AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION

A. PRIMARY
Agriculture AF22-0000-G831

B. SECONDARY
Soil chemistry and physics--Turkey

2. TITLE AND SUBTITLE
Soil testing: Turkey

3. AUTHOR(S)
Fitts,J.W.

4. DOCUMENT DATE
1967

5. NUMBER OF PAGES
25p.

6. ARC NUMBER
ARC TU631.42.F547

7. REFERENCE ORGANIZATION NAME AND ADDRESS
N.C.State

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

10. CONTROL NUMBER
PN-RAA-424

11. PRICE OF DOCUMENT

12. DESCRIPTORS
Soil analysis
Turkey

13. PROJECT NUMBER

14. CONTRACT NUMBER
CSD-287 Res.

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

TU
63142
F547

SOIL TESTING - TURKEY

J. W. FITTS, DIRECTOR
INTERNATIONAL SOIL TESTING

SEPTEMBER 1967

A.I.D.
Reference Center
Room 1656 NS

CONTRACT AID/csd-287
NORTH CAROLINA STATE UNIVERSITY
AT RALEIGH

SUMMARY

Much attention is being given to increasing crop production in Turkey. This includes the introduction of improved high yielding wheat varieties that were developed in Mexico and greatly increasing the use of chemical fertilizers.

A strong soil testing program is imperative to furnish the information needed to obtain the greatest return from the use of fertilizers and other soil amendments.

Soil analyses are now being made by the Ministry of Agriculture, Topraksu and the Sugar Company laboratories, but most of the samples tested are not farmers samples; the analyses are largely for research purposes and for information to be used in soil survey reports.

Suggestions to improve the current soil testing program are listed below:

1) Establish a complete soil-plant analysis program to include: a) research, b) sampling, c) analysis, d) interpretation, e) recommendations, and f) educational follow-up.
2) Appoint a Director of the Soil Testing-Plant Analysis Program; this position should be at a sufficiently high level that all phases of a soil testing program can be coordinated.
3) Increase the capacity of three or four laboratories to test several hundred samples per day (excess of 50,000 samples per year).
4) Correlation studies with laboratory procedures and plant growth should be expanded to obtain more information on the interpretation of soil test results.
5) Guide sheets should be prepared for making recommendations on improved soil management practices including the use of fertilizer.

6) Sampling program should be initiated.

7) Much attention needs to be given to an educational follow-up program to be certain farmers understand the tests and are using fertilizers and other soil amendments as recommended.

8) The Sugar Institute Laboratory should continue to test samples from fields that are in a sugar beet rotation. Another agency should assume the responsibility for all other testing of farmers samples and for developing a soil-plant analysis program.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
A SOIL TESTING PROGRAM	3
APPRECIATION	5
OBSERVATIONS IN TURKEY	6
Organizations Involved in Improving Agricultural Production	6
Soil Laboratories	7
Topraksu Laboratories	7
Ministry of Agriculture Laboratories	9
Sugar Company Laboratory	10
Samples Tested for Farmers	11
Capacity of the Laboratories	11
Control Samples	11
Space and Laboratory Furniture	12
Farmer Contact and Educational Follow-Up	12
Summaries	13
FAO Freedom from Hunger Program	14
GENERAL COMMENTS	14
SUGGESTIONS	16
A Complete Soil-Plant Analysis Program	16
Director for the Program	17
High Capacity Laboratories	17
Procedures	17
Correlation Studies	18
Guide Sheets	18
Samples	18
Communication with Farmers and Local Agricultural Leaders	19
Number of Laboratories	19
The Sugar Institute Laboratory	20
Agency Responsible for Program	21
The International Soil Testing Project	21

SOIL TESTING - TURKEY[1/]

J. W. Fitts

INTRODUCTION

Increasing crop production is of the utmost importance to Turkey. Cultivation of the land in Turkey dates back several thousand years. It is a tribute to the Turkish farmers that these lands have produced crops for so many centuries and are still producing. With the rapidly increasing demand for agricultural production, farming practices must be improved. These practices will include all factors in the yield equation:

Crop yield is a function of the soil, crop, climate, and management.

The use of improved crop varieties and better stands of crops must be accompanied by the correction of nutrient deficiencies, better cultural practices to maximize the rainfall received, and the control of pests such as weeds, insects, and diseases.

A major effort is being undertaken jointly by the Turkish Government and USAID/Turkey to introduce improved wheat varieties since wheat is the major crop in Turkey. The wheat program is cognizant of the other factors influencing yield and steps are being taken to improve these factors also.

During the 1967-68 growing season, the Turkish Government will distribute more than 60 million dollars worth of fertilizer to the farmers, almost all of which will be imported. This will be in the form of fertilizer materials--largely nitrogen and phosphorus but with some potash. Plans are already underway to construct fertilizer plants within the country to reduce

---

1/ Observations made during the period of August 31-September 9, 1967.

the cost of importing fertilizers. One of these plants is scheduled to produce diammonium phosphate. An excellent price has been obtained for the purchase of the fertilizers this year. The cost to the farmers should be lower than in most countries of the world. Nevertheless, 60 million dollars are being invested and the question is, how can these fertilizer materials be utilized to give the greatest return on the investment. Suppost that all of these 60 million dollars worth of fertilizers are scattered equally on all of the area of Turkey by means of airplanes or helicopters. Obviously, a large portion would fall in lakes and rivers or on mountainous terrain which cannot be farmed. This fertilizer would be lost and the remainder would have to more than double its return to even obtain an increase in yield that would pay for the cost of the fertilizer. Admittedly, such an illustration is absurd, but distributing phosphate or potash on lands that are not deficient in these elements will give no return and is equally absurd. Likewise, the distribution of nitrogen and phosphate on soils low in potash will increase the yield but little. The same is true of fertilizing acid or alkaline soils where these adverse conditions have not been corrected.

An indescriminate but wide distribution of fertilizer will result in increased yields on a considerable proportion of the cultivated soils of Turkey. No doubt a return of double the total investment can easily be obtained through such a practice. However, no return will be obtained on many fields and these farmers will have difficulty paying for the fertilizer. The question then becomes not one of will the increase in yields from the 60 million dollars worth of fertilizer be profitable, but how profitable? Is the Turkish Government willing to settle for double its money or a return of 120 million dollars for its investment, or would it prefer a return of four or five dollars for each dollar invested which means 240 to 300 million dollars in increased yields from the judicious use of fertilizers.

A SOIL TESTING PROGRAM

Soil and plant analyses are means of obtaining information relative 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 testing involves a complete program and includes six phases. These are:

1) Representative soil samples. The accuracy of the analysis, interpretation and recommendations can be no better than the accuracy with which the soil sample was taken. Organic residues from both plants and animals, burned materials, deposits and erosion contribute to the variability of the plow layer of soil. Much emphasis must be placed upon obtaining soil samples that represent the area on which information is desired.

2) Laboratory analyses. The laboratory analyses must be made accurately and rapidly. The forms in which the nutrient elements occur in the soils and specific soil conditions encountered will dictate the type of solutions that may be used successfully. The soil testing laboratory should have a capacity of more than 100 samples per day (all determinations plus interpretations and recommendations). It is not difficult to have a capacity in excess of 500 samples per day where multiple unit apparatus and techniques are employed. This permits a laboratory to return results with recommendations to the farmer within 10 to 15 days and also reduces the cost of analysis to a minimum. Control samples should be used frequently to assure accurate laboratory techniques.

3) Interpretation of results. The data obtained from the analysis must be interpreted in terms of nutrient deficiency or sufficiency. Likewise, adverse soil conditions must be identified. Correlation studies with plant growth are essential for the interpretation of soil test results.

4) Recommendations. The yield of a crop is dependent not only upon soil characteristics but other factors too, including crop variety, thickness of stand, climatic conditions, and the control of pests such as weeds, insects, and diseases. Soil tests may be used as a vehicle for recommending all good management practices including the correct use of fertilizers and other soil amendments.

5) Educational follow-up. The information gained from soil analyses must be put into operation in order to make soil testing successful. Farmers must understand the information and must be able to follow the suggestions. The fertilizers and other materials recommended must be available to the farmer. Summaries of soil test results on an area basis are valuable to educational and research programs, and to commercial companies. Visual and audio aids including radio, movies, slide sets, charts, posters, film strips and publications are important tools for the "educational follow-up".

6) Research. The first five phases outlined above are dependent upon information gained through research. Basic information from one area can be tested in another and, if found satisfactory, it can be utilized immediately. Thus the exchange of data across country boundaries is highly desirable and this is one of the important functions of the International Soil Testing Project.

All phases of soil testing as outlined above are very important and must be included in order to achieve a successful program. Periodic reviews of the program are desirable in order to observe the weakest phases and to take steps to strengthen them.

APPRECIATION

Nine days is a very short period of time in which to become acquainted with the soil testing and soil fertility problems within a country as large as Turkey. Thanks to the careful planning of Mr. John M. Hill, Fertilizer Specialist, USAID/Turkey, an excellent itinerary was prepared which gave a cross section of activities and problems. Mr. Hill accompanied me throughout the tour and was most helpful in taking care of the necessary arrangements.

Mr. Dogan Kayran of the State Planning Office gave me a good briefing of the organization of the various Ministries of the Turkish Government. He also outlined problems and questions on which they wanted advice.

Mr. Mehmet Kiroglu, Head of the Plant Nutrition Division of the Ministry of Agriculture, arranged the conference for the leaders in the various organizations which permitted me to present a "soil testing program" and to discuss their operations.

Mr. Kadir Gözübüyük, Director, Topraksu Gm. Md. Laboratory, and Mr.Enver Çakir, Head of the Soils Laboratory (Topraksu) in Ankara, presented to me valuable information in the form of bulletins, maps and charts of the activities of the 14 Topraksu laboratories. They also accompanied me to Izmir and Eskischir to visit laboratories in these regions. In many instances they served as interpreters and took care of local arrangements.

There are many others that contributed much to the success of this visit, and to everyone may I express my most sincere and grateful thanks.

OBSERVATIONS IN TURKEY

Turkey is an agricultural country and much of the economy, particularly exports, is based upon agricultural products. Wheat dominates agriculture and more than half of the cultivated land is planted to wheat each year. Sugar beets, cotton, vineyards, olives, and fruits are importants crops in Turkey, too.

Considerable emphasis is being placed upon increasing crop production in order to improve the economy of the country and to increase the food supply for the increasing population. Almost all, if not all, of the increase in crop production must come from lands currently in cultivation. Most of these lands have been in production for several centuries.

Organizations Involved in Improving Agricultural Production

Several ministries of the Council of Ministers are involved in agricultural production. The Ministry of Agriculture is responsible for research and extension activities. There are several sections in the Agricultural Ministry including fruits, vegetables, field crops, etc. Each section conducts research upon the crops with which it is involved. In the extension activities there is a leader or director in each province. Assigned to this directorate are experts or specialists in specific fields of agriculture. The province is divided into kazas and each kaza has one to three persons who are in contact with the farmer. When a problem is observed within a kaza, the specialist assigned to the province is called in for advice.

Topraksu with its regional offices is in the Ministry of Village Affairs and is concerned with soil erosion control and small water resources. Soil Survey is very important to both activities, so they are actively engaged in the preparation of soil surveys.

The sugar industry, with its 17 factories scattered strategically over Turkey, operates in the Ministry of Industry. Twelve of the factories are State controlled (Sugar Refineries Corp.) and five are owned by the Beet Growers Cooperatives. All 17 factories are administered by one group. Included in the administration of the sugar program is a research institute which has two functions: (1) technical problems in refining of the sugar from sugar beets, and (2) agricultural problems concerned with the production of the beets.

Soil Laboratories

There are at least 18 laboratories in Turkey, exclusive of those in universities, which are making soil analyses. Fourteen of these are operated by Topraksu in the Ministry of Village Affairs under their regional program. Three laboratories are in the Ministry of Agriculture and one in the research division of the Sugar Corporation (Ministry of Industry). Time would not permit the visition of the 18 laboratories. However, it was possible to visit 8 of the laboratories including:

Topraksu Laboratories	-	Ankara, Izmir, Eskischir
Ministry of Agriculture Laboratories	-	Ankara, Izmir (Menemen Research Station)
Eskeschir (Research Station and Forestry Laboratory)		
Sugar Company	-	Ankara

In addition, the Soils Department and laboratory of Ege University in Izmir was visited. Also a visit was made to the Cartographic laboratory of Topraksu in Ankara.

Topraksu Laboratories. A coordinated program of soil analysis has been developed for all of the Topraksu laboratories by Mr. Kadir Gozubuyuk, who is the Director of the laboratory program. The program has been well organized

with certain types of analyses assigned to specific laboratories. Since the Topraksu program in soils is directed largely to survey information relative to soil conservation and small watershed management, all of the laboratories determine texture, permeability, pH, total salts and free calcium carbonate. Most of the laboratories also determine available phosphorus and potassium and test irrigation water. The most complete analysis is made in the Ankara laboratory. In addition to the determinations mentioned above they also determine mechanical analysis, soluble cations and anions (Ca, Mg, K, Na, CO_3, HCO_3, Cl, SO_4NO_3), exchangeable Na and K, cation exchange capacity, free gypsum, boron, organic matter, total silicon, iron, and aluminum. In addition to irrigation water analyses, they also test water for drinking purposes. Some plant analyses are made in this lab also.

Three laboratories, other than Ankara, including the laboratory visited in Izmir, make most of the determinations that are made in Ankara with the exception of total aluminum, iron, and silicon.

All of the Topraksu laboratories that measure available phosphorus and potassium use sodium bicarbonate to extract phosphorus and ammonium acetate to remove potassium. No doubt, these are as good as any and better than most extractants for the soils of Turkey. All of the laboratories visited are equipped with a flame photometer, pH meter, colorimeter, shaker, conductivity bridge, permeability apparatus, and sufficient glassware such as bottles, funnels, beakers, etc.

Most of the Topraksu laboratories are geared to test up to 10,000 samples per year of soil samples and up to 2,000 per year of water samples. Very few of the laboratories are analyzing more than 5,000 samples per year and at least 75 percent of these are for survey purposes. The laboratory at Izmir test about 1,500 samples per year for farmers (25 percent of samples tested).

All of the analyses made in Eskischir are for survey purposes. In the districts where the analyses are made only on survey samples, farmers samples are sent to Ankara for testing.

Ministry of Agriculture Laboratories. All four laboratories of the Ministry of Agriculture were visited. Two of these are located on experiment stations (Menemen and Eskischir). The forestry laboratory at Eskischir is also located on the Forestry Research Station. The analytical work of these laboratories is directed largely to research in connection with projects being conducted on the stations. This involves analysis for fertility information on about 500 to 1,000 samples per year at Menemen and Eskischir. The forestry lab tests about 3,500 samples per year from about 100 nurseries to determine requirements for best growth of seedlings.

These three laboratories analyze some samples for farmers but no concerted effort is made to do this. Not over 25 percent of their analytical work is devoted to farmers samples and probably less than this.

The Ministry laboratory in Ankara likewise is concerned with research. They conduct approximately 200 factorial experiments with two to four rates of N, P, and K in fields scattered in various parts of Turkey. These experiments are conducted on most of the crops grown in Turkey including horticultural crops. This laboratory also tests from 6,000 to 7,000 soil samples per year for farmers. On farmers samples, pH, organic matter, soluble salts, free calcium carbonate, available phosphorus (sodium bicarbonate extractant), and available potassium (exchangeable K removed with ammonium acetate) are determined.

The Ministry laboratories are using similar procedures as the laboratories in Topraksu (sodium bicarbonate to extract phosphorus and ammonium acetate to remove exchangeable potassium). Likewise, they are equipped with a flame photometer, pH meter, colorimeter, shaker, conductivity bridge and permeability apparatus.

Sugar Company Laboratory. There are approximately 300,000 hectares of sugar beets grown in Turkey. The Sugar Company probably has the most extensive agricultural organization at the district level of any of the agricultural agencies. Each district has a superintendent and several field men. The field men work with the farmers in planting, fertilizing, irrigating and harvesting the beets. In fact, the beets generally are planted for the farmer. Thus good fertilizer application methods should be followed and the correct fertilizers used.

New laboratory space is available for the soils laboratory at Ankara. The basement is devoted to receiving samples, drying, and sample preparation. The samples are stored here and weighed for analysis. About four Mettler balances with an individual operator was available for weighing out the samples. Both the laboratory space and the space for receiving and preparation of samples is large and adequate for analyzing a large volume of samples.

At the present time from 200 to 300 soil samples are sent to the laboratory from each district. These samples are supposed to represent the fields in each district and fertilizer recommendations for the area is made accordingly. The laboratory is now testing about 7,500 samples per year but plans are being made to increase the number tested to about 40,000 per year; this would be approximately one sample for every seven or eight hectares of sugar beets. The samples are a composite of 10 cores taken at a depth of 0-20 cms.

The sugar laboratory was the only one found that was not using sodium bicarbonate to extract phosphorus and ammonium acetate to remove potassium. This laboratory is using 0.3 N hydrochloric acid. They are using approximately a 1:2 soil to extractant ratio but use more acid if the soil is highly calcareous. Both phosphorus and potassium are determined in the acid extractant.

The laboratory has four chemists and about 35 helpers. This includes four women to wash dishes and four men to weigh out soil samples.

Samples Tested for Farmers

Samples are analyzed for farmers by the laboratories of Topraksu, the Ministry of Agriculture, and the Sugar Company. No charge is made for the analysis by any of the laboratories. It is difficult to obtain an exact figure of the total number of samples tested for farmers but it probably is about 20,000 to 25,000. The number appears to be about evenly divided between the Ministry of Agriculture, Topraksu and the Sugar Company laboratories. Of course, many other samples are analyzed by the laboratories for research and for soil surveys.

Capacity of the Laboratories

All of the laboratories visited were employing "standard" analytical techniques, apparatus, and supplies. The current capacity of most of the laboratories is between 8,000 and 10,000 samples per year but only a few are exceeding 6,000. Several of the laboratories also are testing 2,000 or more samples of water for irrigation and for domestic uses. None of the laboratories claimed a capacity of more than 50 samples per day and most were analyzing about half that number.

Control Samples

All of the laboratories but the Sugar Company indicated they are including about one control sample per day in their analyses to check the instruments and techniques employed. The sugar laboratory makes duplicate determinations on all of their samples.

Space and Laboratory Furniture

There was considerable variation in the adequacy of space in the laboratories visited. The sugar laboratory was in a new building and the basement and first floor had been designed for laboratory use and for the preparation of samples. The spacious rooms contained standard laboratory desk a little over 1 meter high (stand-up to work type). A large sink for washing glassware was at one end of the laboratory.

The laboratory at the Menemen Research Station probably had the best space and best arrangements for a high capacity laboratory. Receiving and processing of samples was done in a room at one end of the laboratory. The long laboratory space with wall desks and a line of center desks permits assembly-line techniques for handling large numbers of samples.

The Topraksu laboratories are usually located on the upper floors of the Topraksu office buildings. Generally the rooms that are available are small and efficient operations are difficult under such circumstances.

Desks in all of the laboratories were of the stand-up, standard type which has been constructed to meet all laboratory requirements, but actually fit none very well. In general the laboratory furniture (desks, chairs, and stools) were not designed or assembled for specific uses.

Farmer Contact and Educational Follow-up

The Sugar Company, working through their district superintendents and field men, has the best organization to be certain that the information obtained from the soil analyses is put into operation. The field men from each district collect the samples and submit them to the laboratory. The results of the analyses, plus the fertilizer recommendations, are sent to the district superintendent who then uses the information for ordering fertilizers for

his district. The fertilizer is delivered to the farm and applied by the company drill at the time the beets are planted. No doubt some explanation of the tests are given to the farmers by the field representatives, but the greatest educational effort is directed to the district superintendents and field men.

The Sugar Company publishes two magazines. One called "Seker" (sugar) is a technical journal and is published quarterly. A popular magazine with information on all farming practices, in addition to sugar beet production, is distributed to the growers and to the field men.

Information of the soil test results and recommendations relative to fertilizer use is sent directly to the farmer submitting the samples by both the Topraksu and Ministry laboratories. No copies of the soil test results are sent to the local agricultural agents (province or kaza) by any of the laboratories unless the local leader submitted the samples.

Soil samples usually are taken by technicians or field men of the organization that makes the analyses. Therefore, no large educational program is undertaken relative to obtaining representative soil samples or to organizing "community drives" to get samples.

Summaries

Both Topraksu and the Sugar Company have undertaken the preparation of summaries of soil analyses. Topraksu is doing this in connection with their soil survey program which gives them information on the fertility status of soils within a given area. The Sugar Company prepares summaries in order to determine fertilizer needs within areas as a guide in placing fertilizer orders. The summaries of both organizations involve the results of tests conducted during the last eight to ten years.

All of the summaries have been prepared on an individual nutrient basis. That is, separate summaries have been prepared for phosphorus, potassium, pH, organic matter, etc. Maps showing the level of the individual nutrients have been prepared for numerous regions by Topraksu. Area maps are also being prepared by the Sugar Company.

A glance at the maps prepared by Topraksu and the Sugar Company quickly shows the wide variation in the soils of Turkey. The necessity of a strong soil testing program to guide each farmer on the use of fertilizers for specific crops and fields is clearly shown by these summary maps.

FAO Freedom from Hunger Program

The Food and Agriculture Organization of the United Nations has conducted several thousand fertilizer demonstrations in Turkey in cooperation with the Agricultural Extension Service. From all comments received, this has been an effective program and has been instrumental in creating interest among the farmers in the use of fertilizers to increase their crop yields. A second part of the program has been the pilot credit scheme for distribution of fertilizers. This, too, has been successful and has helped farmers get started in the use of fertilizers.

GENERAL COMMENTS

Of the laboratories visited in Turkey, only the Sugar Company laboratory was specifically designed, equipped and staffed to analyze samples from farmers fields to determine fertilizer needs. The Topraksu laboratories were established for soil survey purposes. As part of the information for the areas surveyed, tests are made for nutrient availability (phosphorus and potassium) acidity or alkalinity, and organic matter. The Ministry laboratories were established for research data in conjunction with other studies being conducted.

Both the Topraksu and Ministry laboratories are adequately equipped and staffed for their major objectives--testing for soil survey and for research. Both agencies analyze farmer samples willingly and make the analyses free of charge. The instructions for taking samples, information sheets, and analytical procedures,including extractants, are good for farmers samples. However, a large increase in farmers samples submitted to these laboratories would not only tax their facilities and staff to handle the samples but would also tax their operating budgets.

Approximately 160 million decares of land are cultivated each year in Turkey with another 20 million decares in vineyears, olives, fruits, and nuts. Not all of these cultivated areas will be fertilized in the immediate future, but there will be an investment of more than 60 million dollars in fertilizers in 1968. The more than a million tons of fertilizers will be distributed over several million decares. If only one soil sample is taken for every 100 decares, then 10,000 samples will be required for every one million decares of land to be fertilized or limed. Of course it is not necessary to test every field every year; no doubt once every three to five years will be sufficient for most farms until a very heavy rate of fertilizer is used.

Obviously, if information is going to be made available to farmers on the proper use of the 60 million dollars worth of fertilizer, a far greater number of samples must be tested annually than is being tested at the present time. The program should not be a stepchild or an additional burden to laboratories designed for other purposes.

Since the laboratories were not designed specifically for analyzing farmers samples to determine fertilizer, lime or other soil amendment needs, the laboratories lack a program to obtain the volume of samples (including an even flow), and the capacity to analyze them. Much more correlation data is needed to establish critical levels and to interpret the results.

Communications between the laboratory and the farmers will need much strengthening if the information obtained from the tests is to be put into operation. Farmers must understand the reports and be able to follow through with the recommendations. This includes being sure the fertilizers and other soil amendments called for are available for the farmers to use when needed.

SUGGESTIONS

Soil testing programs in several areas of the world have proven to be an effective means of encouraging improved management practices in crop production. Not only is information obtained relative to fertilizers and other soil amendments that are needed for increased yields, but farmers are also encouraged to plant improved varieties, to follow good cultural practices, and to control pests.

A good start has been made in soil testing in the three agencies, Topraksu, the Ministry of Agriculture and the Sugar Company. However, if the number of samples that will be required to give farmers the information they need in the purchase of more than 60 million dollars worth of fertilizer, several improvements will be needed.

A Complete Soil-Plant Analysis Program

The first general suggestion is to initiate a complete soil testing-plant analysis program which includes the six phases: (1) obtaining representative samples, (2) analytical procedures, (3) interpretation, (4) recommendations, (5) educational follow-up, and (6) research. All phases are very important and must be included in a successful soil testing-plant analysis program.

Soil testing-plant analysis should be established as an individual program and not as a minor part of another program. Routine analyses can

be readily made for research programs or for survey by the soil testing laboratory, but priority must be given to the responsibilities for which the program has been created.

Director for the Program. An overall Director should be appointed for the soil testing-plant analysis program and this position should be sufficiently high in rank that he is able to "open doors" and keep the program "rolling".

High Capacity Laboratories. High capacity laboratories should be established which can analyze 50,000 to 100,000 samples per year. They should be able to test several hundred samples per day if need be.

To achieve this capacity, multiple unit apparatus and techniques should be installed. This would permit greatly increasing the volume of a laboratory without having to increase the laboratory staff.

The high capacity laboratories not only can serve farmers in getting needed information but can serve research also. Field trials should be established on specific soil conditions upon which information is desired. Soil tests can be used to select the sites on which to conduct the studies. This procedure greatly increases the effectiveness of the field trials.

Procedures. The sodium bicarbonate procedure now used in most of the laboratories should be continued with perhaps a few modifications to fit the multiple unit techniques. Thought should be given to using ascorbic acid as a reducing agent in the molybdate procedure for phosphorus. There is also the possibility that sodium bicarbonate can be used for potassium determination in place of the ammonium acetate extractant and with equally good results. This would eliminate one extraction procedure and save considerable time in the analysis. Although control samples are being used in most of the laboratories, the number and the frequency of use should be increased. The reliability of

results from analyses made by untrained or inexperienced laboratory technicians can be greatly improved by this procedure.

Correlation Studies. Correlation studies should be expanded and a high priority given to them. The technique outlined in Tech. Bul. No. 3 of the International Soil Testing Series entitled "Soil Test Interpretation Studies: Laboratory and Potted Plant" is suggested. Only three separations or groupings of the analytical data is recommended. These include a low and a high range,or a range where an economical increase can be anticipated, and a range where the increase usually will not be large. A medium or in-between range is needed also. Using these three ranges a critical level for the nutrient can be established. The critical level established in the laboratory and potted plant studies should be used as a guide in selecting field sites for fertilizer trials.

Guide Sheets. Guide sheets should be prepared to interpret both the results of the laboratory analyses and to use in making recommendations for fertilizers and other soil amendments. Good management practices which are economical should be included with the recommendations. In the preparation of the guide sheets all local research data should be reviewed and summarized. Information from other sources should be considered also.

Samples. Obtaining representative soil samples will be one of the most difficult aspects of a good soil testing program. Paper or cloth bags are now being used to collect soil samples for submission to the laboratory. Attention should be given to the possible use of soil cartons for submitting samples. Instructions for taking samples can be printed on the side of the carton and information blanks about the sample can be included on the other side. The cartons can be used for the crushed and screened soil samples in the laboratory in a manner which reduces the possibility of error by fitting the cartons into trays. It also speeds up the operation of measuring samples.

Studies are needed on the variability of soils in the regions which have been farmed for so long in order to determine the number of cores (or slices) that are needed for a composite sample. Likewise, more information is also needed on the size of an area from which a composite sample should be taken.

Communication with Farmers and Local Agricultural Leaders. The success of any program designed to increase crop production will be greatly influenced by the communication between the sources of information (agricultural specialists) and the farmers. It is not only a problem of getting information on what fertilizers a farmer needs on his farm but also how to get him to understand the differences in fertilizers; which one or ones are needed on his farm; and when, how and at what rates to apply them. Of course, the soil amendments needed in a given area as determined by soil analyses must be available to the farmer. Soil test summaries for given areas, together with crop acreages, will aid the Director of the Soil Testing Program in advising the fertilizer distribution program what fertilizers are needed and the tonnage that is likely to be consumed.

Much greater emphasis is needed in the educational follow-up to determine the best methods of communication between specialists and farmers, and then to put into operation these methods. Visual and audio aids are needed for this purpose and should include the development of radio programs, slide sets, film strips, movies, charts, etc.

Number of Laboratories. Several factors will influence the number of high capacity laboratories that are needed in Turkey. However, the number of such laboratories initially should be held to a minimum and then expanded as needed. The cost of analysis of a soil sample in a laboratory testing less than 5,000 samples per year is like to be $10 to $15; but in a laboratory testing in excess of 50,000 samples per year the cost should be less than

$2 per sample. Therefore, a study should be made of transportation facilities for taking samples to central areas for analysis. If a sample can be transported by air for 20¢ to a central laboratory, it is much more economical than trying to maintain a large number of laboratories.

Areas should be selected where the greatest demand is likely to develop immediately for soil analysis. Existing laboratories may be improved to handle the large capacity if available space permits. In some instances new space may be desirable. It is suggested that no more than three or four high capacity laboratories be established and perhaps at first only one or two be initiated. As the volume of each laboratory exceeds 50,000 then additional laboratories can be established.

The Sugar Institute Laboratory

The Sugar Company Laboratory in Ankara should be continued and assume responsibility for getting information for fertilizer and other soil amendments for sugar beet production. Since sugar beets are grown only once in a four-year cropping system, the question arises as to the recommendation on fertilizer use for the other crops in the rotation. In the immediate future, sampling soils once in four years should be sufficient for most soil conditions. The amount of fertilizer used is not likely to materially change the soil in a four-year cropping period. Therefore, it is suggested that the Sugar Company agronomist make suggestions for fertilizing the rotation. As fertilizer use increases markedly, it may be desirable that the soils be analyzed once every other year. The off year then could be analyzed by a laboratory other than the Sugar Company.

It is suggested that the Sugar Company Laboratory change their analytical procedure to coincide with the other soil laboratories in Turkey, and that they all use sodium bicarbonate as the extractant for phosphorus.

Agency Responsible for Program

Which agency should assume the responsibility of directing an improved soil testing program is a question that can be answered best by the Turkish Government. A consultant who has been in the country only nine days cannot make a sufficient number of contacts or visits to all parts of the country to gain sufficient information to make suggestions on this question. No doubt changes can be made in either the Ministry of Agriculture or Topraksu to successfully undertake this responsibility. Nevertheless, wherever the responsibility is assigned, if Turkey wishes to improve their soil-plant analysis program, it should be remembered that there are six phases of soil testing: (1) research, (2) sampling, (3) laboratory analyses, (4) interpretation, (5) recommendations, and (6) educational follow-up. These six phases include research, education, and service. A successful program must include all phases and steps should be taken to assure that all receive attention. If more than one agency is involved (and this can be done successfully), then the program must be so organized that no one group or activity can greatly retard the program.

The International Soil Testing Project

The International Soil Testing Project will be happy to furnish to Turkey information which has been gained through their program in Latin America relative to developing a complete soil-plant analysis program.