote sensing and meteorological assessment through agronomic and phenological background information;
- to provide basic information on the food security demand side.

The data were continuously updated and distributed on floppy disk under the title: "District Profiles Files", (IGADD, 1993) distributed by IGADD Secretariat or by FAO on behalf of IGADD Secretariat.

CHAPTER 3 AGROCLIMATIC INVENTORY

3.1 Agroclimatic Regions

According to the a priori definition, CPSZs are primarily based on prevailing agroclimatic conditions. This is because, at macro level, the agroclimatic conditions are the major physical factors that govern distribution of crops. Above all, climatic data are readily available, geographically well distributed and are easy to classify and interpolate.

Therefore, agroclimatic conditions have been classified first and in order to maintain the link to statistical information, the classifications have subsequently been applied to administrative units. Many administrative units are characterized by substantial internal gradients of agroclimatic conditions. In the cases where the internal variation exceeded preset thresholds (class limits of agroclimatic conditions), the administrative units were subdivided.

The administrative units are discussed in section 3.2. Details of thermal regime and moisture regime analysis, classifications and inventories are dealt with in section 3.3 and 3.4 respectively.

3.2 Administrative Units

For the sake of compatibility, the CPSZ inventory follows the same level of administrative units as the District Profile Database. The level of units used in the individual countries are the following:

Country	Administrative units	Numbers
Djibouti	Districts	5
Eritrea	Woredas	40
Ethiopia	Awrajas	309
Kenya	Districts	41
Somalia	Degmadas	74
Sudan	Area councils	85
Uganda	Counties	143

3.3 Thermal Regime

The differences in temperature requirements of crops or groups of crops are related to their thermal adaptability characteristics; e.g. response of photosynthesis to temperature and specific phenological temperature requirements (FAO 1977, 1978). Table 1 presents the thermal zone classes which were selected.

For the compilation of a mapped inventory of thermal zones according to the above classification, relationships between altitude[1] and mean annual temperatures were established and are presented in Table 2.

The altitude inventory was converted to a rasterized inventory of annual mean temperatures, using the above relationships. In IGADD countries however, crops are in the great majority of cases grown under rainfed conditions which requires an inventory of temperature regime during the rainy season (growing period). Investigation of possible relationships between annual mean temperatures and mean temperatures during the growing period revealed that the differences between these temperatures were generally very small (less than ~1C) in all seven countries of IGADD. Therefore, the inventory of mean annual temperatures was used as a proxy for the inventory of temperatures during the growing period.

[1] Altitude inventory is derived from interpolation of contour lines, and from available 5-minute altitude grid.

On the basis of this temperature inventory, each administrative unit was characterized according to temperatures i.e. average mean, highest mean and lowest mean and the geographical standard deviation.

Table 1 Thermal zone classes

Tmean (annual)	Description	Typical Crops
> 25° C	Warm	Cotton, Bulrush Millet, Groundnut, Sesame
20-25° C	Moderately warm	Maize, Sorghum, Cassava, Sweet Potato, Banana
15-20° C	Moderately cool	Maize, Bean, Teff, Enset
10-15° C	Cool	Barley, Wheat, Lentil
< 10° C	Cool/Cold	Pasture

Table 2 Relationships between altitude and mean annual temperature

Country	Relationship
Ethiopia/Eritrea/Djibouti	T_{mean} (°C) = 30.42 - 0.0059 * Altitude (m)
Kenya	T_{mean} (°C) = 30.48 - 0.0069 * Altitude (m)
Somalia	T_{mean} (°C) = 29.93 - 0.0064 * Altitude (m)
Sudan	T_{mean} (°C) = 30.61 - 0.0065 * Altitude (m)
Uganda	T_{mean} (°C) = 30.89 - 0.0074 * Altitude (m)

According to the prevailing temperatures, administrative units were assigned to the appropriate thermal zone class or, where an administrative unit covers more than one class, it was subdivided accordingly. Map 1 presents the inventory of thermal zones.

3.4 Moisture Regime

Differences between crops in terms of moisture requirements are related to differences in length of growth cycle and various degrees of susceptibility to moisture stress (FAO, 1978). Accordingly the moisture regime was characterized in terms of the period(s) during the year, when sufficient moisture from rainfall is available for crop growth (length of growing period). The moisture regime was inventoried according to the parameters (a) length of growing period (LGP) and (b) occurrence of number of distinct growing periods per year (LGP pattern).

For the calculation of the LGP characteristics the following definition is used (FAO, 1978): the growing period is the period (in days) when precipitation exceeds half the potential evapotranspiration, plus a period required to evapotranspire excess precipitation stored in the soil profile, to a maximum of 100 mm. Both the LGP and LGP pattern were derived from meteorological station data and the values were subsequently interpolated allowing the delineation of LGP zones[2] and LGP pattern zones. For the delineation use has been made of topography, NDVI derived data and crop calendar information. Table 3 presents the LGP zones classification and Table 4 the LGP pattern zones classification.

Table 3 Length of growing periods

[2] For Kenya and Ethiopia LGPs were taken from existing inventories (FAO 1993; De Pauw 1988)

LGP (days)	Description moisture regime	Typical crops
0	Hyper-arid	no crops, no pasture
1-59	Arid	no crops, marginal pasture
~~60-119~~	~~Dry semi-arid~~	~~bulrush millet, sorghum, sesame~~
120-179	Moist semi-arid	maize, bean, groundnut, peas, barley, wheat, teff
180-169	Sub-humid	maize, cotton, sweet potato, finger millet
> 270	Humid	cassava, coffee, banana, enset, tea, sugarcane

Table 4 Number of growing periods

LGP pattern	Occurrence
No growing periods	Hyper-arid zones
One/two unreliable growing periods	Arid and dry semi-arid zones
~~One reliable growing period~~	~~Moist semi-arid, sub-humid and humid zones~~
Two reliable growing periods	Moist semi-arid, sub-humid and humid zones

According to the moisture regimes prevailing in administrative units or their subdivisions with different thermal regimes, the administrative units were assigned to length of the growing period zones and LGP pattern zones or were further subdivided according to the length of the growing period and LGP pattern (mono- or bi-modal rainfall distribution) zone classes. For the subdivision, use was made of NDVI gradient information. Map 2 presents the inventory of Number of growing periods end Map 3 the Length of (all) growing periods.

3.5 Agroclimatic Codes and Map units

The combination of the thermal zones and growing period zones from the agroclimatic regions inventory served as reference for the compilation of the CPSZ map unit inventory.

The agroclimatic regions were carefully verified with current crop distribution patterns in the individual countries. The project was assisted by national consultants with proven knowledge of the current distribution of crops in their respective countries. The verification resulted in various proposals by the consultants in terms of amendments and shifts of the agroclimatic region boundaries. After careful review of these proposed modifications with the consultants on the basis of climatic data, crop calendar data and NDVI information, the changes were effected and the agroclimatic zones consolidated.

Following the above verification of the agricultural relevance of the agroclimatic regions, the regional map was converted into the CPSZ base map containing 1220 CPSZ map units. Where relevant, the CPSZ units were additionally coded according to occurrence of irrigated areas. Based on the interpretation of NDVI data (see box below) a map overlay was prepared indicating major irrigation schemes.

The agroclimatic codes, related to agroclimatic conditions, are made up of:

- *first position*: Thermal zone class
  1 = warm, 2 = moderately warm 3 = moderately cool, 4 = cool and

5 = cool/cold;

- *second position*: Growing period zone class
  0 = hyper-arid, 1 = arid, 2 = dry semi-arid, 3 = moist semi-arid,
  4 = sub-humid and 5 = humid;

- *third position*: Number of growing periods zone[3] class
  (U = one reliable growing period year, B = two reliable growing periods per year; or
  Irrigation (I = major part irrigated, i = minor part irrigated and r = irrigation along rivers only).

Example: 1.4B warm, sub-humid with two growing periods
1.0r warm, hyper-arid with some irrigation along rivers only.

Irrigated Areas

For the identification and mapping of irrigated areas, especially in arid and hyper-arid areas, use has been made of ADDAPIX, a recently developed software package (Griguolo, 1994). This package has been designed for clustering and displaying at pixel level a time series of single band images. A time series of dekadal low resolution NDVI images (1982-1990) was used to cluster pixels and map areas with relative long crop cycles in comparison with prevailing short growing period (e.g. sugarcane in arid zone) and 'off season cropping'. In this way 'probable irrigated areas' could be located and delineated. This method was used in three particular areas: the central part of Sudan, the Awash middle basin in Ethiopia and the Ouebe-Shebeli and Juba valleys in Somalia.

The location of the main irrigated areas in arid and hyper-arid parts of the IGADD region was incorporated in the 1:5 million scale "Crop Production System Zones" map by overprint: big blue dots identify long cycle crops related to high NDVI level, while smaller dots refer to short cycle crops.

Table 5 provides a listing of agroclimatic units by country. Appendix 1 provides the relationship between CPSZ map units, their administrative subdivisions, agroclimatic code and CPSZ number.

3 The number of growing periods is not indicated in (a) cool/cold humid areas for reasons that in some years one continuous growing period and in other years two separate growing periods may occur, (b) in dry semi-arid and arid areas where in some years two growing periods, some years one and some years no growing period may occur and (c) in hyper-arid and arid areas which have by definition no growing period.

Table 5 Extent (km^2) of agroclimatic regions by country

Code	Djibouti	Eritrea	Ethiopia	Kenya	Sudan	Somalia	Uganda
1.0	20218	29862	68045	29667	559412	298502	0
1.0.i	0	0	0	0	645	0	0
1.0.r	0	0	0	0	153733	0	0
1.1	1909	39132	262898	273127	420894	157126	0
1.1.I	0	0	0	0	8397	0	0
1.1.i	0	0	27211	0	52873	7759	0
1.1.r	0	0	0	0	64506	3449	0
1.2	0	9606	16725	61850	228775	74783	0
1.2.I	0	0	0	0	1849	2260	0
1.2.i	0	0	3005	0	119939	31430	0
1.2.r	0	0	0	0	47693	10065	0
1.3.U	0	0	27377	2678	375888	0	0
1.3.B	0	0	875	18287	0	0	0
1.4.U	0	0	26181	0	321982	0	7717
1.4.B	0	0	829	5726	0	0	0
2.0	0	0	0	950	0	24462	0
2.1	577	1100	14584	24803	28399	27518	0
2.2	0	25028	125694	35373	36281	7537	5236
2.2.i	0	0	724	0	0	0	0
2.3.U	0	0	40562	278	9771	0	5079
2.3.B	0	430	40483	19313	0	0	3071
2.4.U	0	0	50893	0	61933	0	58379
2.4.B	0	675	13773	12235	0	0	28117
2.5.U	0	0	35537	3066	0	0	28229
2.5.B	0	0	0	7178	0	0	57432
3.1	0	0	0	1441	0	8858	0
3.2	0	10756	35468	10767	0	0	0
3.2.i	0	0	1738	0	0	0	0
3.3	0	0	0	0	2513	0	0
3.3.i	0	0	0	0	0	0	0
3.3.U	0	0	90147	0	0	0	0
3.3.B	0	0	8259	17081	0	0	0
3.4.U	0	0	113907	4761	0	0	1290
3.4.B	0	0	49347	18905	0	0	0
3.4.i	0	0	447	0	0	0	0
3.5.U	0	0	36779	11489	471	0	878
3.5.B	0	0	3674	4336	0	0	9226
4.3.U	0	0	3247	1346	0	0	0
4.3.B	0	0	3390	0	0	0	0
4.4.U	0	0	3137	0	0	0	0
4.4.B	0	0	7558	0	0	0	0
4.5.U	0	0	4322	16141	0	0	1353
4.5.B	0	0	0	593	0	0	0
5.4.U	0	0	2636	0	0	0	0
5.5	0	0	4030	1616	0	0	563
Total	**22704**	**116589**	**1123482**	**583007**	**2495954**	**653749**	**206570**

CHAPTER 4 IGADD CPSZ DATABASE

4.1 Introduction

The activities related to the characterization of the CPSZ map units were shared between the project staff and the national consultants. The physical characteristics including remote sensing parameters were inventoried by the project staff with the assistance of the FAO Soil Resources, Management and Conservation Service for the soil and terrain aspects, and of the SADC sister project for spatial interpolation of climatic parameters.

In collaboration with the national consultants, detailed guidelines were formulated for the collection and verification of data related to crop and livestock production by established agroclimatic zone. The national consultants were entrusted with the collection of the data. For this purpose, extensive in-country field trips were made and various relevant institutions visited. The collected data were subsequently provided to the project in the form of detailed reports and data matrices by CPSZ map unit.

4.2 Make-Up of CPSZ Database

A schematic overview of the structure and contents of the CPSZ database is presented in Figure 2. Details on the contents of the data matrices are provided in Appendix 2, while codes and classifications are provided in Appendix 3. The complete CPSZ database including all seven matrices is contained on a diskette included in the backpocket.

Availability and quality of the data in the CPSZ database vary strongly between data matrices and countries (Table 6).

Table 6 Data availability and reliability

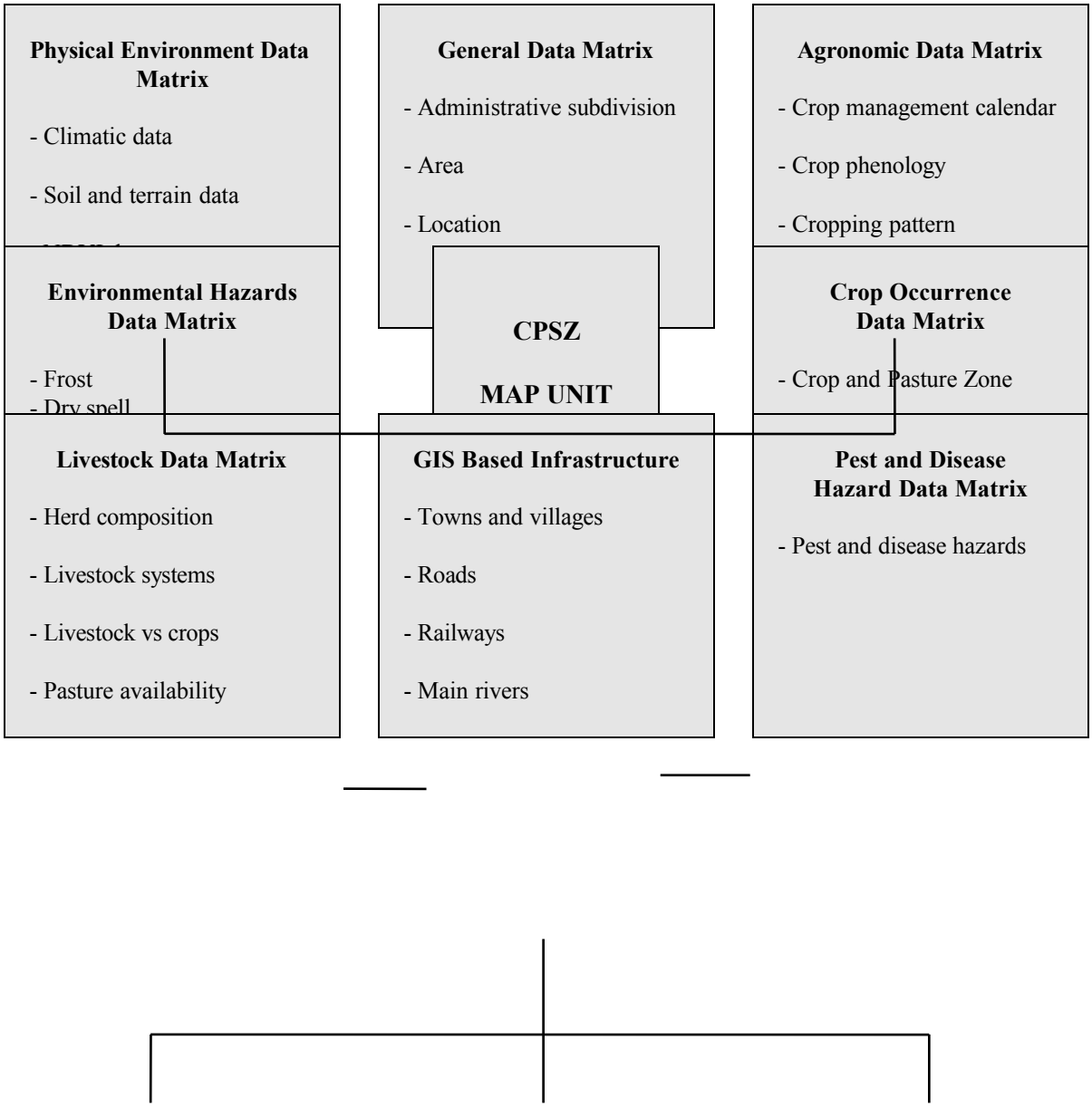
	Djibouti		Eritrea		Ethiopia		Kenya		Somalia		Sudan		Uganda	
	A	R	A	R	A	R	A	R	A	R	A	R	A	R
Crop occurrence data	-	g	+	m	++	g	+	m	-	p	+	m	+	m
Physical environment data	++	g	++	g	++	g	++	g	++	g	++	g	++	g
Agronomic data	-	p	+	m	++	g	+	m	-	p	+	m	+	m
Livestock	-	p	+	m	+	m	+	m	-	p	+	m	+	m
Environmental hazard data	--	n.a.	-	m	+	m	-	m	--	n.a.	+	m	+	m
Pest and disease hazard data	--	n.a.	-	m	+	m	+	m	--	n.a.	+	m	+	m

A = Data availability R = Data Reliability
++: complete - : incomplete g : good p : poor
+: almost complete --: no data m : moderate n.a. : not applicable

4.3 General Data Matrix

This data matrix includes for each CPSZ map unit the following information: agroclimatic code, administrative unit and regions to which the CPSZ map unit belongs; longitude and latitude of its geographical centre, and extent (km^2). The relation between CPSZ map units and administrative units is presented in Appendix 1.

Figure 2 Make-up of Crop Production System Zones Database



4.4 Crop Distribution Data Matrix

This data matrix has been extracted from the agronomic data to facilitate the instant display of specific crop and crop yield maps and crop and pasture zone maps by means of the CPSZ database viewer software (section 5.2). The matrix contains the following data:

- CPSZ map unit and agroclimatic code
- Crop Production System Zones
- Crop zones occurring in marginally productive lowland[4]
- Crop zones occurring in productive lowland
- Crop zones occurring in marginally productive highland
- Crop zones occurring in productive highland
- Crop occurrence classes
- Crop yields

The Crop Production system Zones refer to a generalized inventory for the whole IGADD region. To enable display of this inventory in the CPSZ database viewer software, the crop and pasture zones have been subdivided into five parts as indicated above. The crop occurrence class refers to the relative importance of crops in terms of area occupied and relevance for food security. Three classes of occurrence are distinguished: class 1 for the two main crops; class 2 for third, fourth and fifth crop, and class 3 for other crops. The top five crops are also referred as 'dominant crops'. Crop yields are provided for the dominant crops[5].

4.5 Physical Environment Data Matrix

The physical data matrix provides the environmental characteristics of the CPSZ map units. The matrix contains the following data sets:

- Climate
- Soil and terrain
- NDVI

4.5.1 Climate data

The climatic data set includes classified thermal and moisture regime data; altitude and temperature data; growing period data derived from (a) interpolated meteorological station data, (b) crop calendar data and (c) NDVI data. As mentioned above under 2.3 (viii), monthly rainfall and evapotranspiration data were derived through interpolation and were subsequently area-averaged. The data matrix contains the following climate data:

- Climate regime
- Altitude and temperature
- Start growing period (main/first season)
- End growing period (main/first season)
- Length of growing period (main/first season)
- Start growing period (second season)
- End growing period (second season)
- Length of growing period (second season)
- Area-averaged monthly rainfall and potential evapotranspiration

---

4 Crop zones are defined in Chapter 5.

5 The yields for cassava, sweet potato, white potato and banana refer to fresh weights, for sugarcane to sugar content and for all other crops to 'sun dried yield'.

Growing period data (derived from climate data), in particular start, end and length of the growing periods, were obtained through interpolation of average monthly rainfall and potential evapotranspiration data of meteorological stations.

Climate interpolation

The techniques provided by the IDA GIS TOOLS software by P. Hoefsloot (1994) were used for all climate interpolations. The software package performs spatial interpolation guided by background information which can be positive or negatively correlated with the parameter to be interpolated.

For rainfall, Cold Cloud Duration (CCD) and average NDVI background fields were used, assuming a positive relationship between rainfall and the remote sensing indicators. For potential evapotranspiration (PET), the available five minute altitude grid was used. In this case a negative correlation between altitude and PET was assumed.

From the obtained raster images, rainfall and PET area-averages for the CPSZ map units were computed using Image Display and Analysis (FAO, 1992) software.

The area averaged parameters were used for the calculation of growing period indicators for each CPSZ map unit.

Maps 4 and 5 present small scale rainfall maps for two-monthly periods, and potential evapotranspiration respectively. Map 6 presents an inventory of the start dates of the main growing periods. The maps are based on the interpolations described above.

A separate volume presenting graphical representations of average monthly rainfall, PET and 0.5 PET for each of the 1220 CPSZ map units have been compiled. The graphs are based on interpolations and area-averaged data. Figure 3 presents some samples of these graphs.

4.5.2 Soil and terrain data

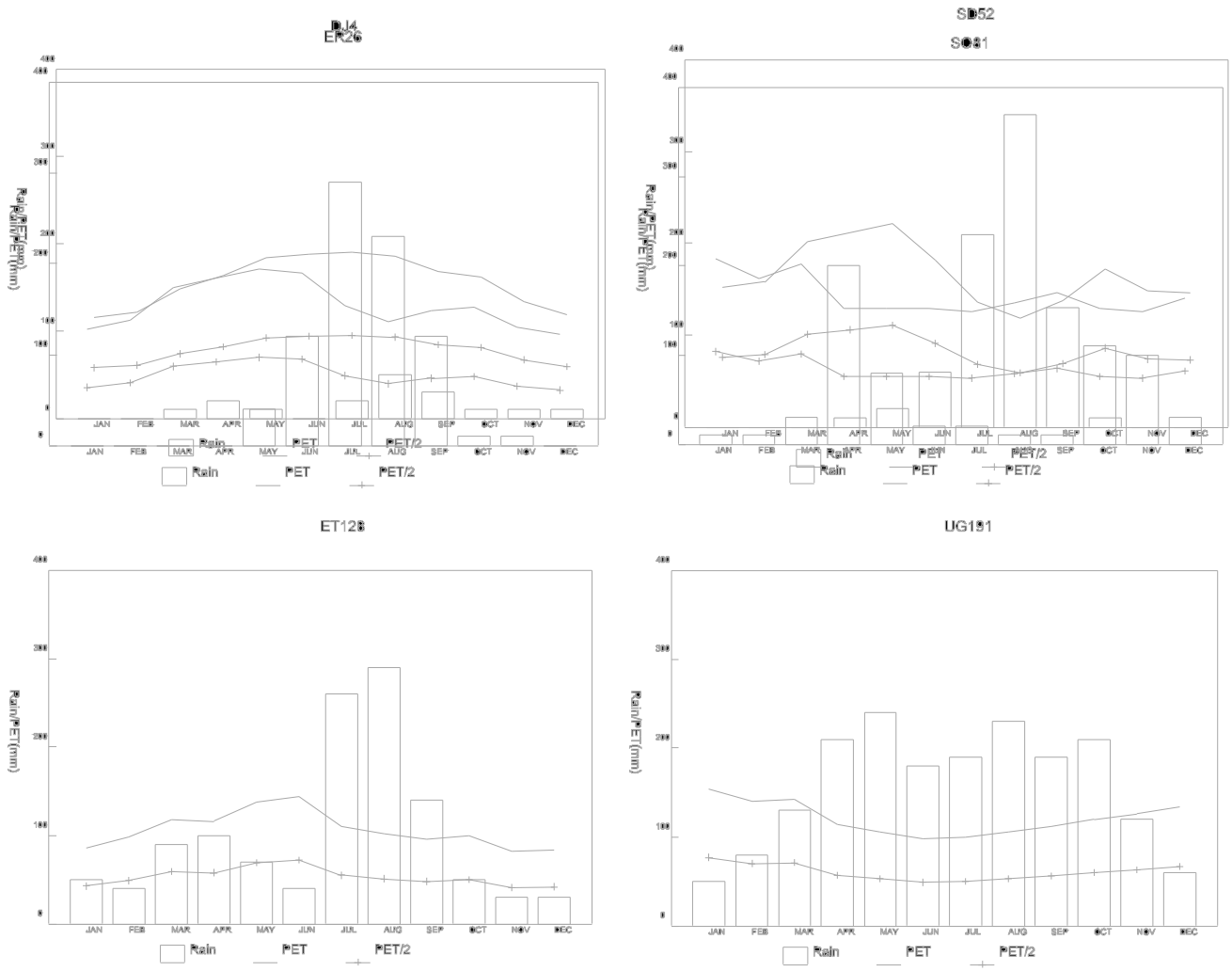
An assessment of selected soil and terrain properties was made for soil mapping units occurring in each CPSZ. Therefore, soil data were extracted from the Soil Map of the World (FAO, 1990) using ARC-INFO. A GIS attribute file was constructed that contains for each CPSZ a code number, the extent of soil mapping units occurring in it, the proportional extent of each soil map unit in the CPSZ and the total extent of the CPSZ. This data file was used to analyze the composition of each soil map unit in terms of topsoil texture, dominant slope and soil phase. Based on established relationships between soil properties and soil classification unit names and other factors (texture, slope, phase), algorithms were developed in order to estimate the proportional extent of the following attributes in each CPSZ map unit (Nachtergaele and Zanetti, 1993):

(a) maximum readily available soil moisture storage capacity;
(b) terrain slope;
(c) inherent soil fertility; and
(d) potential waterlogging and ponding risk.

Further analysis of the data by CPSZ map unit resulted in the following parameters:

- Weighted average maximum readily available soil moisture (mm/m)
- Standard deviation of maximum readily available soil moisture
- Inherent soil fertility class (relative occurrence low; medium and high fertility)
- Weighted average terrain slope (%)
- Standard deviation of terrain slope (%)
- Potential waterlogging/ponding hazard (percentage occurrence of total area)

Figure 3 Sample graphical representation of moisture balances for selected map units.



In the Crop Production System Zones inventory map sheet (backpocket), a small scale map is included which presents a combination of soil fertility and maximum soil moisture storage capacity.

4.5.3 NDVI data

NDVI (Normalized Difference Vegetation Index) images, created by NASA/GIMMS and regularly available every 10 days since 1981, represent the most important remote sensed source for monitoring the response of vegetation to weather conditions in several parts of Africa.

NDVI time series 1982-90 were used extensively in several phases of the CPSZ definition and in particular for the following four purposes:

- to add additional parameters to assess the homogeneity of administrative units;
- to cross-check other physical or agronomic data;
- to include new significant remote sensing information into the CPSZ inventory; and
- to identify, in terms of geographical location and vegetation performances, the major "probably irrigated areas" in the arid and hyper-arid part of the region (see section 3.5).

The information obtained from the composite 1982-90 imagery was crucial to verify the provisional definition of the CPSZ map units. In particular the values of geographical standard deviation within existing administrative units were used as a criteria, combined with the standard deviation of thermal and moisture regime, to verify homogeneity of administrative units and to subdivide them into smaller map units where necessary.

Once CPSZ map units have been defined, dekadal historical databases were created using the Image Display and Analysis (IDA) package. Growing periods were estimated from the NDVI time series to countercheck other physical and agronomic data in the database.

NDVI maximum, minimum and average values during the first and, when applicable, the second season were calculated to improve the physical description of the CPSZ map units. In addition, the NDVI inter-annual standard deviations of the start, end and length of the growing period(s) were computed and included in the database.

Map 7 presents small scale maps of average bi-monthly NDVI for the period 1982-1990.

4.6 Agronomic Data Matrix

The data compiled by the national agronomy consultants included the following data sets:

- Cropping density (cultivation intensity)
- Cropping pattern
- Dominant crops
- Crop management calendar for each of the dominant crops, by season
- Crop phenological stages for each of the dominant crops, by season
- Crop yields for each of the dominant crops, by season

The data were scrutinised wherever possible through comparison with other data sources (e.g. climate, soil and terrain, NDVI derived data, agricultural and demographic statistics). Discrepancies, specially those across national borders, were discussed and as far as possible resolved with and among the national consultants. This also applies to climatic hazard, pest and disease hazard and livestock data.

4.6.1 Cropping Density

The relative area under each crop has been estimated by CPSZ map unit. The following classes have been used:

- No crops (not cultivated)
  This class occurs mainly in hyper-arid and arid areas. Crops only occur in local water collecting sites, small irrigation schemes along rivers and small areas with flush irrigation.

- Sparsely cropped
  Very low occurrence of cropped areas scattered throughout the CPSZ unit.

- Patchy cropped
  Low occurrence of irregular distributed cropped areas within the CPSZ unit.

- Partially cropped
  Occurrences of relatively extensive cropped areas within the CPSZ unit.

- Fully cropped
  Cropped areas occupying the greater part or all of the CPSZ unit.

Map 8 presents an inventory of cropping density. Table 7 provides the extent of cropping density classes by country. In the Crop Production System Zones inventory map sheet (backpocket), a small scale map is included which presents cultivation intensity for IGADD region.

Table 7 Occurrence (%) of cropping density classes by country.

Cropping density	Djibouti	Eritrea	Eth	
No crops	100	60		1
Sparsely cropped	0	25		6
Patchy cropped	0	14		49
Partially cropped	0	1		36
Fully cropped	0	0		8

4.6.2 Cropping Patterns (4 classes)

The following categories of cropping patterns have been inventoried by CPSZ map unit:

- Single cropping
  Only one crop is grown on the same field per season.

- Sequential cropping
  Two or more crops are cultivated in sequence on the same field per season.

GENERAL CROP CODES

Code	Crop	Scientific name
1.	Barley	Hordeum vulgare
2.	Maize	Zea mays
3.	Bullrush Millet	Pennisetum typhoides
4.	Finger Millet	Eleusine coracana
5.	Oat	Avena sativa
6.	Rice	Oryza sativa
7.	Sorghum	Sorghum bicolor
8.	Teff	Eragrostis tef
9.	Wheat	Triticum aestivum
10.	Other cereals	
11.	Phaseolus bean	Phaseolus vulgaris
12.	Cowpea	Vigna unguiculata
13.	Pigeonpea	Cajanus cajan
14.	Chick pea	Cicer arietinum
15.	Lentil	Lens culinaris
16.	Other pulses	
17.	Groundnut	Arachis hypogaea
18.	Sesame (Simsim)	Sesanum indicum
19.	Soybean	Glycine maximum
20.	Sunflower	Helianthus annuus
21.	Other oil crops	
22.	Cotton	Gossypium hirsutum
23.	Sisal	Agave sisalana
24.	Other fibre crops	
25.	Cassava	Manihot esculenta
26.	Sweet potato	Ipmomoea batatas
27.	White potato	Solanum tuberosum
28.	Yam	Colocasia esculenta
29.	Other root and tuber crops	
30.	Banana	Musa Spp.
31.	Enset	Ensete ventricosum
32.	Sugercane	Saccharum officinarum
33.	Pineapple	Ananas comosus
34.	Pyrethrum	
35.	Vegetables	
36.	Coffee	Coffea arabica/robusta
37.	Tea	Camelia sinenis
38.	Other stimulants	
39.	Tree crops / fruits	
40.	Pasture	
41.	Forage	

Table 8 Crops included in the CPSZ data matrix

- Relay cropping
  Two or more crops overlap during part of their life cycles on the same field.

- Intercropping
  Two or more crops are simultaneously grown on the same field per season.

The four classes were grouped in two classes for the purpose of the Crop Production System Zones Inventory: sole cropping (single and sequential cropping) and mixed cropping (relay and intercropping).

4.6.3 Dominant crops

The five most frequently occurring crops (dominant crops) in terms of area occupied and importance for food security were selected for each of the CPSZ units. The crops were further characterized based on the crop management calendar, crop phenology, and severity of pest and disease hazards. The crops included in the CPSZ database are listed in Table 8. Other reported crops are listed in Appendix 2.

An example is given in Map 9 which presents the distribution of Phaseolus Bean in Kenya and Uganda.

4.6.4 Crop management calendars

Crop management calendars, earlier compiled by the project by administrative areas, were provided to the national consultants as reference data. The consultants re-compiled the crop management calendars by crop and by season for each CPSZ. These crop management calendars (for the five dominant crops) include start and end of the following agronomic activities in dekads:

- land preparation
- planting
- weeding
- fertilizing
- harvesting

4.6.5 Crop phenological stages

The major phenological phases have been defined for the annual crops according to the Phenological Atlas of East Africa (1977). For long cycled annual and perennial crops, the phenological phases have been omitted. For the annual crops the following are recorded (durations):

- initial stage
- vegetative stage
- flowering stage
- reproductive stage

- total growth cycle

Crucial data e.g. flowering of maize can be extracted from the data matrix by combining crop management calendar and phenological periods. In this way it is possible to prepare maps with flowering periods of maize.

4.6.6 Crop Yields

For the five dominant crops, reference yields have been estimated for each CPSZ. This estimation was based on:

- data collected by the national consultants for part of the CPSZs; and
- agricultural statistics by administrative subdivisions (Eritrea MoA, 1991; Ethiopia MoA, 1984; Kenya MoA, 1989; Sudan MOANR, 1987; Uganda MoAAI&F, 1990)

For a first verification of reported yield levels and for CPSZ map units for which yield data were incomplete, interpolation techniques have been applied with the IGT package. The yield data were subsequently verified with a yield screen. The yield screen (Table 9) takes into account agroclimatic conditions which condition environmentally attainable yield levels. Yields that were reported to be substantial higher than agroclimatically attainable have been adjusted downward.

Map 10 presents the geographical distribution of rainfed teff yields achieved in Ethiopia.

4.7 Environmental Hazard Data Matrix

Data were collected on frequency of occurrence and severity/damage of climatic hazards affecting the dominant crops. Six types of hazards were inventoried: frost, false start of growing period, dry spell, wet spell/excessive wetness, flooding and hailstorm.

Due to considerable geographical variation in density and reliability of the data, the reader is cautioned that the IGADD-wide climatic hazard data matrix is indicative only.

Map 11 presents an inventory of environmental hazards with high frequency of occurrence and high severity/damage classes as relevant to any of the dominant crops.

4.8 Livestock Data Matrix

Data were collected on: (a) livestock systems (b) herd composition (cattle, sheep, goat, equine and camel), type of grazing (5 classes), (c) overgrazing risk (4 classes), (d) availability of water points (4 classes), (e) pasture potential/availability (4 classes) and (f) relative importance of livestock versus crop production (percentage).

In the Crop Production System Zones inventory map sheet (backpocket), a small scale map is included which presents an inventory of relative importance of livestock versus crop production (Livestock/Crop ratio).

After consistency checks were carried out on the livestock data, it appeared that their quality varies considerably from place to place. The data show rather large discrepancies across national borders. They should be considered indicative only. Data on livestock numbers could not be included within the available time.

Table 11 Yield screen

Crop		CPSZ																			
		1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.3	4.4	4.5	5.5	IRR
Barley	o	-	-	-	-	-	-	0.9	1.8	1.8	1.3	-	1.2	2.3	2.4	1.8	2.3	2.4	1.8	-	3.7
Maize	o	-	1.6	4.5	4.4	1.7	-	1.6	4.5	4.4	1.7	-	0.6	2.9	4.1	3.9	2.9	4.1	2.9	-	7.1
B. Millet	o	-	1.6	2.2	1.0	0.3	-	1.6	2.2	1.0	0.3	-	1.2	1.5	0.6	0.2	-	-	-	-	2.4
F. Millet	o	-	0.7	1.5	1.6	0.9	-	1.0	2.0	2.2	1.2	-	1.0	2.0	2.2	1.2	0.7	1.5	1.3	-	-
Oat	o	-	-	-	-	-	-	-	0.7	1.5	1.5	1.1	-	1.0	2.0	2.1	1.5	2.0	2.1	1.5	3.3
Rice	o	-	-	-	1.8	2.5	-	-	-	1.8	2.5	-	-	-	1.4	1.9	-	-	-	-	5.0
Sorghum	o	-	1.6	3.2	3.2	0.6	-	1.6	3.2	3.2	0.6	-	0.4	2.1	2.6	1.6	2.1	2.6	1.6	-	5.1
Teff	o	-	0.3	0.5	0.6	0.4	-	0.6	1.2	1.4	0.8	-	0.6	1.2	1.4	0.8	1.2	1.4	0.8	-	-
Wheat	o	-	-	-	-	-	-	0.7	2.4	2.6	0.5	-	0.9	3.2	3.5	0.6	3.2	3.5	0.6	-	5.6
Ph. bean	o	-	0.8	2.1	2.0	0.7	-	0.8	2.1	2.0	0.7	-	0.4	1.7	1.8	0.7	1.7	1.8	0.7	-	3.4
Cowpea	o	-	0.5	1.4	1.5	1.0	-	0.5	1.4	1.5	0.7	-	0.4	1.1	1.2	0.5	-	-	-	-	2.4
Pigeonpea	o	-	0.2	2.0	2.1	1.4	-	0.2	2.0	2.1	1.4	-	-	1.5	1.6	1.0	-	-	-	-	3.3
Chickpea	o	-	0.8	2.1	2.0	0.7	-	0.8	2.1	2.0	0.8	-	0.4	1.5	1.6	0.5	-	-	-	-	3.4
Lentil	o	-	-	-	-	-	-	-	-	-	-	-	0.4	1.3	1.4	0.6	1.3	1.4	0.6	-	-
Groundnut	o	-	0.6	1.5	1.5	0.6	-	0.6	1.5	1.5	0.6	-	0.4	1.1	1.1	0.4	-	-	-	-	2.4
Sesame	o	-	1.2	1.6	1.2	0.8	-	1.2	1.6	1.2	0.8	-	-	-	-	-	-	-	-	-	2.6
Soybean	o	-	0.6	1.7	1.6	0.6	-	0.8	2.1	2.0	0.8	-	0.7	1.9	1.8	0.7	-	-	-	-	3.4
Cotton	o	-	0.4	1.8	1.8	0.6	-	0.4	1.8	1.8	0.6	-	-	-	-	-	-	-	-	-	3.2
Cassava	*	-	1.8	8.4	22.4	24.3	-	1.8	8.4	22.4	24.3	-	1.4	6.3	16.9	18.1	-	-	-	-	-
Sw Potato	*	-	5.4	18.9	18.6	13.5	-	5.4	18.9	18.6	13.5	-	4.1	14.4	14.1	10.1	-	-	-	-	-
Wh Potato	*	-	-	-	-	-	-	4.1	13.9	13.5	2.9	-	5.4	18.3	17.7	3.9	18.3	17.7	3.9	-	-
Banana	*	-	-	3.2	8.4	25.2	-	-	3.2	8.4	25.2	-	-	2.4	6.3	17.9	1.6	4.1	12.6	-	-
Sugarcane	**	-	-	0.6	4.6	7.6	-	-	0.6	4.6	7.6	-	-	0.4	3.5	5.8	-	-	-	-	-

o Sun dried yields
* Fresh weight yields with the following moisture content:
Cassava: 65 %
Sweet Potato: 68 %
White Potato: 70 %
Banana: 70 % (plus 10 % skin)
** Sugar content 10 % of total biomass
\- Not applicable

Note : without fertilizer nor chemical pest and disease control, yields can be assumed to be in the order of 50 % of the given yields.

4.9 Pest and Disease Hazard Data Matrix

Data were collected on frequency of occurrence and severity/damage of invasion or infestation by pests or diseases for the dominant crops. In total 44 pests (incl. nematodes, mites, locusts, ants and termites, thrips, bugs, aphids, beetles and weevils, butterflies and moths, caterpillars, birds, rodents and mammals and 26 diseases (incl. bacteria, viruses and fungi) were inventoried.

Map 12 presents an inventory of major pests affecting the five dominant crops in Uganda.

The quality of the pests and disease data too varies considerably from place to place. The discrepancies in contents and detail across national borders suggest that the pest and disease data should be considered indicative only.

4.10 Infrastructure Data

To enable linking the CPSZ database and infrastructure data (roads, towns, villages, railways and main rivers), the latter has been digitized and combined with the CPSZ database. Towns, villages, three classes of roads and railways were taken from the 1:2000000 Michelin road map of East Africa. The infrastructure database has been made part of the CPSZ database viewer software (see section 5.2).

Figure 4 below shows the main infrastructure data for Ethiopia, as contained in the database.

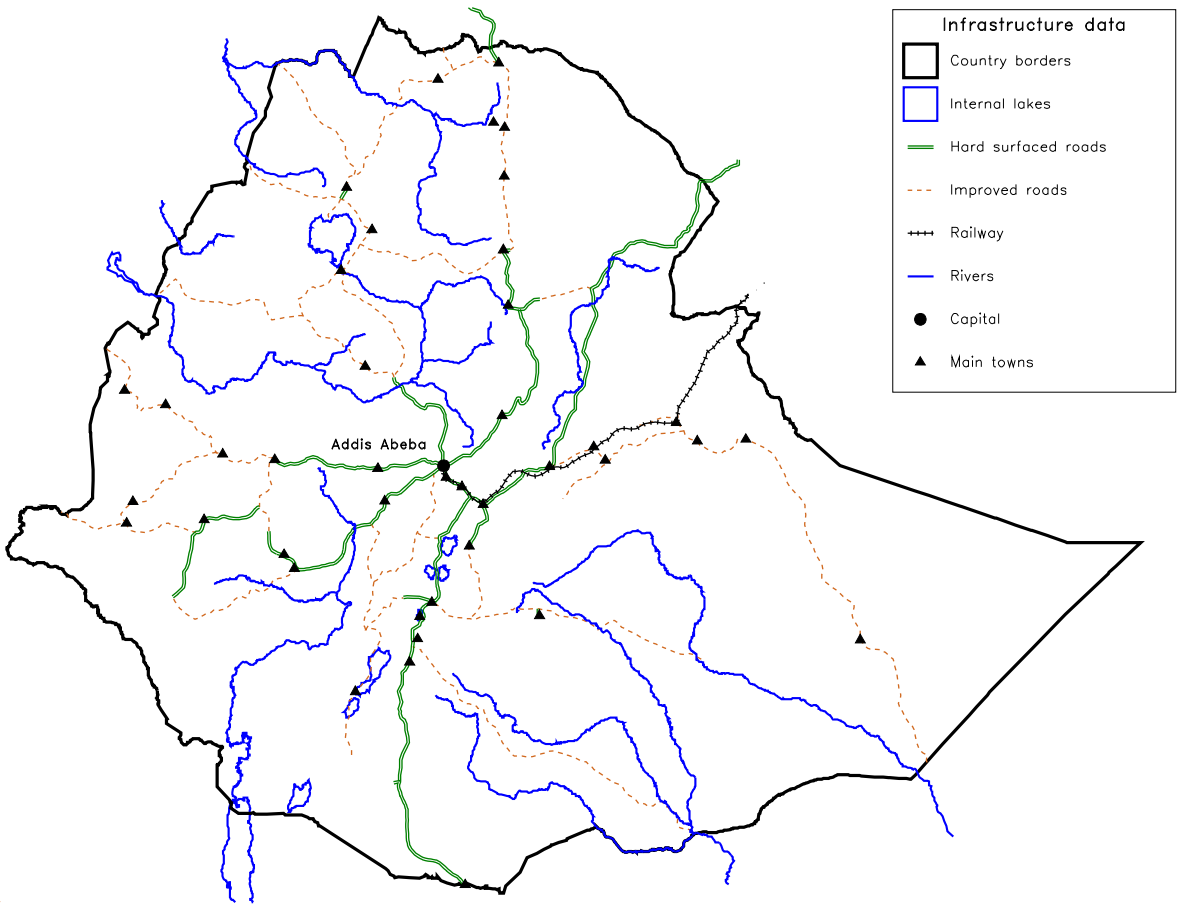


Figure 4 Main infrastructure data for Ethiopia.

CHAPTER 5 OUTPUTS

5.1 CPSZ Inventory Map Sheet

The crop zones were derived from the five main crops, recorded in the agronomic data matrix by CPSZ map unit. The zones were defined on the basis of: (a) sorting procedures applied to five main crops and (b) clustering procedures applied to two main crops and a third complementary crop. The results of the two procedures were further analyzed and checked for consistency and relevance vis-a-vis various other agronomic and physical parameters contained in the data matrices. Subsequently a series of test plots was made for checking the geographical consistency and continuity (especially across national borders) and for the definition of colour schemes.

The obtained crop zones have been grouped according to main agroclimatic conditions representing respectively combinations of warm (> 20˜ C) and cool areas (< 20˜ C), and areas marginal for rainfed crop production due to short growing periods (< 120 days) and more productive areas with longer growing periods (> 120 days).

- Marginally Productive Lowland (dry semi-arid zones)
- Productive Lowland (moist semi-arid, sub-humid and humid)
- Marginally Productive Highland (dry semi-arid zones)
- Productive Highland (moist semi-arid, sub-humid and humid)

The hyper-arid and arid area crops cannot be grown except in water collecting sites or under irrigation. These areas were classified according to pasture availability in four classes:

- Desert zone (no pasture),
- Transitional desert/marginal pasture zone
- Marginal pasture zones
- Pasture zones

Irrigated areas as provided by the national consultants and extracted from available reports and maps were verified and delineated with the help of ADDAPIX (see section 3.5 for irrigated areas). The location of areas classified as irrigated areas is indicated in the crop and pasture zone map by overprints.

Apart from the 1:5 million scale Crop and Pasture Zones map, the demonstration sheet contains six 1:12 million maps of key parameters of CPSZ namely:

- Number of growing periods;
- Growing period days;
- Start of main growing period;
- Cropping density;
- Livestock/crops ratio;
- Soil fertility and potential moisture storage capacity.

Below the explanatory legend of the Crop Zones Inventory is reproduced.

CROP PRODUCTION SYSTEM ZONES

ARID AND HYPER-ARID AREAS (1-4)

1. Desert Zone

Hyper-arid areas without or with very sparse vegetation

2. Transitional Desert/Marginal Pasture Zone

Arid areas with locally sparse vegetation[6]

3. Marginal Pasture Zone

Arid areas with vegetation[4]

4. Pasture Zone

Arid areas and dry part of dry semi-arid areas with natural vegetation and locally short cycle drought resistant crops

MARGINALLY PRODUCTIVE LOWLAND (5-9)

(Dry Semi-arid Lowland and Lowland/Medium Highland Zones)

5. Maize - Pasture - Sesame Zone

Additional crops: locally Cowpea, Phaseolus Bean, Sorghum and Finger Millet; Sole and mixed cropping; Cropping density: low and medium; Relative importance livestock: high and medium

Warm and moderately warm temperatures; One or two unreliable growing periods (mainly dry semi-arid moisture zone); Start main growing period: mid March to mid April; Level and moderately sloping land: Soils: medium and low water holding capacity and varying fertility

6. Sorghum - Bullrush Millet - Sesame Zone

Additional crops: locally Maize, Groundnut and Vegetables; Dominantly sole cropping; Cropping density: low; Relative importance livestock: medium

Warm temperatures; One unreliable growing period (dry semi-arid moisture zone); Start growing period: begin to end June; Moderately sloping land; Soils: medium and low water holding capacity and low soil fertility

7. Sorghum - Bullrush Millet - Groundnut Zone

Additional crops: Sesame and Vegetables; Dominantly sole cropping; Cropping density: low; Relative importance livestock: medium

Moderately warm temperatures; One unreliable growing period (dry semi-arid moisture zone); Start growing period: mid to end June; Sloping land; Soils: low water holding capacity and low and medium fertility

8. Sorghum - Cowpea Zone

6 Very few short cycle drought resistant crops are confined to water collecting sites, wadi bottoms, along rivers, in small pump, flood and spate irrigation schemes.

Additional crops: locally Sesame, Maize, and Vegetables; Dominantly sole cropping; Cropping density: low to medium; Relative importance livestock: medium and high

Warm temperatures; One or two unreliable growing periods (dry semi-arid moisture zone); Start main growing period: mid March to mid April; Level land; Soils: medium water holding capacity and varying soil fertility

9. Sorghum/Maize - Sesame Zone

Additional crops: Locally Bullrush Millet, Finger Millet, Cotton, Cowpea, Phaseolus Bean, Teff and Vegetables; Dominantly sole cropping; Cropping density: low; Relative importance livestock: medium to high

Moderately warm and warm temperatures; One or two unreliable growing periods (dry semi-arid moisture zone); Start main growing period: March to July; Sloping, partly level land; Soils: low, partly medium water holding capacity and varying, partly high fertility

PRODUCTIVE LOWLAND (10-27)

(Moist Semi-arid, Sub-humid and Humid Lowland and Lowland/Medium Highland Zones)

10. Banana - Phaseolus Bean - Maize Zone

Additional crops:Finger Millet, Groundnut and locally Sorghum; Dominantly mixed cropping; Cropping density: medium and low; Relative importance livestock: medium to high

Moderately warm temperatures; Two distinct growing periods (sub-humid moisture zone); Start main growing period: mid January to mid February; Dominantly moderately sloping land: Soils: medium and high water holding capacity and low fertility

11. Banana - Phaseolus Bean - Sweet Potato Zone

Additional crops: Finger Millet and locally Maize and Sorghum; Dominantly mixed cropping; Cropping density: medium; Relative importance livestock: low

Moderately warm and moderately cool temperatures; Two distinct growing periods (humid moisture zone); Start main growing period: mid January; Sloping land; Soils: medium water holding capacity and varying fertility

12. Banana - Coffee - Maize Zone

Additional crops: Phaseolus Bean, Sweet Potato and locally Cassava; Dominantly mixed cropping; Cropping density: high and medium; Relative importance livestock: low

Moderately warm and moderately cool temperatures; Two distinct growing periods (humid and sub-humid moisture zones) Start main growing period: mid January to end February; Moderately sloping land; Soils: medium and high water holding capacity and low, partly varying fertility

13. Coffee - Banana - Phaseolus Bean Zone

Additional crops: Cotton, Maize and locally Cassava; Dominantly mixed cropping; Cropping density: medium and low; Relative importance livestock: very low

Moderately warm temperatures; Two distinct growing periods (sub-humid moisture zone); Start main growing period: mid February to end March; Moderately sloping land; Soils: medium water holding capacity and varying fertility

14. Maize - Tree Crops Zone

Additional crops: locally Cotton, Cowpea and Cassava; Sole and mixed cropping; Cropping density: medium; Relative importance livestock: medium to high

Warm temperatures; One growing period (moist semi-arid moisture zones); Start growing period: end March; Moderately sloping, partly level land; Soils: varying water holding capacity and low fertility

15. Maize - Cowpea - Tree Crops Zone

Additional crops: locally Cassava and Banana; Dominantly mixed cropping; Cropping density: medium; Relative importance livestock: medium

Warm temperatures; Two distinct growing periods (moist semi-arid and sub-humid moisture zones); Start growing period: end March; Moderately sloping land; Soils: medium and low water holding capacity and low fertility

16. Maize - Cowpea - Phaseolus Bean Zone

Additional crops: Pigeon Pea and locally Cassava and Pasture; Dominantly mixed cropping; Cropping density: medium; Relative importance livestock: medium

Moderately warm and warm temperatures; Two distinct growing periods (moist semi-arid moisture zone) Start main growing period: begin March to mid March; Moderately sloping land; Soils: medium and low water holding capacity and low, partly varying fertility

17. Maize - Sugarcane - Phaseolus Bean Zone

Additional crops: Sorghum and locally Rice and Cassava; Mixed and single cropping; Cropping density: high and medium; Relative importance livestock: medium to low

Moderately warm and moderately cool temperatures; One or two growing periods (humid and sub-humid moisture zones); Start main growing period: mid January; Sloping and moderately sloping land: Soils: medium and low water holding capacity and varying fertility

18. Sorghum - Cowpea - Groundnut Zone

Additional crops: Cassava and locally Phaseolus Bean and Vegetables; Dominantly sole cropping; Cropping density: low; Relative importance livestock: medium

Moderately warm and moderately cool temperatures; One growing period (moist semi-arid moisture zone); Start growing period: mid May to end June; Sloping land; Soils: low water holding capacity and varying fertility

19. Sorghum/Maize - Groundnut Zone

Additional crops: Cowpea, Bullrush Millet and locally Phaseolus Bean, Pigeon Pea, Cassava, Sweet Potato, Sunflower, Tree Crops, Sunflower, Sesame and Vegetables; Dominantly sole cropping; Cropping density: low and medium; Relative importance livestock: varying

Warm and moderately warm temperatures; One growing period (sub-humid and moist semi-arid moisture zones); Start growing period: mid February to end March in Kenya and Uganda and mid April to end May in Sudan and Ethiopia; Level and moderately sloping, partly sloping and steep land; Soils: low and medium water holding capacity and varying fertility

20. Sorghum/Maize - Cowpea Zone

Additional crops: Groundnut and locally Bullrush Millet; Dominantly sole cropping; Cropping density: low; Relative importance livestock: high

Warm temperatures; One growing period (moist semi-arid moisture zone); Start growing period: begin May to mid June; Level and moderately sloping land; Soils: medium water holding capacity and varying soil fertility

21. Finger Millet - Sorghum - Sweet Potato Zone

Additional crops: Cassava, Cowpea and locally Sesame, Maize, Cotton, Rice, Banana, Groundnut and Vegetables; Dominantly mixed cropping; Cropping density: medium; Relative importance livestock: low to very low

Moderately warm temperatures; One growing period (sub-humid moisture zone); Start growing period: begin to end March; Level and moderately sloping land; Soils: high and medium water holding capacity and low, partly varying fertility

22. Finger Millet - Cassava - Maize Zone

Additional crops: Rice, Banana and locally Sorghum, Phaseolus Bean and Sugarcane; Dominantly mixed cropping; Cropping density: medium and high; Relative importance livestock: low

Moderately warm temperatures; Two distinct growing periods (humid moisture zone); Start main growing period: end January to mid march; Level land; Soils: high and medium water holding capacity and low fertility

23. Finger Millet - Cassava - Maize Zone

Additional crops: Rice and Banana; Dominantly mixed cropping; Cropping density: medium; Relative importance livestock: medium to high

Moderately warm temperatures; Two distinct growing periods (humid moisture zone); Start main growing period: begin to end February; Level land; Soils: high water holding capacity and low fertility.

24. Sesame - Finger Millet - Cassava Zone

Additional crops: Maize and Phaseolus Bean; Dominantly mixed cropping; Cropping density: low and medium; Relative importance livestock: low to medium

Moderately warm temperatures; One or two growing periods (humid and sub-humid moisture zones); Start main growing period: end February to mid March; Moderately sloping land; Soils: medium water holding capacity and low fertility

25. Cassava - Sesame - Maize Zone

Additional crops: Sorghum and Groundnut; Dominantly mixed cropping; Cropping density: medium; Relative importance livestock: low

Moderately warm temperatures; One growing period (humid moisture zone); Start growing period: mid March; Moderately sloping land; Soils: medium water holding capacity and low fertility

26. Cassava - Finger Millet - Sesame Zone

Additional crops: Groundnut, Sorghum and locally Cotton, Pigeon Pea, Maize, Phaseolus Bean, Yam and White Potato; Dominantly mixed cropping; Cropping density: medium in Uganda and low in Sudan; Relative importance livestock: low

Moderately warm and warm temperatures; One or two growing periods (humid and sub-humid moisture zones); Start of main growing period: mid February to end March; Sloping and moderately sloping land; Soils: medium, partly low water holding capacity and low, partly varying soil fertility

27. Rice - Sorghum - Maize Zone

Additional crop: Groundnut; Dominantly sole cropping; Cropping density: low; Relative importance livestock: very low

Warm temperatures; One growing period (sub-humid moisture zone); Start growing period: begin May; Level land; Soils: high water holding capacity and high fertility

MARGINALLY PRODUCTIVE HIGHLAND (28-30)

(Dry Semi-arid Medium Highland and Highland Zones)

28. Barley/Wheat - Teff - Sorghum Zone

Additional crops: locally Maize, Pulses, White Potato and Finger Millet; Dominantly sole cropping; Cropping density: low; Relative importance livestock: low to medium

Moderately cool temperatures; One unreliable growing period (dry semi-arid moisture zone); Start growing period: mid January to mid February; Steep, partly sloping land; Soils: low water holding capacity and varying fertility

29. Maize/Sorghum - Teff - Wheat Zone

Additional crops: Barley and Phaseolus Bean; Dominantly sole cropping; Cropping density: medium; Relative importance livestock: low to medium

Moderately cool temperatures; One or two unreliable growing periods (dry semi-arid moisture zone); Start main growing period: end May to end June; Steep, partly sloping land; Soils: low, partly medium water holding capacity and medium and high fertility

30. Maize/Sorghum-Teff Zone

Additional crops: Locally Wheat Barley and Finger Millet; Dominantly sole cropping; Cropping density: low; Relative importance livestock: high

Moderately warm temperatures; One unreliable growing period (dry semi-arid moisture zone); Start growing period: mid to end March or begin to end June; Sloping, partly steep land; Soils: low, partly medium water holding capacity and varying fertility

PRODUCTIVE HIGHLAND (31-44)

(Moist Semi-arid, Sub-humid and Humid Medium Highland and Highland Zones)

31. Banana - Maize - Coffee Zone

Additional crops: Cassava and Finger Millet; Dominantly sole cropping; Cropping density: high; Relative importance livestock: medium

Moderately cool temperatures; One growing period (humid and sub-humid moisture zones); Start growing period: mid February to mid March; Sloping land; Soils: high water holding capacity and medium and low fertility

32. Coffee - Banana - Cassava Zone

Additional crops: Sweet Potato and Finger Millet; Dominantly mixed cropping; Cropping density: high; Relative importance livestock: very low

Cool temperatures; One growing period (humid moisture zone); Start growing period: mid January to end February; Steep land; Soils: high water holding capacity and medium fertility

33. Maize - Coffee - Teff Zone

Additional crops: Sorghum, Barley, Wheat and locally Enset, Finger Millet and Phaseolus Bean; Dominantly sole cropping; Cropping density: varying; Relative importance livestock: medium

Moderately cool and moderately warm temperatures; One growing period (sub-humid moisture zone); Start growing period: mid February to mid April; Sloping land; Soils: low and medium water holding capacity and medium and high fertility

34. Maize/Sorghum - Teff - Barley Zone

Additional crops: Locally Wheat, Enset, Finger Millet and Pulses; Dominantly sole cropping; Cropping density: low and medium; Relative importance livestock: varying

Moderately cool and moderately warm temperatures; One or two growing periods (moist semi-arid and sub-humid moisture zones); Start main growing period: end January to March or mid April to end June; Sloping, partly steep land; Soils: low, partly medium water holding capacity and medium and high fertility

35. Maize - Phaseolus Bean - White Potato Zone

Additional crops: Locally Wheat, Finger Millet, Barley, Pyrethrum and Tea; Sole and mixed cropping; Cropping density: medium to high; Relative importance livestock: medium

Moderately cool and cool temperatures; One or two growing periods (moist semi-arid, sub-humid and humid moisture zones); Start main growing period: mid January and end March; Sloping, partly moderately sloping and steep land; Soils: low and medium, partly high water holding capacity and varying fertility

36. Maize - Phaseolus Bean - Coffee Zone

Additional crops: Locally White Potato, Banana, Finger Millet and Tea; Dominantly mixed cropping; Cropping density: high and medium; Relative importance livestock: low to medium

Moderately cool temperatures; Two distinct growing periods (humid and sub-humid moisture zones); Start growing period: mid February to mid March; Steep, partly sloping land; Soils: varying water holding capacity and medium fertility

37. Maize - Phaseolus Bean - Tea Zone

Additional crops: White Potato and locally Finger Millet, Tree Crops and Pyrethrum; Dominantly mixed cropping; Cropping density: high and medium; Relative importance livestock: low to medium

Moderately cool and cool temperatures; One growing period (humid moisture zone); Start growing period: begin January to mid February; Steep, partly sloping land; Soils: high, partly medium water holding capacity and high and medium fertility

38. Maize - White Potato - Pyrethrum Zone

Additional crops: locally Wheat and Phaseolus Bean; Sole and mixed cropping; Cropping density: high; Relative importance livestock: medium

Cool and moderately cool temperatures; One or two growing periods (humid and sub-humid moisture zones); Start of main growing period: mid January to mid March; Sloping, partly steep land; Soils: medium and high water holding capacity and medium fertility

39. Sorghum - Phaseolus Bean - Sweet Potato Zone

Additional crops: White Potato, Maize and locally Cassava and Finger Millet; Dominantly mixed cropping; Cropping density: medium and high; Relative importance of livestock: low

Moderately cool temperatures; One or two growing periods (humid moisture zone); Start main growing period: mid January; Sloping land; Soils: medium water holding capacity and varying fertility

40. Barley/Sorghum - Chat Zone

Additional crops: Locally Coffee, Wheat, Maize, Phaseolus Bean and Teff; Dominantly sole cropping; Cropping density: medium; Relative importance livestock: medium

Moderately cool temperatures; Two distinct growing periods (sub-humid moisture zones); Start main growing period: mid to end June; Sloping land; Soils: low water holding capacity and varying fertility

41. Barley/Wheat - Teff - Pulses Zone

Additional crops: Locally Sorghum and Maize; Dominantly sole cropping; Cropping density: varying; Relative importance livestock: medium and low

Moderately cool and cool temperatures; One or two growing periods (moist semi-arid and sub-humid moisture zones); Start main growing period: begin March to mid June; Sloping land; Soils: low, partly medium water holding capacity and high and medium fertility

42. Barley - Pulses - Wheat Zone

Additional crops: Locally Chickpea and Maize; Dominantly sole cropping; Cropping density: varying; Relative importance livestock: medium

Cool temperatures; One growing period (humid and sub-humid moisture zones); Start growing period end January to end February or mid May to mid June; Moderately sloping, partly steep land; Soils: low and medium water holding capacity and medium and high fertility

43. Enset - Maize - Barley Zone

Additional crops: Teff and locally Wheat, Sorghum, Phaseolus Bean and Coffee; Sole and mixed cropping; Cropping density: varying; Relative importance livestock: low and medium

Moderately cool temperatures; One growing period (sub-humid and humid moisture zones); Start of growing period: mid February to end March, partly mid June; Sloping land; Soils: low, partly medium water holding capacity and medium and high fertility

44. Teff - Barley - Maize Zone

Additional crops: Wheat, Sorghum, Pulses and locally Finger Millet; Dominantly sole cropping; Cropping density: medium, partly high; Relative importance livestock: low to medium

Moderately cool temperatures; One growing period (moist semi-arid and sub-humid moisture zones): Start growing period: begin April to end May; Sloping land; Soils: low water holding capacity and high and medium fertility

IRRIGATED AREAS

Major Irrigation Schemes area indicated on the map by means of overprints with big blue dots.

Minor Irrigation Schemes area indicated on the map by means of overprints with small blue dots.

5.2 CPSZ Database Viewer Software

The CPSZ database is presented in the CPSZ-VIEWER software, which allows the user to consult the database and to extract data contained in the inventory for analysis. The programme also displays the main infrastructure features in the IGADD region.

The software facilitates the access to the database and aims at enhancing the usefulness of the database in general. Its two main functions are to present and access the data in a user friendly way and to simplify the orientation of the user in the CPSZ base map.

Data can be displayed in different ways. Thematic maps allow the visualization of one indicator at the time for all the CPSZ map units. This procedure is fully automated for certain data items, but can be customized by the user, if necessary. The second way to display the data is to present on the screen the complete data base for a single selected CPSZ map unit.

As mentioned, data can be extracted from the database in several ways, for further processing or analysis.

The second purpose of the software is to facilitate the orientation of the user in the CPSZ base map.
Roads, railways, villages, main rivers, towns and villages can be plotted over the CPSZ map and will facilitate the user to locate the CPSZ map units.

Requirements for CPSZ database viewer software

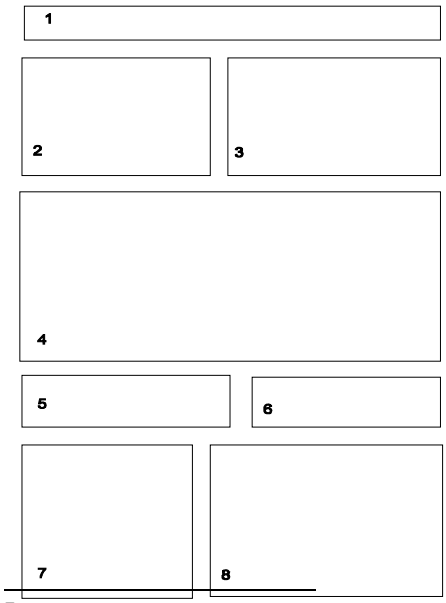
The software requires an IBM compatible microcomputer with 2 MB free space on the hard disk. A Microsoft or compatible mouse driver, version 8.0 or later, is required.

Installation from the diskette A: to hard disk C: is done by typing INSTALL A: C: from the DOS prompt.

Detailed guidelines for the software are found in Appendix 4.

5.3 CPSZ Summary Sheets

The CPSZ summary sheets give an overview of the Crop Production System Zone database which combines environmental, agricultural and remote sensing aspects. One sheet is foreseen for each of the 1220 relatively homogeneous CPSZ map units in IGADD countries[7]. Only the main items of the database are represented on the sheet, and sheets are slightly different between countries, according to the availability of data.



The information is arranged in 8 boxes on the sheet (see outline below).

Box 1 gives general information of the CPSZ map unit, including the name of administrative unit to which it belongs. The environmental setting of the map unit is given in the **agroclimatic code**.

Box 2 describes the location characteristics of the unit: **area**, **longitude and latitude** of the centre, and **average altitude**. The map in the same box illustrates the location of the map unit in the country. Box 3 contains the relevant physical characteristics, including soil indicators reflecting **average slope**, **soil fertility** and **readily available soil moisture capacity**, and NDVI data.

The agronomic data is summarized in Box 4: the **crop zone** indicates the *Crop Production System Zone* to which the unit belongs. **Cropping density** provides the relative area of the map unit that is used as cropland.

7 CPSZ Summary Sheets for Djibouti and Somalia were not prepared due to lack of data.

Further Box 4 contains detailed information on crop management calendar and phenological stages for maximum five main crops[8]. **Planting** and **Harvesting** is given in ranges: e.g. Apr1 - Apr3 stands for the first dekad of April to the third dekad of April. **Phenological phases** and **Cycle length** are quoted in days.
Pest and **Disease** data are represented by the damage caused to the main crops considered. **Average yield** is given in ton/ha.

Box 5 summarizes the **Climatic Hazards** occurring in the map unit: the frequency of occurrence (%) is given in percentage. E.g. 25% would mean one occurrence every four years.

Box 6 provides detailed information on the length of the growing period(s): **Start** and **End** in dekads, **Length** in days. These parameters are related to the Rainfall/PET pattern graphs, provided for in Box 8.

The **Livestock and Pasture** data in Box 7 gives besides the **Herd composition** (%), pasture conditions and livestock/crops ratios.

Box 8 presents a graphical representation of monthly **Rainfall**, **Potential evapotranspiration** (PET) and **NDVI**.

Not available data is coded as n.a., and a dash represents not applicable information.

[9]Figures 5 to 9 give examples of the CPSZ Summary Sheet for Eritrea, Ethiopia, Kenya, Sudan and Uganda.

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8 Some crops have been grouped under general headings e.g. Vegetables, Pulses, Stimulants etc. In the Appendix 3, the

9 Please refer to printed version (see note at beginning of document)

5.4 Moisture Balance Graphs

A simple soil moisture balance model was applied for the definition of the growing period characteristics. The rainfall and potential evapotranspiration data was interpolated using the IGT procedures, and area averaging techniques were applied to estimate average rainfall and PET for the CPSZ map units.
Monthly normal rainfall and potential evapotranspiration patterns were then plotted for all of the 1220 CPSZ map units, which allowed the definition of the LGP pattern.

These graphs constitute a separate Annex. Rainfall was interpolated using NDVI as background indicator and PET was estimated with altitude as negative correlated background to assist the interpolation routines.
The graphs also show the PET/2 curve, which is essential to define the LGP pattern.

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Glossary

CPSZ (Crop Production System Zone): an area with relative homogeneous environmental and agricultural characteristics. The area consists generally of several neighbouring administrative districts, of which some may be split because of environmental (agroclimatic) heterogeneity.

CPSZ map unit: correspond with the smallest administrative unit in the country (see 3.2), except when sharp ecological gradients exist, due to topography, climate,.... In this case the administrative zone has been split into more sub-units, called CPSZ map units, each with a different agroclimatic code.

Agroclimatic code or environmental signature: consists of three codes separated by a dot. The first code reflects the thermal regime of the unit; the second the length of the season and the third the number of seasons. For instance: code 2.3.U stands for a moderately warm (20-25 ^{o}C) temperature regime **(2)** with a moist semi-arid (120-179 days growing period) moisture regime **(3)**. The code **(U)** indicates the number of growing periods: U for uni-modal or one growing period (see 3.5).

Climate regime: is defined in this context as the combination of the moisture and the temperature regimes.

Cropping density: is a qualitative parameter indicating the intensity of crop cultivation in a CPSZ map unit. Five classes were distinguished: no crops, sparsely cropped, patchy cropped, partly cropped and almost completely cropped (see 4.6.1).

Dekad: a dekad is generally a time period of ten days. Each month in the year consists of three dekads, of which the third can have 8, 9, 10 or 11 days. A year has 36 dekads.
Both agrometeorological and remotely sensed information (NDVI, CCD) is usually being processed by dekad.

Growing period: the growing period is defined from climatological data, in particular rainfall and PET. It is considered as the period when rainfall is sufficient to grow crops.

Livestock system: nomadic, semi-nomadic and sedentary livestock systems.

NDVI: Normalized Difference Vegetation Index is recorded by satellites. The index is a measure of photosynthetically active green biomass, and ranges from -0.1 to 0.65. The higher the index, the more living green biomass (natural vegetation and crops, if any) will be found.
The information is available in the form of digital images.

Moisture regime: are defined based on the length of the growing period and the distribution of the rainfall.

Phenological phases: characterize the stages of crop development, e.g. germination, flowering, maturity.

PET (Potential Evapotranspiration): reflects the effect of the climate on the water requirements of crops and is thus a measure of the evaporative power of the atmosphere. It is defined as the evapotranspiration from an extensive green grass cover of uniform height and not short of water, and is expressed in mm or litres per square meter.
PET is widely used in combination with rainfall to define the length of the growing periods (start, end and length).

Thermal regime: is an indicator of the prevailing temperature conditions and seasonality (see 3.3, table 1).

Type of grazing: reflects the way how livestock is being kept and fed. In this context, the main types of grazing are free range, zero grazing and nomadic range.

Appendix 1

IGADD CPSZ Map Units

The following pages list the CPSZ map units by their name, corresponding administrative unit name, the agroclimatic code (AC code) and CPSZ code as described under section 5.1[10].

A prefix (N-, S-, C-...) before the administrative unit name means that the original administrative unit was subdivided due to its agro-ecological heterogeneity. A prefix N- would indicate that the CPSZ unit occupies northern part of the administrative unit. Similar prefixes S-, W-, E-, SW-, NE-, C- ... indicate southern, western, eastern, southwestern, northeastern, central parts respectively. If an administrative unit was split e.g. in several northern parts, then the prefixes N1-, N2- will be found.

10 Please refer to printed version (see note at beginning of document)

Appendix 2

Contents of the CPSZ Database

The variables contained in the CPSZ database are grouped in seven categories:

- General data
- Crop information
- Physical data
- Agronomic data
- Livestock data
- Environmental hazards
- Pest and disease hazards

Two important variables (CPSZ map unit and agroclimatic code) are repeated at the beginning of each category.
All variables are numbered sequentially from 1 to 502. These numbers are also found in the CPSZ database viewer software.

The following pages contain an overview of the contents of the CPSZ database, listing the variable number, the name of the variable and its units.
Definitions of the classes of the qualitative variables are found in Appendix 3.

DATA MATRIX I

GENERAL DATA

1.	CPSZ Map Unit	code
2.	Administrative area (code)	nr.
3.	Administrative area (name)	name
4.	Administrative region (name)	name
5.	Number of map units in administrative area.	nr.
6.	Area	km^2
7.	Area occupied by map unit (% of admin area)	%
8.	Longitude of the centre of map unit (dec. degrees)	~
9.	Latitude of the centre of map unit (dec. degrees)	~

DATA MATRIX II

CROP DATA

10-11 CPSZ

10.	CPSZ map unit	code
11.	Agroclimatic code	code

12-16 Crop and Pasture Zones **code**

12.	Crop and Pasture Zone (Grouped)	class
13.	Crop and Pasture Zone (Group 1)	class
14.	Crop and Pasture Zone (Group 2)	class
15.	Crop and Pasture Zone (Group 3)	class
16.	Crop and Pasture Zone (Group 4)	class

17-55 Crops in the cropping system

17.	Barley	class
18.	Maize	class
19.	Bullrush millet	class
20.	Finger millet	class
21.	Oat	class
22.	Rice	class
23.	Sorghum	class
24.	Teff	class
25.	Wheat	class
26.	Other cereals	class
27.	Phaseolus bean	class
28.	Cowpea	class
29.	Pigeonpea	class
30.	Chickpea	class
31.	Lentil	class
32.	Other pulses	class
33.	Groundnut	class

34.	Sesame	class
35.	Soybean	class
36.	Sunflower	class
37.	Other oil crops	class
38.	Cotton	class
39.	Sisal	class
40.	Other fibre crops	class
41.	Cassava	class
42.	Sweet potato	class
43.	White potato	class
44.	Yam	class
45.	Other root and tuber crops	class
46.	Banana	class
47.	Enset	class
48.	Sugarcane	class
49.	Pineapple	class
50.	Pyrethrum	class
51.	Vegetables	class
52.	Coffee	class
53.	Tea	class
54.	Other stimulants	class
55.	Tree crops/Fruits	class
56.	Pasture	class
57.	Forage	class

58-88 Crop yields

58.	Barley	ton/ha
59.	Maize	ton/ha
60.	Bullrush millet	ton/ha
61.	Finger millet	ton/ha
62.	Oat	ton/ha
63.	Rice	ton/ha
64.	Sorghum	ton/ha
65.	Teff	ton/ha
66.	Wheat	ton/ha
67.	Phaseolus bean	ton/ha
68.	Cowpea	ton/ha
69.	Pigeonpea	ton/ha
70.	Chickpea	ton/ha
71.	Lentil	ton/ha
72.	Groundnut	ton/ha
73.	Sesame	ton/ha
74.	Soybean	ton/ha
75.	Sunflower	ton/ha
76.	Cotton	ton/ha
77.	Sisal	ton/ha
78.	Cassava	ton/ha
79.	Sweet potato	ton/ha
80.	White potato	ton/ha
81.	Yam	ton/ha
82.	Banana	ton/ha
83.	Enset	ton/ha
84.	Sugarcane	ton/ha

85.	Pineapple	ton/ha
86.	Pyrethrum	ton/ha
87.	Coffee	ton/ha

DATA MATRIX III

PHYSICAL DATA

88-90 CPSZ

88.	CPSZ map unit		code
89.	Agroclimatic code		code
90.	Irrigation status		class

91-94 Climatic regime

91.	Thermal zone		class
92.	Length of growing period	class	
93.	Number of growing periods		class
94.	Number of planting seasons		class

95-102 Altitude and temperature regime

95.	Average altitude		m
96.	Maximum altitude		m
97.	Minimum altitude		m
98.	Altitude geographical SD		m
99.	Annual mean temperature	˜C	
100.	Highest annual mean temperature		˜C
101.	Lowest annual mean temperature		˜C
102.	Temperature geographical SD		˜C

103-106 Start growing period season 1 (main season)

103.	Start growing period (calculated from climate)		dekad
104.	Start growing season (derived from crop calendar: first planted crop)	dekad	
105.	Start growing season (derived from NDVI - average 1982-90)		dekad
106.	Inter-annual SD of start growing season (from NDVI - 1982-90)		dekad

107-110 End growing period 1 (main season)

107.	End growing period (derived from climate)	dekad	
108.	End growing season (derived from crop calendar: last harvested crop)	dekad	
109.	End growing season (derived from NDVI - average 1982-90)	dekad	
110.	Inter-annual SD of end growing season (from NDVI - 1982-90)		dekad

111-114 Length growing period 1 (main season)

111.	Length growing period (derived from climate)		dekad
112.	Length growing season (derived from crop calendar: longest crop cycle)		dekad
113.	Length growing season (derived from NDVI - average 1982-90)		dekad
114.	Inter-annual SD of length growing season (from NDVI - 1982-90)		dekad

115-118 Start Growing period season 2 (second season)

115.	Start growing period (calculated from climate)		dekad
116.	Start growing season (derived from crop calendar: first planted crop)	dekad	
117.	Start growing season (derived from NDVI - average 1982-90)		dekad
118.	Inter-annual SD of start growing period (from NDVI - 1982-90)		dekad

119-122 End growing period 2 (second season)

119.	End growing period (derived from climate)	dekad	
120.	End growing season (derived from crop calendar: last harvested crop)	dekad	
121.	End growing season (derived from NDVI - average 1982-90)	dekad	
122.	Inter-annual SD of end growing season (from NDVI - 1982-90)		dekad

123-126 Length growing period 2 (second season)

123.	Length growing period (derived from climate)		dekad
124.	Length growing season (derived from crop calendar: longest crop cycle)		dekad
125.	Length growing season (derived from NDVI - average 1982-90)		dekad
126.	Inter-annual SD of length growing season (from NDVI - 1982-90)		dekad

127-132 Soil and Terrain Parameters

127.	Weighted average readily available soil moisture		mm
128.	SD readily available soil moisture		mm
129.	Inherent soil fertility class	class	
130.	Average terrain/slope characteristics		%
131.	Slope class		class
132.	Waterlogging/ponding hazard (%)		%

133-140 NDVI derived data

133.	NDVI average (1982-90)		index
134.	NDVI average during total first growing season		index
135.	NDVI maximum during total first growing season		index
136.	NDVI minimum during total first growing season		index
137.	NDVI average during total second growing season		index
138.	NDVI maximum during total second growing season	index	
139.	NDVI minimum during total second growing season	index	
140.	NDVI geographical SD		index

141-166 Interpolated average monthly rainfall and PET

141.	Rain January		mm
142.	Rain February		mm
143.	Rain March		mm
144.	Rain April		mm
145.	Rain May		mm
146.	Rain June		mm
147.	Rain July		mm
148.	Rain August		mm
149.	Rain September		mm
150.	Rain October		mm
151.	Rain November		mm
152.	Rain December		mm

153.	Average annual rainfall	mm
154.	PET January	mm
155.	PET February	mm
156.	PET March	mm
157.	PET April	mm
158.	PET May	mm
159.	PET June	mm
160.	PET July	mm
161.	PET August	mm
162.	PET September	mm
163.	PET October	mm
164.	PET November	mm
165.	PET December	mm
166.	Average annual PET	mm

167-180 Average monthly NDVI

167.	NDVI January	Index
168.	NDVI February	Index
169.	NDVI March	Index
170.	NDVI April	Index
171.	NDVI May	Index
172.	NDVI June	Index
173.	NDVI July	Index
174.	NDVI August	Index
175.	NDVI September	Index
176.	NDVI October	Index
177.	NDVI November	Index
178.	NDVI December	Index
179.	Average annual NDVI	Index

DATA MATRIX IV

AGRONOMIC DATA

180-181 CPSZ

180.	CPSZ map unit	code
181.	Agroclimatic code	code
182.	Crop and Pasture zone	class
183.	Cropping density	class
184.	Dominant cropping pattern	class
185.	Associated cropping pattern	class
186.	Dominant crop	code
187.	Second crop	code
188.	Third crop	code
189.	Fourth crop	code
190.	Fifth crop	code

191-222 Crop management calendar/crop phenological stages of first crop

191-206 Main season

191.	Land preparation start	dekad
192.	Land preparation end	dekad
193.	Planting start	dekad
194.	Planting end	dekad
195.	Fertilizing start	dekad
196.	Fertilizing end	dekad
197.	Weeding start	dekad
198.	Weeding end	dekad
199.	Harvest start	dekad
200.	Harvest end	dekad
201.	Initial stage	# biodekads
202.	Vegetative stage	# biodekads
203.	Flowering stage	# biodekads
204.	Reproductive stage	# biodekads
205.	Crop growth cycle length	# biodekads
206.	Yield	ton/ha

207-222 Second season

207.	Land preparation start	dekad
208.	Land preparation end	dekad
209.	Planting start	dekad
210.	Planting end	dekad
211.	Fertilizing start	dekad
212.	Fertilizing end	dekad

213.	Weeding start	dekad
214.	Weeding end	dekad
215.	Harvest start	dekad
216.	Harvest end	dekad
217.	Initial stage	# biodekads
218.	Vegetative stage	# biodekads
219.	Flowering stage	# biodekads
220.	Reproductive stage	# biodekads
221.	Crop growth cycle length	# biodekads
222.	Yield	ton/ha

223-254 Crop management calendar/crop phenological stages of second crop

255-286 Crop management calendar/crop phenological stages of third crop

287-318 Crop management calendar/crop phenological stages of fourth crop

319-350 Crop management calendar/crop phenological stages of fifth crop

DATA MATRIX V

LIVESTOCK DATA

351-352 CPSZ

351.	CPSZ map unit		code
352.	Agroclimatic code		code
353.	Livestock system	class	

354-358 Herd composition

354.	Cattle		% of herd
355.	Sheep		% of herd
356.	Goat		% of herd
357.	Equine		% of herd
358.	Camel		% of herd
359.	Water points		class
360.	Pasture potential	class	
361.	Pasture availability		class
362.	Overgrazing risks		class
363.	Type of grazing		class
364.	Livestock/crop ratio		(%)

DATA MATRIX VI

ENVIRONMENTAL HAZARD DATA

365-366 CPSZ

365.	CPSZ map unit	code
366.	Agroclimatic code	code

367-370 Frost

367.	Start	dekad
368.	End	dekad
369.	Frequency of occurrence	%
370.	Severity/damage	class

371-374 False start of main growing season

371.	Normal start	dekad
372.	False start	dekad
373	Frequency of occurrence	%
374.	Severity/damage	class

375-378 Dry spell

375.	Start	dekad
376.	End	dekad
377.	Frequency of occurrence	%
378.	Severity/damage	class

379-382 Wet spell/ excessive wetness

379.	Start	dekad
380.	End	dekad
381.	Frequency of occurrence	%
382.	Severity/damage	class

383-386 Hailstorm

383.	Start	dekad
384.	End	dekad
385.	Frequency of occurrence	%
386.	Severity/damage	class

387-390 Flooding

387.	Start	dekad
388.	End	dekad
389.	Frequency of occurrence	%
390.	Severity/damage	class

DATA MATRIX VII

PESTS AND DISEASES DATA

391-392 CPSZ

391.	CPSZ map unit	code
392.	Agroclimatic code	code

393-462 Pest hazards

393.	**Crop 1**	**code**
394.	Pest 1	code
395.	Start	dekad
396.	End	dekad
397.	Frequency of occurrence	%
398.	Severity/damage	class
399.	Pest 2	code
400.	Start	dekad
401.	End	dekad
402.	Frequency of occurrence	%
403.	Severity/damage	class

404-414 Pests on crop 2
415-425 Pests on crop 3
426-436 Pests on crop 4
437-447 Pests on crop 5

448-502 Disease hazards

448.	**Crop 1**	code
449.	Disease 1	code
450.	Hazard period start	dekad
451.	Hazard period end	dekad
452.	Frequency of occurrence	%
453.	Severity/damage	class
454.	Disease 2	code
455.	Hazard period start	dekad
456.	Hazard period end	dekad
457.	Frequency of occurrence	%
458.	Severity/damage	class

459-469 Diseases on crop 2
470-480 Diseases on crop 3
481-491 Diseases on crop 4
492-502 Diseases on crop 5

Appendix 3

List of Codes and Classifications used in the Data Matrices

Classes used for the qualitative data contained in the CPSZ database are listed in this Appendix. Additional codes are listed in file "MORECODE.TXT" on the diskette.

Physical data:

Thermal regime	1	Warm (> 25 C)
	2	Moderately Warm (20-25 C)
	3	Moderately Cool (15-20 C)
	4	Cool (10-15 C)
	5	Cool/Cold (< 10 C)
Moisture regime	0	Hyper-arid (0 days of growing period)
	1	Arid (1-59 days of growing period)
	2	Dry semi-arid (60-119 days of growing period)
	3	Moist semi-arid (120-180 days of growing period)
	4	Sub-humid (180-270 days of growing period)
	5	Humid (> 270 days of growing period)
Moisture distribution	0	none (no growing period)
	1	one reliable growing period
	2	two reliable growing periods
	3	one or two short/unreliable growing periods
Soil fertility	1	Low
	2	Low-medium
	3	Medium-low
	4	Medium
	5	Medium-high
	6	High-medium
	7	High
	8	Low-medium-high

Agronomic data:

Cropping density	1	no crops
	2	sparsely cropped
	3	patchy cropped
	4	partially cropped
	5	fully cropped
Cropping pattern	1	sole cropping
	2	double cropping
	3	relay cropping
	4	intercropping

Livestock information:

Livestock system	1	nomadic
	2	semi-nomadic
	3	sedentary
Pasture potential	1	bad
	2	poor
	3	medium
	4	good
Pasture availability	1	bad
	2	poor
	3	medium
	4	good
Waterpoints	1	very poor
	2	poor
	3	fair
	4	good
Type of grazing	1	free range
	2	zero grazing
	3	free range and zero grazing
	4	nomadic range
	5	free and nomadic range
Overgrazing risk	1	extreme
	2	high
	3	low
	4	very low

Climatic hazards:

Climatic hazard severity	1	low
	2	medium
	3	high

Pest and diseases:

Pest and disease damage	1	light
	2	moderate
	3	severe

General crop codes:

Code	Crop	
1.	Barley	Hordeum vulgare
2.	Maize	Zea mays
3.	Millet bullrush (pearl)	Pennisetum typhoides
4.	Millet finger	Eleusine coracana
5.	Oat	Avena sativa
6.	Rice	Oryza sativa
7.	Sorghum	Sorghum bicolor
8.	Teff	Eragrostis tef
9.	Wheat	Triticum aestivum
10.	Other cereals	
11.	Phaseolus bean	Phaseolus vulgaris
12.	Cowpea	Vigna unguiculata
13.	Pigeonpea	Cajanus cajan
14.	Chick pea	Cicer arietinum
15.	Lentil	Lens culinaris
16.	Other pulses	
17.	Groundnut	Arachis hypogaea
18.	Sesame (Simsim)	Sesanum indicum
19.	Soybean	Glycine maximum
20.	Sunflower	Helianthus annuus
21.	Other oil crops	
22.	Cotton	Gossypium hirsutum
23.	Sisal	Agave sisalana
24.	Other fibre crops	
25.	Cassava	Manihot esculenta
26.	Sweet potato	Ipmomoea batatas
27.	White potato	Solanum tuberosum
28.	Yam	Colocasia esculenta
29.	Other root and tuber crops	
30.	Banana	Musa Spp
31.	Enset	Ensete ventricosum
32.	Sugercane	Saccharum officinarum
33.	Pineapple	Ananas comosus
34.	Pyrethrum	
35.	Vegetables	
36.	Coffee	Coffea arabica/robusta
37.	Tea	Camelia sinenis
38.	Other narcotics and stimulants	

39. Tree crops / fruits

40. Pasture
41. Forage

All other crops reported by the national consultants were grouped:

Other pulses:	Field pea, Grass pea, Faba bean, Vetch, Green grams, Lima beans, Dry broad bean.
Other oil corps:	Noug, Linseed (Flax), Rape seed, Safflower
Vegetables:	Onion, Tomato, Pepper, Swiss cabbage, Carrot, Okra, Lettuce, Water melon, Garlic, Egg plant, Cucumber, Purslane, Jews mellon, Squash, Pumpkin, Musk melon.
Other fibre crops:	Kenaf.
Other narcotics and stimulants:	Chat and Tobacco.
Tree crops/Fruits:	Cashewnut, Coconut, Citrus, Cocoa, Vanilla, Passion Fruit, Mangoes, Date, Guava, Karkadae, Oil palm.

Appendix 4

Guidelines for the use of CPSZ database viewer software

This Appendix contains detailed guidelines on the use of the CPSZ database viewer software. The text can also be found on the diskette in file "CPSZVIEW.TXT".

CPSZ database viewer software

The software CPSZ VIEWER facilitates the access to the CPSZ database and aims at enhancing the usefulness of the database in general. The two main functions of the software are to present the data in a user-friendly way and to simplify the orientation of the user in the CPSZ base map.

For users not entirely familiar with the geography of the region, the software allows to draw the main infrastructure data on the base map. Drawing roads, towns, rivers, ... will give a better idea of the geographical location of each of the CPSZ map units.
The CPSZ database itself can be accessed in several ways using automatically created thematic maps and other type of information display. All data, including the boundary files, can be exported for further analysis.

The software however, does not provide for any updating or editing facility and the databases can not be modified in any way. There is also no provision for data analysis in the software itself. Users can export data, and reformat it for their current data analysis software.

1. Requirements for CPSZ database viewer software

The CPSZ VIEWER software requires an IBM compatible computer with 2 MB free space on the hard disk, and a VGA colour screen. A mouse is compulsory and requires a Microsoft mouse or compatible driver, version 8.0 or later.

2. Installing and running CPSZ VIEWER

The software and the database can easily be installed using the installation routine.

To install CVIEW:

- Insert the diskette into drive A (or B). Type the following command, then press the Enter key.

  A:INSTALL A: C:

  This if you want to install the software on drive C:, suppose you want to install from drive B: to D: then type B:INSTALL B: D:.
- If the hard disk does not have 2 MB of free space, the installation will be aborted. You should then make extra room on the disk.
- The directory CVIEW will be created on the destination drive and this directory will contain the programme. All data files are stored in the subdirectory DATA, and these files should not be altered for proper functioning of the programme.
- At the end of installation, you might want to add the directory C:\CVIEW to the path of your AUTOEXEC.BAT.

To run CVIEW:

- Make sure that the mouse is connected and that the mouse driver (MOUSE.COM) is loaded.
- Go to directory C:\CVIEW and type CVIEW or alternatively if you included C:\CVIEW in the path of the AUTOEXEC.BAT, just type CVIEW.
- All files must be present, otherwise the programme will not run. These files are:

- CVIEW.EXE : The programme

All data files are in subdirectory \DATA:

- CPSZDATA.BIN : CPSZ database

- CPSZLEG.BIN : CPSZ legends
- CPSZINFO.BIN : CPSZ summary
- IGADD.BND : CPSZ map units boundary file
- IGADD.SUM : CPSZ summary boundary file
- IGADDEB.BND : Country boundary file
- TOWNS.BND : Towns
- ROADS.BND : Boundary file of the roads
- RAILWAY.BND : Boundary file of the railways
- RIVERS.BND : Boundary file of the rivers
- LOGO.SCR : the logo for the opening screen

4. Using the CVIEW software

Mapping the CPSZ map and infrastructure data.

Once the CVIEW programme has started, the CPSZ base map will be drawn on the screen.
When moving the mouse over the map, longitude and latitude of the mouse pointer will be displayed in the box at the right. Some simple manipulation with the map are:

a. Zooming

The first thing you may want to do is to zoom in a specific area of the map. Therefore, select with the mouse ***ZOOM*** in the menu and pick two corners of the area to zoom.
The base map and attributes, if previously selected, will be redrawn.

b. Resetting the map

There are two ways to reset the base map. By selecting ***RESET*** in the menu, the map is being reset at its original size, and all attributes, such as towns and themes, are removed.
Option ***REDRAW*** however will only remove the attributes excluding the theme if a thematic map was on display. This means that the previously set ZOOM factor does not change. When a thematic map was displayed, and REDRAW is selected, the newly drawn map will show the CPSZ map unit boundaries.

c. Unzoom and pan.

The small arrows below the menu (see outline) allow to unzoom and to pan. Once zoomed, you can unzoom or move the screen over the map (panning) using pre-defined steps. Panning can be done in the four directions and is always for 1.5 degrees. The unzoom feature will reset the map to its original size.

d. Displaying infrastructure data on the CPSZ map.

By selecting ***TOWNS***, ***ROADS***, ***RIVERS***, ***RAILWAY*** in the menu you will draw the respective infrastructure on the base map.
Towns and roads can be displayed at different levels. Towns are grouped in three categories: capitals, towns and villages. You can select any of these. Also for roads there are three levels: Hard Surfaced roads, (Partially) improved roads and Earth roads.

e. Selecting CPSZ map units

To obtain information about a singular map unit you can either select it by pointing the mouse on a specific unit or by the option ***SELECT*** in the menu. When you prefer the latter, then you must provide the CPSZ map unit code (e.g. ET125, UG25...).

The selected map unit will be highlighted and a box with the most important information for that unit will appear below the map. Select ***DETAIL*** to visualize in detail the CPSZ data available for the map unit. General, physical and agronomic data can be displayed, and if more detailed list of the data is necessary, all data can be exported in an ASCII file.

f. Saving a map as PCX image

A map actually displayed on the screen can be saved as PCX, and further edited in image editing software. The menu will not be included in the image, and if a thematic map is on display, the legend will instead be saved.

g. Quitting the programme

Select ***QUIT*** to quit CVIEW and go back to DOS.

Accessing the CPSZ data base

Access to the CPSZ database is provided through the option ***CPSZ DATA*** in the menu. Displaying automatic or customized thematic maps, exporting CPSZ data and boundary files is done through this menu. Access to the CPSZ database for one selected CPSZ map unit is described above.

Select ***CPSZ DATA*** and a new screen will appear, with the box at the left listing the data groups, including the map files. At the right of this box you will find the items which belong to the actually selected data group. Use the arrows to move the cursor in the boxes. To select an item, you must point at the item and a star will appear at the right of the item, indicating that the item is selected. In the same way you can deselect items. Selecting items is only necessary for exporting data.

h. Automatic thematic maps

Automatic thematic maps will be prepared for these items for which a legend is displayed. For the other items you should use **Customized thematic map** instead, but most of these maps will have no significant meaning.
The automatic map will be prepared for the data item the cursor is positioned even if you selected other items before.
Select ***AUTO MAP*** in the menu and the thematic map will be displayed on the screen. All previously selected attributes are removed, and only the national boundaries are drawn.
Again you can zoom, draw infrastructure data etc...
The title will be displayed on the map area, and the legend will replace the menu. Move the mouse pointer to the menu area to re-display and access the menu. Moving the mouse pointer back to the map area will show the legend.

Unlike the national boundaries, boundaries of the CPSZ map units are not drawn, but selecting the ***REDRAW*** option in the menu, will include these and will facilitate your orientation.

i. Customized thematic maps

Almost all data of the CPSZ database, excluding the boundary files, can be mapped by the user. It should be noted however that most data items in the database for which no automatic mapping was foreseen, will not result in meaningful maps, since some re-arrangement of the data is necessary.

Creating a customized thematic map requires following input from the user: the class dividers and the colours, to be chosen from a standard colour scheme. Up to 12 classes can be created and colours can be chosen from the samples displayed on the screen.

Option ***CASES*** in the menu computes the number of cases for each class.

j. Exporting CPSZ data

CPSZ data are exported in ASCII format (see box below). You can select as many items as you wish from different data groups. The sequence of the data in the exported file is always sequential according to the number of the data items in the list, and not in the sequence they were selected.

The first column of the exported file will always contain the CPSZ map unit code, it is therefore not necessary to select it when exporting.

Export data file format

Export data files from the CPSZ-VIEWER programme are in comma separated ASCII format. All strings in the files are quoted, to allow easy import in Lotus 123. Below is an explanation of the data file format:

Line 1 - Title

The title is standard and gives date and time of the export.

Line 2 - Number of variables (N)

This line contains only a number, with how many variables are in the data file. The data are stored in rows and columns, where each column contains a different variable, or measured quantity and each row represents a different CPSZ map unit. The data file may hold as many variables as you want.

Line 3 to N+2 - Variable names and measurement units

The lines following the number of variables contain the names for each variable. Both are quoted, and separated by a comma.
The first line (corresponding to the first variable) will always contain the names of the CPSZ map units.

Line N+3 to End of File - the Data matrix

This is where the data are stored. Columns represent variables, and rows represent CPSZ map units. In a given line in the file, variable values are separated by one comma, with units specified above. String variables are always quoted.

k. Exporting CPSZ boundary files

Exporting CPSZ boundary files is done in the same menu CPSZ Data.

CPSZ boundary files include all the map files being used by the programme, including the infrastructure data. Files are exported in the BNA format, which is directly compatible with IDA (Image Display and Analysis) or can be imported by most other mapping software.
All files are exported with two names in the header. CPSZ map units are exported as polygons, roads, rivers... as lines and towns as points.

Export of boundary files is only possible if no other item of the CPSZ data matrix was selected.

NOTE TO THE USERS

The Crop Production Systems Zones inventory map sheet (A0 format) and other information missing from this electronic document can be found in the printed version of the publication which is part of the FAO Agrometeorology Working Paper Series No. 10.

Copies can be obtained by contacting:

IGAD
Intergovernmental Authority on Development
P.O. Box 2653
Djibouti
Djibouti

Tel: +253 - 354050
Fax: +253 - 356994/356284/353195
Email: igad@intnet.dj

Copies of the A0 map sheet can also be obtained from:

The Coordinator
Agrometeorology Group
Environment and Natural Resources Service
SDRN - FAO
Viale delle Terme di Caracalla
00100 Rome, Italy

Tel: +39-6-57054121
Fax: +39-6-57055731
Email: agromet@fao.org