S O I L M A N A G E M E N T -

A F G H A N I S T A N

By

Dr. J. W. Fitts
Director of the International Soil Testing Project
North Carolina State University

Agriculture Division
U.S. Agency for International Development
Kabul, Afghanistan

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PREFACE

Dr. J. W. Fitts, the author of this report, is Director of the International Soil Testing Project of North Carolina State University at Raleigh.[1] The Agency for International Development Mission to Afghanistan (USAID) was fortunate to be able to obtain the services of Dr. Fitts for consultation for an eighteen day period from September 10 to September 28, 1967.

While in Afghanistan Dr. Fitts reviewed the needs and potentials for a soil testing program and for soils management. He visited the soils laboratories of the Faculty of Agriculture, Kabul University, and those of the Ministry of Agriculture and Irrigation, and spent considerable time with employees and officials of the Ministry. He also visited some of the farming areas and noted soil conditions and management practices and problems. Finally he conducted a two-part Seminar (one session each day on two different days) which was participated in by Ministry officials, employees, foreign advisors on soils and agronomy, students of Kabul University and Peace Corps Volunteers.

His report will be valuable as a guide to the further development of soils study and management in Afghanistan.

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[1] This is an AID financed project for Latin America but may be expanded to serve countries in other areas.

SOIL MANAGEMENT - AFGHANISTAN

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SOIL MANAGEMENT - AFGHANISTAN

Introduction

Increasing crop production is of utmost importance to Afghanistan. First of all, the current food deficit (reportedly more than 250,000 tons of wheat alone in 1966) must be overcome. Then, an increase in crop production must be obtained to take care of the increase in population and to bolster the economy of the country. Approximately 13 million acres are reported to be under irrigation in Afghanistan, but only 60 percent of this area is cultivated each year. A little over 5 million acres are dry-farmed. Although there may be some increase in irrigated land (perhaps 60,000 acres by 1971) most of the increase in crop yields must come from lands which are presently cultivated. Bringing all irrigated lands into production each year will help considerably. This will entail a more judicious use of water in many instances in order to have enough to irrigate all areas.

Increasing the yield of wheat is a major program in Afghanistan. The use of improved wheat varieties must be accompanied by better management practices to correct nutrient deficiencies and to maximize the use of the water that is available (both under irrigated and dryland farming). Of course, good cultural practices (planting, cultivating, harvesting) must be followed and pests (weeds, insects, diseases, etc.) controlled. All of the factors influencing crop growth (variety, stand, fertility, water, aeration, climatic conditions, control of pests and cultural practices) must receive attention in order to achieve the high yields desired.

Appreciation

Eighteen days is a short period of time in which to become acquainted with soil fertility and soil management problems of a country. I wish to express thanks to H.E., Minister of Agriculture and Irrigation, Engineer Mir Mohammad Akbar Reza and his staff for information furnished about soils and farming conditions of Afghanistan. Mr. Mohammad Asim of the Water and Soil Survey Authority accompanied me on all trips around the country and was very helpful in interpreting and explaining conditions.

Mr. James B. Davis, Chief of the Agricultural Division, and Mr. Donald R. Yeaman, Deputy Chief of the Agricultural Division of the Agency for International Development, Afghanistan, were responsible for arrangements of the trip and for arranging conferences. For all of their efforts, I am particularly grateful. In the Agricultural areas visited, Mr. T. L. Wilson showed me the agricultural problems and research station near Kunduz; Mr. Reece Dampf was responsible for my trip around Baghlan; and Mr. O. M. Patten for the tour around Mazar-i-Sharif. To these men, may I say, Many Thanks; all of your efforts are much appreciated.

Soil Fertility and Soil Moisture

In semi-arid and arid regions, water is obviously a limiting factor in the production of crops. Much emphasis is given to the development of irrigation projects, and rightfully so. However, as soon as the water is delivered to the land through canal systems or by pumps, then proper distribution of the water becomes very important. Soils vary greatly in water holding capacity, in permeability and in the stability of aggregates to maintain good permeability. The same soil characteristics which are important to irrigated farming are also important to dryland farming. The storage of water per unit of depth of the profile, evaporation from the surface of the soil, and root distribution of the crop will greatly influence the efficiency of water use in irrigation and the effectiveness of dryland farming.

Often, so much emphasis is placed upon water that the equally important factor in crop production, soil fertility, is overlooked. Water cannot substitute for fertility and fertility cannot substitute for water. In order to produce a given yield, for example 80 bushels of wheat per acre, certain amounts of water and nutrients must be available for either irrigation or dryland farming. Having an excess of one over the other does not result in increased yield but an inefficient use of water or nutrients.

In developing an effective soil management program, it is imperative to obtain as much information about the soils as possible. Soil surveys are a source of information relative to the characteristics of the profile. These characteristics do not change materially over a period of many years. However, the plow layer of the soil does change rather rapidly due to the addition of plant and animal residues, to application of soil amendments, to deposition of soil materials and to erosion. Soil testing is an excellent source of information to measure these changes and to predict the response that can be obtained from application of fertilizers or other soil amendments.

Plant tissue testing is another important source of information for use in soil management. A soil test can tell whether the nutrients are present in a soil and the tissue test will indicate whether or not the plant is assimilating these nutrients.

A Soil-Plant Analysis Program

Soil and Plant analyses are means of obtaining information relative to physical properties of the soil, to nutrient deficiencies and adverse soil conditions on specific areas of land. The information obtained must be interpreted in terms of economic practices which the farmer can follow to improve his crop yields. Thus, soil-plant analyses involves a complete program and includes six phases. These are:

1. Representative Samples: The accuracy of the analysis, interpretation of results and recommendations can be no better than the accuracy with which the samples are taken. Much emphasis must be placed upon getting samples that represent the area upon which information is desired.

2. Laboratory Analyses: The laboratory analyses must be made rapidly and accurately. Characteristics of the soil and special conditions encountered will dictate the procedures that can be used successfully. Control samples should be included frequently to assure that accurate laboratory techniques are being used.

3. Interpretation of Results: The data obtained from the analyses must be interpreted in terms of water available to plants, to nutrient deficiencies, and the adverse soil conditions must be identified. Correlation studies with plant growth are essential for the interpretation of the laboratory data.

4. Recommendations: The yield of a crop is influenced by many factors, including; variety of crop, thickness of stand, soil fertility availability, moisture, climatic conditions, control of pests and cultural practices. Recommendations made to the farmer should include suggestions for all good management practices based upon all the information that has been obtained about his farming conditions.

5. Educational Follow-up: The information gained from the analyses must be put into operation in order to have a successful program. Farmers and local agricultural leaders must understand the information and must be able to follow the suggestions. The fertilizers and other materials suggested must be available to the farmer in order that he can use them. Many "tools" will be needed in this educational phase of the program. Radio, movies, slide sets, film strips, charts, posters and publications are important visual and audio aids.

6. Research: The first five phases outlined above are dependent upon the information gained through research. However, it is not necessary for all research to be repeated in every country. Basic facts obtained in one area can be tested in another and if found satisfactory can be utilized immediately. The exchange of information across country boundaries is highly desirable and is one of the important functions of the International Soil Testing Project.

All of the phases of a soil-plant analysis program, outlined above, are very important and must be included in order to achieve a successful program. Periodic review of a program is desirable in order to observe the weakest phases and then steps should be taken to strengthen them.

Observations in Afghanistan

Afghanistan is an agricultural country with more than 80 percent of the total national revenue derived from agriculture. Wheat is the most important crop grown and is responsible for about one-third of the agricultural economy. Cotton, sugar beets, rice, corn and livestock are also important sources of agricultural income.

Organizations Involved in Improving Agricultural Production

The Ministry of Agriculture and Irrigation of the Royal Government of Afghanistan is responsible for the development of Agriculture in Afghanistan. There are several departments of the Ministry, including: Administrative Department, Planning Department, Veterinary Science and Animal Husbandry Department, Plant Protection Department, Research and Extension Department, Forestry and Pastures Department, Irrigation and Engineering Department, Water and Soil Survey Authority and the Construction Department.

The organization of the Ministry indicates the importance assigned to water in crop production. Much emphasis is placed upon development of irrigation systems and in determining the hydrological potential of the various regions of the country.

Helping in obtaining information relative to feasibility of irrigating various regions is the Food and Agriculture Organization of the United Nations. Surveys were made in the Kabul River valley and its tributaries, the Ab-e-Estada-Dila area, the Ghazni, and Jelga valleys, and the Nahar valley. The information obtained was published in six volumes. Volume IV reports information on soils and land classification. FAO is currently working in Afghanistan, mapping areas for irrigation projects.

The USAID Mission is helping develop the agriculture of Afghanistan through its program in Crop Improvement, Surface Water research and irrigation. Activities of the USAID Mission are closely coordinated with the Ministry of Agriculture and Irrigation of the Royal Government of Afghanistan.

Wyoming University has an AID contract to support the Faculty of Agriculture of the Kabul University. Much of the emphasis of this program is in education but research on agricultural problems is conducted also.

Several other countries including Russia, Germany, France, England and China have programs to support certain phases of agriculture in Afghanistan.

Soils Program in Afghanistan

Almost all the emphasis in soils work in Afghanistan has been directed to survey and classification. Most of these surveys have been in connection with feasibility determinations of potential irrigated areas. The Water and Soil Survey Authority has a section for soil survey with a Director General in charge of the program. The Irrigation and Engineering Department has two sections dealing with soils, Director of Survey and Director of Lands.

The distribution of fertilizers is assigned to the Research and Extension Department, although this department has no section for soils. It is more or less commodity-oriented with five projects in research and extension. These are: (1)wheat and other cereal crops (corn and rice), (2)cotton development, (3)sugar beet development, (4)fruit and vegetable development and (5)fisheries. The country is divided into six regions and each region has a research station. Also, there are substations in some of the provinces. Portions of the five projects of the Research and Extension Department are conducted at many of the regional and subregional stations.

Soil Laboratories

There are four laboratories in Afghanistan including the one of the Soils Department of Kabul University, that are making soil analyses. Two of the laboratories are under the Ministry of Agriculture and Irrigation and are located in the same building in Kabul. The fourth lab was established near Bost in the Helmand Valley to serve the Helmand Arghandab Valley Authority project.

Visits were made to the three laboratories located in Kabul, but time did not permit a trip to the Helmand Valley.

1. Laboratory of the Water and Soil Survey Authority: This laboratory was established by FAO in cooperation with the WSSA. The work of this laboratory is concerned with the analysis of soil and water samples taken by the FAO and Afghanistan staff in connection with their survey program. Mr. R. G. Menon is in charge of the laboratory. During the past two years the laboratory has analyzed 1,300 soil samples from the various horizons of the soils surveyed. They also test about 40 samples of water per week to determine suitability for irrigation. All soil samples are tested for pH, free calcium carbonate, organic matter content, soluble salts, water soluble sodium, potassium, calorium, magnesium, chloride, sulfate, carbonate, bicarbonate, phosphorus and gypsum. The exchangeable cations, calcium, magnesium and potassium, are determined on a few selected samples using sodium acetate as the extractant.

   The lab is equipped with a Lange flame photometer for measuring sodium and potassium. No compressed gases such as butane or propane are available so airplane gasoline is burned in the flame photometer. A conductivity bridge, two colorimeters, a 6-unit Kjeldahl apparatus, reciprocal shaker, 2 pH meters, 2 analytical balances, and a muffle furnace also were in use in the laboratory. No hood is available, so when total nitrogen determinations are made, the Kjeldahl apparatus must be moved outside. Likewise, much of the laboratory space is not heated which makes analyses during winter months difficult.

Equipment and supplies of this laboratory are to be turned over to the Royal Government of Afghanistan upon completion of the FAO project. However, if a Special United Fund project is initiated it will be assigned to the new project.

The staff of this laboratory includes four college graduates and four high school graduates.

2. Laboratory of the Irrigation and Engineering Department: This laboratory is adjacent to the laboratory of the Water and Soil Survey Authority and apparently an effort is being made to combine the two. During the past five years this laboratory has analyzed about 2,000 samples of soil, water and fertilizers (total number). Some of the samples analyzed in this laboratory have been taken from farmers' fields. The laboratory makes about the same determinations on soil samples as the Soil Survey Authority laboratory, namely, pH, percent organic matter, calcium carbonate equivalent, soluble salts, total nitrogen (Kjeldahl) and water soluble potassium, calcium, magnesium and sodium. They are equipped with two Coleman pH meters (110 volt AC), one Bausch and Lomb Colorimeter, conductivity bridge, several analytical balances (only one in working order) and two flame photometers (one a Coleman and the other a French instrument). Neither flame photometer was in use since butane or propane is not available. This laboratory also has the problem of no hoods or exhausts for poisonous gases, no sample preparation room or sample storage area. The spaces assigned to either this or the WSSA laboratory were not constructed for use as laboratories and cannot be easily arranged into efficient working areas.

The staff in this laboratory includes 10 technicians. The goal is to have a college graduate in charge of the laboratory and at least one technician, a high school graduate.

3. Laboratory of Kabul University: The soils laboratories at the University of Kabul have two nice rooms. The larger room is used largely for teaching a course in general soils and for some research. The smaller laboratory is used for a little more advanced course in soil chemistry and soil physics. It, too, is used for research purposes. These laboratories have been developed under the direction of Dr. G. A. Nielsen, formerly a member of the Wyoming Team, and have good equipment. Several pieces of apparatus such as a modulus of rupture apparatus has been improvised and appears to be working satisfactorily. A multiple unit dispenser has been constructed, too, with pipettes mounted on a wooden panel. A large wooden tray holds the bottles for extraction of samples.

Soil samples are collected from various parts of Afghanistan and analyzed by this laboratory. Several fertilizer trials are being conducted with wheat. The results of the first year of study are published in Tech. Bul. 1 of Kabul University by A. Q. Samin and G. A. Nielsen. The results of the soil analysis are included with the yield data. The results of the second year of similar studies has been completed and will soon be available in Tech. Bul. 2.

Experiment Stations

As previously noted, each of the six regions have an experiment station. Three of the regional stations were visited; these included the stations at Kunduz, Baghlan, and Mazar-i-Sharif. Only about one day was spent at each location which included visitation to farming areas in the vicinity of the station. Most of the stations are relatively new and might be considered as being in a developmental stage.

Cultivated Soils

There are approximately 35.5 million acres of arable land in Afghanistan, of which about 5 million acres are reported to be dry-land farmed and 13 million acres irrigated. Obviously, only a very small portion of the soils of Afghanistan were observed during the brief tour. Likewise, only a portion of the soils have been surveyed and the results published.

From the meager observations and from published reports, it appears that many of the soils are relatively young from a geological viewpoint and have not been extensively weathered. In all of the analyses reported by FAO (Volume IV - Survey of Land and Water Resources - Afghanistan) the soils are alkaline in reaction and contain an excess of free calcium carbonate. In fact, most of the soils have a pH above 7.8 and contain more than 10 percent free calcium carbonate. Similar results are reported by Samin and Nielsen in Technical Bulletin 1 of Kabul University. A majority of the soils appear to be derived from windblown material (loess) or from alluvium (alluvial and colluvial). The soils generally are fairly deep and would appear to permit deep rooting of crops if moisture conditions are favorable.

Most of the soils are relatively low in organic matter (few soils contain more than 1.5 percent and many contain less than one percent organic matter) as might be anticipated from the age of the soils and the climatic conditions.

Soils in the southern and western parts of the country were not observed and information relative to them was not reviewed. Considerable information was collected in the Helmand Valley preparatory to the development of the irrigation project and, no doubt, other information is available also in other projects.

1. Nutrient Deficiencies: Since the soils are low in organic matter, nitrogen will probably be the most widespread nutrient deficiency. For high crop yields nitrogen fertilizers will be needed on almost all, if not all, soils of this country.

   The presence of the free calcium carbonate in the soils will quickly convert the phosphorus present to tri-calcium phosphate which is relatively insoluble. Thus, phosphorus fixation is likely to be widespread and a good response should be obtained generally from application of phosphate fertilizers. However, care must be exercised in the placement of the fertilizers to minimize fixation. Use of granulated phosphate, placed in bands, is suggested. The water solubility of phosphate is important on alkaline soils such as these.

   Since the soils are not strongly weathered, no doubt much potassium remains in mineral forms. Potassium deficiencies probably will not be widespread but under certain conditions a response may be obtained from application of potash fertilizers. Soil tests can serve as a useful guide in uncovering these conditions.

   The free calcium carbonate also influences the availability of other elements that are essential for plant growth. The micro-nutrients, iron, zinc and manganese may be deficient, particularly for certain crops.

   Sulfur occurs in the soil largely in the organic matter. Sulfur is used by plants in approximately the same quantities as phosphorus. Since the soils of Afghanistan are relatively low in organic matter and since there is no source of sulfur from smoke, etc., sulfur deficiency could quickly develop under intensive cultivation.

2. Special Soil Conditions: Although the soils generally are relatively young in Afghanistan, some of those in the valleys next to streams have been farmed for centuries. These have been plowed by oxen, frequently when wet. Such a practice could easily develop a plow pan. In one field near Kunduz a plow pan was noted when taking some soil samples. How widespread this condition may be is not known.

   Saline and sodium alkali conditions exist in many areas. Some of the lower areas near streams report as much as 10 percent of the area has a saline or alkali condition. These conditions will require special treatment to make the land productive. Of course, one of the requirements will be adequate drainage.

Many of the soils which have not been weathered extensively and which are relatively low in organic matter, probably will not have aggregates or structure which will be stable when wet. Therefore, during cultivation, plowing, etc., and during irrigation, care should be exercised to maintain the soils in a good state of tilth. Otherwise permeability to water and the movement of air will be greatly reduced.

3. Storage of Water in the Soil Profile: The texture of the soils in the Kabul valley and in the northern provinces should permit storage of a considerable volume of water per unit of depth. Very little or no attention is being paid to this very important property of soils in either dryland or irrigated farming. Camel thorn may be important for fuel but should it be produced at the expense of precious soil water?

Sources of Fertilizers

Some chemical fertilizers have been used for about 10 years in Afghanistan. Initially the emphasis was in the application of nitrogen and phosphate on cotton. Lacking a background in proper use of fertilizers, several farmers were disappointed in the response obtained with superphosphate and now they apparently are adverse to using it.

Last year the government imported 2,000 tons of ammonium nitrate, 4,000 tons of urea and 4,000 tons of 19-percent superphosphate. This was subsidized by almost 50 percent for the farmers. Some of the nitrogen fertilizer was sold but the Ministry still has most of the superphosphate and about 3,000 tons of the urea. The total urea available for fall seeding of wheat in 1967 will be 4,000 to 4,500 tons. A similar amount is anticipated for topdressing of wheat in the spring.

Construction of a urea plant is now under way at Mazar-i-Sharif. This 105,000-ton-per-year plant should come on stream in 1971. Prospecting is under way for phosphorus but in the immediate future phosphate fertilizers will have to be imported.

Suggestions

Importance of Water and Soils

The Ministry of Agriculture and Irrigation of the Royal Government of Afghanistan is to be congratulated in its efforts to harness the waters of their country for use in irrigated farming. Water is very important to crop production. Likewise soil is very important in plant growth because soil is the reservoir to hold water for the plant and is also the source of nutrient elements which are essential for growth. As soon as water is delivered to the farm, soil management (which includes distribution of water in the soil profile) and soil fertility become very important.

Therefore, soils should be afforded the same status and receive the same emphasis as water.

Soils Department Developed

It is suggested that a strong soil science department be developed to include initially soil survey, soil fertility and soil management. The other disciplines of soil science, physics, chemistry and microbiology, can be added in the future. The soils department should serve both irrigated and dry farming regions. Many of the basic principles of soils will apply to both situations.

Soil and Plant Analyses

Soil analysis to furnish information about the soils is the first step in soil management. All six phases of a soil-plant analysis program will have to be developed in Afghanistan. Steps should be taken to obtain information relative to these six phases but launching a large program for soil testing farmers' samples should be delayed until correlation data can be obtained and recommendations can be tested.

It is suggested that plans be developed for a modern soils laboratory with a capacity of more than 100 samples per day. Adequate space with standard facilities (hoods, etc.), should be made available. Multiple unit apparatus will permit testing a large number of samples without increasing the size of the staff. Supplies such as propane or butane will have to be available in sufficient quantities to permit continuous operations of the laboratory. The laboratory can serve soil fertility, soil management and soil survey needs.

Only the determinations which can be interpreted and put into use should be made. The frequent use of control samples should be initiated to assure accuracy of results.

Although the laboratory can test farmers' samples, the initial responsibility should be to service the experiment stations. Soil samples should be taken from fields and analyzed before establishing fertilizer trials. Time, methods and rates of application of fertilizers should be studied in conjunction with the soil tests in order to give background information for the recommendations to farmers.

Correlation studies will be needed to test critical levels of soil nutrients and to observe if they agree with results from other areas. After the critical levels are established they will have to be tested for the major crops produced.

The sodium bicarbonate procedure for phosphorus extraction probably will be best for the alkaline soils of Afghanistan. Turkey will be using this procedure on their alkaline soils and this will present an opportunity for exchanging data.

Storage of Water in the Soils

Studies should be initiated in the very important subject of storage of water in the soil. Most of the soils observed should hold at least two inches of available water per foot of depth. Roots of wheat and corn should extend to a depth of two meters in many of these soils, providing there is moisture in the soil and a plow pan or similar adverse layer does not limit growth. Deep rooting of crops will permit more infrequent irrigations and will stretch the capacity of canals to deliver water.

The soil moisture studies should include:

1. Distribution of water for important penetration of the soil. This will also improve efficiency of water use.

2. Rooting of various crops in respect to the soil.

3. Evaporation of water from the surface of the ground. Depth at which stored water is relatively safe from evaporation should be determined.

4. Protection of the surface of the ground to maintain good permeability but to minimize evaporation.

5. Cultural practices that should be used in summer fallow to catch and retain the highest proportion of precipitation.

6. How much yield can be anticipated in respect to the amount of water stored in the soil at planting (either through pre-irrigation or by summer fallow). This information is desirable in ascertaining the amount of fertilizers to apply.

Much information on these subjects is available and all of the research need not be repeated, just tested to see if it applies.

Root Distribution

The distribution of roots of crops in the soil is important in relation to both water and nutrient availability. Observations on root distribution by digging some pits beside growing plants may furnish some important information relative to soil management practices.

Training Personnel

In developing a soil science department and a soil testing program a problem will be encountered in obtaining a sufficient number of trained persons. Kabul University will graduate eight persons this year who are majoring in crop production, but they will have no graduates in soil science. A few AID participants currently are in training in the United States and plans are under way to send more.

Although it will be difficult to obtain a sufficient number of trained soil scientists immediately, plans should be prepared with a time schedule for training the needed scientists.

The International Soil Testing Project

Although the responsibilities of the International Soil Testing Project are largely in Latin America (a regional AID contract) information obtained in other areas can be made available to Afghanistan. Much of their information will be relative to the six phases of soil-plant analysis programs. Guidance can also be given in the development of a high capacity laboratory.