SOILS BULLETIN 2

A SURVEY OF SOILS LABORATORIES IN SIXTY-FOUR FAO MEMBER COUNTRIES

by

J.C. Brogan, Petezval Lemos and R.E. Carlyle

Soil Survey and Fertility Branch

Land and Water Development Division

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome 1965

SOILS BULLETIN No. 2

A SURVEY OF SOILS LABORATORIES IN SIXTY-FOUR FAO MEMBER COUNTRIES

by

J.C. Brogan
FAO Consultant and Head
Soil Chemistry Department
The Agricultural Institute, Wexford Eire

and

P. Lemos and R.E. Carlyle
Technical Officers
Soil Survey and Fertility Branch
Land and Water Development Division

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME 1965

TABLE OF CONTENTS

I. INTRODUCTION

The Soil Survey and Fertility Branch of FAO for some time has been interested in the methods of soil analyses used in the soil laboratories of Member Countries of the Organization. The collection of soil analyses data and its interpretation on a world basis is complicated by the non uniformity of methods of analyses employed. These vary from region to region and country to country and sometimes even within countries. In considering the problem it was apparent that a list of the soils laboratories particulary in developing countries did not exist nor was much known about the size, facilities and operations of these laboratories.

As a prelude to any work in surveying the analytical chemical methods, the interpretation of data and its application to crop production it was decided to determine how many soil laboratories exist, where they were located and in - so - far as possible the extent of their facilities. Preliminary inquiries through FAO Country Representatives provided a list of 330 laboratories in 74 member countries. Questionaires were sent to all these laboratories. The questionaire provided for information on technical personnel employed, size of individual laboratories, the type of analytical service provided, the methods employed and the interpretation of results.

The survey generally speaking covered the tropical and semi-tropical areas which include most of the developing countries. This, however, led to some anomalies such as the inclusion of Japan which is not classed as a developing country and Jugoslavia which is in the temperate zone. Otherwise the survey covers developing countries in the tropics or semi-tropics.

Two hundred and twenty-seven replies were received but 20 of these were discarded as being negative. Thirty-four percent of the replies came from four countries as follows: India 36, Turkey and Japan 13 each and Pakistan 11. Otherwise the replies were reasonably well distributed in the three areas. The survey made no attempt to cover the developed countries of Europe and North America or non-Member Countries of FAO.

ACKNOWLEDGEMENT

The authors wish to thank the members of the laboratories who answered the questionaires which made this survey possible. Thanks are also due to Mr. F.C.R. Freitas who helped with the final stages of the bulletin's preparation.

II. LIST OF LABORATORIES SURVEYED 1/

Afghanistan

Soils Laboratory, Faculty of Agriculture, Kabul University, Kabul, Afghanistan. University - Teaching.

Soils Laboratory of the U.N.S.F. Land and Water Project, c/o United Nations P. O. Box 5, Kabul, Afghanistan.

Argentina

Instituto de Suelos y Agrotecnia, Cervino 3101, Buenos Aires, República Argentina. State - Survey.

Bolivia

Ministerio de Agricultura, Bueno 191, La Paz, Bolivia. State - Survey + Farmers.

Físico-Químico de Suelos y Aguas, Estación Experimental "La Tamborada", Bolivia. University - Survey + Farmers. Ditto.

Brazil

Laboratorio da Secção de Solos, do IPEAS, Caixa Postal E. - Pelotas, R.S. Brazil. State - Survey + Farmers.

Laboratorio de Quimica e Fisica da Secção de Solos, Sete Lagoas, Minas Gerais, Brazil. Farmers.

Secçao de Solos - IPEANE Caixa Postal 205, Recife, Pelotas, Brazil. Research - Survey + Farmers.

British Guiana

Division of Agricultural Chemistry and Soils, Ministry of Agriculture, Forests and Lands, Georgetown, British Guiana. State - Survey.

Burma

Land Use Laboratory, Agricultural Research Institute Building, Gyogon. (N.B. Communications to: The Director, Land Use Bureau, 27th St., Rangoon, Burma). State - Survey.

1/ The list consists of those laboratories which answered a questionaire sent to all known soils laboratories in 700 member countries of Africa, Asia, and Latin America.

Cambodia

Departement de Science du Sol-Ecologie, Institut de Recherches sur le Cautchouc au Cambodge, (I.R.C.C.) Boite Postale II, Kompeng, Cambodia. State - Research

Cameroun

Laboratoire de Chimie du Service des Sols, Office de la Recherche Scientifique et Technique Outre Mer. (O.R.S.T.O.M.) I.R.C.A.M., B.P. 193, Yaounote, Cameroun. State - Survey.

Ceylon

Soil Chemistry Laboratory, Agricultural Research Station, Maha Illuppallama, Ceylon. State - Research.

Soils Laboratory, Agricultural Research Station, Gurutalawa, Ceylon. State - Farmers + Survey.

Land Use Division, Agriculture Station, Kundasale, Ceylon. State - Survey.

Division of Chemistry, Dept. of Agriculture, Peradeniya, Ceylon. State - Farmers.

Rubber Research Institute of Ceylon, Research Laboratories, Dartonfield, Agalawatta, Ceylon. State - Research.

Soil Chemistry Division, Coconut Research Institute, Lunuwila, Ceylon. State - Research.

Chile

Depto. de Edafología, Laboratorio de Suelos, Facultad de Agronomía, Universidad Católica, Arda Bernado O'Higgins, Santiago de Chile, Chile. University - Survey.

Laboratorio de Suelos, Escuela de Agronomía, Universidad de Chile, Casilla 1004, Santiago, Chile. University - Survey.

Laboratorio Oficial de Suelos, Casilla 5577, Santiago, Chile. State - Farmers.

Laboratorio de Suelos, Sección Agrología, Morandé No. 71, I^{o} piso, Santiago, Chile. State - Survey.

Laboratorio de Suelos, Eduardo Besain M.
Chile. State - Survey.

Colombia

Laboratorio de Suelos del Departamento Agrológico, Instituto Geográfico "Agustín Codazzi", Bogotá, Colombia. State - Survey + Farmers.

Químico Regional Cooperativo, Facultad de Agronomía, Palmira, Colombia. State - Survey + Farmers.

Laboratorio de Suelos, Facultad de Agronomía, Medellín, Colombia. State - University + Farmers.

Laboratorio de Suelos, Centro Nacional de Investigaciones Agropecuarias, Palmira, Valle, Colombia. State - Survey.

Costa Rica

Laboratorio de Física y Química de Suelos, Ministerio de Agricultura y Ganadería, San José, Costa Rica. State - Survey + Farmers.

Departamento de Suelos, Facultad de Agronomía, Universidad de Costa Rica. University - Survey + Farmers.

Cuba

Suelos, Plantas y Aguas, Estación Experimental Agronómica I.N.R.A., Santiago de Las Vegas, Habana, Cuba. State - Survey + Farmers.

Agrícola "Jaronu", Central Brasil, Provincia de Camagüey, Cuba. State

Cyprus

Chemistry Laboratory, Department of Agriculture, Nicosia, Cyprus. State - Survey + Research + Farmers.

Soil and Water Use, Cyprus Agricultural Research Institute, Nicosia, Cyprus. State - Research.

Ecuador

Laboratorios de la Caja Nacional de Riego, Riofrío 314, Quito, Ecuador. State - Survey.

Laboratorio de Edafología, Ministerio de Fomento, Quito, Ecuador. State - Survey + Farmers.

El Salvador

Laboratorio de Análisis de Suelos, Dirección General de Investigaciones Agronómicas, Santa Tecla, El Salvador. State - Survey + Farmers.

Laboratorio de Análisis Rápidos de Suelos, (b) Laboratorio de Caracterización de Perfiles, Dirección General de Investigaciones Agronómicas, Santa Tecla, El Salvador. State - Survey + Farmers.

Ethiopia

Soil Testing Section of the Forestry Research Institute, University College, Addis Ababa, Ethiopia. P.O. Box 399. University - Research.

Awash Valley Soil Laboratory, Forestry Department, University College, Addis Ababa, Ethiopia. University - Research.

College of Agriculture, Haile Selassie University, P.O. Box 138 Dire Dawa, Ethiopia. University - Part time.

Gabon

Laboratoire de Pedologie de la Mission de l'Office de la Recherche Scientifique et Technique Outre Mer au Gabon, B.P. 3103 Liberville, Gabon. State - Survey + Farmers.

Ghana

Chemistry Division, Soils and Fertilizer Section, Cocoa Research Institute, Tafo, Ghana. State - Research.

Soil Research Unit, Ghana Academy of Sciences, Agricultural Research Institute, P.O. Box 1433, Kumasi, Ghana. Survey +Research.

Soil Science Laboratory, Faculty of Agriculture, Kivaine Nkrumah University, Kumasi, Ghana. University - Research.

Guatemala

Laboratorio de Suelos, Subsección de la Sección de Suelos, Instituto Agropecuario Nacional, Finca "La Aurora", Zona, Guatemala. State - Farmers.

Honduras

Laboratorio de Recursos Naturales, El Picacho, Tegucigalpa, D.C., Honduras. State - Survey + Farmers.

Vining C Dunlap Laboratory, Division of Tropical Research, Tela Railroad Co., La Lima, Honduras. Private - Survey + Farmers.

India

Soil Testing Laboratory, College of Agriculture, Nagpur Mahavashtra, India. State - Farmers.

Chemistry Laboratory - Soil Survey Section, Central Coconut Research Station, Kasaragod P.O., Kerala State, India. Research - Survey.

Soils Laboratory, Soil Conservation Dept., Damadar Valley Corporation, Hajaribagh, India. State - Survey + Farmers.

Agricultural Chemistry Laboratory, Central Potato Research Inst., Simla, India. State - Research.

Govt. Hill Fruit Research Station, P.O. Chaubattia (Dist. Almora), V.P., Inida. State - Research.

Agricultural Chemistry Division, Central Rice Research Institute, Cuttack 6, India. State - Research + Farmers.

Agriculture Research Institute, Gwalior - 2 M.P., India. State - Survey + Farmers.

State Agricultural Chemists Laboratory and Soil Testing Laboratory, Jabulpur.
(i) Agricultural Chemist M.P. Agric. Res. Inst., Jabulpur.
(ii) Soil Testing Laboratory Adhartal, Jabalpur.
State - Survey + Farmers.

Soil Testing Laboratory, Agartala Centre, Tripura.
Soil Testing Laboratory, Office Lane, P.O. Agartala, Tripura, India. State - Survey + Farmers.

Soil Testing Laboratory, Agricultural College and Research Institute, Hebbal, Bangalore Z4, India. State - Farmers.

Soil Testing Laboratory, Central Tobacco Research Institute, Ragahmundry Andhra, Pradesh, India. State - Farmers.

Physico - Chemistry, Tocklai Experimental Station, P.O. Cinnamara, Assam, India. Private - Research + Farmers.

Soil Science and Analytical Chemistry, Central Arid Zone Research Institute, Jodhpur (Rayasthan) India. State - Survey.

Section of Sugarcane Chemistry, Sugarcane Breeding Institute, Coimbatore - 7, S., India. Research - Farmers.

India (Cont'd.)

Chemistry Section, Central Coconut Research Station, Ochira, P.O. Kayangulam Kerala, S. India. Research - Survey + Farmers.

Soil Testing Laboratory, Research Department Coffee Board, 2638, II Main, V.V. Mohalla P.O., Mysore - 2 Mysore State, India. Research - Farmers.

Section of the Agricultural Chemist to Govt. V.P. Kanpur, Agricultural Gardens, Kanpur, V.P. India. State - Survey + Farmers.

Regional Soil Laboratory, Nanital, India. State - Survey + Research.

Regional Soil Laboratory, University Area, Ahigarh, India. State - Survey + Research.

Regional Soil Laboratory, Civil Lines, Jhansi, India. State - Survey + Research.

Regional Soil Laboratory, Rundrafeur - (Nanital), India. State - Survey + Research.

Soil Testing Laboratory, Agricultural Research Institute, Rajendranagar, Hyberabad - 30, Andhra Pradesh, India. State - Farmers.

Chemical Laboratories, Agricultural Research Institute, Rajendranagar, Hyderabad - 30, Andhra Pradesh, India. State - Survey + Farmers.

Regional Research Station Laboratory, Nawabgan, Bareilly, V.P. India. State - Research + Farmers.

Soil Science and Agric. Chemistry, Section, Indian Institute of Sugarcane Research, P.O. Dilkusha, Lucknow - 2, (Uttar Pradesh), India. State - Research.

Soil Testing Laboratory, Indian Agricultural Research Institute, New Delhi - 12, India. State - Farmers.

Soil Testing Laboratory, Adulthurai, Madras State, India. State - Farmers.

State Agricultural Chemist's Laboratory and Soil Testing Laboratory, Jabalpur, India. Research - Survey + Farmers.

Soil Testing Laboratory, 24 Paota Dept. of Agriculture, Jodhpur, Rajasthan, India. State - Survey + Farmers.

Soil Testing Laboratory, Agricultural College and Research Institute, Trivandrum, India. State - Farmers.

Regional Research Station, Hardoi, Government Agricultural Farm Hardoi (V.P.), India. State.

India (Cont'd.)

College of Agriculture, Punjab Agric. University, Ludhiana, Punjab, India. University - Survey + Farmers.

Soil Testing Laboratory, Aligarh, India. State - Farmers.

Soil Studies Section, Sugarcane Research Station, Shanjahanpur, India. Research - Survey + Farmers.

Laboratory of the Agricultural Chemist, College of Agriculture, Poona - 5, India. State.

Research Laboratory of the Agricultural Chemist, Division of Agricultural Chemistry, Agricultural College and Research Institute, Heygal, Bangalore - 24, India. Research - Survey.

Indonesia

Ilmu Tanah bagian Pedologi, Faculty of Agriculture, Soils Dept., Djalan to Iskandardianata, Bogor, Indonesia.
University - Survey + Farmers.

Bagian Kesuburantanah (Soils Fertility Division) Lembaga Penelitian Pertanican Manokwari (Agricultural Research Institute Manohwari), Indonesia. Survey - State.

Division of Analysis, DJ Perniagaan 42, Bogor, Indonesia.
State - Survey + Farmers.

Balai Penjelidikan Perusahaan Gula (Sugar Experimental Station) Djl. Pahlawan 25, Pasuruan, Indonesia. Research - Survey.

Soil Laboratory of the RISPA. Kampung Baru, Medan - Sumatra - Indonesia. Research - Survey + Farmers.

Soil Laboratory, Dept. of Soils and Fertilizers, Faculty of Agriculture, Gadjah Mada University, Jogjakarta, Indonesia.
University - Survey.

Iraq

Soil and Water Testing Laboratory, Tell - Mohammed - Baghdad, Iraq. Research - Survey.

Iran

Soil Science, Agricultural College, Karadj, Iran.
Teaching - Survey.

Israel

Soil - Water - Plant Extension Laboratory, Israel, Western Galilee M.and E. Post Oshrat, Israel. Survey - Farmers.

Dept. of Soil Chemistry and Fertilization - National and University Institute of Agriculture, Rehovot, P.O.B. 12, Israel. University - Research.

Agricultural Laboratory - Upper Galilee, District Council Kiryat - Shamonah, Israel. State - Survey + Farmers.

Field Extension Service - Central Laboratory, Hamidrasha, Le'chakia'VT, Emek Hefer, Israel. State - Survey + Farmers.

Department of Soil Science, Div. of Pedology and Soil Survey Faculty of Agriculture, Rehovot, Israel. University - Research + Survey.

Jamaica

Cane Farmers Laboratory, 4 North Avenue, Kingston Gardens, Jamaica - W.I. Private - Survey + Farmers.

Agricultural Chemistry Laboratory, Ministry of Agriculture and Lands, P.O. Box 480, Hope, Kingston 6, Jamaica W.I. State.

Sugar Manufacturers Association (of Jamaica) Ltd., Research Department, Mandeville, Jamaica, W.I. Private - Farmers.

Sugar Research Department, The Sugar Manufacturers Association (of Jamaica)Ltd., Kendal Road, Mandeville, Jamaica W.I. Private - Research + Farmers.

Banana Board Research Department, 10 Sough Avenue, Kingston Gardens, Kingston, Jamaica, W.I. Research - Farmers.

Jordan

Soil and Water Laboratory, Research Department, P.O. Box 226, Amman, Jordan. Survey - Farmers.

Japan

Soils, Department of Agricultural Chemistry, Faculty of Agriculture, Kyushu University, Hakoyaki, Fukuoka city, Japan. University - Research.

Pedology, Section of Soils and Plant Nutrition, Kyushu Agricultural Experimental Station, M.A.F., Chikugo, Fukuoka Prefecture, Japan. State - Research + Survey.

Japan (Cont'd.)

1st Section of Soil Science, Faculty of Agricultural Chemistry, 95, Hachiken, Kotoni-cho, Sapporo-city Hokkaido, Japan. State - University + Research.

Laboratory I of Soils and Fertilizers (for paddy soils). Laboratory II of Soils and Fertilizers (for upland soils). Shimo-Kureyagawa, Morioka-city, Iwate - pref., Japan. State - Research.

Soil and Fertilizer, Department of Upland Crops, Central Agricultural Esperimental Station. Kitamoto-Machi, Saitama Prefecture, Japan. State - Research.

Laboratory of Soil and Manure, I and II. Lab. of Soil Conservation, Zentsuyi City, Kagawa - Ken, Japan. State - Survey.

The Sericultural Experiment Station, Ministry of Agriculture and Forestry of Japanese Government, 2 - 104, Koenji, Suginami, Tokyo, Japan. State - Research.

Laboratory of Soil and Manure (1st and 2nd), Hokuriku Agric. Exp. Station, Takada City, Nugata - Pref., Japan. State - Research + Survey.

Soil Survey Division, Soil Analysis Laboratory, Forest Experiment Station, 770, 4-chome, Shimomeguro, Meguro-Ku, Tokyo, Japan. State - Survey.

Laboratory of Soils, C/o College of Agriculture, Kyoto University, Kyoto, Japan. University - Research.

No. 4 Laboratory of Forage Crops Section, Aoba-cho, Chiba-shi, Japan. State - Research.

3rd Laboratory, Section of Grassland, 296 Mishima Nichinasuno Cho, Nasugun, Tochigi Pref., Japan. State - Research.

1st Soil and Fertilizer Laboratory (rice Fertility), 2nd Soil and Fertilizer Laboratory (upland crops Fertility), Chugoku National Agricultural Exp. Station, 450 Higashifukatsu-cho, Fukugama City, Hiroshima Prefecture, Japan. State - Research.

Kenya

Tea Research Institute of East Africa, P. O. Box 91, Kericho, Kenya. Research - Farmers.

East African Agriculture and Forestry Research Organization, P.O. Box 21, Kikuyu, Kenya. State - Research.

Scott Agricultural Laboratories, P. O. Box 30028, Nairobi, Kenya. State - Survey + Farmers.

Korea

Chemical Laboratory, Bokdae-dong, Chang ju Chung Puk, Korea.
State - Survey + Farmers.

Soil Laboratory Institute of Plant Environment, Office of Rural Development, ≠ 249 Sudun, Suwan, Korea. State - Survey + Farmers.

Soil Testing Room, Sosaup, Buchongun, Kyonggi Privinœe, Korea.
State - Survey + Farmers.

Laboratory of Soil Chemistry College of Agric. Korea University
1 Anam-dong, Sungbuk - Ku, Seoul, Korea.
University - Research + Survey.

Kuwait

Chemistry Laboratory, Government Research Station, Ministry of Public Works, Kuwait, Arabia. State - Survey + Farmers.

Lebanon

Laboratoire de Chimie des Sols et Biochimie, Tel Amara par Rayak, Liban. State - Survey - Farmers + Research.

Liberia

Tubman Research Laboratory, Central Agriculture Experimental Station, Suakoko, Liberia. State - Research.

Libya

Chemical Agricultural Laboratory. Ministry of Agriculture, Department of Agriculture, Sidi Mesri, Tripoli, Libya.
State - Survey + Farmers.

Madagascar

Laboratoire des Sciences du Sol de l'Institut de Recherche Scientifique de Madagascar, I.R.S.M., B.P. 434 - Tsimbazaza, Tananarive, Madagascar. State - Survey + Farmers.

Malaysia

Plantation Research Department (M), Malayan American Plantations, Process Department, Bedong, Kedah, Malaysia. Private - Research.

Forest Research Institute, Silviculture - Afforestation Section - Kepong, Selangar, Malaysia. Survey - Research.

Soils Division, The Rubber Research Institute of Malaysia, P.O. Box 150, Ampany Rd., Kuala Lumpur, Malaysia.
State - Survey + Farmers.

Malaysia (Cont'd.)

Soil Laboratory, Department of Agriculture, Kuching, Sarawak, Malaysia. State - Survey + Research.

Soil Science Division, Division of Agriculture, Ministry of Agriculture and Co-operatives, Jalan Swettenham, Kuala Lampur, Malaysia. State - Survey + Research.

Agricultural Research Centre, Tuaran, Sabah, Malaysia. State - Research.

Malawi

Chemical Laboratories, Department of Agriculture, Chitedze Research Station, P. O. Box 158, Lilong'we, Malawi. State - Survey + Farmers.

Mauritius

Chemistry Laboratory, Mauritius Sugar Industry Research Institute, Reduit, Mauritius. State - Survey + Farmers.

Chemistry Mauritius Sugar Industry Research Institute, Reduit, Mauritius. State - Survey + Farmers.

Morocco

Laboratoire des Sols - Sogetim, 2 Rue Pegoud, Rabat, Morocco. State - Survey + Farmers.

Laboratoire Pedologique de la Station de Recherches Forestieres, Avenue Mangin Prolongee, Rabat, Morocco. State - Research.

Laboratoire de Pedologie, Perimeter de la Basse Maulauya, Berkane, Morocco. State - Research.

Laboratoire Central de Pedologie de I.O.N.I., Route de Casablanca, Rabat, Morocco. Research - Survey.

Nigeria

Soil Science Laboratory, Institute for Agricultural Research, P.M.B. 1044, Samaru, Zaria, Northern Nigeria. State - Survey + Research.

Niger Delta Development Board, Private Mail Bag 67, Port Harcourt, Nigeria. Survey - Research.

Western Nigeria Ministry of Agriculture and Natural Resources, Soil and Chemistry Laboratories, Agricultural Research Division, W.N.M.A.N.R. Moor Plantation, Private Mail Bag 5029, Ibadan, W.Nigeria. Survey - Research.

Pakistan

A.C.E. Testing Laboratories, Variawa Building, McLeod Road, Karachi, Pakistan. Survey - Farmers.

Land Reclamation Laboratories, Canal Bank, Moghalpura Lahore - 15, Pakistan. Survey - Farmers.

Soil Science Laboratory, East Pakistan Agricultural University, Mymensingh, Pakistan. University - Research.

Agriculture Chemist and Soil Physicists Laboratories, Agriculture Research Institute, Tandojam, West Pakistan. State - Survey +Farmers.

Chemistry and Meteorological Division, Pakistan Tea Research Station, P.O. Srimangal, Dist. Sylhet, East Pakistan. Research - Survey + Farmers.

Atomic Energy Agricultural Research Centre, 172/A Dhanmandi Residential Area, P.O. Box No. 158, Ramna, Dacca, East Pakistan. State - Survey + Research.

Soil and Agricultural Survey DUN (Soil Research Lab.) Green Rd., Tejgaon, Dacca 5, East Pakistan. Survey - Research.

Chemical Section 1, Ayub Agricultural Research Institute, Lyallpur, West Pakistan. State - Research.

Agriculture Chemist and Soil Physicist Laboratories, Agriculture Research Institute, Tandojan, W. Pakistan. State - Survey + Farmers.

Division of Soil Science, Agricultural Research Institute, Tarnab, Peshawar, W. Pakistan. State - Research + Farmers.

Soil Survey Laboratory, East Pakistan, P. O. Tejgaon, Dacca, East Pakistan. Survey - Research.

Panama

Laboratorio de Suelos, Ministerio de Agricultura, Comercio e Industrias, Apartado 1631, Panama, Republica de Panama. State - Survey - Farmers.

Rhodesia

Soil Testing Laboratory, Chemistry Branch, P. O. Box 8100, Causeway, Salisbury, Rhodesia. State - Survey + Farmers.

Senegal

Centre de Recherches Pedologiques, B.P. 1386 Dakar-Hann., Senegal. State - Survey + Research.

Senegal (Cont'd.)

Laboratoire des Sols et des Eaux, Centre de Recherches Agronomiques, Bombey, Senegal. State - Survey + Farmers.

Laboratoire d'Agro-Pedologie I.R.A.T., Station Experimentale de Sefa par Sedhiou - B.P. 46, Casamance, Senegal. Survey - Research.

Sierra Leone

Rice Research Station, Rokupr, Sierra Leone. Survey - Research.

Research Branch, Ministry of Natural Resources, NJala, via Mano, Sierra Leone. State - Survey.

Somali

Soils Laboratory, Afgo, Research Institute, c/o Agr. Division USAID, Mogadiscio, Somali Republic. State - Survey.

Sudan

Soil Science Section, Gezira Agricultural Research Station, P.O. Box 126, Wad Medani, Republic of the Sudan. State - Survey + Farmers.

Chemistry Section, Hubeiba Agric. Res. Station, P.O. Box 31, Ed. Damar, Sudan. State - Research.

Soil Science Section, Kenana Research Station, Abu Naama (B.N.P.) Republic of the Sudan. State - Research.

Syria

Multipurpose Laboratory, Agricultural Services, Aleppo, Syria. Research - Farmers.

Agricultural Chemistry Laboratory, Chamber of Agriculture, Deraa, Syria. State - Research.

Agricultural Chemistry Laboratory, Direction of Agriculture, Homms, Syria. State - Research.

Laboratory of Soils and Agricultural Chemistry, Ministry of Agriculture, Damascus, Syria. State - Survey + Farmers.

Tanganyika

Coffee Research Station, Lyamungu, P. O. Box 3004, Moshi, Tanganyika. State - Research.

Soils Laboratory, Central Centre, Private Bag, Kilosa, Tanganyika. Research - Survey.

Sisal Research Station, P. O. Ngomeni, Tanganyika. Research - Survey + Farmers.

Tchad

Laboratoire de Pedologie, Centre de Recherches Tchadiennes, Boite Postale No. 65, Fort Lamy, Tchad. Survey - Research.

Thailand

Soil and Plant Nutrition Laboratory, Agronomy Dept., Kasetsart University, Bangkok, Thailand. University - Research.

Soil and Isotope Laboratory, Technical Division, Rice Department, Ministry of Agriculture, Bangkok, Thailand. State - Survey + Farmers.

Chemical Laboratory, Research and Laboratory Section, Royal Irrigation Department, Bangkok, Thailand. Research - Survey.

Togo

Centre O.R.S.T.O.M. au Togo - Institute de Recherches au Togo (I.R.T.), B.P. 375, Lome, Republique du Togo. Research - Survey.

Trinidad

Soils Division, Central Experiment Station, Centeno, c/o Arima P.O., Trinidad. State -Survey + Farmers.

Tunisia

Laboratoire de la Subdivision d'Etudes Pedologiques, KM 4, Route de la Soukra, Ariana, Tunisia. Research - Survey.

Laboratoire de Chimie Agricole, I.N.R.A.Y. Auirua, Tunisia. State - Research.

Turkey

Toprak Tahlil Laboratuari (Soil Testing Laboratory), Topraksur XI, Toprak Tahlil Laboratuari, Samsun, Turkey. Research - Survey + Farmers.

Sulu Ziraat Deneme ist. Toprak Tahlil Lab., Topraksu Sulu Ziraat Deneme is Cumra, Konya, Turkey. State - Survey.

Soils and Agricultural Chemistry Division of the Sugar Beet Research Institute, Seker Pancari Arastirma Enstitüsü, Seker Fabrikasi, Eskisehir, Turkey. State - Survey + Farmers.

Soil Laboratory Ziraat Fakultesi, Tprak Kürsüsü, Ankara, Turkey. State - Survey + Farmers.

Soil and Fertilizer Research Institute, Fatih Caddesi, No. 68, Diskapi, Ankara, Turkey. Research - Farmers.

Ege Bolgesi Toprak Tahlil Laboratuari, Topraksu I ci Bolge Mudurlugu Toprak Tahlil Laboratuari, Izmir, Turkey. State - Survey + Farmers.

Toprak Laboratuari, Ankara Ziraat Fakültesi, Ankara, Turkey. State - Research + University.

Soil Fertility, A.Ü. Ziraat, Fakültesi, Bitkibesleme, Kürsüsü, Turkey. University - Research.

Radioisotop Laboratory A.Ü. Ziraat Fakültesi Isotop Laboratory, Turkey. University - Research.

Ege Universitesi Ziraat Fakültesi, Bitki-besleme, Kürsüsü, Bornaua, Izmir, Turkey. Research - Farmers.

Sulu Ziraat Arastirma Enstitiesu Toprak Laboratory, Tarsus, Turkey. Research - Survey + Farmers.

Topraksu IV Bolge Laboratuari Bestekar Sokak No. 25 Kavaklidere, Ankara, Turkey. Research - Survey + Farmers.

Topraksu Tahlil Laboratuari Buyukkaraman Cad. Parkhan, No. 11/15 Fatih, Istanbul, Turkey. Survey - Farmers.

U.A.R.

Soil Science Department, Faculty of Agriculture, University of Ain Shams, Shoubra et Khema, Cairo, Egypt. University - Research.

Uganda

Kawanda Research Station, P.O. Box 265, Kampala, Uganda. State - Survey.

Uruguay

Laboratorio del Instituto Nacional de Colonización, Arenal Grande 2792, Montevideo, Uruguay. State.

Instituto Nacional de Colonización, Cerrito 488, 3er piso, Montevideo, Uruguay. State - Farmers.

Venezuela

Laboratorio de Suelos, Servicio Shell para el Agricultor, Cagua, Edo. Aragua, Venezuela. Survey - Research.

Sección Química de Suelos, Instituto de Edafología, Facultad de Agronomía, Universidad Central de Venezuela, Maracay, Venezuela. University - Research + Survey.

Viet-Nam

Laboratoire de Chimie des Sols, 1 Rue Phan-thank-Gian-Saigon, Viet-Nam. State - Survey + Farmers.

Institut des Recherches sur le Cautchoue Av Viet-Nam, B.P. 456, Saigon, Viet-Nam. Research - Survey.

Yugoslavia

Institut za proucavanje zemljista, Theodora Drajzera 7, Yugoslavia. State - Research.

Laboratory of Pedology, Zemjodelsko - Ispitatelen Institut, Skopje, Yugoslavia. University - Survey.

Zavod za poljoprivredne melioracije, Novi Sad, Maksima Gorkog 30, Yugoslavia. Research.

Zambia

Mount Makulu Research Station, P.O. Box 7, Chilanga, Zambia. State - Survey + Farmers.

Zanzibar

Chemical Laboratory, P.O. Box 159, Zanzibar. State - Farmers.

III. STAFF AND FACILITIES

Staff

An analysis of the variation in staff numbers is shown in Table 1. Some of the laboratories which quoted high graduate numbers included field surveyors who used the laboratory as headquarters.

Table 1. Distribution of staff in the laboratories

Graduates:

No. of graduates	0	1	2	3	4	5	6-10	>10
No. of laboratories	15	39	35	26	28	11	29	24

Technicians:

No. of technicians	0	1-2	3-4	5-6	7-8	9-10	11-20	>20
No. of laboratories	9	18	49	46	20	16	27	22

Facilities

In general the laboratories were well equipped for their purpose and almost all were fitted with electricity, gas and fume extraction. Laboratory instruments included pH meters, colorimeters and flame photometers. Special facilities and equipment are listed in table 2. Sixty-four percent of the laboratories were associated with field experimental facilities and 47.5 percent had greenhouse facilities.

Table 2. The number of laboratories with special facilities

Facilities	No. of laboratories possessing special facilities
Spectrophotometer	96
Spectrograph	19
Radioisotopes	21
Greenhouse facilities	95
Field experimental facilities	128

IV. LABORATORY ANALYTICAL OUTPUT

The data on number of samples analysed are quoted in Table 3. For all countries the total number of samples received from farmers during 1961-63 inclusive, was 328,000 and for soil survey, 158,000. A large number of the laboratories were only recently established and were still being developed. It is likely therefore, that the output will steadily increase. The figures quoted are, however, a useful index of the present application of soil technology to farming in the countries surveyed.

Table 3. Output of analyses from the laboratories

Type of samples	Number of samples handled per annum		
	<1000	1000-10,000	>10,000
Farmers	55	24	19
Soil Survey	74	43	2

The maximum number of samples analysed in one laboratory was 50,000 (Asia) for farmers and 14,000 (Latin America) for soil survey. The former reported a graduate and technical staff of 107 but the latter reported only 6.

V. TECHNIQUES

1. Sampling

No marked preference was shown in the training of personnel who sampled the soil. Graduate advisors, trained technicians and farmers were equally prevalent. Some laboratories received samples from all three types. Detailed printed instructions were issued by several laboratories and these were all similar in their recommendations for the selection of uniform sampling area, the random selection of sampling points within the area and the thorough mixing of the sample. The variations in recommended sampling depths, number of cores per sample and maximum permissible area of one sample are shown in Table 4.

Table 4. The range of area sampled, number of cores per sample and sample depth employed by the surveyed laboratories

	Max. area sampled acres			No. of cores per sample			Sample Depth	
Range	0-2	3-10	11-25	< 10	11-20	> 20	cm 0-15	cm 15-30
No. of laboratories	23	44	26	74	29	4	28	58

2. Preparation of Soils for Analyses

Pre-treatment of soil samples before analysis was very uniform over all laboratories. Standard practice consisted of air drying, crushing by hand and sieving through a 2 mm sieve. For carbon or nitrogen estimations the soils were ground finer. Oven drying was used to a limited extent.

3. Methods of Chemical Analyses

a) pH - One laboratory used a quinhydrone electrode to determine pH, six used indicators but all other used a glass electrode. Water, potassium chloride and calcium chloride at various soil/solution ratios were used. Table 5 shows the frequency of use of the most common techniques.

Table 5. Frequency of various methods of extraction for pH determination

Solution	Soil: Solution Ratio			
	1:1 or less	1:2	1:5	1:10 or greater
Water	61	84	17	8
N.Potassium Chloride	8	21	-	2
Calcium Chloride	1	4	3	1

b) Soluble, exchangeable or available fractions - All methods considered under this category are empirical. Small details of technique, e.g. soil/extractant ratio can alter the significance of the results. Rigid standardisation is, therefore, essential before results can be compared between laboratories.

c) Calcium and Magnesium - Both of these elements were normally determined with the same extract. Normal ammonium acetate was the extractant most commonly used but there was a very wide range in the soil:extractant ratios. Table 6 shows the frequency of use of the most popular extractants and soil:extractant ratios.

Table 6. The number of laboratories using various extractants and soil:extractant ratios for Calcium and Magnesium determinations

Extractant	Soil:Extractant Ratios				
	1/2 or less	1/5	1/10	1/20	1/50 or wider
Ammonium Acetate	10	11	18	31	14
Water	10	4	2	1	
Ammonium Chloride		1		2	1
Sodium Chloride			1		4

Titration with E.D.T.A. 1/ was the method most frequently used for determining calcium and magnesium in the soil extracts. Calcium was also determined by flame photometer and by precipitation with oxalate followed by permanganate titration. Magnesium was determined in some instances by spectrography, a colorimetric method using Brilliant yellow and by precipitation with ammonium dihydrogen phosphate.

d) Potassium and Sodium - Ammonium acetate was again the most frequently used extractant. Table 7 lists the range of extractants and soil:extractant ratios used for potassium. The flame photometer was almost universally used for determing sodium or potassium but the cobaltinitrite turbidity method was an alternative for potassium and the magnesium uranyl acetate was used for sodium.

Table 7. The numbers of laboratories using various extractants and extractant ratios for the determination of available potassium

Extractant	Soil:Extractant Ratios				
	1/2 or less	1/5	1/10	1/20	1/50 or wider
Ammonium Acetate	5	17	19	31	11
Water	6	4	3	1	
Sodium Acetate	3	11	1		
Acetic Acid			2		3

1/ Ethylene diamine tetraacetate.

Seventy-six percent of the laboratories used ammonium acetate as the extractant and 27 percent used an extractant ratio of 1:20.

e) Phosphorus - A greater diversity of extractants was recorded for soil phosphorus than for the cations. The reduction of phospho-molybdic acid was the most common method of determining phosphorus but the vanadomolydate was used in five laboratories.

Olsen's method was used by 40 percent of the laboratories while Bray I and Truog methods were used by 18 and 22 percent respectively.

Table 8. The number of laboratories using various methods and extraction ratios for the determination of available P_2O_5

Extractant	Soil:Extractant Ratios				
	1/2 or less	1/5	1/10	1/20	1/50 or wider
Olsen	1		2	49	1
Bray I		6	18	1	
Bray II		1	8		
Truog				1	29
HCl	3		6		
Morgan	4	5			

f) Nitrogen - Total Kjeldahl nitrogen was used more often than any other test to predict fertilizer nitrogen requirements. Ammonium and nitrate nitrogen were also measured in a number of laboratories but were not commonly used for advice to farmers. Water was the extractant most often used for these ions but solutions of potassium chloride, sodium chloride, sulphuric and hydrochloric acids, calcium sulphate, copper sulphate, calcium acetate and sodium acetate were all used. Two laboratories used alkaline permanganate to estimate available nitrogen. Phenoldisulphonic acid, brucine dipycrylamine or Devarda's alloy were the reagents used for nitrate estimation and Nessler's reagent or distillation with magnesium oxide were used for determination of ammonium.

g) Micronutrients, Aluminium and Free Iron Oxides - Minor elements analyzes were only carried out in a small number of laboratories. The methods quoted were used in research projects. In view of this the degree of standardisation between laboratories was remarkable. For boron hot water was chosen as extractant by sixteen out of a total of nineteen laboratories doing this analysis. Carmine,

curcumin, dianthramide and quinalizarin were all used as colorimetric reagents for boron. There was also good agreement on manganese analysis which was normally a colorimetric periodate method after extraction by ammonium acetate or acetic acid. Copper was determined in sixteen laboratories by either a colorimetric, polarographic or spectrographic method. Aluminium analysis was listed in twenty nine laboratories. Potassium chloride extraction followed by an aluminium colorimetric determination was the most common procedure. Free iron oxides were estimated in thirty seven laboratories and in the majority of these sodium dithionite was the extractant.

h) Cation Exchange Capacity - A wide variety of saturating and displacing salts were used in the measurement of cation exchange capacity. Table 9 shows the frequency of use of the more common ones.

Table 9. The number of laboratories using various saturating and displacing salts for the determination of cation exchange capacity

	No. of Laboratories	Percentage
Saturating Salts:		
Ammonium acetate	83	61
Sodium acetate	25	18
Barium chloride	8	6
Calcium chloride	7	5
Other salts	13	10
Displacing Salts:		
Ammonium acetate	35	33
Sodium Chloride	28	27
Potassium chloride	10	10
Sodium hydroxide	6	5
Other salts	26	25

i) Special analyses for Saline Soils - These analyses covered total soluble salts and soil anions. Only small differences in techniques were quoted and several laboratories referred to "Diagnosis and Improvement of Saline and Alkali Soils" U.S.D.A. Handbook 60 as a standard reference.

Total soluble salts were determined either gravimetrically or conductimetrically on saturated soil pastes or 1:5 soil water extracts in 108 laboratories.

Chlorides were measured in 108 laboratories by titration with silver nitrate.

Sulphates were determined either titrimetrically, gravimetrically or turbidimetrically with barium chloride. Three laboratories used benzidine as reagent for sulphate. Eighty-nine laboratories listed sulphate analysis for saline and alkaline salts.

Carbonate and bicarbonate analyses which were recorded for ninety-two laboratories were invariably determined acidimetrically using phenolphthalein and methyl orange indicators.

The Schönover method (titration with EDTA) quoted in U.S.D.A. Handbook 60 was the most common method used for measuring gypsum requirement.

j) Analysis for Total Quantities - The total quantity of any element in the soil is an absolute rather than an emphirical value and therefore rigid standardisation should not be as important in comparing results between laboratories as when comparing available figures. Nevertheless some of the methods do involve presumptions which are not universally true and may preclude comparisons between sets of data. The factor of 1.34 used in calculating carbon by the Walkley Black method is one example of this.

The main difference between methods of estimating total quantities and available fractions lies in the techniques used to bring the soil elements into solution. For total quantities these techniques fell into three classes. (1) Fusion with sodium carbonate, potassium carbonate, sodium peroxide or magnesium oxide. (2) Ignition followed by extraction with hydrochloric acid. (3) Treatment with hot acids - perchloric, nitric, hydrofluoric or a sulphuric hydrofluoric mixture. Following these treatments the various elements were determined quantitatively by methods already recorded for the available fractions. Silicon was usually measured gravimetrically but distillation as silicon tetrafluoride and colorimetric methods were also employed.

Total organic carbon was estimated in all cases by a sulphuric acid/dichromate oxidation method, the Walkley - Black technique being the most common. Total nitrogen was always determied by the Kjeldahl method.

4. Mineralogical Analysis

Mineralogical analysis was predominantly associated with research projects and was not a widely established service even for soil survey. Thirteen laboratories used differential thermal analysis in studying the minerals, nine used X-ray, five used thermal analysis, three used the electron microscope and one used infra red.

5. Physical Analysis

a) Soil texture

The main variations in methods of determining soil texture are in the choice of dispersing agent, range of fraction sizes and whether the pipette or hydrometer is used for determining the weight in each fraction. Table 10 shows the frequency of use of the most popular systems. Sodium hydroxide, hydrochloric acid, pyrophosphate, sodium carbonate, sodium silicate and ammonium hydroxide were frequently used as dispersing reagents. Supersonic vibrations were also used.

Table 10. The number of laboratories using various methods for particle size determination

Dispersing Agent		Fraction Sizes			Method	
Na hexameta phosphate	Na Oxalate	International 2/.2/.02/ .002 mm	U.S.D.A. 2/.2/.05 .02/.002	Others	Pipette	Hydro-meter
74	21	62	12	48	62	79

b) Soil structure

Only fifty-two laboratories examined the structure of the soil. Five examined thin sections microscopically. All other structure measurements were variations of the wet sieving methods estimating aggregate stability. Some laboratories carried out the wet sieving analysis in water alcohol and benzene to make the definition of stability more precise.

c) Porosity

Total pore volume was determined in fifty-seven laboratories. It was most often calculated from the bulk density and the particle specific gravity. The paraffin wax method and the pyconometer were also used. Sixteen laboratories examined the pore size distribution usually by the difference between total pore volume and field capacity or other tension levels. One laboratory calculated the pore size distribution from the differential pf curve.

d) Soil moisture retention

Ninety-one laboratories made some measurements of moisture equivalents. The centrifuge, pressure plate and pressure membrane apparatus were most frequently used to estimate the moisture equivalent, field capacity and wilting co-efficient. Eight laboratories used sunflowers to determine the wilting co-efficient.

VI. INTERPRETATION OF RESULTS OF ANALYSES

For soil analyses to be of value to the farmer a relatively simple relationship must be established between soil test result and yield response to a nutrient. Information was sought on the constancy of this relationship between laboratories by requesting laboratory directors to classify the analytical results into categories very low, low, medium, high and very high and to list the recommended fertilizer treatments for each category. This procedure was crude perhaps but it followed the usual system in advisory work and was sensitive enough to show major differences between laboratories using the same extractant.

There are very big differences in each category in the classification of analytical results by laboratories and no agreement could be found between these classifications and soil groups. It would appear some classifications have been adopted without a basic field experimental work to establish the relationship between soil test results and yield responces to plant nutrients.

1. Nitrogen

Total Kjeldahl nitrogen was the soil test most commonly used for predicting fertilizer nitrogen requirements. Table 11 shows the classification of soil test results into very low to very high categories for the twenty-nine laboratories which recorded this classification. There is more than a twenty-fold difference between laboratories.

Table 11. The range of interpretation for total nitrogen determinations (Kjeldahl method)

Very low	Low	Medium	High	Very High
.01	.02	.03	.05	.08
.01	.02	.05	.10	.15
.01	.02	.03	.05	.06
.025	.1	.15	.25	> .25
.04	.1	.2	.3	> .3
.05	.075	.1	.15	> .15
.05	.1	.2	.35	> .35
.05	.1	.3	.8	> .8
.05	.15	.2	.35	> .35
.05	.1	.2	.25	> .25
.06	.1	.15	.2	> .2
.06				.6
.08	.1	.18	> .18	
.1	.12	.15	.2	> .2
.1	.17	.25	.35	> .35
.1	.2	.3	.5	> .5
.1	.3	.5	1.0	> 1.0
.1	.2	.25	.3	.5
.1	.2	.5	1.0	> 1.0
	.1		.4	
	.2	.4	.6	
	.2	.5	1.0	
.3	.5	.75	1.0	> 1.0
.3	.5	.75	1.0	> 1.0
.4	.6	.9	1.5	2.5
	.3	.6	> .6	
	.25	.5	> .5	
.5		1.0		2.0
.5	1.0	1.5	2.0	

2. Phosphorus

Olsen's method was the phosphorus test most commonly used to predit fertilizer phosphorus requirements. Thirty laboratories classified the results of analysis into very low to very high. Table 12 lists the values quoted. There was reasonable agreement between laboratories on this classification.

Table 12. The range of interpretation of available phosphorus determinations (p.p.m) according to Olsen's method

Very low	Low	Medium	High	Very High
2	5	10	20	> 20
2	5	10	20	> 20
2	4.5	11	22	> 22
2	4.5	11	22	> 22
	3.5	11	> 11	
2.2	4.5	11	22	> 22
2.2	4.5	11	22	> 22
2.5	5	15	20	> 20
2.7	5.2	10	15	> 15
3	5	10	25	> 25
3	7	10	11	> 11
3	7	10	11	> 11
	5	10	> 10	
	4.5	11	> 11	
5				20
4	8	14	18	
4	8	12	16	> 16
4.5	9	18	> 18	
4.5	9	18	> 18	
4.5	9	18	> 18	
4.5	9	18	> 18	
4.5	9	18	> 18	
4.5	9	18	> 18	
4.5	9	18	> 18	
4.5	9	18	> 18	
5	10	25	50	> 50
	6	9		
	7	13	> 14	
	10	25	250	> 250
	10	25	> 25	

3. Potassium

Ammonium acetate was the potassium extractant most frequently used in predicting fertilizer requirements. Differences did occur between laboratories on the delineation of the very low or very high groups but there was reasonable agreement on the values considered "medium".

Table 13. The range of interpretation of available potassium determinations stated as p.p.m.K.

Very Low	Low	Medium	High	Very High
10	30	70	150	> 150
20	40	60	100	> 160
20	40	100	160	
20	40	80	160	
40	60	120	200	> 200
40	160	240	400	> 400
50	100	200	500	> 500
50	150	250	350	450
50	100	150	200	> 200
50	70	100	> 150	> 150
	50	150	> 150	
	80	150	150	
	60	100	200	
	100	200	> 200	
60	120	400	2000	>2000

4. Lime

Only twenty-six laboratories commented on the use of lime. A number stated that no response had been obtained in their regions and others reported that lime was too expensive to use.

Table 14. The range of interpretation of pH values used in determining lime requirements

Very Low	Low	Medium	High	Very High
	5.0	5.5	6.0	
4.5	5.0	5.5	6.0	
5.0	5.5	6.5		
	5.4	6.0	> 6.0	
	5.0			
4.7	5.0	5.3	5.6	5.9
5.0	5.9	7.0	7.9	> 8.0

VII. UNITS USED IN REPORTING SOIL ANALYSES

In comparing results between laboratories a difficulty arose due to the wide range of units used even where the analytical method was the same. This was particularly true of the available fractions. Common units included parts per million, pounds per acre, kilogrammes per hectare, milliequivalents per 100 grammes and the mineral was quoted as the element, the oxide or a salt e.g. P, P_2O_5 or $Ca_3(PO_4)_2$. Any one of these units would be adequate if universally accepted but as all are in current use the selection of one system would facilitate international comparison.

For this purpose some units seem more attractive than others. The use of milliequivalents is of little value except where the ionic form is known and an ion balance is sought. With phosphorus, however, the ionic form is a function of pH and must be presumed. Where units of land area are employed e.g. pounds per acre, or kilogrammes per hectare an arbitrary factor must be included to relate area to the weight of the soil. Furthermore, those using the results often expected the soil test result and the pounds of fertilizer element used to be additive. Values quoted in parts per million or milligrammes per hundred grammes are unambiguous and in fact other units are usually calculated from these. The reporting of results as the amount of element rather than oxides or salts is also simpler and less presumptive.

VIII. CONCLUSIONS

From the data reported it may be concluded:

In general the laboratories are well equipped.

The standard practice for the preparation of soil samples for analyses was air drying, crushing by hand and sieving through a 2 mm. sieve. For carbon and nitrogen estimations, the soils were ground more finely.

The pH is generally estimated by glass electrode and the soil: solution ratio most commonly used was 1:2 (52 percent - 210 laboratories). Ammonium acetate was the most common extractant used for calcium and magnesium (76 percent - 110 laboratories) and also for potassium and sodium (71 percent - 117 laboratories), but there was a wide diversity in the soil extractant ratio. For the determination of calcium and magnesium, E.D.T.A. was the most frequently used. Flame photometry was almost universally employed for determining potassium and sodium.

In the case of phosphorus a diversity of extractants was employed; the proportions according to method being as follows: Olsen 39 percent, Truog 22 percent, Bray I 19 percent, others 20 percent out of 135 laboratories. The reduction of phosphomolydic acid was most commonly used for phosphorus determinations.

In cation exchange capacity determinations, 61 percent of the laboratories used ammonium acetate as saturating salts and 18 percent used sodium acetate. In the same determination, 33 percent of the reporting laboratories used ammonium acetate while 21 percent used sodium chloride as a displacing salt out of 136 laboratories.

Total organic carbon was estimated in all cases by a sulfuric acid dichromate oxidation method, the Walkley-Black technique being used most commonly.

Nitrogen was always determined by the Kjeldahl method. Chlorides were generally determined by titration with silver nitrate. Carbonates and bicarbonates were invariably determined acidimetrically using phenolphtaleine and methylorange as indicators. Gypsum requirement was most commonly determined by E.D.T.A.

To predict fertilizer nitrogen requirement, the Kjeldhal method was used more often than any other test. To predict fertilizer phosphorus requirement, Olsen's method was the most commonly used. To predict fertilizer potassium requirement, ammonium acetate was the most used extractant.

There was a wide variation in the interpretation of the results of analyses in predicting plant nutrient requirements and a wide range of units used in reporting soil analyses.

Micronutrient determinations and mineralogical analyses were predominantly associated with research projects.