EXECUTIVE SUMMARY

FOR THE

LAND CLASSIFICATION AND SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

MAY 1983

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OF THE

YEMEN ARAB REPUBLIC

Contract No. AID/NE-C-1665

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EXECUTIVE SUMMARY

AN OVERVIEW OF THE LAND CLASSIFICATION AND SOIL SURVEY OF THE YEMEN ARAB REPUBLIC USAID CONTRACT NO. AID/NE-C-1665

INTRODUCTION

Without a doubt, information about the nature and distribution of soils and land use of Yemen is vital for development and improvements in the country. Both general and detailed soil and land use maps are essential for selecting and planning projects. Many agricultural projects of various sorts have been proposed or undertaken by international development agencies and by the Yemen government itself. All of these projects can or could have benefitted from some kind of soil and land use survey. As a first step, this project has produced generalized soil and land use maps of the entire area of the Yemen Arab Republic west of longitude 45 degrees 30 minutes east, not including Red Sea islands.

The soil map at 1:500,000 scale gives information on the general distribution of soils throughout all of the Yemen Arab Republic. It will be very useful in locating general areas of soils of high potential for specific agricultural development projects. Once a general area is located it will be necessary to undertake a more detailed soil survey at a larger scale so that site-specific soil information will be available.

This soil survey will also serve another very useful purpose. Important agronomic technology painstakingly developed in other areas of the world with similar soils and climates may be transferred to areas in Yemen without repeating many years of expensive research. This transferability is possible because map units in the survey are classified according to Soil Taxonomy. Soil Taxonomy is a quantitative, scientific means of classifying soils. Because of its quantitative nature, it permits transfer of successful management techniques from one area to similar soils in another.

The land use map reflects much of the information found in soil surveys in many ways. In defining and classifying the land use/cover for Yemen Arab Republic, a regional geographical analysis approach was identified as being appropriate. Yemen was divided into four major regional units and eighteen specific elements of land use. The land use elements, viewed as subsets of a region, reflect thematically the physical and cultural features and localized land use practices that

can be systematically identified. Within the four regional units of the Tihama Coastal Plain, Western Highlands, Central Highlands, and Eastern Plateau, the major agricultural land use elements or categories identified are intensive agriculture, rainfed cropland, terrace and wadi cultivation, cultivated highland plains, and plateau wadi agriculture.

Mapping was planned, coordinated, and carried out at the national level to facilitate integration into other base data sets now existing or those that might be developed in the future. The spatial information which has been prepared can be used for a range of agricultural or natural resource development applications.

CONTRACT OBJECTIVES

The contract called for the preparation of a general soil map of the Yemen Arab Republic at a scale of 1:500,000 and a land use map at a scale of 1:250,000. With the presentation of this report and maps, the terms of the contract have been met. In certain respects, the terms of the contract have been exceeded. For example, for the soil survey, in addition to having map units described as associations of subgroups in the legend, the one hundred individual soil profiles described and sampled in the field have been classified to the family level and some cases as phases of families. Additional mineralogical analyses were also performed to permit classification to this level. Finally, a reconnaissance of the vegetation of the Yemen Arab Republic has been made and is discussed in the main report.

The original intention was to provide land use maps on a classification prepared for the US Geological Survey, known as Level I Classification, from the USGS Professional Paper No. 964. The techniques used allow for the production of a much more detailed classification of land use. Minimum map units were reduced and higher degrees of accuracy were obtained than had been originally projected. Information on population as well as topography was incorporated into the data base, providing correlative data which considerably expands the effective utility of the mapped land use information.

BACKGROUND INFORMATION COLLECTION FOR THE SOIL SURVEY AND LAND USE SURVEY

SOIL SURVEY

The initial stages of the soil survey involved collection of background information in both Yemen and at Cornell on geological and climatic data and also on agricultural surveys and projects which had been completed in Yemen, particularly those which had soils components. This information was needed to determine a soil survey strategy and to determine in what areas it would be most practical to concentrate survey efforts.

After information had been collected and digested on geology, geomorphology, climate, and existing soils studies, a field methodology was determined. In the determination of this field methodology, soil genesis principles for Yemen were defined by several reconnaissance studies in diverse areas of the country. Soil parent materials were observed and defined. Of particular interest in this regard was the predominant influence of calcareous windblown fine material (loess) deposited over large areas of the country and, also, the volcanic parent rocks which are extensive throughout most of the country. Also of interest was the great extent of human influence on soil formation, through the construction of terraces in the mountainous regions and extensive spate irrigation on the intermountain plains and Tihama. As a result of these reconnaissance studies soils/landscape relationships and the approximate areal size of soil map units were defined.

Additional background information important for agricultural/ecological studies in Yemen is included in this report. A detailed vegetation study was made and is reported here for all of Yemen (Chapter 3, main report text). This study details the distribution of plant types by area as shown on accompanying maps.

LAND USE SURVEY

Statistical compilation for each 100km UTM referenced cell has included the total cultivated land within each land use/cover category, mean percentage of cultivated land, and variance among land class samples. Data have also been developed and geo-referenced on the agricultural land use map as derived from topographic maps and on the basis of population density/distribution. The land use map indicates a total estimated cultivated land area of 2.06 million hectares for the Yemen Arab Republic. This estimate includes all active and fallow agricultural land and represents 17.2% of Yemen's total land area within the project study area (west of 45 degrees 30 minutes east longitude, not including Red Sea islands).

MAKING THE SOIL AND LAND USE MAPS OF YEMEN ARAB REPUBLIC

SOIL MAP

After the reconnaissance stage of determining soil genetic relationships, the actual field methodology involved selecting appropriate "pilot" sites thought to be typical of the major soils of a particular region. Typical pilot sites were approximately several hundred square kilometers in area. Within the pilot sites profile sites were selected. Profiles were dug, described and samples taken for laboratory analyses. On the basis of the laboratory results and the description of morphological features of the soil in the field, the soil profiles were then classified to the subgroup level according to the principles set forth in Soil Taxonomy. As profiles and pilot sites were described and studied, Landsat false-color infrared imagery was studied and boundaries for pilot sites were drawn as were boundaries for other areas which had features similar to the observed pilot sites. These other sites which showed similarities on the imagery were then usually checked in the field on a later visit.

An important element of the field operations in Yemen was the development and analysis of soil samples at the Taizz FAO research laboratory. Several critical pieces of equipment were bought, sent to the lab, and made operational. Among other items, this equipment included a water distillation unit and a pipette system for detailed particle-size analysis. Similar lab analyses were performed at Cornell on several of the same soil samples analyzed at Taizz for quality control purposes. The soil chemistry laboratory at Taizz provided all of the basic data to classify the soil profiles at the subgroup level. Clay mineralogy was determined by Cornell researchers in order to classify the soil profiles to the family level. Classifying the soils to the family level should aid in the transfer of soils technology to the Yemen Arab Republic from other areas in the world.

LAND USE MAPS

The Yemen land use classification, developed and used in Project 279-0042, contains several categories of agricultural land. Some of these include nearly 100% cropland. Each agricultural land use category contains a relatively consistent percentage of actual cropland.

Several sample sites representing each land use category were compiled through a stratified random selection process. A percentage of cropland was calculated for each sample site using standard aerial photographic interpretation and remote sensing techniques, and these were averaged to yield a mean.

In the Yemen land use inventory, land use and vegetative cover in Yemen were mapped from satellite imagery, geographically referenced, and statistically summarized. Multispectral imagery from the earth resources satellite Landsat III was spectrally enhanced using masking techniques, chromatic Diazo materials, and standardized photographic and optical processes. The area west of 45 degrees 30 minutes east longitude was mapped from these images at a scale of 1:250,000. The minimum map unit was 25 hectares. The Universal Transvers Mercator (UTM) grid system was incorporated for geographic referencing, statistical summary of land use measurements, and data storage and retrieval, using a standard cell size of one hundred square kilometers.

HOW TO USE THE SOIL AND LAND USE MAPS AND REPORTS

SOIL MAP AND REPORT

The map and legend are intended to show the general distribution of the different soils of the Yemen Arab Republic. The map and legend should permit agricultural planners to locate general areas suitable for different agricultural projects. For example, if a citrus farm or experimental nursery is being proposed, the map will, firstly, help planners to eliminate those areas which are definitely unsuitable. From those areas left the most suitable may be selected. The map should not be used to actually site a specfic farm or field. It does not include enough detail to do this. For actual siting a more detailed survey will have to be performed.

In deciding which areas are generally suited for specific projects, interpretations of map units will have to be made. To make an interpretation of a specific map unit for a certain crop, for example, the soil and climatic requirements of that crop need to defined. An experienced agronomist can do this. Once the crop's requirements are known, then these can be compared to the requirements (or lack of them) of the crop in question. In the main report, interpretations have been made for twelve important crops on seventy-two different soil groups (families) in Yemen. The crops are maize, sorghum, cotton, millet, citrus, dates, bananas, wheat, chick peas, potatoes, coffee, and alfalfa. For example, suppose a planner is interested in locating a possible site for citrus production. Soil groups (families) with isothermic temperature regimes, deep and well drained, with no aquic moisture regimes (high water tables) would be very suitable. Such a soil will be found in map unit number nine, which contains Typic Ustorthents with isothermic temperature regimes (see the soil map legend printed on the map and in chapter 5). Soil groups (families) with isomesic (fairly cool) temperature regimes are unsuitable for citrus production. This information is given in detail

in the body of the report. Once the different soils, suitable or unsuitable, for the production of certain crops are known, the planner can refer to the legend on the map to see which map units are appropriate. By matching the color and designation symbol of the map unit the planner can then determine those areas in Yemen which are most appropriate and likewise those areas which are not.

LAND USE MAP AND REPORT

Careful examination of the maps will give the reader a better appreciation of the complexity of Yemen's agricultural lands and in particular of the relationships between the agricultural lands, population distribution, and the physical environment.

The land use maps display the location and area of four regional units: the Tihama Coastal Plain, Western Highlands, Central Highlands, and Eastern Plateau. A total of eighteen land use classification units were identified. Major agricultural land use elements identified are intensive, rainfed, terrace and wadi, cultivated highland plains, and plateau wadi agriculture. The intensity of agricultural land use, or amount of land used for various basic types of agriculture can be identified, located, and measured from these maps. Evaluation of the land use maps can demonstrate relationships between the agricultural lands, population distribution, and the physical environment. Planning functions can use the information effectively to maximize use of or protection of the most productive land use areas.

FUTURE SOILS AND LAND STUDIES

SOILS

The cost of producing this map has been estimated to be approximately $0.047 per hectare. The AID project review team considered this figure to be very cost-efficient. The economic benefits to be made through efficient and effective planning, if the map is used properly, will greatly outweigh the costs of the survey.

As stated previously, however, more detailed surveys need to be undertaken for project site location and feasibility studies. The soil map produced under this contract should only be considered a first step towards the development of a Yemen Arab Republic national soil survey center. There is a great need for trained Yemeni soil scientists. The Yemen government should not depend on expatriate soil scientists to make and interpret all of its soil surveys. More detailed soil surveys should ideally be carried out by a trained cadre

of Yemeni soil scientists reporting to a specific government office. This will permit a much greater degree of sound agricultural planning and efficient use of Yemen's most important natural resource: its soils. A trained cadre of Yemeni soil scientists could produce the needed detailed surveys upon request by government planners. In this way the government could assure that the most suitable sites in Yemen were being properly selected for all agricultural projects. Also the soil survey bureau could be used as a data repository for all related information.

LAND USE

The present land use map system was produced at a recognized low cost of $0.03 per hectare. Project review personnel figured this expense to be about one-half to two-thirds of the expected cost for this quality of product.

The land use project has been developed in concept as a multi-phased program. The work completed represents Phase I. Phase II should be carried out as a means of generating more detailed information about a broader range of classifiable land use units. The minimum map unit would be reduced to one hectare or less.

By generating more detailed land use survey information far greater values may be gained for applications in the planning and management of the country's productive land resources. Aerial photographs provide greatly increased amounts of information over what can be prepared from satellite imagery, and they would be most useful to a more detailed survey effort.

Through the use of a more detailed land use inventory (whether computerized or manually prepared) planning groups at all levels of government could assure that the quality of the land-based resources would match the productive use of the resource.

TECHNOLOGY TRANSFER TRAINING PROGRAM

Institutionalization through technology transfer and adaptation is one of the major objectives of the Yemen land classification and soil survey project. To facilitate this objective a specially designed training program was integrated with the originally contracted project work. Two Yemen Ministry of Agriculture staff members were sponsored for one year of academic study in the United States at Cornell University. They took formal and informal courses in soils, remote sensing, land use, and natural resources. In addition they received instruction in the identification of appropriate technologies applicable to their country--specifically in respect to how a particular technological development package integrates into their social, economic, technical, and/or physical environment. With all this a substantial base of knowledge now exists for Yemen. It is on this base that agricultural planning can begin to depend--providing this type of information is maintained, disseminated to users, and kept updated through a resource information office.

MAIN REPORTS

The soil survey main report is composed of one volume on the soil survey and interpretations including the map in the back pocket. The soil report includes sections on soil genesis, classification, vegetation, the map legend, and management and interpretations of soils for agricultural uses.

The main report of the land use survey includes three volumes: the main body, appendices and bibliography, and map sets enclosed in three portfolios.