INSTITUTE OF AGRICULTURAL RESEARCH

SOIL PROBLEMS IN ETHIOPIA AND SUGGESTED SOLUTIONS

BY

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INTRODUCTION

The goal of the present report is to explain in a synthetical form the main problems of the Ethiopian agriculture with particular reference to the branch of soil science- and to propose short, medium and long term measures in order to overcome this over looked or neglected problem. The work was accomplished in accordance with the agreements established in the "Intentions memoranda" signed by the Governments of Cuba and Socialist Ethiopia in September 1978.

This draft includes a proposal of Development Programme for the Soil Science direction of Ethiopia for the coming 21 years period. Detailed chapters on excutional themes like organized solutions, staff training, inputs foreigh advisory staff needed etc. are included in the proposal. The recommendations to be implemented by the agencies of the Ministry of Agriculture and Settlements and the ones to be coordinated by other agencies of Ethiopian State are listed separately.

The report is the product of 2½ months work of an Ethio-Cuban Soil Science experts working group whose members are listed in Annex I.

During 45 days the working group travelled more than 10,000 km visiting research, production, teaching and peasants advisory/ development Centers in the main ecological and productive zones of the country. The itinerary pf the working group is as shown in Annex II.

The members of the Ethio-Cuban Soil Science experts working group would like to express their gratitude to the officers of the different agencies and authorities of the Ethiopian Government and particularly to the Managers of the I.A.R. for the data and suggestions offered during the visitis and working sessions and also to the members of the Cuban Agric. Mission for their suggestions and support.

CHAPTER 1 : Review on present conditions

1.1 Soil Survey Situation

Until the present year soil surveys carried out in Ethiopia covered an area of about 54,751,388 ha., out of which 59.2% or 32 32,436,000 ha. was of a semi-reconnaissance or reconnaissance nature 40.4% or 22,140,000 ha is of a semi-detailed scale, and only (Chart 1:1:1) 0.32% or 175,388 ha is of a detailed scale.

From the FAO World Soil Map, Experts of IAR have enlarged the Ethiopian part from the scale of 1:5,000,000 to 1:2,000,000 on a sound quality cartographical base map. On this 13 major soil unite of the country are delineated.

From chart 2:1:1 one can see that a great part of the surveyed areas were done in very small scales which have no practical use in agricultural practice. For instance, soil survey carried out in the Blue Nile River Basin is a very general one with the purpose or identifying the possible areas for irrigation. As a result three irrigability classes were established based on only two major soil groups in the whole basin.

A general aerial reconnaissance survey of 7,000,000 ha. of the Awash River Basin was done at a scale of 1:1,000,000 in order to identify the areas possible for irrigated agricultural development. As a result eight soil categories and six irrigation categories were established. Another study of selected areas in the Middle Valley and in the lower plains at the scale of 1:100,000 was done to identify possible development projects, for each of which semidetailed surveys were done.

The survey of the Wabi Shebele River Basin is basically similar to the above mentiondd in that it was done at a small scale.

.../...

Chart 1:1:1 Surveyed Areas in Ethiopia

No.	Zone	Total Surveyed Area in ha.	Surveyed Area: General Scale	Semi-detailed	Detailed	Scale	Year	Agency
1.	Blue Nile River Basin	20,400,000	-	20,4000,000	-	1:100,000	59/62	U.S. Department of Interior.
2.	Awash River Basin	7,000,000	1,000,000	-	-	1:1,000,000	61/64	Hunting Surveys
2.1	Middle Valley (Lower-Plains	836,000	836,000	-	-	1:250,000	61/64	" "
2.2	Middle Valley (Lower-Plains	240,000	-	240,000	-	1:100,000	61/64	" "
2.3	Melkasedi - Amibara	28,548	-	-	28,548	1:20,000	63/68	Italian Consult
2.4	Lower Plain	114,000			114,000	1:20,000	72/73	Hunting Survey
2.5	Tibila	18,000	-	-	18,000	1:20,000	72/73	BDPA (France)
2.6	Angelela-Balhamo	14,000			14,000	1:20,000	73/74	Hunting Surveys
3.	Wabe Shebele River Valley	18.000,000	18,000,000	-	-	1:1,000,000	70	BDPA
3.1	Lower Valley	382,000	-	382,000	-	1:50,000	70	BDPA
4.	Setit Humera	782,000	-	182,000	-	1:100,000	72/73	TAMS
5.	Rift Valley Lakes Zone	5,500 000	5,500,000	-	-	1:500,000	73	Great Bretain Agency
6.	Wollenkomi-Addis Ababa	200,000	-	200,000	-	1:100,000	73	IAR
7.	Sendafa-DebreZeit	136,000	-	136,000	-	1:50,000	73	IAR
8.	IAR Holetta Station	390	-	-	390	1:5,000	73	IAR
9.	IAR Gode Station	450	-	-	450	1:10,000	73	IAR
10.	Tigray	1,100,000	1,100,000	-	-	1,250,000	76	Hunting Technical Service
	TOTAL	54,751,388	32,436,000	23,140,000	175,388			
	% of Surveyed Area		59.24	40,43	0.32			
	% of Country Area		26.58	18.14	0.14			

[illegible] survey of the Abbay [illegible] River Basin is tentatively similar to the [illegible] undertaken in the [illegible] small scale.

The Rift Valley survey includes nine regional, eight local, and three special development Areas. Each of these are defined in more detail in terms of land resources and development potential. The accompanying maps are at a scale of 1:500,000. From chart 2:1:1; it becomes obvious that of the total surveyed area the reconnaissance or lower scale level stduies cover a total of 32,436,000 ha. or 26,58% of country. This figure might appear quite high, but as a matter of fact it only includes survey done at a reconnaissance level. Moreover these surveys were carried out with different objectives and using different methodologies.

Surveys carried at a semidetailed scale covered an area of 22,144,000 ha which represents only 18.14% of the country. This figure includes part of the Blue Nile River Basin with 20,400,000 area as mentioned above.

The larger scale surveys covered an area of only about 175,388 ha. or 0.14% of the country. From the chart it is evident that surveys made at larger scales, which would be more useful for agricultural purposes, covered a very small portion of the country. It is necessary to remark that even these surveys were carried out by different foreign agencies using different methods whose details are not well known.

These surveys include parts of Shoa, Gojam, Arsai, Gemu Goffa, Balle and Tigray Regions. On the other hand, regions like Wollo, Illubabor, Wollega, Kaffa and Sidamo, which are of agricultural and of national economic importante, were not surveyed at all.

Some Important Soil Problems

Soil Burning (Gai)

On the heavy black vertisols of the highlands, soil burning is a common practice among the peasants. The process involved building a mound of Soil which has a lot of sod. The mound is burned with cow dung at the center of the mound and after some days the remaining soil and ash mixture is spread and ploughed.

This practice is carried out in order to improve the yield of the following 2-3 years crop and after 2-3 years cropping the burned field will be left fallow for a period of about 15 years. While soil burning results in the mineralization of plant nutrients from the soil and organic matter, the practice leads to soil degradation through the lose of organic matter and changes in soil clay minerals. Further, the human resource required for soil bruning is enormous and yet productivity due to soil burning is quite low since crop production is only possible for the first 2-3 years and left fallow without any production for a number of year.

In Sheno and Ginchi sub-station of IAR Research work is underway to overcome this soil destruction practice. Research data show that by improved drainage and use of fertilizers it is possible to obtain yearly yield, three to six times higher than by soil burning. However, the use of traators to improve the drainage of the peasant holding remains a problem since the peasants can not efferd to buy them.

Drainage

One of the most important soil problem in Ethiopian agriculture is the poor drainage of the flat vertisols on the highlands and in most of the valleys of the western and eastern plateau found all over where crop production of the country is very improtant for the economy of the country,

The flat lands remain water-logged, sometimes are ponded during the rainy season. Sometimes when the amount of rain is higher than the infiltration capacity of the soil, a hazardous ereeion problem may occur.

The economically beneficial effect of drainage improvement is demonstrated in some IAR sub-stations where the yields were three times higher than on the non-improved plots.

On the vartisols of Diksis state farm (Arssi Region) a quite simple drainage system where by drainage ditches were cut every 40 meters following the contour allowed to forecast wheat yields of 35-40 Quintals/hectare.

Salinity

Another soil problem which need to be remarked on is soil salinity. In the country there are vast areas of saline and would be saline soils, mainly in the Rift Valley and Harerge, where evaporation is higher than the rainfall. These Zones have soils with relatively little leaching (low rainfall) and are at a lower altitude and thus salts might be carried into them from the adjacent higher grounds.

In theMelkasedi state farm (Formerly MAESCO) it was possible to identify a growing salinity problem (probably Mg. Salinity) which had affected more than 200 ha. of banana. This kind of problem is very often associated with irrigated agriculture where adequate drainage facilities are not proved to remove excess salt and must be closely observed and rectified.

In order to summarize the most important soil problems are:-

- Lack of a comprehensive soil science agency capable of providing the producers an effective soil science advisory servic.

- Lack of qualifeid manpower capable of establishing the soil science advisory systems.

- Lack of soils inventory due to the absence of soil survey.

- A low level of soil management practices which is the subsequent cause of many other problems.

- Waterlogging problem which in many places has caused the reduction of the possible yield by 66%

- Soil burning practices which reduce productivity of the areas to 10%.

- Severe erosion problems whose extent is difficult to account in terms of the amount of fertile top soil eroded.

- Salinity problems in areas of large agriculture potential with irrigation possibilities.

1.2. Soil Conservation

The topography of Ethiopia is unique. The central part of the country is characterised by a large mountain massive where the slopes are steep heavy deforestation practiced and the rainfall is high and falls relatively in short periods and extensive farming is practiced.

From the physiographical point of view, the country could be divided into five regions. Each is characterized by different relief and climatic condtions.

1. The plateau and plains of Ogaden

This physiographical region is loaated on the south-east of the country with slopes from NW.? to SE.?. Agriculrally this region is poor. The rainfall is irregular and usually less than 400 mm per annum. Wind erosion is extensive in character.

2. The Eastern Highlands

This region form the north and west boundary of the Ogaden plateau. These high-lands are made up of a mainly sandstone limestone and basaltic. tic massives. Due to the high altitude of this region the climate is temperate. The soils are fertile and the rainfall ranges from 700-1000 mm./anum. The rainy season is only three months.

3. The Rift Valley : is located in the central part of the country it extends from the Red-Sea coast in the north to the Kenya border in the south. The rainfall in this region is 600-800mm.

4. Western highlands : This part of the country is a mountain massive in which the plateaus are bordered by deep eroded Canyon. In the Eastern part the Vegetation is sparse and decreases in the western direction. Rainfall in this region range from 1000 - 2000 mm.

5. Western Low lands is a wide land strip formed as a result of erosion Processes of the slopes of western high lands. The rainfall ranges from 200 - 600 mm.

A soil loss of 33 tons/ha/year has been reported in Tigrai region by the Hunting Technical Service. From the same source it has been indicated that in May - Dollo catchment the one year soil looses is 17 T/ha. Taking this figure for calculation, it has been estimated that the soil losses in the central highlands in 1975 was 17 million tons or 1200 ha of 1m deep fertile land.

The general landscape topography, heavy deforestation, very low level of soil management, intensive rainfall are the main reasons for the heavy erosion problem in the country. Due to these basic reasons the vertisols which are considered to be erosion resistant are being eroded.

The above discussed factors indicate the erosion problem situation in the country. In several places some efforts are carried in order to reduce the destructive nature of erosion processes which actually occur in the main agroecological zones.

Among the main measures to implement, it is important that the training of peasants in peasant associations on simple technical systems like terraces, dams and etc. should be given proper consideration.

On the other hand, the Forestry Department of the Ministry of Agriculture is carrying afforestation programme in the most Affected zones. Some Research work in Tigray and Sidamo Regions are being executed. In spite of all these, we feel that the measures remain unsatisfactory compared with the grave situation. The reason for the alarming situation can be breify summarized as follows.

1. The lack of a strong organisation capable to advise the government and the peasants in soil conservation problems.

2. Lack of trained man - power.

3. Lack of systematic research work in soil conservation.

4. Lack of a detailed soil knowledge in specific zones to establish soil conservation programme.

5. Lack of a systematic climatological net work capable of providing information on the hydrological cycles and erosion danger due to rainfall.

6. The capacity of forestry seedlings production is not enough in order to follow a more intensive afforestation programme.

7. Lack of a proper legal (law) basis in the field of land use, erosion control, afforestation and other related fields.

1.8. L A B O R A T O R I E S

Laboratories in the country for soils, plants water and fertilizers analysis are not in a good conditions inorder to facilitate the soils work in different branches of soil science; this is due to:-

1. Lack of qualified man-power:- higher level as well as medium level.

2. Small rooms, and poor facilities in some stations.

3. Lack of chemicals, glass wares, adequate and up-to-date instruments.

It is evident that inorder to carry out soil studies work according to the development program, there must be an efficient laboratory services. The Holetta station laboratory with the analytical capacities of only, 4000 - 5000 soils, 7000 - 10000 plants samples per year, is the biggest service giving laboratory of its kind in the country. This is a drop of water in the sea, compared to the demand for soil, plant fertilizer, water analysis need of the country.

The situation is more aggravated in the agricultural college and junior college where there is no specialization and specific training program offered for laboratory technicians. Alemaya College the most improtant educational center for agriculture in the country, has got small and non-functional soil analysis laboratory. Old type apparatus, with no spare parts, inadequate chemicals, glass wares, and other devices are the main feature of the laboratory.

Jimma Agricultural College has similar situation with that of Alemaya. The Junior College of Debre Zeit is buidling a laboratory which will be used for the station work and teaching purposes.

It is important to note that in the curiculum of College and Junior Colleges soil, plant, water, fertilizer analysis are not included. Because of this the student after graduation have no knowledge of laboratory work.

The Bahar Dar Polytechnic Institute is the only Institution in the country which has got a good training program and facilities for the training of laboratory technicians. The courses that are offered includes beside others, chemical and physical analysis of soils.

The laboratory of the Ministry of Agriculture in Addis Ababa is a grave condition similar to the other stations excluding Holetta. Although potentialy it has enough rooms and basic apparatus which are useful for analysis and training, it is found to be in a very disorganized state. In general if it is reorganized and additional staffs is recruited it will serve as a service giving laboratory until a new one is build.

Consequently inorder to carry out, the programmes for soil servey, Fertility studies, fertilizer application, irrigation, conservation, land evaluation work at different phases of agricultural development the need for a strong analytical unit is evident.

1.4 The Use of Fertilizer In Ethiopian Agricultures

Actually the use of fertilizers in Ethiopian Agriculture is quite limited and statistic information is not complete. To clarify this point the analysis of the 1977-78 cropping season is presented. During that season the total fertilizer used was about 25-30 thousand tons, mainly DAP (70-80%) Urea (15-20%) and smaller quantities of other formulas 5-10 %) given by FAO.

Table 1.4.1 Fertilizer consumption In 1977/78 (In the Peasant Sector)

Group of Crops	Area Fertilizer/ed				Fertilizer Consumed		
	Total	DAP	URea	Natural	Total	DAP	Urea
Annual	308.4	263.9	44.5	251.6	19.39	16.17	3.22
Perennial	-	-	-	117.4	-	-	-

This table shows that the commercial fertilizer were mainly used on Annual crops, while on perennial crops only natural fertilizer were used.

In the following Table 1.4.2. the use of fertilizers on different crops is presented.

Table 1.4.2 Use of Fertilizer on The Main Crops

CROPS	Area 000/ Ha.	% of the Fertilized Area				Yield Q/ha	Mean quantity application kg. na		
		Total	DAP	UREA	Natural		Total	DAP	Urea
Teff	1521.9	9.6	7.9	1.7	4.9	7.7	6.9	5.2	1.2
Barley	876.0	10.3	8.5	1.8	4.4	8.4	6.3	5.0	1.3
Wheat	462.3	17.5	15.6	2.1	4.0	9.1	10.3	8.8	1.5
Maize	877.9	2.0	2.0	-	4.4	11.4	1.1	1.1	-
Sorghum	706.8	0.1	0.1	-	5.3	8.7	0.0	0.0	-
Millet	204.0	18.6	16.1	2.5	2.0	10.4	11.7	10.0	1.7
Horse Bean	278.5	1.7	1.4	0.3	6.8	9.8	11.4	1.1	0.3
Chickpea	155.1	-	-	-	0.8	6.9	-	-	-
Fieldpeas	17.3	-	-	-	9.1	7.1			
Peas	128.6	2.8	2.8	-	2.0	7.1	2.3	2.3	
Lentils	69.7	2.6	2.2	0.4	2.0	5.6	4.0	2.2	1.8
Linseed	25.9	-	-	-	2.6	4.1	-	-	-
Noug	120.0	-	-	-	2.3	3.6	-	-	-
Turnip	0.5	-	-	-	-	7.7	-	-	-
Vetch	37.7	-	-	-	-	6.1	-	-	-
Oat	17.2	-	-	-	-	7.0	-	-	-
Sesame	0.5	-	-	-	-	6.3	-	-	--
Other	-	1.1	6.9	0.2	51.4	-	0.6	0.5	0.1
Total Temp.	5489.9	7.0	6.0	1.0	5.7	-	4.5	3.7	0.8
Enset	-	-	-	-	45.3	-	-	-	-
	-	-	-	-	6.1	-	-	-	-
Chat	-	-	-	-	73.3	-	-	-	-
Hops/Gesho	-	-	-	-	11.9	-	-	-	-
Total Permanents	-	-	--	-	31.4	-	-	-	-

This table shows that mineral fertilizers were applied on cereals while permanent crops, coffee is one of them, received only natural fertilizers in very few areas. Not enough attention is given to the economically important crops coffee. According to our calculation the global index of fertilizer application does not reflect the fertilizer efficiency since the hectarage applied is very low.

Table 1.4.3 Mean Index of Fertilizer Usage In Areas Where Fertilizer was Actually Applied

CROPS	Fertilizer Cons. in t.			Applic. Index kg/ha		
	Total	DAP	Urea	Mean	DAP	Urea
Teff	9759.4	7913.9	1826.3	66.80	65.80	70.29
Barley	5518.8	4380.0	1138.8	61.16	58.82	72207
Wheat	4813.3	4112.2	605.4	58.85	57.15	61.71
Maize	695.7	695.7	-	54.99	54.99	-
Millet	2386.8	2040.0	346.8	62.91	62.11	68.00
Horse Bean	389.9	306.7	83.2	82.43	78.55	99.46
Peas	295.8	295.8	-	82.16	82.16	-
Lentils	258.8	142.3	116.5	154.05	100.29	447.92**

* It seems that there are some statistical errors. There is no technical as well as financial justification to apply more than 206 kg/ha of nitrogen for legume crops.

The above table clearly shows that the index of fertilizer application on the main crops is lower than the recommended rates for crops in the major zones. This is again reflected without doubt in the response and effectivness of fertilizers.

Here it should be emphasized that the fertilizer usage differ significantly from one region to the other. This is shown in Table 1.4.4.

Table 1.4.4 : Fertilizer Use inDifferent Regions

Region	Fertilized Area Percent of Total Area				Global Index of Application kg/ha		
	Commercial Fertilizer			Natural Fertilizer			
	Total	DAP	Urea		Total	DAP	Urea
Arrasi	21.4	18.7	2.4	4.7	13.6	11.6	2.0
Gemu Goffa	-	-	-	8.7	-	-	-
Gojam	10.5	7.7	2.8	4.9	8.9	5.2	1.9
Gondar	0.7	0.4	0.3	-	0.4	0.2	0.2
Illubabor	0.8	0.8	-	0.9	0.8	0.8	-
Kaffa	1.5	1.5	-	5.2	2.2	2.2	-
Shoa	7.0	6.2	0.8	5.0	4.4	3.7	0.7
Sidamo	5.3	5.3	-	13.3	3.1	3.1	-
Wollega	8.8	8.1	0.7	12.3	3.2	2.8	0.4
Wollo	-	-	-	5.9	-	-	-
Average	7.0	6.0	1.0	5.2	4.2	3.5	0.7

The above presented table shows that the differences in application index between regions is very wide. The index in three of the regions is above national mean index (one of them is Arssi which has an index three times greater). In the other seven regions studied the index is below average.

Nevertheless, the index of fertilizer application does not necessarily show the production potential of a region. This may be only a consequence of low technical level in fertilizer use.

Table 1.4.5 shows the average index of fertilizer application in regions and average yield of selected crops among crops where the fertilizer index was high.

Table 1.4.5.

Region	Fertilization		YIELDS Q/Ha				
	Fertilized Area %	Application Index kg/ha	Teff	Barley	Wheat	Horse Beans	Peas
Arssi	21.4	13.6	13.2	11.3	12.4	12.4	6.2
Gemu Goffa	-	-	4.4	2.4	2.6	2.7	1.9
Gojam	10.5	6.9	7.9	5.1	7.9	9.2	4.3
Gondar	0.7	0.4	9.6	9.1	4.8	7.7	14.1
Illubabor	0.8	0.5	5.9	3.4	2.3	1.3	2.0
Kaffa	1.5	2.2	7.7	3.4	11.5	6.4	10.4
Shoa	7.0	4.4	7.8	5.9	5.1	11.0	5.6
Sidamo	5.3	3.1	9.3	3.4	13.8	5.5	10.8
Wolegga	8.8	3.2	5.0	5.3	5.3	4.6	5.1
Wollo	-	-	11.2	6.9	9.1	12.6	5.1
Average	7.0	4.2	7.9	7.3	8.4	9.9	7.6

The presented table show that with the exception of Arssi region which has a higher index of fertilizer use and higher yields, the other regions do not show any correlation between fertilizer and yields obtained. Therefore we can observe that in Shoa, Gojam and Wollega regions with higher national average in fertilized area., the yields of four crops out of five studied are lower than the national average. On the other hand Wello region which practically do not use fertilizers the yields of three crops was found to be higher than the national average.

The major factors that limited the efficiency of fertilizers in Ethiopia can be summarized as follows:-

1. Ignoring the natural conditions of soils inrelation to crops that restrict fertilizer response. The most often conditions prevalent in the country are high acidity, salinity and erosion etc...
2. The periodical adverse climatic conditions, mainly drought.
3. Deficient cultural practices on the major crops in the country. e.g. the use of the superficial local plow.
4. The shortage of experimental information on the optimum rates of fertilizer application.
5. Use of varieties with low genetic potential and poor quality seeds.
6. The absence of the size concept on the peasant farms. e.g. a rate of fertilizer recommended for hectare sometimes is applied on 1.5 or 2 ha of land.

The wide use of fertilizers in the agriculture of the country is limited by the following factors:

1. The absence of fertilizer industries
2. Limited financial Capacity to import fertilizers
3. Weak port infra-structure and roads which limit Interval transportation of fertilizers.
4. The financial inability of the peasants to purchase fertilizers even in credit system.

Nevertheless the available data in fertilizer use proves that mineral fertilizers could become an important input to increase the yields and overcome the grain shortage in the country. To support the above thesis, some of the results of the demonstration fertilizer trials carried by FFHC of FAO in 1968/1971 and experiments carried by EPID/IAR Joint project is presented in Table 1.4.6.

Table 1.4.6. Summary of FFHC and EPID/IAR Fertilizer Trials

	Yield increase due to application of 1 ton mixed 2:1 DAP and URA Applied at Rate of 150 kg/ha	
Crops	Tons of Grain	Kilocalories
Teff	7.3	25.6
Wheat	9.2	30.4
Barley	9.7	33.0
Sorghum	24.7	76.0
Maize	16.4	45.9

The presented table clearly shows the importance of mineral fertilizers to raise the grain production of the country. To cite an example, IAR research results show that an average of 3 tons of grain per ton of fertilizer applied could be obtained under different climatic conditions.

Fertilizer Industry Development

At present there is no single fertilizer industry in the country. However, two different studies were carried to develop a fertilizer industry. A study that was carried by UNIDO before the revolution considered industry development in three phases:-

1. Establishment of one fertilizer mixing unit by a process of bulk blending possibly at Assab port or near by. The raw material was to be imported.

2. Establishment of a factory of diamonium phosphate (DAP) which which will use imported Amonia (NH_3) and Phosphoric acid (H_3PO_4).

3. When the market justifies, then establish national production of ammonia 600-700 t.NH_3/day and production of phosphoric acid from imported rock phosphate.

After the revolution, two soveit experts who studied the possibility of establishing a facotry came to conclusion that establishing a factory is not feasible unless the soil is properly studied and enough agronomical data's available.

If we take the year 1980 when the country will have about 6 million hectars of land under annual crops, with the average application of 1000 kg/ha of fertilizer, it is clear that the country has the capacity to use from 500 to 600 thousand tons. Considering the perennial crops which need fertilizers and with the possible improvement, increased rates of application for annual crops due to the introduction of new varieties, better cultivation methods, the amount of fertilizers to be used for the coming ten years will be considereble and will justify the development of a big fertilizer industry. Consequantly it is our feeling that the first and third phases of the UNIDO should be implemented. The second phase should be studied deeply. The difficulty of handling materials that need special ships, port installations and special storage facilities are all impractical due to high costs.

1. 5. SOIL SCIENCE RESEARCH SITUATION

The first fertilizer trials in the country were carried out in the 50's by the US teaching staff of the Jimma Agric. High School. Results of these trials are not easily available and it is difficult to tell how far they could be useful now.

In the late 50's and during the 60's a quite interesting work on description of soil fertility parameters of the top soils, mainly along the roads, of the country were carried by Dr. H.F. Murphy who was then a member of Alemaya Agricultural College. Even with some of the practical limitations it has, such as the lack of experimental data on the response of the main crops to fertilizers on some of the soils, this study was the most important soil fertility characterization of the Ethiopian top soils until now. During the same period Asmara University carried some fertilizer trials.

From 1967 to 1971 in the frame work of the FFHC the FAO and IAR carried out a large number of an eight plot fertilizer demonstration trials all over the country. From these trials it has been possible to determine essentail nutrients which could improve yields, but such results were not sufficient to establish optimum fertilizer rates for a specific soil-crop ecologial conditions. During this campaign the number of demonstration trials conducted were, 522 in 1967/68, 987 in 1968/69 and 1165 in 1969/70 and the average efficiency rate was 57-62%. The data obtained were summarized in a crude manner by EPID and IAR and are being used for generalized advisory purposes. At the same time this information is found in the FAO(ROME) Data Bank on magnetic tapes and should be requested to be processed by FAO computer. The main crops covered under this programme were teff, wheat, barley, sorghum and maize. Overall results indicated that in major part of the areas studied there was high response of crops to Nitrogen, about 25% to phospharus and only in a few places response to potassium was obtained.

Through 1971-75 EPID continued to carry out such kinds of demonstration trails. During this study, trial sites were selected according to zonal classification of the country with special remarks to black and red soils, inorder to obtain suitable data for developing fertilizer use recommendations.

After 1975 the main work in soil fertility is being carried by IAR in different stations and sub-stations including the experimental sites of IAR/EPID joint projects.

Acturally the main research activity in soil science is handled by the Soil Science Department of IAR whose central location is at Holetta Research Station. At the same time the department is the main national coordiantor for research work in this field.

The Soil Science Dept. of EAR has three Sections at present.

The Soil Fertility Section is the oldest one, and then it came to existence 13 years ago, its major task was conducting fertilizer trials on farmers fields. At present the section's staff consists of 1 Ph.D. and 4 M.Sc level research workers. Out of these, one M.Sc holder is stationed at Bako and another one at Melka Werer Res. Station, while the rest are located at Holetta Res. Station from where they are also supposed to carry some research work in other stations and sub-stations.

In Jimma, Mekele and Awassa Res. Stations, soil science Research work must practically be started. The existing soil science laboratories in the last two stations are only little romms without the minimum equipment, and they are not in a situation to provide sufficient analytical services to the stations' needs. Laboratories in Bako and Melka Werer Stations are in a bit better position but cannot still give the research work a minimal analytical service.

Soil and Plant Analysis Section

The main laborator is located at Holetta Res. Station. It is capable of carrying a well developed assortment of different analysis like soil physical and chemical analysis, macro and micro analysis of leaf materials, water and fertilizer analysis.

The laboratory equipment is quite modern but the lab. is facing a lot of problem in maintenance and repairing work of apparatus because of lack of maintenance experts and spare parts. In this section, an expert with M.Sc. 1 lab. technicain, 4 lab. assistants and 3 lab attendants are working.

The analytical capacity is not very high, but it is the better in the country with a present annual analytical out-put of 2000-3000 soil samples and 10,000plant samples.

Soil Survery and Land Evaluation Section

This section started it's work in 1971. Detailed soil survey works were carried out for Holetta, Gode and Jimma Res. Stations, In addition to these, two land resources evaluation studies have been carried out on about 300,000 ha. around Holetta and Addis Ababa. Expept for Gode and Holetta the reports of the other project are being delayed for more than 4 years because of delays in Analytical results.

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The sections staff consists of an M.Sc. research officer, one assistant research officer with B.Sc., two technical assistants and one drafts man.

The main organizational problem existing in the soil science research work is related to soil conservation work which at present is conducted by the Agricultural Enginnering department of IAR without any contact with the Soil Science Department.

The Soil Science Department's research programme is directed towards solving the most important problems in the field, But it could be evaluated as very ambitious from the resource point of view and as very poor from the country's problems point of view. However, the existing research officers of the department are very well qualified for conducting true research programme.

1.6 Soil Science Teaching in The Country

As a higher agricultural educational institution the Agricultural college of Alemaya was visited. The curriculum of the plant science department shows that there are four courses on soil science.

- Introductory soils
- Soils and plant nutrition
- Soil management practices
- Soil and water conservation

The last course is given only in the Engineering Department. During our visit, we have come to witness the absence of adquate laboratory facilities. Moreover the condition of soil science teaching has been aggravated since there is no qualified lecturer in this vital field of Agriculture.

The Ambo, Jimma, Awaassa and Debre Zeit Junior Colleges were visited also. In the curriculum the following soil science course are indicated:-

- Introductory soils
- Soils and fertilizers
- Soil and water conservation

The condition was not found to be different from Alemaya. The Jimma Agricultural Junior College - Soil Science Laboratory is about 20 years old. All the facilities are out of order and the rooms are not good for teaching purposes. In Awassa and Debre Zeit Junior Colleges laboratory buildings for soil science teaching are present. We feel that Debre Zeit Junior College has the conditions for development of a soil science department.

Although the Bahr Dar Polytechnicla Junior College produces laboratory technicians which are well qualified to work in soil laboratories, we have been told that the number of graduates each year are very few in number.

Chapter 2 : Recommendations

First Phase 1979 - 1985

1. Establish the Soil Science Direction in the Ministry of Agriculture in accordance with the structure and duties shown in Annex 3.

2. Appoint a Director of the Soil Science Direction.

3. Appoint the Officer-in-Charge for the present Soil Science laboratory of the Ministry of Agriculture which will then be under the Soil Science Direction.

4. Begin to recruit the staff proposed for the first phase and contact foreign experts, where needed, to serve as advisors.

5. Draft and Issue out a general directive on elementary soil, water and forestry consevation principles.

6. Improve analytical capacity of the present soil science laboratory of the Minsitry of Agriculture by improviing the buildings through maintenance work and recruiting new laboratory technicians and assistants. This laboratory would start the laboratory assistants' training courses prior to the commencement of which the contents are submitted to the Soil Science Direction for approval in accordance with the proposed structure (1979/80).

7. Improve the analytical capacity of the Holetta Research Stations' Soil Science laboratory by increasing the storage and working spaces, and by recruiting new laboratory technicians and assistants (1979/81).

8. Strengthen the laboratories of Bako, Melka Werer, Awassa and Mekele Research Stations (1979/81).

9. Build and equip the central soil science laboratory in Addis Ababa in accordance with the proposal of the Laboratory Commitee Headed by IAR. This central soil science laboratory when finihsed will substitute the present soil science laboratory of the MOA (1979/81).

10. Start laboratory assistant's training course in Addis Ababa and Holetta laboratories.

11. Summarize the soil survey results available in the country in an appropriate scale that would help to generalize the characteristics in order to recommend land use and soil management practices.

12. Establish a priority program for soil survey jointly with the Physical Planning Commission, state farmes corporation and peasants affairs authority.

13. Start soil physics and chemistry research program in order to establish average values of different parameter or characteristics of most improtant soil groups.

14. Draft the methodology for soil survey at different scales.

15. Start a programme of short term soil science training courses for those who have graduated in plant sciences at B. Sc. and Diploma levels. These courses must include training in Socialist country as shown in Chapter 5.

16. To avoid soil burning practices, implement at a pilot scale the available data of IAR in order to gain experience for a country-wide propoganda, extension and credit programmes.

17. Draft a handbook on methodology for soil evaluation.

18. Establish agroproductivity categories for soils, taking into account the different ecological data.

19. Organize the data bank of the soil science direction on a conventional archive basis.

20. Draw a 20 year' research programme for soil science on the basis of the evailable data.

21. Summarize the available research and demonstration data on Soil conservation from the work of IAR, EPID, WADU, forestry department and other agencies.

22. Start a simple and easy elementary soil conservation practices such as:

a) avoiding inadequate agrotechnical works
b) countour plowing
c) construction of drainange canals
d) construction of simple terraces
e) afforestation on erosion endangered zones
f) forest protection measures

23. Summarize the experimental results from theFFHC and EPID demonstration trials and IAR/EPID joint programmes in order to establish a general fertilizer use recommendation for different crops on different soils in different ecological zones. For this work it may be useful to use the computer programme worked out at FAO H.Q. by the FAO - FFHC country basis data bank (1980)

24. Work out a technical background in cooperation with the Chemical Industry Authority for the urgent need of development of fertilizer industry. In this work possible crop yield increment to be obtained from fertilizer use, the existing local market and the world market prices should be taken into consideration 1979/80)

25. With the agencies of the Ministry in charge of marketing, gathering, state farms and peasants affair, draft a policy on fertilizer distribution based on experimental results and a sound knowledge of soil properties.

26 Continue the work with the Misistry of Industry on the perspective development plan of fertilizer industry and national fertilizer distribution policy.

27. In the research field it is necessary to have a means to obtain experimental data on fertilizer effectiveness. The joint IAR/EPID project is quite suitable for this. But to improve the efficiency of this work it is necessary to organize 2-3" trial teams" of 1-2 technical assistants each who would carry out the most part of the field work at IAR-EPID sites (plot dividing in the field, fertilizer application, crop and soil sampling, harvest).

7. Work on the preparation of a new and more detailed legistlature on soil, water and forestry conservation.

8. Organize the regional soil conservation sections.

9. Begin projecting soil conservatin techniques to specific cachtments.

Fourth Phase 1996 - 2000

1. Implement the structural organization and staffing proposed for this phase.

2. Finalize the first medium level scale soil map of the country. Publish the 1:500,000 scale soil map of the whole country, with the explanatory textbook.

3. Prepare the development programme for the next 20 years period with the aid of a high technical level mission from the USSR.

4. Expand the analytical services into new agricultural fields such as; microbiology, micronutrients, animal feed, [illegible] balance of animal feeds etc.

5. Execute the training programme proposed for this phase.

6. Complete the soil evaluation studies on agroproductivity taking into acount economical aspects in every year.

7. Prepare soil conservation recommendations specifically for state farms and cooperatives located in economically important catchments.

8. Execute the propoganda and teaching programme among the state and peasants farmers in the field of soil conservation.

9. Complete the soil erosion map of the country at a medium scale.

10. Establish specific fertilizer use recommendation system for state farms and cooperatives on the basis of experimental data, soil fertility data and evaluation of economical information of the enterprise.

Chapter 3 Phases of development of the soil science services of Socialist Ethiopia

General Conditions

1. It is felt proper to forecast the development of soil science service of socialist Ethiopia up to the year 2000 with the only reason that a 20 years period gives enough possibility for a gradual development and to plan for a longer period, there isnno enough concrete government directives and it is hard to forcast the conditionsof agriculture depending on certain objective bases of the country.

2. Considering the fact that the main foreign assistance in the formation of soil science service of Socialist Ethiopia would be sought from other Socialist countries, it is felt proper to divide the phases of development into 5 years period for proper excution of the programme.

3. The only exception from the above mentioned conditions will be the first phase which will be the transition period (1979/80) and then continues the 5 years period 1981-85.

4. On this chapter the goals to be achieved in each phase is fixed. The main national executive agency will also be pointed. The necessary man-power, material and financial resources will be discussed in the chapters to follow.

First Phase of Development 1979-1985

The first phase of the development of the soil science services of socialist Ethiopia should set a goal to establish the material bases for the service and in the mean time make use the existing scientific technical informations.

Second Phase 1986-1990

In this phase the soil science service will start full scale operation. The establishment of regional department of the soil science service and zonal laboratories will start. Projects on soil conservation on certain limited areas will start. The soil mapping of economically important areas will be finished.

Third Phase 1991 - 1995

In this phase the soil science service will go deeply into agricultural areas. The regional laboratories and the regional soil conservation departments would be established. The systematic soil survey and mapping work would be initiated in all regions of the country.

Fourth Phase 1996 -2000

As the result of the complation of this phase the agriculture of Ethiopia will have an integral soil science service. In this period the first soil map of medium scale will be finished (probably in honour of the 25th anniversary of the Ethiopia Revolution). The 20 years work will be evaluated and a new project of development for the coming 20 years period will be worked out.

FIRST PHASE DEVELOPMENT - 1979/85

No.	Objectives	Executing National Agency	Period
1.	Appoint the Director of Direction	M.O.A.	1979
2.	Establish structure for first phase, select staff and necessary, requests foreign aid	SSD	1979/85
3.	Use the available results of fertilizer studies to draw preliminary recommendations for the farms.	SSD	1979/85
4.	Revise the soil studies in the country and realize new studies in priority areas	SSD	1980/85
5.	Increase Analytical Capacities		
	5.1 Increase capacity in SSD provisional Lab. and Holetta Station Lab.	SSD/IAR	1979/80
	5.2 Establish central Lab. in A.A.	SBD	1980/81
	5.3 Strengthening lab. in following stations Bako, M. Werer, Awassa and Mekele	IAR**	1979/80
6.	Elaborate Development programme for research at long term	IAR	1980
7,	Staff Training		
	7.1 Establish Soils Dept. in D. Zeit Junior School	Higher Edu. Commission IAR SSD	1980 (first Graduation 1983/84)
	7.2 Training lab. assitants	SSD	1979/80 (in the future without foreign aid)
	7.3 Soil Experts, University Level in Socialist Contues	SSD	1979/85

First Phase Continued.

No	Objectives	Executing National Agency	Period
7.4	establish Soil Dept. in Alemaya College	Higher Education Commission	1980/81 (first graduation 1984/85
7.5	Soil and Agrochemistry post-graduatée (different specialities)	SSD/IAR	1980/85
7.6	Short term training for one year or less in different specialities (soils agrochemistry laboratories, soil conservation, etc.)	SSD/IAR	1980/85

NOTE : Experimental works for post-graduate courses, must be, main done in the country.

*) Soil Science Direction

**) Institute of Agricultural Research

SECOND PHASE DEVELOPMENT - 1986 - 90

No.	O B J E C T I V E S	National Executing Agency	PERIOD
1.	Organ. of Soil Science Regional Departments	M.O.A./SSD	1986/88
2.	Establish soil science zonal lab.	S.S.D	1986/90
3.	Establish soil cons. Dept. in S.S.D.	S.S.D	1986/88
4.	Elaborate fertilizer recomm. for the mainly crops and main zones (according new dates)	S.S.D/I.A.R.	1986/90
5.	Finished soil survey in priority areas of economical development	S.S.D	1990
6.	Staff Training		
6.1	Junior Technician in D- Zeit	HEC*	Continued from first phase
6.2	College students Alemaya	HEC	" " " "
6.3	Soil Science post-graduates (different Specialities)	S.S.D/I.A.R	" " " "
6.4	Laboratory Assitants	Centrel. Lab.	" " " "

NOTE : Expt. works for post-graduates course, must be, done mainly in the country.

*) Higher Education Commission.

THIRD PHASE DEVELOPMENT - 1991 - 95

No.	O B J E C T I V E S	National Executing Agency	Period
1.	Complete the staff in soil science regional department	S.S.D	1991/95
2.	Establish Regional Laboratories (7-9 Units)	S.S.D	1991/95
3.	Establish Soil Conservation Section in Regional Department	S.S.D	1991/95
4.	Commence systematic Soil mapping in all regions of the country	S.S.D./ S.S.R.D.P*	1991
5.	Establish teams for soil mapping in Awraja's of economical importance	S.S.D	1994/95
6.	Staff Training		
	6.1 Junior Technician	Continued From Former Period	
	6.2 College Students		
	6.3 Laboratory Assistant	"	
	6.4 Post- Graduates	"	
	6.5 Post-graduate studies in soil science at Alemaya College	H.E.C	
		Alem. College	1993

*) Soil Science Regional Department

FOURTH PHASE DEVELOPMENT -- 1996 - 2000

No.	O B J E C T I V E S	National Exectuing Agency	Period
1.	Complete the staff requirement of the Direction	S.S.D	1996/98
2.	Extend Analytical Service	S.S.D	1996/2000
3.	Establish mapping teams in selected Awraja's	S.S.D	1996/98
4.	Elaborate fertilizer recommendation for specific state farms, farmers associations according concrete conditions	SSD/IAR	1996/97
5.	Complete soil map of the country at a medium scale	S.S.D/SSR Dept	1999
6.	Prepare projects for the coming 20 years (2000- 2020)	S.S.D	1996/97
7.	Continue staff training as required and as suggested in the previous periods		

Training of Laboratory Assitants

Training for these personnel will be in Soil Science Direction Laboratories. The number of people to be trained would be yearly depending on the development of determinated new laboratories and increase capacity. The duration of the course would be 6 months to 1 year. The initial curriculum would be prepared with the aid of the Cuban technicians.

Other Areas of Training

The development of Soil Science requires other supporting specialities not discussed above.

This specialities are:

- Agricultural Engineer (Machinery) 16
- Economist 16
- Mathematics 2
- Computer technical of medium level training-

Short Term Training

During the first phase it is required to employ plant science graduates for the various assignments in Soil Science Direction. Depending on their assignments and the courses taken at Alemaya College, it would be necessary to provide short term courses with foreign aid and accasionally in foreign countries. The subject and duration of such a courses must be agreement upon with each country annually. In the last six months of 1979 a course must be organized in Cuba for 30-45 days duration to orient the Soil Science Director and another designated expert on the general organization of Soil Science Services.

The objectives of this course would be the following:-

1. To be familiarized with organizations, structures and features of a system similar to that proposed for Ethiopia.

2. To be oriented in the planning and control methods in soil Science and Agrochemistry tasks.

3. To know the functional inter-relations of different units in the system.

4. Obtain the Cuban experiences in the organization of the system.

Chapter 5 : Building's Necessities

In this chapter, the constructure necessities during each phase of development of the Soil Science activities at the national and regional levels are shown.

From the presented table it is evident that in the first phase all efforts are concenmrated on the building of the Central Soil Science Laboraoty in Addis Ababa and on the acquiring of the needed working area for the national Direction.

A total of 14 regional laboratories are proposed to be built. 7 of these are planned to be built in the 2nd phase while the building of the remaining 7 is planned in the 3rd phase.

It is necessary to decide how to accomodate the regional departments. There are three altemnatives for this:-

The first one is to include the office area in the laboratory building. The second alternative is to add a new modale of the necessary size in each phase. The third way is to accomodate it in the area of the Regional Agricultural Offices.

It is considered that the best solutions are the second and third alternatives because in the second phase only 12 staff workers are needed and the final working area in the fourth phase is about 533 m^2 which represents 44.4 m^2/worker or a unrational utilization of more than 40 m^2 for worker during a 10 years period.

For a more National use of the working areas it is necessary to have an independent building for the laboratory and a near by building of offices for the Soil Science Department.

However, it must be remarked that the ratio of useful area per worker in regional departments (without laboratories) must be as follows:-

2nd	phase	5.3m^2/worker
3rd	"	4.6m^2 "
4th	"	3.7m^2 "

From the above figures it is clear that a little reduction of relative working area decreases but the final rate is quite acceptable from the point of view of international standard. On the other hand it is necessary to take into account that about the half of the staff are soil surveyers inspectors, topographers etc. who work mainly in the country side and because of that the maximum staff charge in offices will be only during the 3-4 months of the rainy season.

In order to accomodate the National Direction in the different phases, it is possible to allocate the offices in the building of the Ministry according to the staff growth or to build an office of its own near the Central Laboratory.

The area/worker ration in the national direction should grow from 2.4 m^2/worker in the first phase to 4.1 in the fourth which seems more appropriate from the architectural point of view. This is because of the fact that from the third phase onwards some of the national staff will be transfered to the regional departments in order to strengthen their service abilities leaving only the control and normative duties at the national level.

Table 5.1 Construction Requirements of the Soil Science Driection - UNIT : SQUARE METTERS

DESCRIPTION	First Phase National		Second Phase NATIONAL		Second Phase REGIONAL		National and Regional Total 2nd Phase	Third Phase NATIONAL		Third Phase REGIONAL		National and Regional Total Second Phase
	Units	Total	Units	Sub Total	Units	Sub Total		Units	Sub Total	Units	Sub Total	
	6	6	6	6	6	6	6	6	6	6	6	6
Dirrection	20	20	-	20	168	168	188	-	20	-	168	188
Evaluation	4	4	8	12	56	56	68	8	20	-	76	76
Soil Science and Drawing	60	60	-	60	560	560	620	-	60	1306	2366	2426
Advisor	-	-	-	-	-	-	-	-	-	406	406	406
Fertilizer	4	4	8	12	56	56	68	8	20	-	56	76
Soil Conservation	4	4	60	64	56	56	120	8	72	980	1036	1108
Typist Room	-	-	-	-	-	-	-	-	-	210	210	210
Laboratories	1200	1200	-	1200	5600	5600	6800	-	1200	5600	11200	12400
T O T A L	1292	1292	76	1368	6496	6496	7864	24	1392	9002	15498	16890

Table 5.1 Required Resources

Resources	1st Phase	
	Direction	
	Units	Sub Total
Rural Cars (4 wheel Drive)	16	16
Office Desks	15	15
Files	12	12
Book shelves	5	5
typewriter	2	2
Tables	4	4
Photocopying Machine	1	1
Calculating Machine	3	3
Scuding Drills	30	30
Altimeters	15	15
Clinometers	15	15
Pocket Steorescope	15	15
Munseel Soil Colour Charts	15	15
Metric Tapes	30	30
Binoculars	15	15
Photographic Camera	15	15
Trailers	10	10
Mirror Stecrescopes	4	4
Drawing Table	5	5
Light Table	1	1
Maps file	2	2
Maps Printers	1	1
Leroy	3	3
Pathgraphs	2	2
Planimeter	2	2
Compasses	5	5
Infiltrometers	5	5
Penetro meter	5	5
Theodolite	-	-
Level	-	-

2nd Phase				Total	3rd Phase				Total
Direction		Region		Direction and Region	Direaction		Region		Direction and Region
Units	Sub. Total	Units	Sub Total		Units	Sub Total	Units	Sub Total	
4	20	84	104	104	21	21	182	266	287
21	36	126	126	162	11	47	448	574	621
10	22	98	98	120	5	27	210	308	335
2	7	56	56	63	-	7	28	84	91
3	5	14	14	19	1	6	42	56	62
1	5	28	28	33	-	5	56	84	89
-	1	14	14	15	-	1	-	14	15
6	9	42	42	51	5	14	84	126	140
-	30	140	140	170	-	30	140	280	310
5	20	70	70	90	2	22	84	154	176
5	20	70	70	90	2	22	98	168	190
-	15	42	42	57	-	15	98	140	155
-	15	70	70	85	-	15	70	140	155
6	36	70	70	106	-	36	126	196	232
-	15	70	70	85	-	15	70	140	155
-	15	70	70	85	-	15	70	140	155
-	10	42	42	52	-	10	98	140	150
-	4	28	28	32	-	4	28	56	60
4	9	14	14	23	-	9	84	98	107
1	2	14	14	16	-	2	14	28	30
2	4	42	42	46	-	4	70	112	116
-	1	14	14	15	-	1	-	14	15
3	6	14	14	20	-	6	42	56	62
1	3	14	14	17	-	3	56	70	73
2	4	14	14	18	-	4	47	56	60
5	20	70	70	90	2	22	70	140	166
-	15	70	70	85	-	15	70	140	155
-	15	70	70	85	-	15	70	140	155
4	4	-	-	4	-	4	28	28	32
4	4	-	-	4	-	4	28	28	32

Table 6.1 Continued

Resources	4th Phase				Total Direction and Region	Resources For Each Unit	
	Direction		Region			Region	
	Units	Sub Total	Unit	Sub Total			
Rural Cars (4 wheel Drive)	-	21	280	546	567	39	21
Office Desks	8	55	588	1162	1217	83	55
Files	3	30	216	518	548	37	30
Books Shelves	-	7	-	84	91	6	7
Typewriter	-	6	14	70	76	5	6
Tables	-	5	-	84	89	6	5
Photocopying Machine	-	1	-	14	15	1	1
Calculating machine	1	15	154	280	295	20	15
Sounding Drills	-	30	350	530	660	45	30
Altimetter	-	22	196	350	372	25	22
Clinometer	-	22	182	350	372	25	22
Hocket Stoorescopes	-	15	154	294	309	21	15
Munsell Soil Colour Charts	-	15	154	294	309	21	15
Metric Tapes	-	36	238	434	470	31	36
Binoculars	-	15	154	294	309	21	15
Photographic Camera	-	15	154	294	309	21	15
Trailers	-	10	154	294	304	21	10
Mirror Steoroscope	-	4	42	98	102	7	4
Drawing Table	-	9	84	182	191	13	9
Light Table	-	2	-	28	30	2	2
Maps File	-	4	14	126	130	9	4
Maps Printer	-	1	-	14	15	1	1
Leypy	-	6	56	112	118	8	6
Pantographs	-	3	14	84	87	6	3
Planimeter	-	4	14	70	74	5	4
Compasses	-	22	154	294	316	21	22
Infiltrometer	-	15	154	294	309	21	15
PenetroMeter	-	15	154	294	309	21	15
Theodolite	-	4	56	84	88	6	4
Levels	-	4	56	84	88	6	4

Table 7.2 Foreign Experts Requirement for the First Phase 1979-85

No	Posts	Amount	Working Place	Main Duties	Arrival Year	Leaving Year	M/M
1.	General Advisor	1	SSD	Assist and advise the director in systematic organiz. of the direction	1980	1985	72
2.				- Coordinate the work of foreign experts. - Advise the director in programme implementing			
2.	Lab. organizer (installation and organization	1	SSD and HRS	- Advise in Lab. organi- - zation - Work in lab. asst. trainting	1979	1980	12
3.	Soil and Plant Analysis	1	SSD HRS	- to assist in analytical work	1979	1980	12
4.	Instrumental method Analy. (expert)	1	SSD HRS	- to assist in analytical work	1979	1980	12
5.	Maintenance and Repair Work	1	SSD HRS	to assist in maintenance	1979	1979	6
	Soil Surveyers	6	SSD	to work in soil survey and training local experts	1980	1981	72
7.	Soil Surveyors	10	SSD	"	1981	1985	600
8.	Lab. organizer	1	SSD	to assist in the set up and organ. of the would be central Lab. to train local experts in the use of instruments if new instruments are brought to the lab.	1981	1983	3*

Table 7.4 Foreign Experts Requirement for the third phase 1991-1995

No	Post	Amount	Working Place	Main Duties	Arrival Year	Leaving Year	M/M
1.	General advice	1	SSD	- Advice the director of SSD in his duties	1991	1995	60
2.	Soil Conservation Expert	1	SSD	- Advice soil conservation head of SSD			
				- Coordinate the work of other experts	1991	1995	60
3.	Expert in soil. Conserv.	1	SSD	- Advice in excuting the projects (soil conserv.)	1991	1995	60
4.	" " " "	1	SSD	- to train technicians in soil conserv.	1991	1995	60
5.	" " " "	14	Region	- Advice the regional Sector of soil conserv.	1991	1995	672
6.	" in land evaluation	1	SSD	- advice head of land use dept. of SSD	1993	1995	36
7.	Soil Fertility expert	1	SSD	- Advice head of soil fert. dept. of SSD	1993	1995	36
8.	Computer expert	1	SSD	- Advice head of soil fert. of SSD in the use of mathematical method for recommendation purpose	1993	1995	36
	TOTAL	21					

Table 7.5 Foreign exptertsrequirement for fourth phase 1996 - 2000

No	Post	Amount	Working Place	Main Duties	Arrival Year	Leaving Year	MM
1.	General advisor	1	SSD	Assist and advice the director in systematic organ. of the direction Coordinate the work of foreign experts Advice the director; in programme Implementation	1996	2000	60
2.	Soil Survey Advisor	1	SSD	To advice the head in soil survey matters	1996	2000	60
3.	Land Evaluation Expert	1	SSD	Advice in land eval. matters	1996	2000	60
4.	Computer expert	1	SSD	Assist in the use of computer programme for soil fert. and fertilizer recomm.	1996	1998	24
5.	Project Planning Expert	1	SSD	Advice in project planning for the coming 20 years.	1996	1997	12
6.	Soil Science Expert	2	SSD	To work in project planning	1996	1997	24
	Total	7					

Chapter 8 : Contributions by the Other agencies

The following recommendations are drawn for other agencies to support the proposal.

Higher Education Commission

It should be the responsibility of the Commission to follow the necessary stpps to organize and open a soil science department at the Debre Zeit Junior Agricultural College. The programme should be a two years teaching soil science course to produce soil science technicians. The start of this programme should be such that the first middle level soil science technicians will graduate in 1983-84.

The soil science courses at Alemaya Agricultural College could be strengthened if strong soil science department is opened. We feel that the commission should take the necessary stpps on this line. The GDR's advise and assistance should be sought in this respect. Alemaya Agric. College should produce qualified people majoring in soil science. As to our opinion the college should graduate such people in 1984-85. With the accomplishment of this programme, the post-graduate level of soil science courses should be started. Alemaya College should be capable of offering M.Sc. and Ph.D. degrees in soil science by the year 1991-1995.

Ministry of Mines and Energy

The ministry of mines and energy should be prepared to analyze the feasibility of exploiting the potash mines.

Intensive geological search should be carried in order to find phosphate deposits. The energy resources for the development of national fertilizer industry needs proper study.

National Salt and Soap Corporation
(National Chemical Corporation)

Carry out a feasibility study for the development of a potash fertilizer industry and the marketing possibilities inorder to use the currency income from this fertilizer to finance the development of fertilizer Industry.

To satisfy the needs of the country in nitrogen fertilizers at least 2-3 nitrogen fertilizers plants with a total daily capacity of 1800-3000 tons of NH_3. In order to attain this objective a proper feasibility study should be initiated now. The work to establish the bulk blending plant should be started. If phosphate deposits is found then the feasibility study to establish a plant should be carried. This plant should produce concentrated phosphatic fertilizers (DAP, TSP).

Annex 1

Members of the Ethio-Cuban Soil experts working group for the Development of the Soil Science Organizations of Socialist Ethiopian.

Cuban Members

Abdon Joaquin Tremols Gonzalez	Fertilizer Use Expert
Modesto J. Naranjo Gutierrez	Soil Evaluation Expert
Guillermo Orozco Rodriguez	Soil Survey Expert
Roberto Miranda Figueredo	Soil Conservation Expert
Hector Recio Plata	Soil and Plant Analysis Expert

Ethiopian Members

Asnakew Woldeab	S. Fertility Expert
Mesfin Abebe	" "
Sahlemedhin Setsu	" "
Tadele G/Selasse	" "
Asgelel Dibabe	" "
Berhanu Debele	S. Survey Expert
Shawl H/Mariam	" "
Taye Bekele	S and Plant Analysis Expert

Annex 2

Itinerary of the Ethio-Cuban working group for the development of the Soil Science of Socialist Ethiopia.

During 6 weeks the working gropp visitdd the following places.

Research Centers

Institute of Agricultural Research
Bako Res. Station
Melka Werer Res. Station
Awassa Res. Station
D. Zeit Expt.-Station
Mai Mekden sub.-Station
Illala Sub-station
Mettu Sub-Station
Holetta Res. Station
Mekele Res. Station
Nazareth Res. Station
Jimma research Station
Sheno Sub.-Station
Quiha Sub-Station
Gera Sub-station
Soviet Phytopathological Lab.

Experimental Sites of IAR/EPID Joint Project

Woldia
Bure
Indibir
Ammanuel
Degem

Teaching Centers

Alemaya Agric. College
Jimma Agric. Junior College
D. Zeit Agric. Junior college
Ambo Agric. Junior College
Awassa Agric. Junior College
Bahir Dar Politechnical Inst.

Extension and Peasants' Development Organizations

EPID Agronomy Section
" Local level in Amba Giorgis
" Local level in Kola Diba
Wolaita Agric. Development Unit (WADU)
Arssi Rural Development Unit (ARDU)
Settlement area in Abaya Valley (Wolaita)

Production Units

Fincha Rapid State Farm
Rapid State farm near Jijiga
Guder State Farm
Didessa State Farm
Cheffa State Farm
Melka Sedi State Farm (MAESCO)
Middle Valley Awash State Farms
Abadir State Farm
Nura Era State Farm

Merti Jeju state Farm
Diksis State Farm
Lole State Farm
Herero State Farm
Awassa Agro-Industry
Ghibie State Farm
Birr Valley State Farm
Andassa State Dairy Farm
Woretta State Dairy farm Area

Particular Farm near Bahir Dar(Fruit and Vegetable Production)

Sugar States

Metehara Sugar State
Wonji Sugar State

National Agencies

Lab. of the Ministry of Energy and Mines
Chemical State corporation

Local Orgnizations

General Administration of Tigray Region
" " " Kaffa "
Agricultural Office in Gojam Region
" " Gondar "

Historical Places

Center for Socialist Ethiopia Peoples Heroes
Gondar Casstle
Karamara Hills.
Bahir Dar Palace
Blue Nile Falls

Other

Soil Science Laboratory of the Ministry of Agriculture and Settlement in Addis Ababa.

Annex 3

Soil Science Direction and Subordinate Units

ORGANIZATION AND FUNCTIONS

Soil and fertilizer activities is part and parcel of the system of the Min. of Agriculture. The organization and functions is outlined according to permises of the general system. Organization of the activity is proposed to be developed in 4 phase, from 1979-2000. This phases had been programmed in a such way that there will be possibilities to train staff and taking into account the necessity of intense development of the system. The activities are intended to be organized in three levels.

1. National level with planning and methodological character. However, during the first and second phases it will be executing agency.

2. Regional level will have administrative link with the regional office of the Ministry of Agriculture but the technical and planning link will be with the national level. The regional level will have a direct link with production.

3. At Awraja level at this level there will be a soil survey team if the awraja is economically (from the agricultural point of view) important.

General administrative as well as working links and relations with other ministry units is shown in Chart. No. 1.

Soil and fertilizer activity is a control as well as advisory instrument for development of agriculture and cattle production in a revolutionary state. Therefore it should be included in the state budget. However, it is anticipated that at the fourth phase some soil science services offered will be paid by the beneficiary.

Duties of Soil Science Direction
General Duties

a) Execute the laws of the country and directives of the PMAC, the revolutionary National production Campaign and Central Planning Council and other government institutions.

b) Participate in the meetings to work out plan of various departments and directions of the ministry of agric. and settlement.

c) To elaborate and direct programmes of the Direction.

d) According to the necessities of the Direction, direct it on scientific basis and promote the introduction of science and technical advances.

e) To promote the development and increased production of the state farms and farmers associations.

f) to Follow up the practical application of the approved policy and support technical and cultural training for workers and farmers.

g) To excahnge epperiences and information with the different units of the ministry, take part in advisory and controlling of the regional agriculture office and other agricultural enterprises,

h) To participate in the improvement of the methods and methodological instruments, related activities. To direct and control the application of instructions, methods in the various department of the ministry.

j) Carry out studies in soil science and share the results with other departments of the ministry.

k) Participate in programme preparation with foreign agencies according to the regulation of the Ethiopian Government and follow up the execution of the sub-programme.

Specific Duties

a) To direct, organize and control technical services for land use, soil conservation, fertilizer application and liming.

b) To estaglish proper use of soils and control exectuion of it in state farms and peasant farms.

c) To establish and control proper soil conservation methods and supervise execution of this methods.
making.

d) To standardize the use of mineral, organic fertilizers and other chemical soil conditioners. Advise the higher authorities in in policy making.

e) Advise fertilizer industries about the actual necessity of fertilizers in type and quantity in order to plan its future development

f) To promote scientific and technical development in this activity and support professional staff.

To fulfill the above duties, it is proposed to establish soil science direction and the following departments:-

Department of Soil Conservation

The department of Soil Conservation at a national level is the methodological center for this activity and must propose on the following

1. Methodology and standard of soil cnnservation in the country.

2. Small scale projects of soil conservation in basin and sub-basins.

3. The government laws, resolutions and genral measures of soil conservations that must be executed by different organizations.

4. According to priories soil conservation projects for different regions in the country.

5. Control the execution of the projects in the regions.

6. The permanent control and information gathering from regions and zones on the potential dangers of soil degradation and suggest control measures.

The department will be working in close coordination with IAR and EPID in order to establish research on soil Conservation addition it has to develop links with Forestry Department in order to develop the afforestation programme. The department will be responsible for training of staff on soil conservation, in the country and abroad.

Soil Fertility Department

1. Standardize and control the use of organic and mineral fertilizers and other soil improving materials.

2. Participate in decision making of importing fertilizer and other soil improving materials, when the fertilizer industry is established participate in the development and planning of fertilizer production.

3. Advice on the distribution and marketing of mineral and organic fertilizers.

4. Advice high authorities in the ministry of agriculture and the government on a national policy on distribution of different types and amounts of fertilizer (minerals and organic and other materials for soil improvement.

5. Control the methodology; and advise, whenever needed, the regional soil fertility section. Advise in planning of projects and coordinate this plan nationally.

6. Encourage close cooperation with research centers inorder to get the necessary information for fertilizer recommendations.

Centeral Soil Science Laboratory

Central Laboratory is established in order to carry out the following three basic objectives.

- analysis of soil, plants, fertilizers, foods and water samples from studies in different branches of the agriculture in the country.
- Control of chemical analysis in zone and regional laboratories and studies of modern analytical methods.
- Training laboratory assistants and technicians for zonal and regional laboratories.

This duties are divided in five analytical sections, each with its own staff and the section head with B.Sc. level. Training in the central laboratory, is a very important for the development of laboratories. The central laboratory should be a training school, directed by the laboratory head, and lectures are given by section heads-.

Central laboratory will analyse and send reports of analytical results to the respective departments to land use department, according to the approved method. It also controls the uniformity of analysis in zonal and regional laboratories periodically.

Regional Soil Science Department

The regional soil science department will be established in the 2nd phase of development. It is the basic service of the system. From administrative point of view, it is subordinate to the regional agricultural office, but from the technical side it is subordinate to the Soil Science Direction.

The Regional Soil Science Department carries its duties of inspection and supervision directly in the production units (state farms and/or cooperatives) and at the same time carry its advisory duties through the Regional Department in charge of state farms and development agents who work in the peasants associations.

Functionally the Regional Soil Science Dept. is divided into the following sections:-

Soil Survey Section
Soil Conservation Section
Land Evaluation Section
Soil Fertility Section
Advisory Section
Regional Soil Science Laboratory

Structure development of Regional Soil Science Department in the different phases is showed in charts 6,7,8,9 and the staff's development is showe in table 2. of this annex.

Regional Soil Survey Section

- Carry with the soil surveyer's teams the field and Office works on soil survey in the established scales
- Follow the methodological standard for soil survey's work established by the National Department-
- Follow the soil survey policy estbblished by the ministry.
- Execute the soil survey work up to the final report
- Obtain the approval of the National Department before the publication of finished soil survey wor.

Soil Fertility Section

- Central of national and local standards for the use of chemical and local fertilizers and chemical land improvement products ($Ca.C0_3$, $CaSO_4H_2O$ etc.)
- Carry the studies and evaluation in order to forecast the prespective needs on chemical and organic fertilizers and chemical land improvement products at the regional level and inform to the national level the results obtained.
- According the national methodological instructions and using the national and local experimental data, work out regional soil fertility recommandations.
- Advise the development agents in the matters related to soil fertility and use of chemical, organic fertilizers and others products for chemical land improvement.

Soil Survey Unit at the Awraja Level

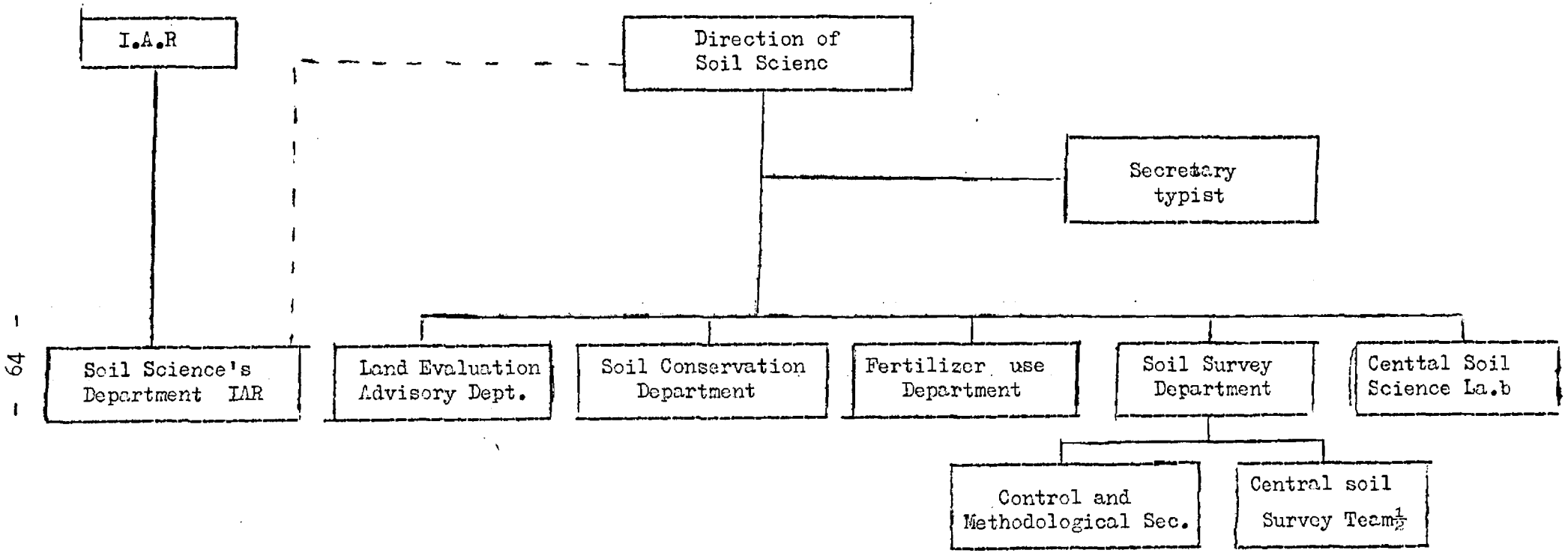
Where there are large production areas and intensive economical development that justifies the establishment of Awraja soil survey team, these will be established in the 3rd and 4th phase.

This soil survey team will be directly under the Awraja agricultural office from administrative point of view and under the regional soil science department from the technical point of view.

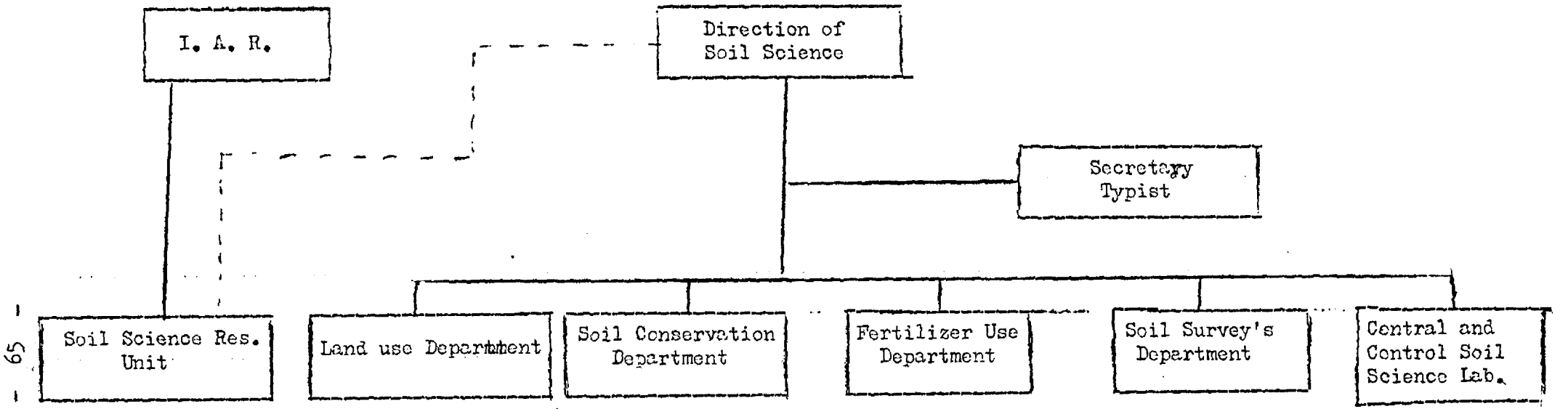
The main duty of these Awraja soil survey team will be to carry the systematic soil survey in the Awraja.

The structure and staff of the Awraja soil survey team is shown in chart No. 10.

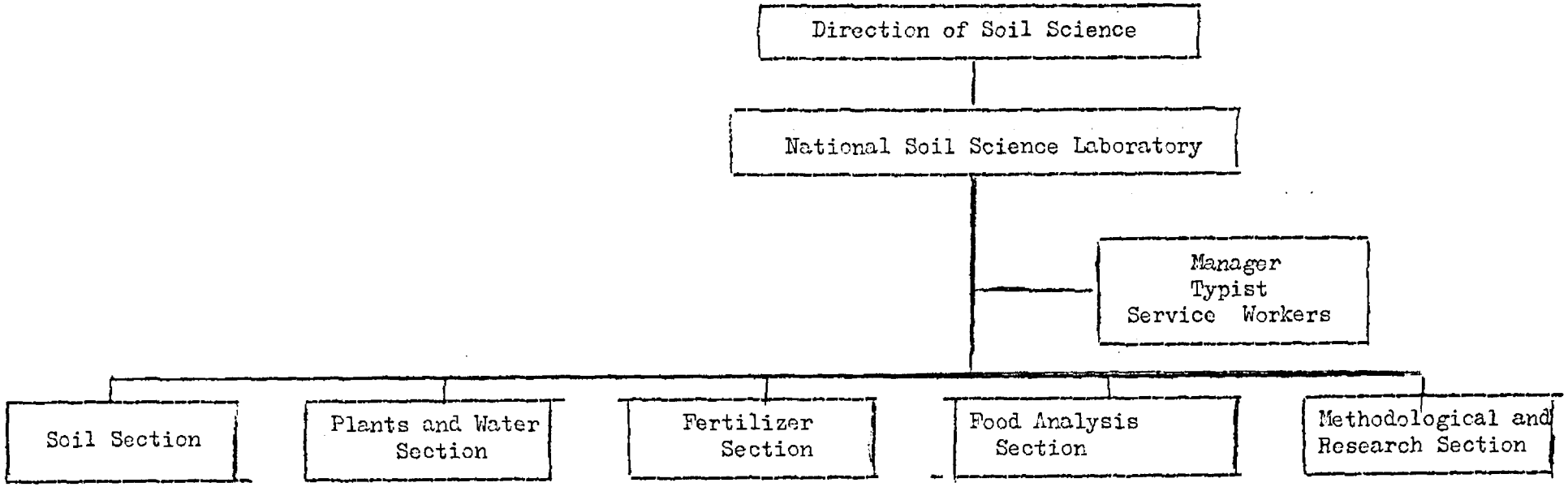
Soil Science Direction's Second Phase Structure



Soil Science Direction's Third/Fourth Structure

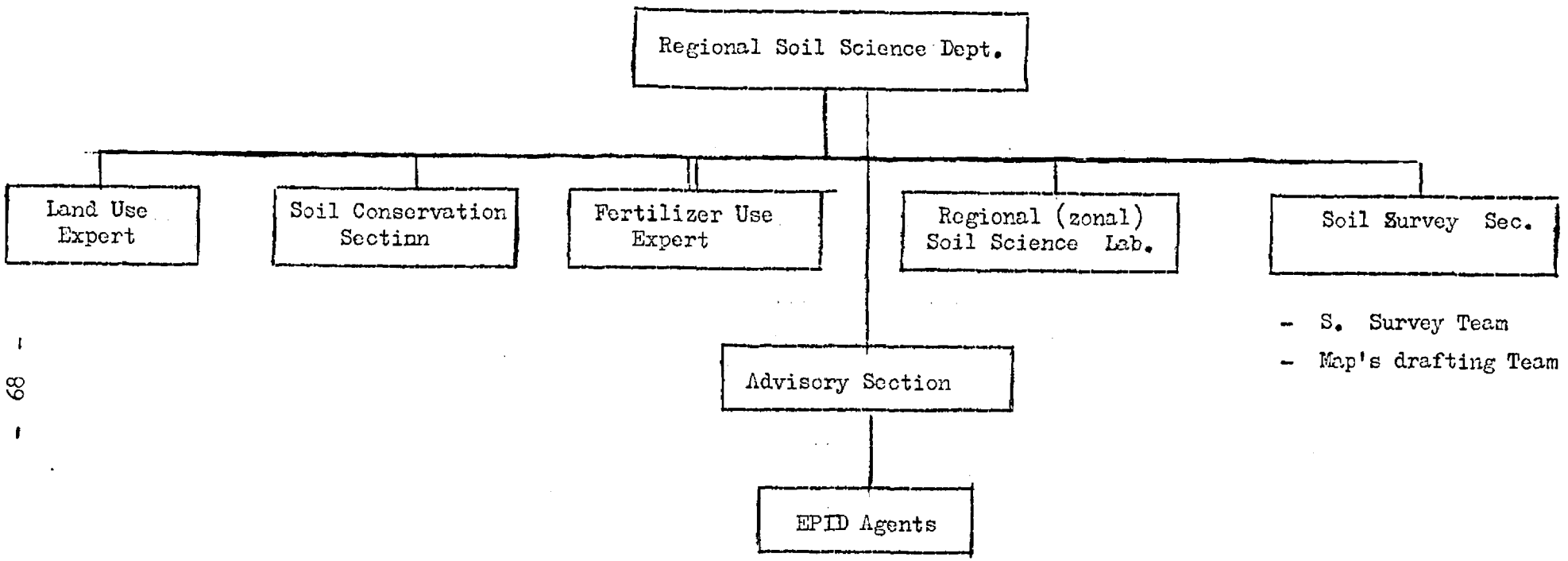


National Soil Science Laboratory' Structure First, Second, Third, Foruth Phase

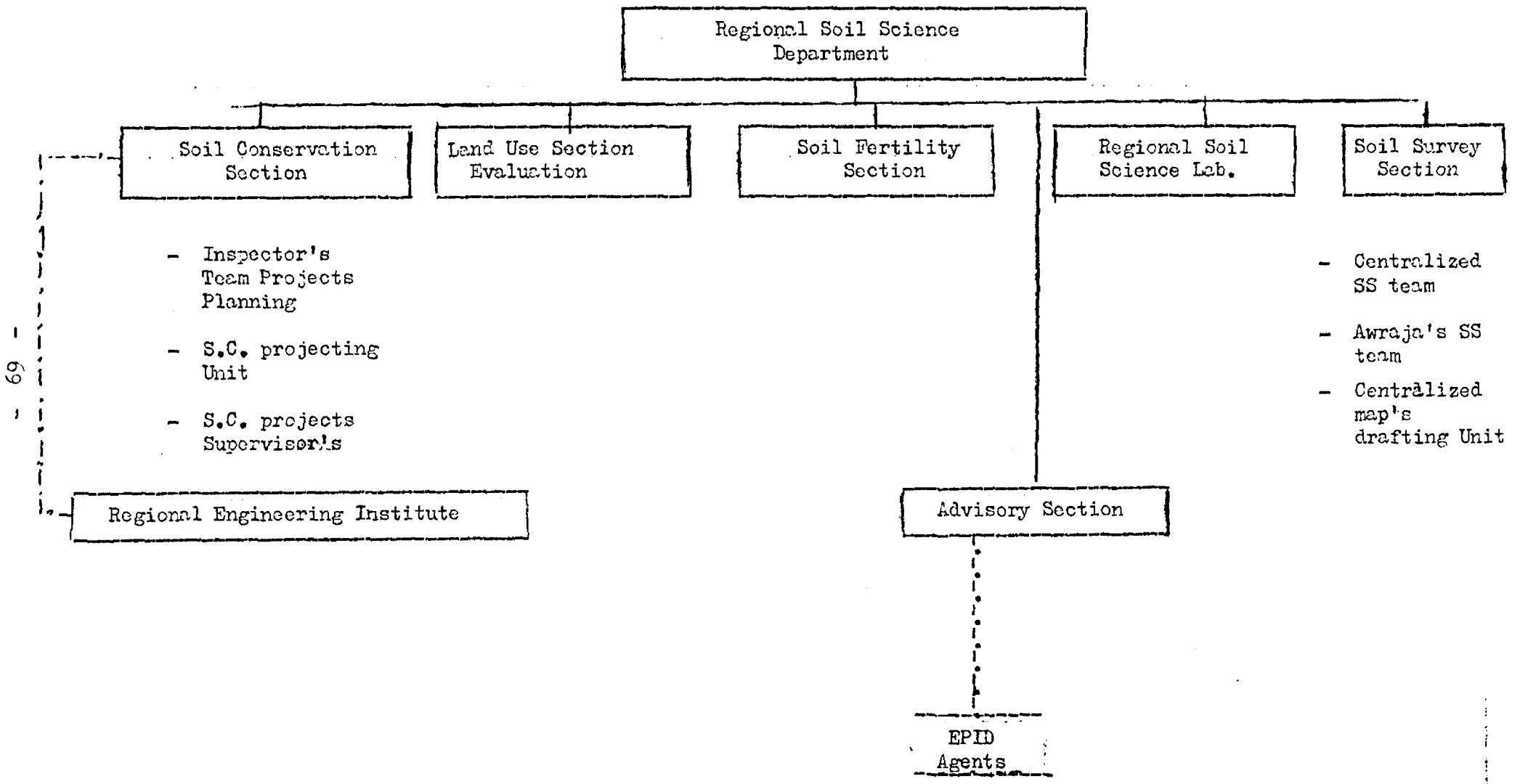


- Chemical analysis
- Physical analysis

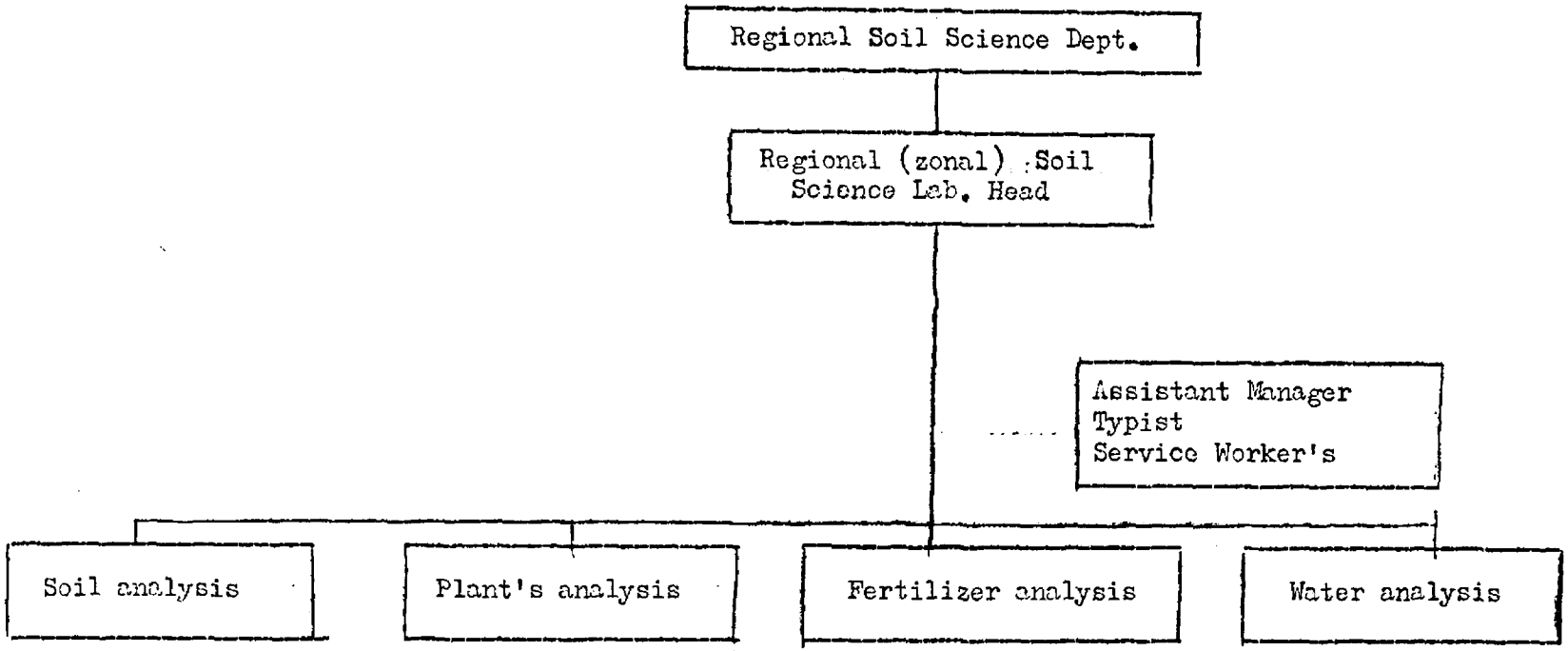
Regional Soil Science Department Third Phase Structure



Regional Soil Science Dept. Fourth Phase Structure

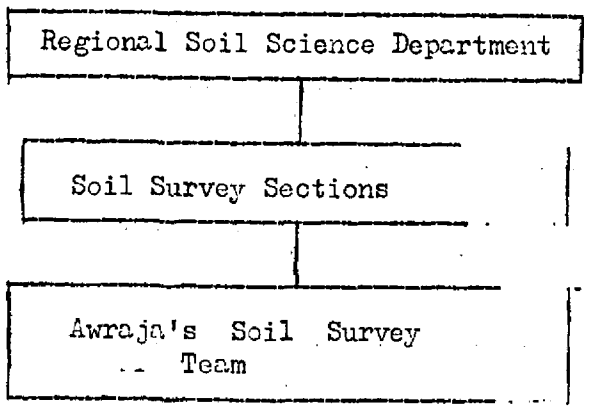


Regional (zonal Soil Science Laboratory's Structure Second, Third, Fourth Phases



- Soil Chemistry
- Soil Physics

Structure and staff for a typical awraja's soil Survey Team



Post	Educational Level	Stage	
		II	IV
Soil Survey Team's Heas	B.Sc.	-	-
Senior Soil Surveyer	"	-	-
Junior Soil Surveyer	M.Sx.	5	10

NOTESE

The Awraja's Soil Survey team is to be organized only in selected Awrajas.

SOIL SCIENCE DIRECTION's STAFF

P O S T	Educational Status	I Stage	II Stage	III Stage	IV Stage
Directory	Ph.D/M.Sc.	1	1	1	1
Secretary		1	1	1	1
Typist		1	1	1	1
Land Use Expert	Ph.D./M.Sc.		1	1	2
"	M.Sc/B.Sc	1	2	3	3
Soil Survey's Head	Ph.D/M.Sc.	1	1	1	1
" Experts	"	-	1	3	5
" Experts	M.Sc/B.Sc	5	10	3	3
Soil Surveyess	Medium Level	20	20	-	-
Soil Maps Drawers	" "	5	5	$\frac{1}{2}$	$\frac{1}{2}$
Land Use Head	Ph.D./M.Sc.	1	1	1	1
" Expert	"	-	1	2	3
" Expert	M.Sc/B.Sc.	-	2	3	3
Fertilizer use Head	Ph.D/M.Sc.	1	1	1	1
" " Senior Expert	"	-	1	1	2
" " Junior Expert	M.Sc/B.Sc.	-	1	3	4
Mathematician	"	-	-	1	1
Economist	"	-	-	1	1
Soil Conservation Head	Ph.D./M.Sc.	1	1	1	1
Soil conservation Senior Exp.	"	-	2	4	3
Soil Conservation Junior Exp.	M.Sc/B.Sc.	-	4	6	10
Agricultural Engineer	"	-	1	1	1
Agro-Climatologist	"	-	1	1	1
Forestry Expert	M.Sc/B.Sc.	-	1	1	1
Topographs	Medium level	-	8	10	2
Drawers	"	-	2	6	2
Lab. services Head	Ph.D./M.Sc.	1	1	1	1
Lab Manager's	-	1	1	1	1
*Senior Lab. Experts	Ph.D/M.Sc.	5	8	8	12
Junior Lab. Experts	Mediu Level	7	10	10	15
Lab. Assistants	"	20	25	30	40
Lab. attendants	Not Qualified	8	10	10	15
Typist	-	1	1	2	2

*) Section's Head and Research Officer's

Annex 4 Laboratory Performance

Central Laboratory for Soils, Plants, Water, Fertilizer, Food Analysis and Methodological and Technical Set-up in Regionals (Zone) Laboratories

1. Size : 1200m^2 (Approx.)
2. General Structure Conditions

   - Two Floors
   - Concrete roof and bricks walls
   - In the first Floor there will be the following facilities

     Reception, offices, meeting room, class room, stores and sample reception and preparatinn room.

   - The second floor will be left mainly for analysis and must be well ventilate
   - Adequate water supply
   - Constant electric supply

3. Analysis Rooms (Inner Division)(Second Floor)

   3.1 Soil chemical analysis
   3.2 Soil Physical analysis
   3.3 Plant and water analysis
   3.4 Fertilizer analysis
   3.5 Food analysis
   3.6 Analytical and technical balances
   3.7 Nitrogen determination (Kjedhal apparatus), water distilation room furnaces and ovens
   3.8 Atomic absorption and flame photometers apparatus with gas exaust fitting. Instrumental room

4. Activities

   4.1 Chemical analysis of soils, major and minor elements (for soil survey and Fertility Evaluation).
   4.2 Complete physical analysis of soils.
   4.3 Plant analysis for N-P-K, minor elements, and other important constituent.
   4.4 Water analysis, conductivity, anions and cations, total salts, Salinity index evaluation and recommendations.
   4.5 Fertilizer analysis for major elements in raw materials and minor fertilizers.
   4.6 Food analysis (Grains, Fruit, Cereals, and others) including livestock feed (Forage crops)
   4.7 Methodological and analytical control in regional laboratories.

5. Technical Staffs

5.1 Central Laboratory Head

- Soil Fertility Expert or Soil Chemist	M.Sc.	1

5.2 Soil Analysis Section

- Head of the section Senior Chemist	B.Sc.	1
- Junior Chemist		1
- Lab. Technician		1
- Lab. Assistants		8
- Lab. Attendants		2
		13

5.3 Plants and Waters Section

- Head of the section. Senior Chemist	B.Sc.	1
- Junior Chemist		1
- Technical Assistant		1
- Lab. Assistant		4
- Lab. Attendant		1
		8

5.4 Fertilizer Section

- Head of the Section. Senior Chemist	B. Sc.	1
- Lab Technician		1
- Lab. Assistant		2
- Lab. Attendant		1
		5

5.5 Food Analysis

- Head of the section - Senior Chemist	B.Sc.	1
- Junior Chemist		1
- Lab. Technician		1
- Lab. Assistant		3
- Lab. Attendant		2
		7

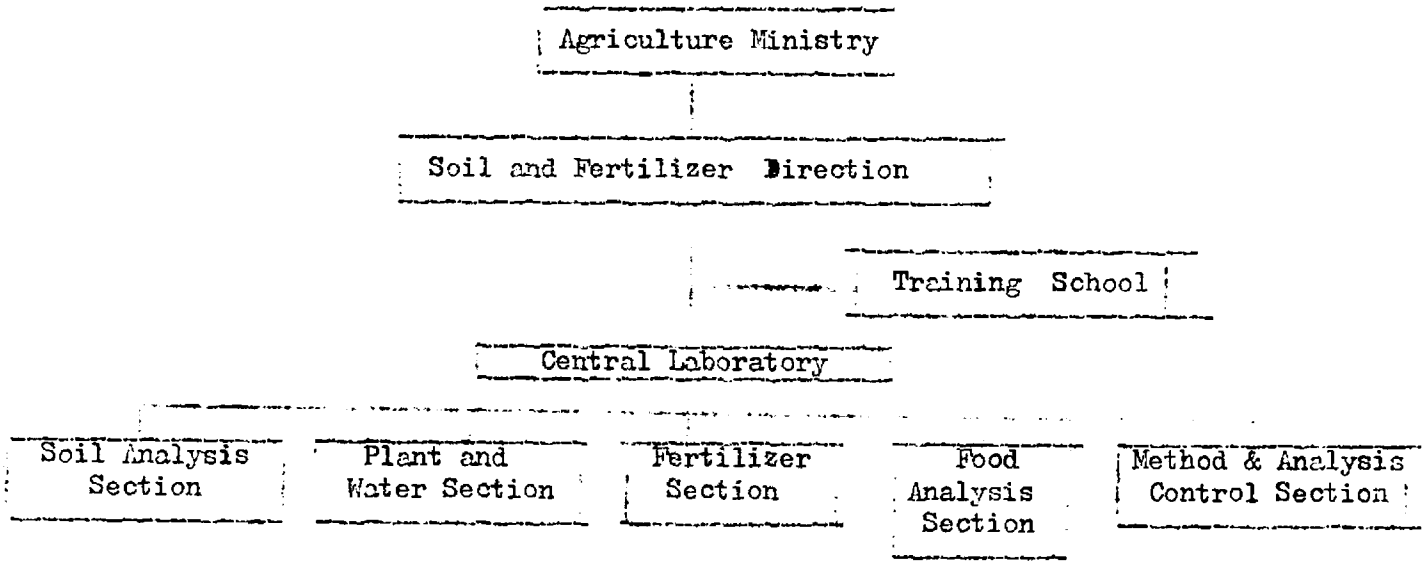
5.6 Methodological and Technical Control

- Head of the Section. Senior Chemist Junior Chemist	B.Sc.	1
- Lab. Technician		2
- Lab. Assistant		3
- Lab. Attendant		2
		8

6. Technical Staff Summary

- High level graduates	M.Sc.	1
- High level graduates	B.Sc.	5
- Junior .... graduates (medium level)		8
- Lab. Assistant		20
- Lab. Attendant		8
		42

ORGANIZATION CHART



8. Analytical Capacities per year (Approx.)

	Samples
- Soils	15,000
- Plants	10,000
- Waters	3,000
- Fertilizer	200
- Foods	3,000

9. Essential Equipments	Quantity (Minimum)
9.1 Electronics	
- Atomic absorption	1
- Flame photometer	3
- Photo colorimeter	3
- pH meter	4
- Conductivity meter	2
- Gas chromatography	1
9.2 Heat	
- Kjeldhal equipment with digestion and distillation units	3
- Hot plates	5
- Steam bath	4
- Ovens with air circulation (large size)	3
- Ovens (common type)	4
- Furnaces	3
- Water Distiller	4
9.3 Balanaces	
- Analytical	3
- Technical	5
9.4 Laboratory Mills	
- Soils	3
- Plants	2

Typical Regional Laboratory for Soils, Plants Fertilizers and Waters Analysis

1. Size - 800m^2 (Approx.)

2. General Structure Conditions

- One Floor
- Concrete roof and bricks walls
- Analytical rooms with appropriates conditions and facilities
- Adequate water supply
- Constant electric supply

3. Analytical Rooms (inner division)

3.1 Physical and chemical soil analysis
3.2 Plants and water analysis
3.3 Fertilizer Analysis
3.4 Analytic and Technical Balances
3.5 Nitrogen determination (Kjeldhal apparatus), water, dastiller furnaces and ovens (heat room)
3.6 Soil samples preparation room
3.7 Plant samples preparation room
3.8 Library
3.9 Office

4. Activities

4.1 Chemical analysis of soils Major elements (soil survey and fertility evaluation)
4.2 Main physical analysis of soils
4.3 Plant analysis major elements N-P-K.
4.4 Water analysis Conductivity, anions, cations Salinity index evaluation and recommendations
4.5 Fertilizer analysis for major elements in, raw materials and mixed fertilizers.

5. Technical Staff

5.1 Laboratory Head

Senior Chemist - M.Sc. or B.Sc.

5.2 Soil Analysis Section

- Head of the section, Junior Chemist	1
- Lab. Assistant	4
- Lab. Attendant	3
	8

5.3 Plants and Waters Section

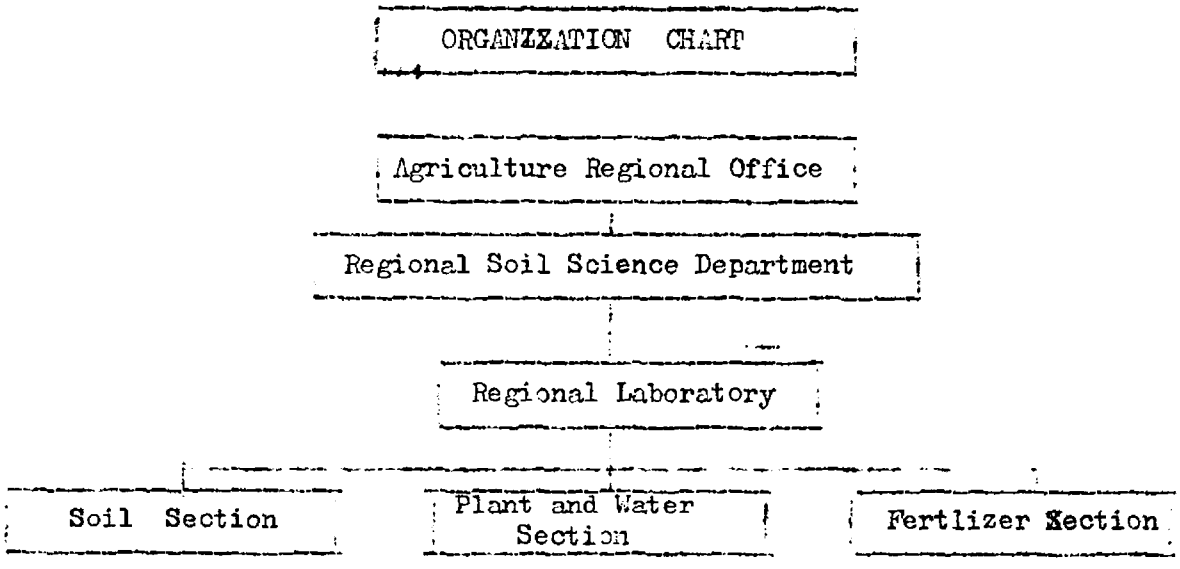
- Head of the section, Junior Chemist	1
- Lab. Assistant	3
- Lab. Attendant	1
	5

5.4 Fertilizer Section

- Head of the Section, Junior Chemist	1
- Lab. Assistant	3
- Lab. Attendant	1
	5

6. Technical Staff Summary

- High level Graduate	M.Sc.	1
- Junior School Graduates (Medium Level)		3
- Lab. Assistant		10
- Lab. Attendnts		5
		19



8. Analytical Capacities per year (Approx.)	Samples
- Soils	8000
- Plants	4000
- Waters	1600
- Fertilizers	100

9. Essential Equipment	Quantity (Minimum)
9.1 Electronics	
- Flame photometer	2
- Photo colorimeter	2
- pH meter	2
- Conductivity Meter	1
9.2 Heating Elements	
- Kjeldha Equipment with Digestion and distillation units	2
- Hot plantes	3
- Oven with air circulation (large size)	1
- Ovens (common type)	2
- Steam Bath	3
- Furnace	2
- Water Destiller	2
9.3 Balances	
- Analytical	2
- Technical	3
9.4 Laboratory Mills	
- Soils	2
- Plants	2

Annex 5 General Observations on Soil Survey in Ethiopia

Ethiopia has very valuable soil resources which, in the major zones, suffer heavy yearly looses and which brings only a relatively small production, mainly due to the law level of soil managment and use. This is a direct consequence of the general lack of basic knowlegge about the most important physical, chemical and morphological characteristics of the soils.

Because of the above mentioned reasons one of the main tasks to be considered by the Soil Science Service of Socialist Ethiopia must be the drafting of a soil map of the country at a scale of enough details to be useful in the short, medium and long term agricultural development planning. Such a map must be useful for working out recommendations for soil use, management and conservation.

The first step of this work should be determining of the priority zones or regions which must be surveyed. This selection must be based on the economic importance of the zones or regions as highlighted in the directives of the Development Campaign of the Ethiopian Revolution.

The Soil Survey of the country should be carried out at three fundamental scales, possibily as follows:-

a) Detailed scale (scales larger than 1:50,000) This scale must be used for those areas where there are planned to be intensive agricultural production unit or agroindustrial enterprice of a big economical importance and where it will be necessary to evaluate a large number of ecological factors.

b) Semi-detailed scale (1:50,000) This scale should be used for the Soil Survey of large areas or whole regions of economical importance where quite detailed data must be provided for agricultural planning. At this scale 1 cm^2 on the map corresponds to 25 ha in the field.

c) Reconnaissance scale (1:250,000) This scale should be used in areas or zones of less economical importante, for instance semi-desertic zones in the NE, NW and S of the country, where climatic conditions are severe limiting factors for agricultural production. Nevertheless this scale must be considered generaly quite detailed because 1 cm^2 on the map represents 625 ha in the field.

Finally a separate edition of all the soil map's must be done on a 1:500,000 scale annexing the corresponding written reports. This is for the purpose of facilitating the compilation of the soil map and the country of a suitable scale.

In addition to the above mentioned factors the choice of a suitable soil classification system to be used in systematic soil survey of the country must be taken into account. For this, a detailed review of the available bases was done and it is found that the FAO soil classification system is the most suitable which must be properly used for training and for the soil survey at different scales.

Moreover, it must be remarked that every soil survey work in the country must be carried out under a unified methodology whereby the following data must be systematically collected.

1. General description of the area
2. Systematic evaluation of climatological data
3. Geological formations
4. Physiography
5. Water resources
6. Soil cover
7. Erosion
8. Drainage
9. Agricultural Production

The following data, in particular, should be deeply analyzed:

1. Soil taxonomical units
2. Natural vegetation cover
3. Profiles description (soil morphology)
4. Releaf
5. Parent soil materials
6. Physical and chemical soil characteristics

a) Main physical constants
b) Acid-base equilibrum
c) Soil improvement practices
d) Exchangeable cations
e) Salinity problems

7. Irrigation water needs and quality
8. Special management practices or main soil groups
9. Plant nutrients availability
10. Erosion problems
11 Organic matter status
12. Agrological capability
13. Agricultural practices

In order to describe the typical taxonomic soil units, the following special purpose soil analyses must also be considered;

1. Total elemetal analysis
2. X-Ray difraction
3. Electron microscopy
4. Differential thermal analyses

Annex 6 : Methodological Aspects On Soil Conservation

Taking into acount the economical potential of the erosion effected area, and the high values of soil losses due to erosion which may reach up to 17tons/yr. it is of importance to remark about the particular characteristics of the country's relief, rainfall pattens and the deforestation which have agravated the situation. These factors together with the low agrotechnical level of the peasant farmers are the main cause of the dangerous development of erosion processes in the highlands.

It is the first and formost step to recognize that agricultural lands are all peoples measure i.e. the treasure of the nation; and the conservation of these lands depend on the appropriate land use methods or agricultural practices that is adopted by peasants and state farms on the different land scapes. In each kind of landscape the appropriate systems of agrotechnical practices should be adopted in order to save the agricultural lands. This is the main principle of the soil conservation theory.

After the definition of the areas that are considered to be the object of a soil conservation programme the soil conservation section should carry out all the necessary studies, surveys and projecting works on them in order to avoid the erosion processes in a whole cachtment.

The studies for a detailed soil conservation programme in a cachtment should include the following:

1. Soil survey (integrated evaluation of soil characteristics and properties.
2. Detailed soil map
3. Agrological capability map
4. Erosion map (showing a clear distribution of the different erosion grades.
5. Soil fertility map
6. Map of land use
7. Land tenure map
8. topographical base map
9. Slopes map
10. Geological survey with maps and reports
11. Rainfall pattern data
12. Water flow description
13. Water balance of the zone
14. Natural vegetation survey (Distribution pattern and species composition)
15. Forestry side evaluation of the zone. Existing forests and possible development of new ones.

16. Evaluation of the economical behavior of the zone. Discussions about development programmes drafted for the cachtment.

17. Demographical aspects of the zone

The integral evaluation of all the above mentioned data shall be the basis for the drafting of a comprehensive soil and water conservation programme in the cachtment area.

The programmed activities of soil consefvation advises can be grouped into 6 main phases:

1. Erosion control (water and wind erosions)
2. Drainage and waterlogging control
3. Soil management and land use planning
4. Research, demonstration and extension trials on soil improvement practices
5. Water management practices
6. Training and propoganda

At the same time studies of priority areas with particular problems within the catchment shall be considered if its economical development justify the work, but this will always be a sub-system in the whole catchments system, or at least a phase of the general work.

The erosion control measure shall include:

a) short term measures in order to limit the erosion process
b) programmed research work on the erosion characteristics and its control in the catchment area.
c) extension and training programmes on erosion control practices

Among the most important measures in drainage and waterlogging control the following method shall be considered:

a) Open drans and natural water way drainage systems
b) Underground water ways drainage systems
c) both methods

For waterlogging control, the following measures must be included in the system:-

a) Natural water ways' rectification
b) Building of necessary water ways
c) drainage well
d) Dam building
e) Construttion of water regulation dams
f) Maintenance systems in discharge canals

Correction measures of salty and alkaline soils will have to be preceded by the programme of special studies on the hydrological characterisiics of the zone.

Among the many, the following most common soil management and land use measures shall be considered;

a) Establish vegetal species with the best behavior in the ecological system.

b) Establish the agrotechnical system for each crop with special emphasis on the practices which shall be prohibited.

c) Establish a statistical system in the area in order to calculate the efficient of the whole soil conservation system.

d) Establish forestry management practices.

In the research demonstration and extension fields the study and solution of the following problems shall be included.

a) Naturally compacted soil horizons (hardpan , clay pans etc.)
b) Soil horizons compacted by grazing animals or cultivation cultural practices.
c) Superficial compactation problems
d) Sedimentation (accumulation problems)
e) Soil improvement practices (liming etc.)
f) Relationships between soil moisture content and cultural practices.

On the water use and management problems the following aspects shall be considered.

a) The quantity and quality of the underground water resources shall be established and the possibilities of artifitially increasing these reserves and their use must be studied.

b) If it is possible the optimum rate of use of the underground water by the main crops of the area shall be established.

c) Research works shall be programmed on irrigation practices in order to establish.

- evapotranspiration rate and water consumption coeffient for the main crops.
- water needs of each crop
- water use in the cropping season
- water researve in the soils
- soil teaching problems
- irrigation efficiency calculation
- efficiency of different irrigation methods

In the field of training and propogandas activities the following shall be included:

a) The regional soil science departments shall draft a propoganda programme that includes different soil conservation methods must be used in order to extend the knowledge among the producers.

b) In the peasants' organizations meeting different speches about the usefulness of recommended soil conservation systems.

c) Field days shall be organized on soil conservation systems.

d) The soil conservation sections shall produce brochures (booklets) on soil conservation practices.

e) The training teaching soil conservation technical staff for every catchment shall be coordinated with Ministry of Education

Results of EPID Trials and Demonstration

Ministry of Agric. and Settlement - EPID Publication no 39 - March 1977.

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Annex 1 - Land Vegetation Resource
2 - Water Resources - Vol. 1 Hydrology and Surface Waters
Vol. 2 Ground Waters

6 - Forestry
7 - Agriculture - Conservation
8 - Social Organization
10 - Extension and Intra-structure
11 - The Rural Economy

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