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SOIL FERTILITY SURVEY

of

KAFR EL-SHEIKH, EL-MANSURIYA

and

EL-MINYA SITES

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SOIL FERTILITY SURVEY of KAFR EL-SHEIKH, El-MANSURIYA and EL-MINYA SITES

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GENERAL SUMMARY AND CONCLUSION

Egypt Water Use and Management Project (EWUP) is designed to assist in improving the irrigation and farm management practices of small farmers. This project is a joint venture of Ministries of Irrigation and Agriculture. A soil fertility survey was conducted to determine the soil fertility status of small farms in project sites. The project contract specified that such a survey be conducted for determining nutrient needs of crops in small farms located in project sites and for determining the feasibility of providing soil testing services for small farmers.

A soil fertility survey was conducted in Abu Raya area, Kafr el-Sheikh; Beni Magdul and El-Hammami areas in El Mansuriya, Giza; and Abyuha area, El-Minya.

The Abu Raya farmers presently follow a cotton-winter crop-rice rotation. The main winter crops are temporary clover (berseem), wheat, and flax.

The Beni Magdul and El-Hammami farmers presently grow vegetables as winter and summer crops. They also grow berseem and wheat as winter crops and maize as summer crop. At Beni Magdul area berseem is number one winter crop in acreage. In El-Hammami area vegetables occupy number one position in acreage.

The Abyuha farmers presently grow cotton, maize, and sugarcane as the main summer crops. Main winter crops are beans (full), Berseem and wheat.

Soil fertility survey results show that presently nitrogen, phosphorus, zinc and iron could be considered as the plant nutrients deficient in soils of some farms in EWUP sites.

Since organic matter levels in Egyptian soils are low, they could be considered low in available nitrogen. However, residual nitrogen was found to be high in El-Hammami soils on the average and low in soils of other sites. In El-Hammami farmers apparently overfertilize their vegetable crops as do vegetable growers in other parts of the world. It is important that on-farm field studies be carried out to determine the importance of soil residual nitrogen in providing nitrogen needs of crops.

Average phosphorus level is moderately low in surface soils of Abyuha and Abu Raya and high in soils of El-Mansuriya. The results show the importance of phosphorus fertilization for Egyptian agriculture. However, it is proposed that on-farm field studies be carried out for a better calibration of soil test levels and allocation of fertilizers according to soil test levels and crop requirements.

The EWUP site soils are well-supplied with native potassium and in general potassium fertilization is not required for field crop. If potassium fertilizers are used, then they should be used in low to medium testing soils, especially for crops that require high levels of potassium such as potatoes and fruit trees.

Zinc was found to be deficient in most of Abyuha and El-Hammami soils and some soils of Abu Raya and Beni Magdul. The data reveal the importance of zinc fertilizers to increase crop production in these areas. It is imperative that extension service show the farmers the proper method of zinc fertilizer application. Economics of soil application of zinc and its residual effect and foliar applications should be determined under different soil conditions.

Available iron levels were lowest in El-Hammami soils. A small number of farms in Beni Magdul and Abyuha suffer from iron deficiency problems. The soil application of iron fertilizer is very expensive since only very expensive iron chelates are effective for correction of iron deficiency in alkaline soils of Egypt. Therefore, foliar application of iron solutions provides the immediate solution to this problem. But for a long term solution it is recommended that vegetable varieties and crop varieties be screened for tolerance to soils with low iron availability.

Manganese and copper were found in adequate available levels in soils of EWUP sites.

The results show that at the time of sampling about 37, 24 and 35% of soils in Abu Raya, Beni Magdul and El-Hammami were moderately to highly saline. However, only 6% of Abyuha farm soils were classified as saline.

The results show that most farms in Abu Raya are one feddan or less in area.[1] The corresponding figures are 0.50, 0.19, and 0.50 feddan for Beni Magdul, El-Hammami and Abyuha, respectively.

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[1] In this report a farm is defined as contiguous fields cultivated by one household.

Since the farm size is small in Egypt, testing of soils of each farm will be very expensive. Besides, at this time due to lack of an adquate number of soil testing laboratories in Egypt, it is not feasible to test soils on single farm basis. Therefore, it is suggested the soil sampling and testing be done at the hôd or village level at this time. Statistical procedures were used to devise sampling procedures for EWUP sites. These have been discussed in detail in the text.

It is recommended that soil testing program and on-farm fertilizer tests for a better interpretation of soil test results be expanded so that fertilizer recommendations become tailor-made to the soil conditions and needs of each village or region.

AMERICAN EQUIVALENTS OF EGYPTIAN ARABIC TERMS AND MEASURES COMMONLY USED IN IRRIGATION WORK

Land Area	*in sq meters*	*in acres*	*in* feddans	*in hectares*
1 acre	4,046.856	1	0.96335	0.40469
1 *feddan*	4,200.8335	1.03805	1	0.42008
1 hectare (ha)	10,000.00	2.47105	2.38048	1
1 square kilometer	100×10^4	247.105	238.048	100.00
1 square mile	259×10^6	640.00	616.4	259.00

Water Use	*in acre-feet*	*in acre-inches*
1 billion m^3	810,710	
1,000 m^3	0.81071	9.72852
1,000 m^3/*feddan* (= 238 mm of rainfall)	0.781	9.372
420 m^3 rainfall (= 100 mm of rainfall)		

Other Conversions	*metric*	*U.S.*
1 *ardab*	198 liters	5.62 bushels
1 *ardab/feddan*		5.41 bushels/acre
1 kg/*feddan*		2.12 lb/acre

Egyptian Units of Field Crops	*Eg. Unit*	*in kgs*	*to convert Eg. units/*feddan *to tons/ha, multiply by*
Cotton (unginned)	metric *qintar*	157.5	0.3749
Cotton (lint or ginned)	metric *qintar*	50.0	0.1190
Sugar, onion, flax straw	*qintar*	45.0	0.1071
Rice (rough or unmilled)	*dariba*	945.0	2.2496
Lentils	*ardab*	160.0	0.3809
Clover (*birsīm*)	*ardab*	157.0	0.3737
Broadbeans, fenugreek	*ardab*	155.0	0.3690
Wheat, chickpeas, lupine	*ardab*	150.0	0.3571
Maize, sorghum	*ardab*	140.0	0.3333
Linseed	*ardab*	122.0	0.2904
Barley, cottonseed, sesame	*ardab*	120.0	0.2857
Groundnuts (in shells)	*ardab*	75.0	0.1785

ABSTRACT

Egypt Water Use and Management Project is designed to assist in improving the irrigation and farm management practices of small farmers. A soil fertility survey was conducted to determine the soil fertility status of small farms in project sites as specified in the contract.

The soil fertility survey was conducted in the project sites located in Kafr el-Sheikh, Giza, and El-Minya governorates. The sites were Abu Raya, El Mansuriya and Abyuha, respectively. Two locations in El Mansuriya, namely Beni Magdul and El-Hammami were used. The objectives of the survey were:

1) to obtain information on the available nutrient levels and their variability in the soils of EWUP sites.
2) to determine the feasibility of providing soil testing services for Egyptian farmers.

Ten to fifteen percent of the farms in each area were selected at random. Two soil samples per farm were obtained. All soil samples were analyzed for pH, EC, and available P. Potassium was determined in Beni Magdul and El-Hammami sites representing a moderately heavy soil and a sandy soil, respectively. Nitrates, Zn, Fe, Cu and Mn were determined in a varying number of samples equivalent to 2-10% of farms in a given area.

A logarithmic transformation made the distribution of above measurements closer to a normal one except for pH which had a near normal distribution to begin with.

Analysis of variance was done on the pH values and on the transformed data. The components of variance were determined. Sampling intensity was calculated at different levels of sampling error for the geometric mean of soil parameters.

The salinity levels have been interpreted for moderately sensitive and fertility for sensitive crops, respectively.

The average EC values showed that about 37, 24 and 35% of Abu Raya, Beni Magdul and El-Hammami soils were moderately to highly saline, while only 6% of Abyuha soils were saline. This finding once again reveals the importance of monitoring soil salinity for evaluation of on-farm water management practices of small farmers.

Nitrate distribution in soils of Abu Raya farms to be planted to cotton and El-Hammami vegetable farms showed enough variation to make an evaluation of soil test for nitrates valuable. Nitrate was not determined in Abyuha soils. In Beni Magdul farms and AbuRaya farms to be planted to rice a large proportion of soils tested low in residual NO_3-N.

Considering average P fertility of the soil profile to a depth of 60 cm, response to phosphorus fertilizers will probably be small in El-Hammami and Beni Magdul, and probably moderate to large in other areas. However, 70, 43, and 84% of surface samples (0-20 cm) may be classified as low in P availability in Kafr el-Sheikh, El-Mansuriya and El-Minya sites, respectively. If root depth is limited to surface soils then response to P is expected in these soils. Field experiments are required for a better calibration of phosphorus soil test.

Zinc levels are low in a large proportion of soils in Kafr el-Sheikh, El-Hammami, and El-Minya areas and response to zinc fertilization is highly probable for sensitive crops growing in low testing soils. Most Beni Magdul soils were well-supplied with Zn but 18% of samples tested low to marginal in Zn availability.

Potassium levels were high in soils of all pilot areas except in El-Hammami soils (sandy soils) where only 3% of soils tested medium in available K. If potassium fertilizers are used, then they should be used in low to medium testing sandy soils, especially for crops that require high K levels such as potatoes and fruit trees.

Iron availability was marginal to deficient in 8% and 54% of Beni Magdul and El-Hammami soil samples, respectively. Abu Raya and Abyuha soils were well-supplied with Fe. Manganese and copper availability indices were found to be adequate for crop production.

The results indicated that soil testing for fertility evaluation could be done for each hôd located in Abu Raya and Abyuha sites. This was due to the lack of a significant difference between soil fertility, EC and pH values of farms within each hôd. Most farms within each hôd also follow a uniform cropping pattern at least for summer crops.

In Beni Magdul and El-Hammami vegetable growing areas soil testing based on composite sampling of a number of farms should not be followed due to the diversity of cropping patterns, high cost of vegetable production and high risks involved. If samples from each farm are

obtained, the cost of soil testing per feddan will be high due to small size of farms. A suggested strategy is to obtain samples from a number of farms in each village and to make farmers aware of what nutrients were found deficient in their area. These nutrients may then be provided for farmers who desire to purchase them. It is imperative that farmers be shown the proper use of micronutrients, such as zinc, with which they have very little experience.

It is suggested that for determination of fertilizer requirement of each crop, 30 soil sampling units (one shovelful of soil = sampling unit) to a depth of 60 cm be obtained from 30 different farms per hôd in Kafr el-Sheikh and El-Minya governorates. This sampling intensity will result in a 95% confidence interval of geometric mean of about ±14% for P, ±23% for Zn in both areas and ±27% for NO_3-N in Kafr el-Sheikh. Nitrate test was not run on El-Minya soils.

It should be emphasized that field fertilizer experiments should be carried out for a better calibration of soil test results.

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INTRODUCTION

Currently, the fertilizer recommendations in Egypt are made for a farming area or district based on the responses obtained at the local experiment station. Because the various management practices on the experiment station may, and probably do, differ considerably from that on a farmer's field, the fertility status of the soil should be determined on the farmer's fields.

One of the objectives of the Egypt Water Use Project (EWUP) was to determine the soil fertility status of small farms. A soil fertility survey was conducted for this purpose in the project areas namely, Kafr el-Sheikh in the Nile Delta, El-Mansuriya west of Cairo and El-Minya in the central part of the Nile Valley. The results of this survey will be given in the following sections.

INTERPRETATION OF SALINITY AND FERTILITY INDICES

Soil salinity and fertility values should be interpreted according to the crop species used. In this paper the salinity and fertility indices have been interpreted for moderately sensitive and sensitive field crops, respectively (Soltanpour et al. 1979, Halvin and Soltanpour, 1981, USA handbook 60). The following tables show the classification used in this paper.

TABLE i

Salinity Interpretation

Salinity Hazard	Abu Raya and Abyuha Soils 1/	Beni Magdul Soils 2/	El-Hammami Soils 3/
	----------mmhos/cm of 1:5 extracts----------		
Low	0-0.8	0-0.5	0-0.2
Moderate	0.8-1.6	0.5-1.0	0.2-0.4
High	1.6-2.4	1.0-1.5	0.4-0.6
Very High	>2.4	>1.5	>0.6

1/ SP = 100%. Multiply table values by 5 to get an equivalent value for EC of saturation extract.

2/ SP = 62.5%. Multiply table values by 8 to get an equivalent value for EC of saturation extract.

3/ SP = 25%. Multiply table values by 20 to get an equivalent value for EC of saturation extract.

The above extrapolation technique assumes lack of gypsum in the soil samples.

TABLE ii

Fertility Interpretation
for Surface Soils

Classification	NO_3-N*	P	K	Zn	Fe	Cu	Mn
	----------ppm----------						
Very Low	0-10	0-3	-	-	-	-	-
Low	10-20	3-7	0-60	0-0.8	0-2.5	0.0.2	0-0.5
Medium	20-30	7-11	60-120	0.8-1.5	2.5-5.0	-	-
High	30-40	>11	>120	>1.5	>5	>0.2	>0.5
Very High	>40	-	-	-	-	-	-

* Interpretation is for 60-cm deep samples. Assuming a feddan-60 cm volume of soil weighs 3,000,000 kg (Bd = 1.2). Then the following formula may be used to convert ppm No_3-N to kg N per feddan-60-cm:

ppm x 3 = kg N/feddan-60cm.

Soil Fertility Survey In Abu Raya, Kafr el-Sheikh

BACKGROUND INFORMATION

The Egypt Water Use and Management Project (EWUP) in Kafr el-Sheikh governorate is designed to assist in improving the irrigation and farm management practices of small farmers in the northern Nile Delta.

One of the EWUP's objectives is to survey on-farm water and agronomic management practices and to identify the primary constraints to increased crop production and efficient water use. This soil fertility survey is part of that problem identification program. The soil fertility survey was designed:

1) To obtain information on the available nutrient levels and their variability in the soils of EWUP sites.
2) To determine the feasibility of providing soil testing services for Egyptian farmers.

Soil Classification

The Abu Raya site, selected for conducting the water use and management studies in Kafr el-Sheikh governorate, lies in the northcentral part of the Nile Delta and consists of 2000 feddans. According to Abdel-Wahed et al. (1980), the soils of this area are typical of the lower Delta soils. They state that the soils are fine textured and the clay fraction is predominantly montomorillonitic. The major portion of the soils are classified as Vertisols (Torrerts suborder) and the remainder as Entisols (Fluvents suborder). Moreover, the land surface is flat and very gently sloping toward the north and the area in general lies 2 m above sea level.

The soil classification survey results show that the soils of the study area are generally similar in major characteristics such as soil depth, texture, color, calcium carbonate content, cation exchange capacity and water holding capacity. The main differences are in some properties such as salinity, sodicity, water table depth and the presence of gypsum accumulations in the subsoil. These differences dictate certain management practice in farming the area.

The swelling nature of the clay minerals dominating the area causes deep and wide cracking in the soil upon drying. These cracks will allow rapid downward movement of water and may facilitate the initial

leaching of salts from the surface soil. Also, the cracks increase the evaporation rate of water and salt accumulation.

Cropping System

Abu Raya farmers follow a two-year rotation in which the area is divided into two equal blocks. The first block is planted to temporary clover in winter followed by cotton as the summer crop. The second block is divided into two parts - one for clover (and other legumes) and the other for wheat and flax grown in winter. Rice is usually the summer crop that follows the winter flax, cereals and legume. This sequence is rotated in the two blocks in the second year and so on (El-Togby, 1976).

It was found during the soil fertility survey in Abu Raya area that a relatively large number of farms (17%) were fallowed at the time of sampling before planting cotton which may be attributed to labor shortage and possibly lack of mechanization.

Farm Size Distribution

In this report farm is defined as contiguous fields cultivated by one household. The farm size distribution is considered in the present study in order to examine the feasibility of soil testing technique for fertilizer recommendations. Farm size will affect the efficiency of soil testing implementation if every farm in an area is to be sampled.

The Abu Raya area consists of five large hôds where only four of them were surveyed in this study. Those hôds were namely: Matarine 1, Matarine 2, Bakir 1 and Bakir 2, which cover an area of 1713.75 feddans. The farm size within this area ranges from 0.13 to 30 feddans with a mode value of one feddan. Sixty-nine percent of the farms range in size from 0.13 up to two feddans (Tables I-1 and I-2).

MATERIALS AND METHODS

Field Procedures

The farm units to be sampled were drawn at random from the list of farms in each hôd. About 10% of farms in each hôd were sampled before cotton and before rice planting. Clean shovels were used to take samples to prevent contamination of samples with micronutrients. Samples were obtained from 0-20 cm depth. Two sampling units (sampling unit = one shovelful of soil) were obtained from each farm. Subsoil samples (20-40

and 40-60 cm) were obtained from a few farms.

Laboratory Procedures

The following properties of soil samples were determined: pH and conductivity, nitrates, phosphorus, potassium, zinc, iron, copper, and manganese.

Nitrate was extracted with water. Chromotropic acid method was used to determine nitrate (West and Ramachandran, 1966). The pH was determined in 1:2.5 soil-water suspension, whereas 1:5 soil-water extract was used to determine the conductivity of the supernatent solution according to the procedures given in the USDA Handbook No. 60 (U.S. Salinity Laboratory Staff, 1954). The 0.5 molar $NaHCO_3$ method was used to extract available P (Olsen, et al., 1954). The ammonium molybdate-ascorbic acid method was used to develop P blue color (Watanabe and Olsen, 1965). The NH_4HCO_3-DTPA (Soltanpour and Schwab, 1977) method was used to extract K and its concentration was determined by a flame-photometer. Zinc, Fe, Cu, and Mn were determined using the NH_4HCO_3-DTPA method (Soltanpour and Workman, 1979).

Statistical Methods

Tests for normality

Histograms for distribution of each element per hôd was made. If visual observations indicated skewness, then non-transformed data were tested for normality. Statistical tests for skewness were used to test the normality of distributions. If tests indicate significant deviation from normality, then logarithmic transformations were made. The transformed data were tested for normality to see if transformations made the distributions closer to a normal one (Snedecor and Cochran, 1967).

Analysis of variance

In order to determine if the differences between soil nutrient levels in different hôds and farms within the same hôd were significant, the analysis of variance technique was used on the normalized data. The two sampling units taken from each farm were used to determine the within farm error variance. Total, hôd, farm, and error sums of squares, mean squares and F values were calculated and tested.

Table I-1. The mean, mode, range of farm size, farm number and the total area of the hôds located in Abu Raya area

hôd	Mean	Mode	Range	Area	Number of Farms
	----------Feddans----------				
Matarine (1)	2.61	2.00	0.33 - 30.0	557.79	213
Matarine (2)	2.27	1.00	0.29 - 12.0	332.23	146
Bakir (1)	1.68	1.00	0.13 - 7.0	440.60	262
Bakir (2)	1.62	1.00	0.29 - 9.0	383.13	236
Total Area	1.99	1.00	0.13 - 30.0	1713.75	857

Table I-2. The relative frequency of the farm size in Abu Raya area

Class	Relative Frequency
Feddan	%
0.13 - 0.50	10
0.50 - 1.00	29
1.00 - 1.50	12
1.50 - 2.00	18
2.00 - 2.50	8
2.50 - 3.00	9
3.00 - 3.50	3
3.50 - 4.00	4
4.00 -30.00	7

Sampling plan and intensity

Sampling plan indicates how a sample should be taken - random, stratified or systematic (Peterson and Calvin, 1965). Sampling intensity refers to the number of sampling units to be obtained from an area or field in order to get a representative sample. Sampling units are composited (physically averaged) to reduce the cost of analysis.

Analysis of variance assumes a normal distribution. But, the fertility and electrical conductivity values were not normally distributed and a logarithmic distribution made the distributions closer to a normal one. The analysis of variance was then performed on the transformed data. The analysis showed that, in general, hôds to be planted in a given crop can be sampled as one farming unit for soil fertility evaluation.

The equation {1} was then used to determine the number of cores (n) to be composited for a 95% confidence interval (CI) of the mean of each soil fertility index or electrical conductivity.

$$\{1\}\ CI = \pm\ t_{0.05,d} \left\{ \frac{s_c^2}{n} \right\}^{1/2}$$

where s_c^2 is the error variance of each sample and s_c^2/n is the error variance for the mean fertility of each hôd or site. The s_c^2 was calculated by adding the within farm error variance (s^2_w) to the among farms error variance (s^2_F). To calculate the s^2_F, the difference between "among farms mean square" and "error mean square", (s_w^2), was divided by the coefficient of among farm error variance.

Since a logarithmic transformation was used, the antilog of the mean ($\bar{x}$) of the transformed data for a given measurement is the geometric mean of that measurement. Therefore, $10^{\bar{x}}$ is the geometric mean. The CI value shown in {1} is for the transformed values, therefore, equation {2} is the relative confidence interval for the geometric mean (Reuss, Soltanpour and Ludwick, 1977).

$$\{2\}\ \frac{10^{\bar{x}\pm CI}}{10^{\bar{x}}} = 10^{\pm CI}$$

Different values were assigned to CI and n was determined from equation {1}.

For example, for an error of +20% for the geometric mean, the log value for 1.20 was determined to be 0.0792, i.e., $10^{0.0792} = 1.20$. Now $10^{-0.0792} = 0.83$. Using the value of 0.0284 for s_c^2 for phosphorus and a value of 2.0 for t and 0.0792 for CI in equation {1}, we will have $0.0792 = 2.0 \left\{\frac{0.0284}{n}\right\}^{1/2}$. Squaring both sides and solving for n we will have equation {3}.

$$\{3\} \quad n = \frac{t^2 s_c^2}{(CI)^2} = 4 \times \frac{0.0284}{(.0792)^2} = 18$$

Eighteen is then the number of sampling units per basin to be taken for a 95% CI of +20% and -17% of the geometric mean for soil phosphorus. For simplicity, we may average the values and say that the 95% confidence interval (CI) of the geometric mean is ±18.5%.

The above procedure is to determine the number of samples, to take for a given confidence interval of the geometric mean. However, in practice composite samples are obtained. A composite sample is equivalent to an arithmetic mean. Therefore, arithmetic means are used in practice. One can assume that the distribution of the means is closer to a normal one than the distribution of individual values. Therefore, it is justified to assume that an arithmetic mean (composite sample) is representative of the field.

RESULTS AND DISCUSSION

The distribution and variation of pH, conductivity and fertility values of samples are discussed below. The distributions of all determinations in the surface samples were tested for normality. All the distributions were found to deviate from normality except the one for pH. Therefore, a logarithmic transformation was made for all the parameters except the pH. This resulted in reducing the coefficient of variability and a distribution closer to a normal one in general.

pH

The analysis of cotton and rice soils in Abu Raya area revealed that the pH values ranged from 7.9 to 8.9 (Figs. I-1 and I-2) with 90% between 8.0 and 8.9. Most of the surface soil samples were of pH values below 8.5. The pH values did not change with depth (Fig. IV-1). The alkaline pH values are due to the presence of lime in these soils and result in a reduction in availability of phosphorus and micronutrients.

In general, sodicity problems as surmised from pH values were not widespread. However, at high EC values one cannot estimate sodicity from pH values. The pH values were determined in a 1:2.5 soil:water suspension and pH values between 8.5 and 8.9 could be attributed to the dilution effect. However, this dilution effect was more or less cancelled by the salt effect in rice fields. One drawback of this study is that SAR values were not determined.

Electrical Conductivity

These values were determined using 1:5 soil:water ratio. The saturation percentage of these soils ranged from 80 to 100%. Therefore, by multiplying the electrical conductivity (EC) values by 5, one can estimate the EC of saturation extract. In the case of gypsiferous soils, this extrapolation method will lead to an overestimation of EC. Therefore, it is recommended that EC values be determined on saturation extract if soils are gypsiferous.

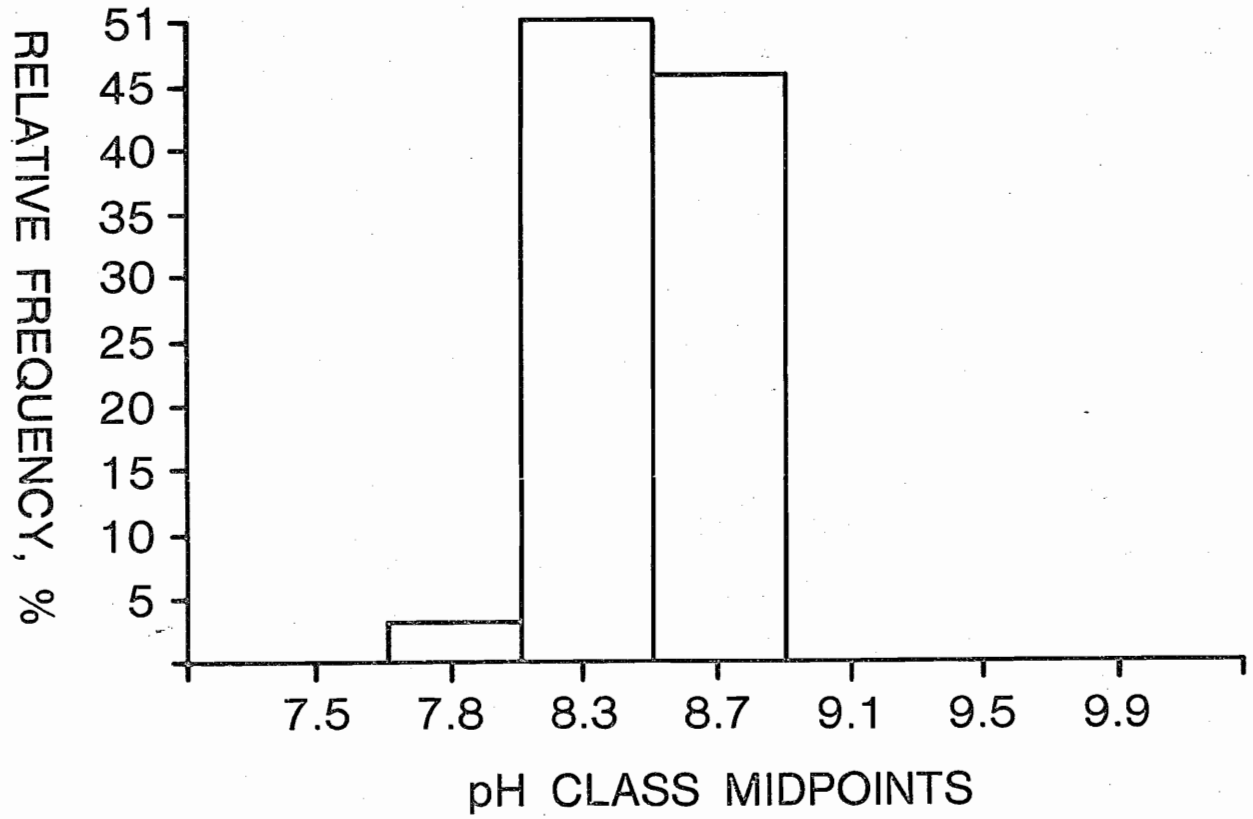

Fig. I-1 Frequency distribution of pH values of Abu Raya cotton farms after a rice crop and a winter crop

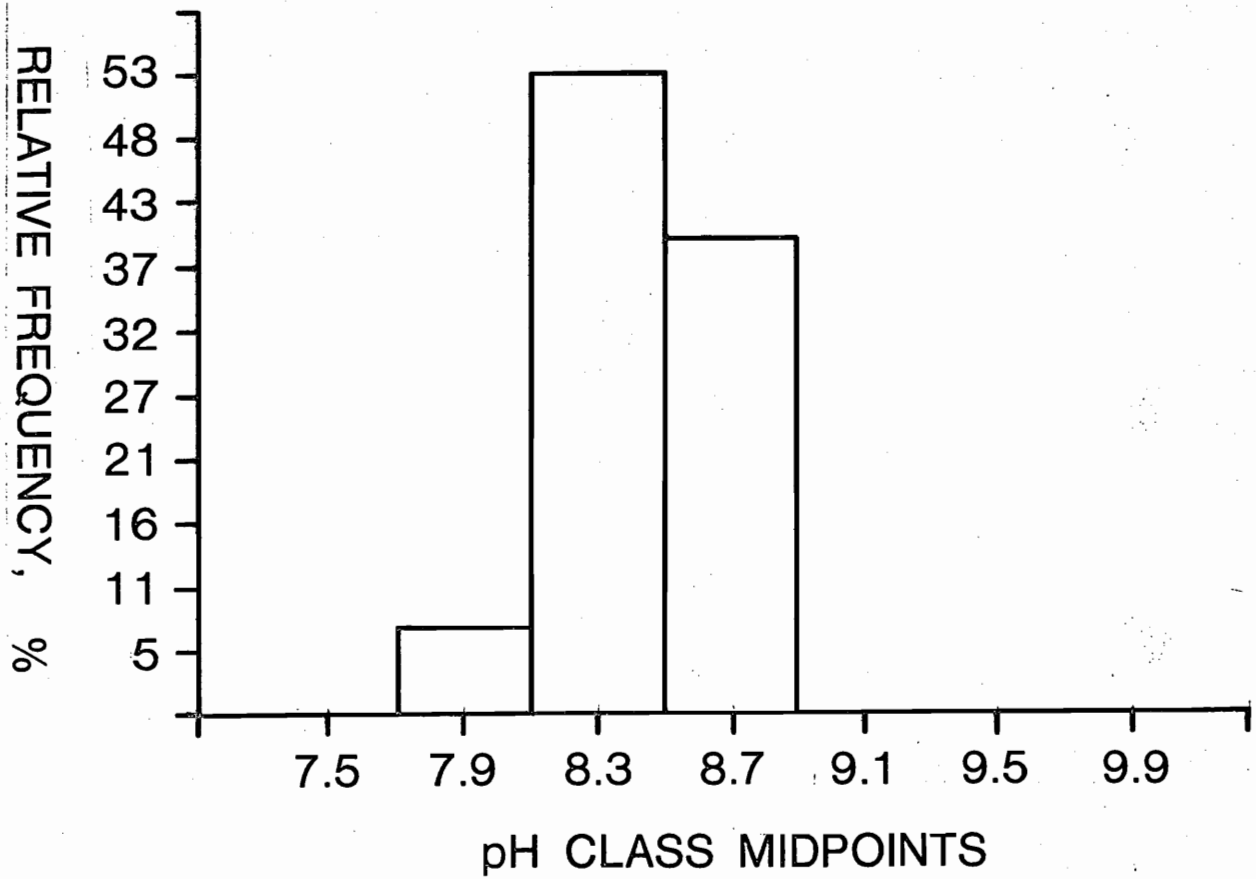

Fig. I-2 Frequency distribution of pH values of Abu Raya rice farms after a cotton crop and a winter crop

The conductivity values for the 1:5 soil:water extracts range from 0.2 to 2.9 and from 0.2 to 4.2 mmhos/cm in cotton and rice soil samples, respectively (Figs. I-3 and I-4). According to our previous discussion, we can say that about 45 and 29% of the surface soils are saline (EC > 0.8 mmhos/cm) in rice and cotton fields, respectively. It seems the salts are leached out of the surface soil during flooding of rice in previous season. The salinity problem becomes more serious with depth (Fig. IV-2). The mean conductivity values were 0.6, 0.7 and 1.0 for the depths of 0-20, 20-40, and 40-60 cm in the case of cotton farms, respectively. Those means were relatively high in the case of rice farms and amounted to 0.9, 1.2, and 1.4, respectively.

The results show that the farmers are leaching the soluble salts to lower depths in the profile. The differences in conductivity values with depth has implications for irrigation management and plant growth. The deeper soil layer may reach permanent wilting point sooner than the surface soils due to a higher osmotic potential. This means that even at relatively high moisture levels in these lower soil layers, plant roots may not be able to extract water from these layers if osmotic potential values are too high for plant internal osmotic adjustment. Another detrimental effect of high salts on plant growth result from physiological disorders (Lagerwerff and Eagle, 1961).

There was no significant difference between the conductivity values of the farms located in the same hôd for cotton and rice areas.

In the case of the cotton area, the hôds differed significantly in their conductivity values at the 1% level. In the case of the rice farms, there was a significant difference between the hôds at 10% level of probability (Table I-3).

Nitrates

The values of nitrate nitrogen ranged widely in the surveyed cotton and rice farms. The range was 2 to 104 ppm in cotton farms and about 0.3 to 23 ppm in rice farms (Figs. I-5 and I-6).

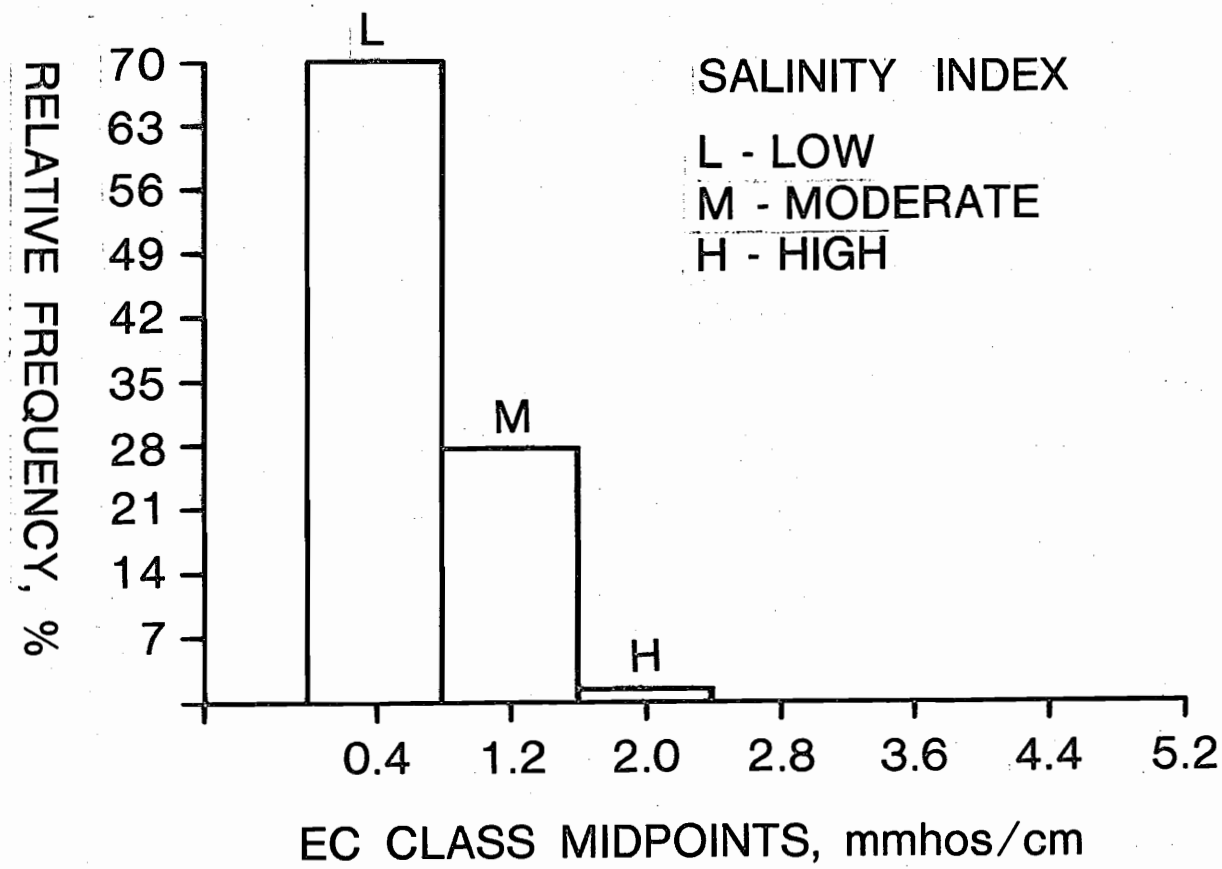

Fig. I-3 Frequency distribution of EC (1:5) values of Abu Raya cotton farms after a rice crop and a winter crop

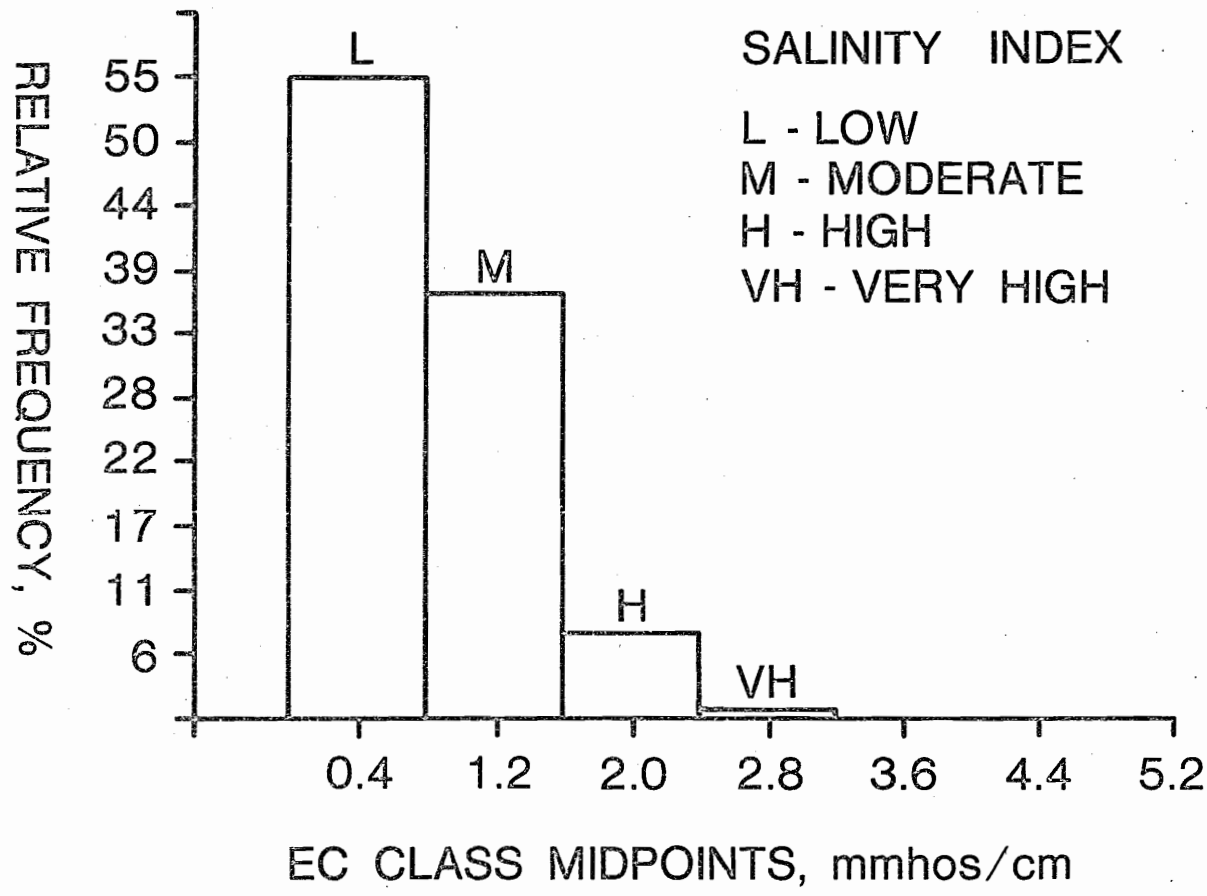

Fig. I-4 Frequency distribution of EC (1:5) values of Abu Raya rice farms after a cotton crop and a winter crop

Table I-3. The means of conductivity values of 1:5 soil:water extracts of the surface samples (cotton and rice areas) of Abu Raya

hôd	Conductivity values Cotton	mmhos/cm	Rice
Matarine 1	0.45		0.88
Matarine 2	0.84		0.79
Bakir 1	0.83		1.21
Bakir 2	0.89		0.94
Mean	0.75		0.96
C.V. (%)	76.8		153.5
F	1%		10%

About 42 and 88% of the surface soil samples taken from the cotton and rice farms, respectively, contained less than 10 ppm of NO_3-N.

All subsoil samples contained less than 10 ppm of NO_3-N (Fig. IV-3). The analysis of variance of NO_3-N values of deep samples revealed that the NO_3-N content decreased significantly with depth in rice and cotton farms. The average values of NO_3-N were 12, 5, and 4 ppm for the samples taken from cotton farms at 0-20, 20-40, and 40-60 cm, respectively. Those values were 6, 3, and 3 ppm for rice farms.

All the hods were similar in their NO_3-N values in both the cotton and rice areas. However, as shown above, the soil NO_3-N values in surface soils of fields to be planted to cotton were twice as much as those to be planted to rice. Nitrates are subject to leaching and denitrification. Therefore, field studies are required to determine the usefulness of nitrate soil test for the Nile Delta farmers. For an example of how nitrate soil test is used see Soltanpour, Ludwick and Reuss (1979).

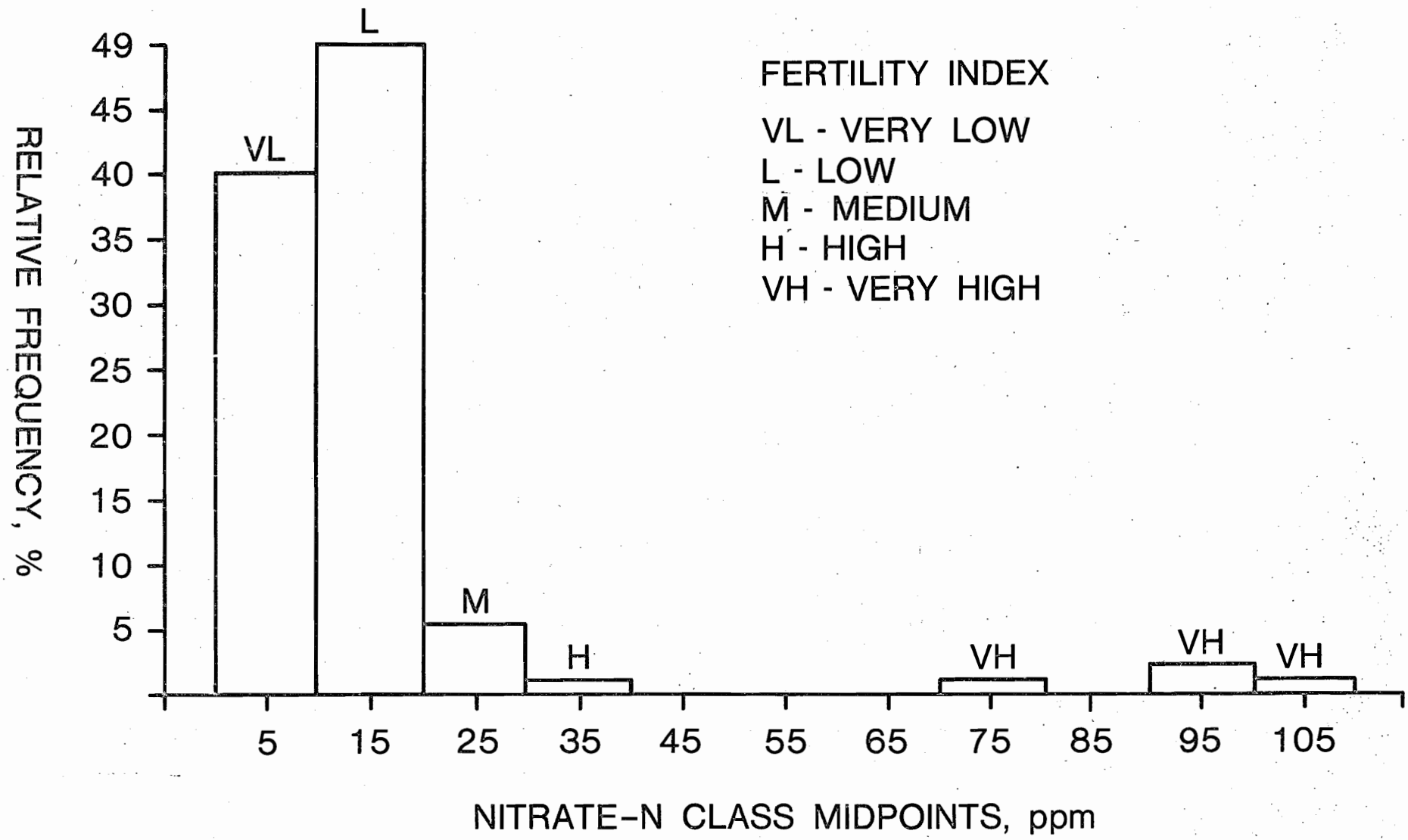

Fig. I-5 Frequency distribution of Nitrate-N values of Abu Raya cotton farms after a rice crop and a winter crop

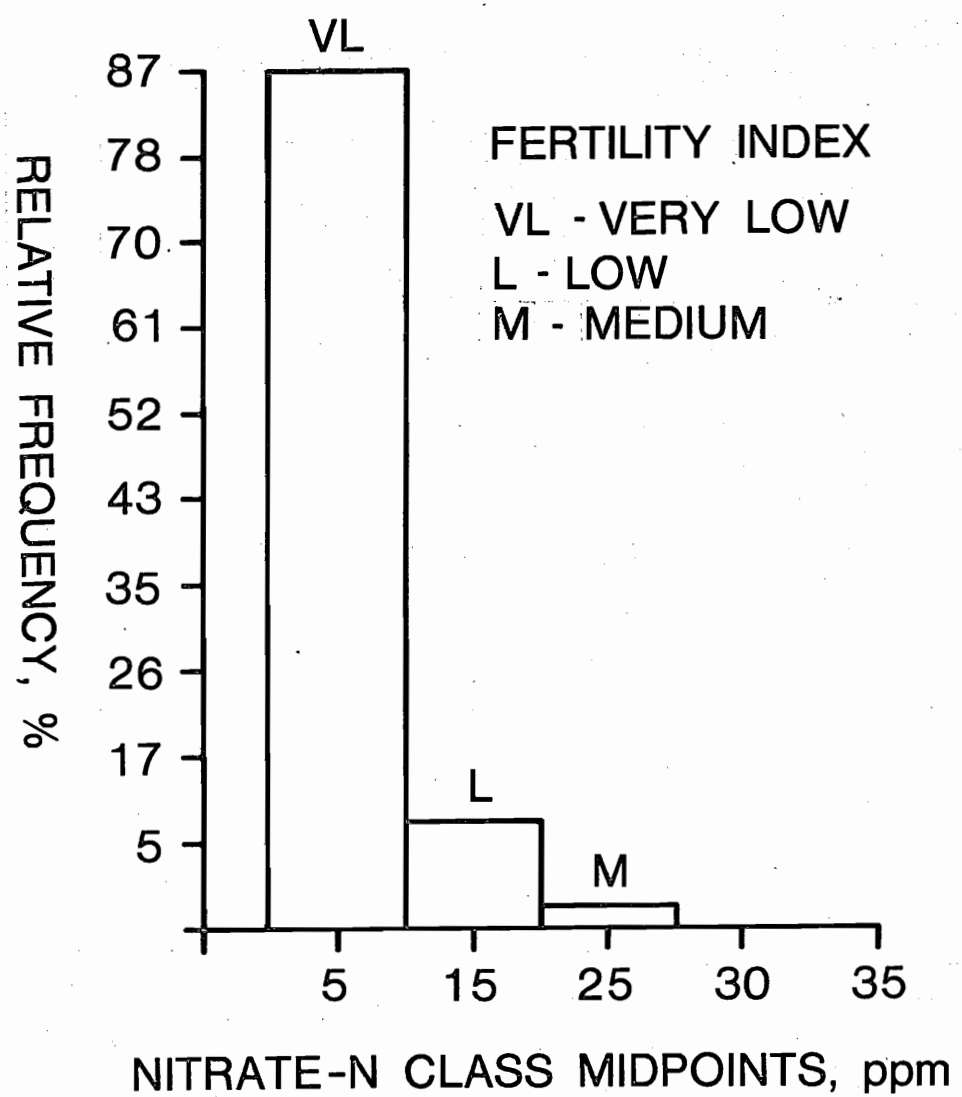

Fig. I-6 Frequency distribution of Nitrate-N values of Abu Raya rice farms after a cotton crop and a winter crop

Phosphorus

Analysis of surface soil samples showed that 27% of cotton farms tested very low and 54% tested low in phosphorus availability. For rice farms 58% of the farms tested low in phosphorus (Figs. I-7 and I-8). The average phosphorus fertility index values were 6.5 and 7.5 ppm for cotton and rice farms, respectively. The higher phosphorus level in rice farms after cotton may be due to higher fertilizer rate received by the summer and winter crops preceding rice.

A significant change in soil phosphorus content with depth was observed in cotton farms with mean values of 5.3, 5.1, and 8.5 ppm for the 0-20, 20-40 and 40-60 cm depths. For rice farms, phosphorus values were 7.9, 6.4 and 7.2 ppm for above depths, respectively (Figs. IV-4).

Considering the average phosphorus fertility of soil profile, it is likely that cotton response to phosphorus fertilization will be moderate unless the root depth is limited to the surface soil. Response of rice to phosphorus is less likely due to an increase in phosphorus availability by flooding. Field experiments should be carried out to relate soil profile phosphorus fertility to crop response to phosphorus fertilizers.

Orabi et al. (1982) found corn response to phosphorus at El-Nuberia Research Station where soil test level for $NaHCO_3$-P was 9.2 ppm.

The coefficient of variabilities for phosphorus values were higher for deep samples compared to the surface samples. This observation is contrary to the common belief that surface soil fertility is more heterogeneous than subsoil fertility. The high clay content of the Abu Raya soils and cracking of these soils and subsequent falling of fertilized surface soil to the subsoil layers through these cracks may be responsible for the heterogeneity of subsoil and its high P level.

A significant difference was obtained between the phosphorus content of different hôds for cotton or rice areas (Table I-4). The farms within the same hôd were statistically similar in their soil P-levels.

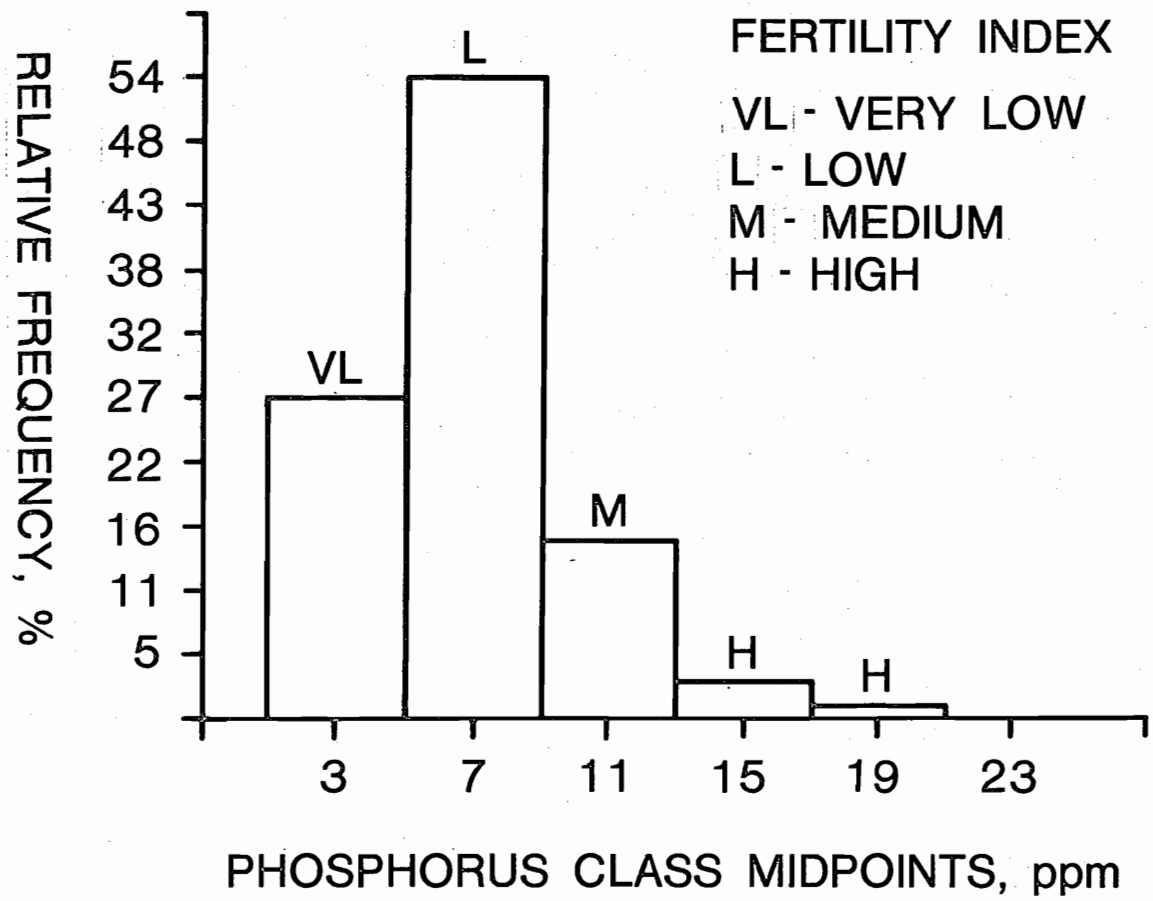

Fig. I-7 Frequency distribution of phosphorus values of Abu Raya cotton farms after a rice crop and a winter crop

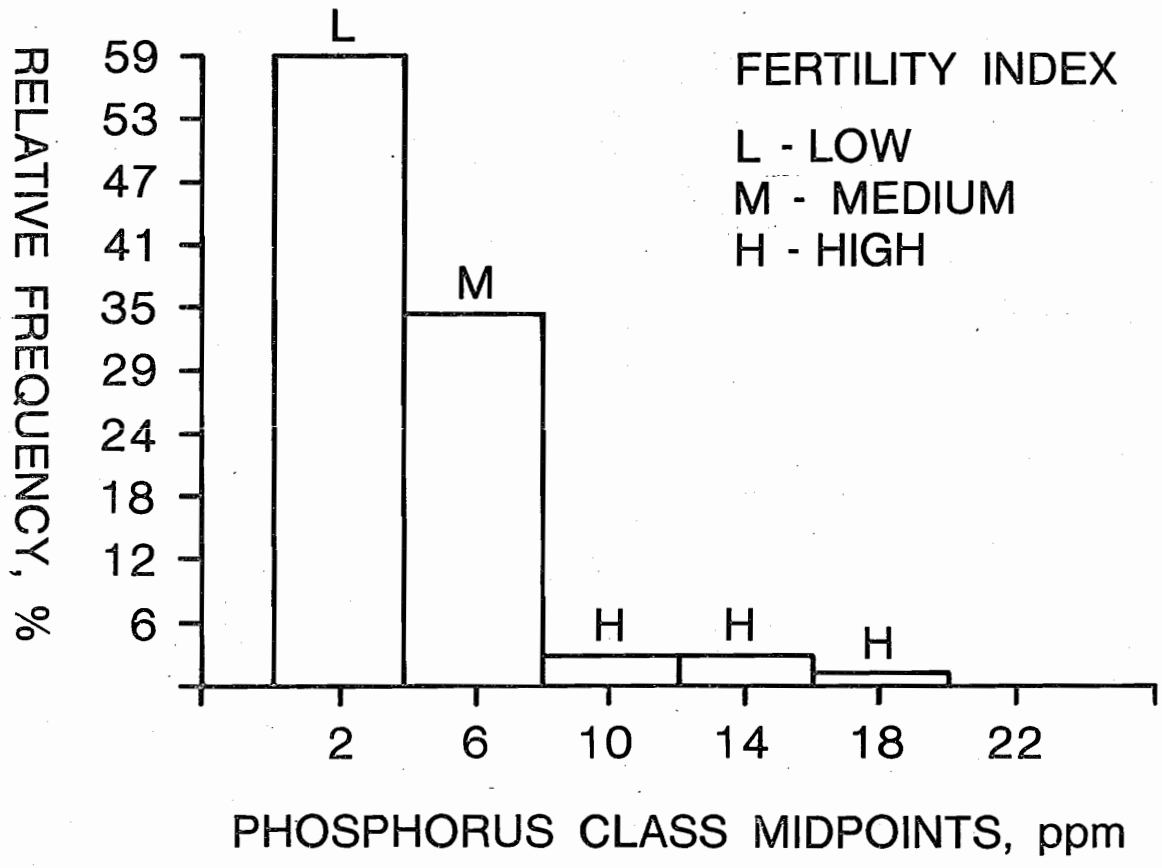

Fig. I-8 Frequency distribution of phosphorus values of Abu Raya rice farms after a cotton crop and a winter crop

Table I-4. The mean phosphorus values of the surface samples (cotton and rice areas) of Abu Raya.

hôd	Phosphorus	
	Cotton areas	Rice
	----------ppm----------	
Matarine 1	5.9	8.0
Matarine 2	7.5	8.3
Bakir 1	7.3	6.4
Bakir 2	4.8	7.0
Mean	6.4	7.4
C.V.	19.4	14.0
F	1%	1%

Potassium

Soil survey report by Abdel-Wahed *et al.* (1980) shows that water soluble potassium levels in Abu Raya soils are very high. Considering that soils are of clay texture and there is an equilibrium between exchangeable and soluble potassium, one reaches the conclusion that potassium levels are generally adequate for crop production.

Zinc

It should be mentioned that micronutrient analysis was carried out for the samples taken from the cotton area only. The data (Fig. I-9) show that the zinc level ranged from 0.1 to about 3.0 ppm in surface soil samples. About 16% of the surface soil samples tested low in zinc availability, whereas, 61% of the soils tested medium in availability.

Table I-5. Mean zinc, iron, copper and manganese levels for deep samples of Abu Raya cotton farms.

	Zn	Cu	Fe	Mn
cm	----------ppm----------			
0-20	1.3	7.1	31.1	16.3
20-40	0.9	5.0	15.9	13.4
40-60	0.9	4.8	21.7	11.8

Moreover, most of the deep samples could be rated low to marginal in zinc availability averaging 0.9 ppm (Table I-5). Serry et al. (1974) showed that wheat response to zinc fertilization in alluvial soils of Egypt was modest but high in calcareous soils. Orabi et al. (1982) found large corn yield response to soil-applied zinc sulphate at El-Nuberia Research Station in the Nile Delta.

The data indicated that the farms within each hôd were similar in their Zn-content and the hôds had similar zinc values (Table I-6), although the differences between hôds were statistically significant.

Iron

The available iron level in soils of Abu Raya were adequate for field crops. The iron level decreased with depth (Table I-5). Coefficient of variability was about 33% for top soil samples and increased to 64% for 40-60 cm deep samples. The mean iron level for the three hôds tested were 13.8, 31.6 and 35.5 ppm (Table I-6). The iron was of significantly different levels for each hôd. The farms with each hôd were similar in their iron fertility.

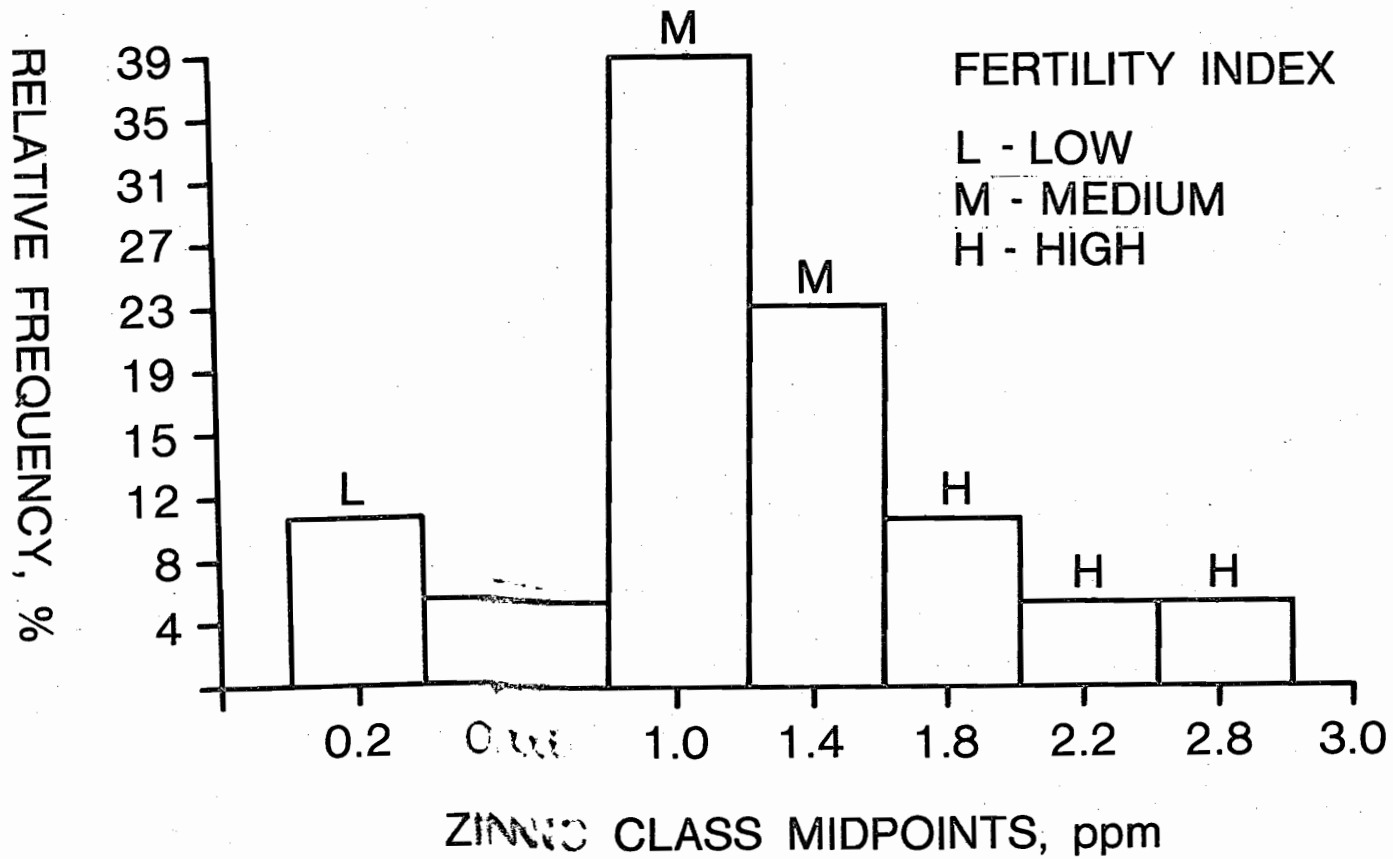

Fig. I-9 Frequency distribution of zinc values of Abu Raya cotton farms after a rice crop and winter crop

Copper

All the surface samples tested high in copper content (Table I-5). The Cu availability in the deep soil samples was somewhat lower compared to the surface samples (Table I-5). The coefficient of variability was 18, 40 and 60% for 0-20, 20-40 and 40-60 cm deep samples, respectively. Both the hôds and the farms within each hôd were statistically similar in their Cu availability.

Manganese

The manganese situation resembled that of Cu and Fe as all the surface and deep samples tested high in available manganese (Tables I-5 and I-6). The data also revealed that there was a significant decrease in manganese availability with depth.

The farms within each hôd were similar in their manganese content. The manganese levels were significantly different among the hôds.

Table I-6. The mean values of zinc, copper, iron, and manganese of surface samples of Abu Raya

hôd	Zn	Cu	Fe	Mn
		(in ppm)		
Matarine 1	1.6	7.4	18.6	14.1
Matarine 2	1.4	6.5	31.6	14.4
Bakir 1	1.6	6.3	35.5	18.6
Bakir 2	1.6	--	--	9.33
Mean	1.5	6.75	28.5	14.0
F test significance	1%	n.s.	1%	1%

Sampling Plan and Intensity

The results indicated that the farms located within each crop hôd were not significantly different in their soil fertility levels. However, the hôds in general had different salinity and fertility levels. Therefore, the sampling may be stratified at the hôd level.

Based on these results, one may sample each crop hôd separately for the evaluation of soil fertility and fertilizer recommendations. This sampling plan will make soil testing feasible for Egypt. If, for example, the U.S. model is used and each farmer samples his field separately, soil testing will become very expensive due to the small size of farms in Egypt.

It was found that nitrogen, phosphorus and zinc are deficient in some soils of Abu Raya cooperative. For evaluating the soil fertility with regard to the above nutrients, 30 farms per hôd may be sampled, the sampling depth may be 60 cm due to the heterogeneity of the subsoils. More studies are required to determine the appropriate sampling depth for mobile nutrients such as nitrates. The above sampling intensity results in a 95% confidence interval (CI) for the geometric mean of about ±14% for P, ±23% for Zn, and ±27% for NO_3-N based on error estimates of the surface soil samples obtained in cotton fields after rice harvest (Table I-7). The soil samples may be split into two 30 cm increments and each increment tested separately. Alternatively, the 60 cm deep cores may be analyzed as one sample. Soil sampling may be done before winter or summer crops.

The same sampling intensity will results in a 95% Cl of ±19% for EC measurements (Table I-7). The soil properties were more heterogeneous in cotton farms after a rice summer crop and a winter crop or a winter fallow than after a cotton summer crop and a winter crop. This may be due to flooding of soils during rice growth and subsequent draining of soils.

These sampling errors are similar to sampling error for nitrates in Colorado soils (Reuss, Soltanpour, and Ludwick, 1979). If lower errors are desired, then sampling intensity should be increased (Table I-7).

One unbiased strategy is to sample different farms in different years so that all farms are sampled once in each sampling cycle (number of years required to sample all farms in a hôd with a given intensity).

Table I-7. Number of cores to composite to get a 95% confidence interval (CI) expressed as % of geometric mean

	CI					
	91-110 %	87-115 %	83-120 %	80-125 %	77-130 %	74-135 %
Cotton area	Number of cores					
NO_3-N	212	98	58	38	28	21
P	66	30	18	12	8	6
Zn	161	75	44	29	21	16
Cu	21	9	5	3	2	2
Mn	13	6	3	2	1	1
Fe	76	35	20	14	10	7
EC	116	54	31	21	15	11
Rice area						
NO_3-N	139	65	38	25	18	14
P	54	25	14	9	7	5
EC	105	49	28	19	13	10

If one follows the above sampling plan and if farmers follow a uniform fertilizer recommendation, after a number of years sampling error may become smaller and better estimates of fertilizer requirements of different crops may be made.

SUMMARY AND CONCLUSIONS

Abu Raya cooperative in Kafr el-Sheikh governorate was selected as a site in the Nile Delta for the Egypt Water Use and Management Project (EWUP). One of the objectives of EWUP was to survey soil fertility status of its sites in order to determine nutrient needs of crops in small farms and the feasibility of providing soil testing services for small farmers.

The major portion of the soils of Abu Raya areas are classified as Vertisols (Torrerts suborder) and the remainder as Entisols (Fluvents suborder). Clay minerals in these soils are mainly montmorillonitic which upon drying, cause deep and wide cracks in the soil. These cracks increase the evaporation rate and affect irrigation practices.

Abu Raya farmers follow a two-year rotation in which the area is divided into two equal blocks. The first block is planted to temporary clover (berseem) in winter followed by cotton as the summer crop. The second block is divided into two parts - one for clover (and other legumes) and the other for wheat and flax grown in winter. Rice is usually the summer crop that follows the winter flax, cereals and legumes. This sequence is rotated in the two blocks in the second year and so on.

The farm size varies from 0.13 to 30 feddans with 69% of farms lying in 0.13 to 2.0 feddan range. The average farm size is 1.99 feddans.

In 1978 before planting summer crops, four hôds in Abu Raya cooperative were sampled. About 10% of farms within each hôd were randomly selected for sampling. Two samples per farm were obtained to allow determination of within farm variability. Subsoil samples (20-40 and 40-60 cm) were obtained from every fifth farm.

The distribution and variation of pH, electrical conductivity and fertility index values of soil samples will be discussed below. Soil salinity and fertility indices are interpreted in terms of moderately sensitive and sensitive crops, respectively. These interpretations will vary among crop species and varieties having different physiological characteristics.

The soil pH values ranged from 7.9 to 8.9. Most of these soils had pH values less than 8.5 which indicate lack of sodicity problems in non-saline soils.

About 45 and 29% of surface soils were saline in rice and cotton fields, respectively, at the time of sampling. It seems the salts are leached from the surface during flooding of rice in previous season. Salinity increased with depth. These results indicate that irrigation management practices should consider the removal of excess salts to keep soil salinity below detrimental levels for different crops.

About 42 and 87% of the surface soil samples taken from cotton and rice farms, respectively, contained less than 10 ppm nitrate-nitrogen. All subsoil samples had less than 10 ppm nitrate-nitrogen. The results indicate that nitrate testing may be of benefit to Egyptian farmers. Since nitrates are subject to leaching and denitrification, field studies are required to determine if nitrate soil test would be useful for Kafr el-Sheikh farmers.

Phosphorus availability was very low in 27% of sampled cotton farms following a rice summer crop and a winter crop. Phosphorus availability was low in about 56% of farms regardless of previous crop. Soil phosphorus level increased with depth for cotton farms following a rice summer crop and a winter crop.

Of micronutrients, zinc was the only one testing low. Available zinc was low in 16% and marginal in 61% of the soils tested.

In general, the analysis of variance results indicated that differences in soil fertility levels among farms in the same hôd were not significant. Therefore, the sampling may be stratified at the hôd level. This would facilitate soil sampling because about 69% of farms located in each hôd occupy the range of 0.13 to two feddans and sampling each farm separately would be expensive. The results indicated that nitrogen, phosphorus and zinc are deficient in some soils of Abu Raya cooperative. For evaluating the soil fertility and EC, 30 farms per hôd per summer crop may be sampled to a depth of 60 cm. The sampling may be done before planting summer crops. The above intensity results in a 95% confidence interval of about ±14% for P, ±23% for Zn, ±27% for NO_3-N and 18% for EC.

Sampling a different set of 30 farms at each sampling time will eventually lead to testing soils from all farms in a hôd. Such a plan in conjunction with a uniform fertilizer recommendation per hôd will result in increasingly better estimates of fertilizer requirements of crops.

Another point to be emphasized is the need for on-farm fertilizer experiments to better calibrate soil tests.

The present study has shown that nitrogen, phosphorus, and zinc are the nutrients most often deficient in Kafr el-Sheikh soils. These results are consistent with the findings of the Egyptian Ministry of Agriculture. Therefore, it is recommended that soils at the minimum be tested for nitrates, phosphorus, and zinc for fertility evaluation and for pH and electrical conductivity (EC) for evaluation of salinity status. Sodium adsorption ratio should be determined if pH of saturated paste is greater than 8.5 or if pH is less than 8.5 and EC of saturation extract is greater than 4 mmhos/cm. Gypsum requirement should be determined if SAR is greater than 12.

Part II - Soil Fertility Survey for Beni Magdul

and El-Hammami, Mansuriya

SOIL FERTILITY SURVEY OF BENI MAGDUL AND EL HAMMAMI, MANSURIYA

BACKGROUND INFORMATION

Mansuriya is one of the areas selected for conducting the water use and management studies. It lies in the Giza governorate about 10 km west of Cairo. Two sites were selected within this area, namely, Beni-Magdul and El-Hammami. These two sites are served by Beni Magdul, and El-Hammami main canals, respectively. Both of these canals get their water from Mansuriya canal. Soil fertility survey was carried out in this area with the following objectives:

1. To obtain information on the available nutrient levels and their variability in the soils of EWUP sites.
2. To determine the feasibility of providing soil testing services for Egyptian farmers.

Soil Classification

Beni-Magdul site

The Beni Magdul soils are classified into three series (Dotzenko, et al., 1979). The series #1 occupies the largest portion of Beni Magdul sites where the clay content generally ranges from 40 to 60%, but occasionally with higher levels. The clay content in the topsoil of profiltes adjacent to Mansuriya canal is less than 40% because of the effect of the wind-blown sand from the Western desert.

The series #2 occupies the area located west of Beni Magdul village between the canal and the drain, where the clay fraction is less than 30% and sand is the dominant fraction. Series #3 occupies a small area in the corner between the Nahia drain and Mansuriya canal, where the soil has a sandy texture except for the top-soil which can be either a loamy sand or sandy clay.

El-Hammami Site

The Soil Survey Report (Dotzenko, et al., 1979) indicated that the soil profiles of the entire area are quite uniform, of recent age and were formed from aeolean sand deposits blown from the near western desert. The soil texture generally is sandy throughout the profile. The topsoil in many cases is a loamy sand to depths of up to 30 cm because of the addition of the suspended matter from previous Nile floods.

Cropping System

Unlike Kafr-el Sheikh and El-Minya, no fixed rotation is followed. Farmers decide by themselves which crop they are going to cultivate. Berseem is the number one winter crop in total acreage. Berseem constitutes the main livestock feed in winter. The winter crops in this area are berseem, wheat and vegetables in rotation with maize and vegetables as summer crops. Vegetables are more extensively grown in El-Hammami than Beni Magdul. Intercropping is a common practice. Some intercrop combinations include: squash with tomatoes, tomatoes with wheat, and hot peppers with green beans.

Farm-Size Distribution

The farm in this report is defined as contiguous fields cultivated by one household. The total acreage of Beni Magdul area is 680 feddans divided into 730 farms with a mean farm size of 0.93 feddan. The total acreage of El-Hammami area is 966 feddans divided into 602 farms with a mean farm size of 1.60 feddan. Most farms (42%) are 0.5 feddan and less in area (Table 1). The next most common size is between 0.5 and 1 feddan. This extreme land fragmentation makes soil sampling and soil testing of individual farms expensive.

TableII-1.The relative frequency of farm size in Beni Magdul and El-Hammami areas

Class	Beni Magdoul	El Hammami
Feddan	%	%
0.01-0.50	41	42
0.50-1.00	28	23
1.00-1.50	13	13
1.50-2.00	7	6
2.00-4.00	7	9
4.00-10.00	4	4
10.00-42.50	0	3
Mean	0.93 Fed.	1.60 Fed.

MATERIALS AND METHODS

Field Procedures

Five sites per every reach (first, middle and last) of the lined Beni Magdul canal were selected (see map 2, Appendix I). Sites were situated on both sides of the canal. Each site was selected to represent the studied area considering the cropping patterns, farm size, and soil texture. From 5 to 10 farms per site were sampled in January 1978. In total, 101 farms were sampled which amounted to 14% of all farms in this area. Two cores per farm were obtained to a depth of 20 cms in each site. Every fifth farm was sampled in 20-cm increments to a depth of 60 cm.

Ten sites each 10 feddans in area were selected to represent El-Hammami area. From 11 to 24 random farms per site were sampled in February, 1978, which amounted to about 15% of all farms. Two cores per farm were obtained at a depth of 20 cm in each site. Every fifth farm was sampled in 0-20, 20-40, and 40-60 cm depths.

Laboratory Procedures and Statistical Methods

These were the same as those for Abu Raya, Kafr-el-Sheikh.

RESULTS AND DISCUSSIONS

Because of the distinct difference in soil texture between Beni Magdul and El-Hammami areas, the results of the soil fertility survey of these two areas are discussed separately.

The distributions of pH, conductivity and fertility index values were tested for normality. All distributions except the one for pH deviated from normality. A logarithmic transformation made these distributions closer to a normal distribution.

Beni Magdul site

pH

The pH values, in case of the surface samples, ranged from 7.3 to 9.1 (Fig. II-1). Noticeably, 30% of the surface samples were of pH values of 8.5 or higher. This percentage increased with depth and amounted to 84% for both 20-40 and 40-60 cm layers. However, the mean pH varied little with depth (see Fig. IV-1). The high pH values may be indicative of high exchangeable sodium levels in the profile. Unfortunately, SAR values were not determined.

The soil pH values in Beni-Magdul Canal reaches varied little. The pH values of sites within every reach varied little and there existed no significant difference between the farms located within each site.

Soil Conductivity Values

The results show that there was no significant difference between conductivity values of samples taken from different depths (see Fig. IV-2). The mean conductivity values varied from 0.4 to 0.5 for all depths.

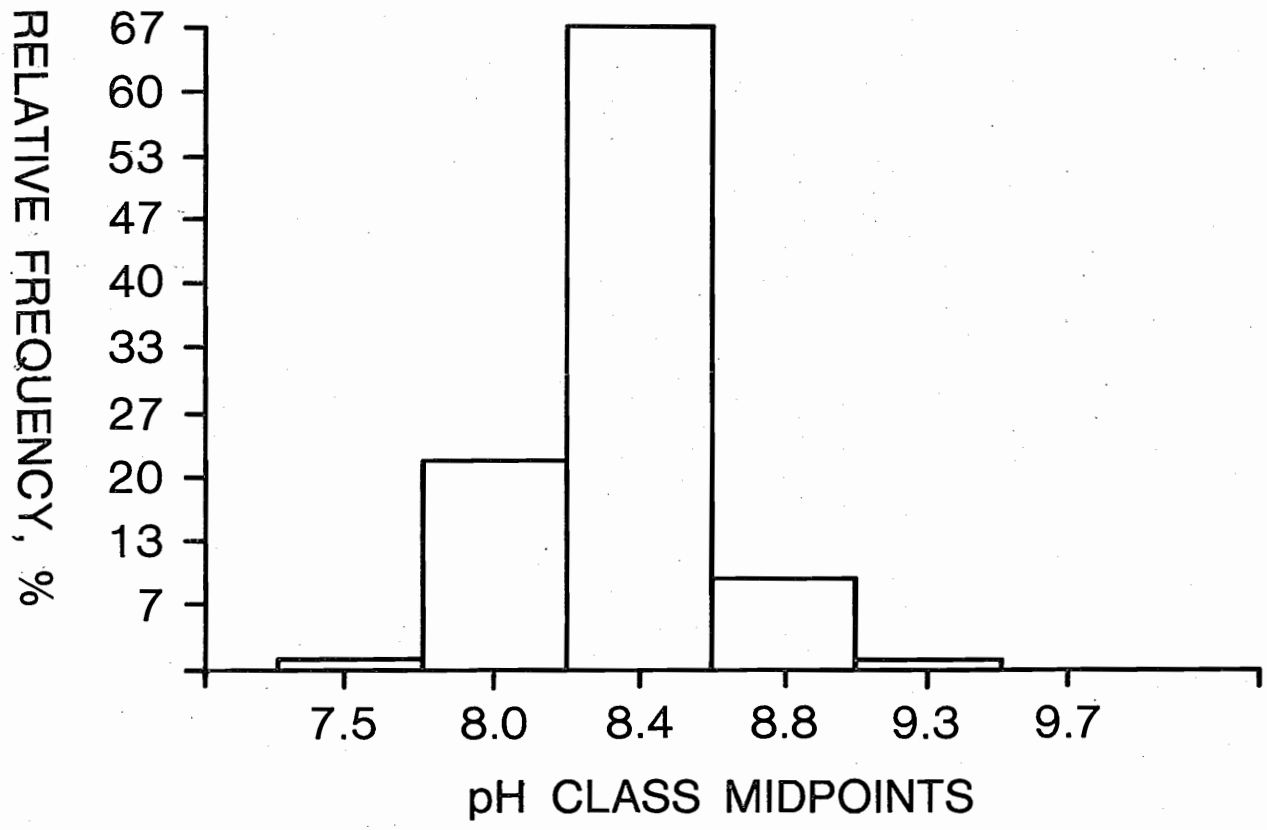

Fig. II-1 Frequency distribution of pH values of Beni Magdul farms

Assuming a saturation percentage of 62.5 (Dotzenko, et al., 1979), one should multiply the EC values by 8 to get an approximate value of saturation extract EC. The results (Fig II-2) indicate that 77% of surface soil samples were non-saline. About 10% of samples were moderate, 4% were high, and 9% were very high in soluble salt content. Dotzenko, et al., results show that 75% of samples were non-saline. The coefficient of variability for conductivity values was higher for surface than subsoil samples.

A highly significant difference existed between the conductivity values of the three reaches and also between the sites located in every reach. At the same time, there was no significant difference between the farms within each site. The mean conductivity value for the entire area was 0.35 mmhos/cm, which is relatively low.

Table II-2. The mean conductivity values of Beni Magdul Canal reaches and sites.*

Reaches/sites	(1)	(2)	(3)	(4)	(5)	Mean
			mmhos/cm			
First reach	0.40	0.34	0.42	0.93	0.60	0.54
Second reach	0.26	0.20	0.25	0.22	0.20	0.22
Last reach	0.65	0.25	0.28	0.29	0.36	0.38

* The F tests for reaches and sites were significant at the 1% level.

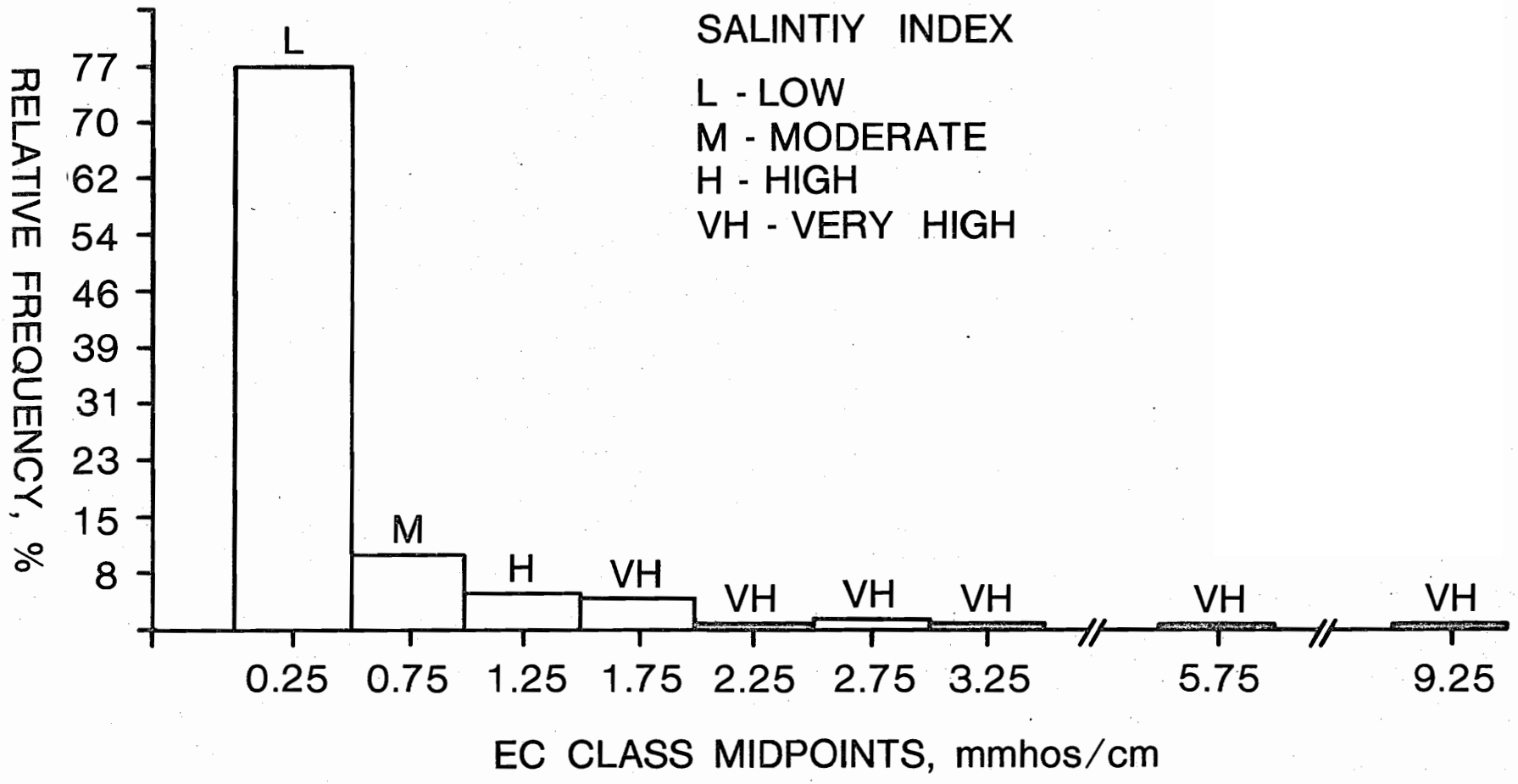

Fig. II-2 Frequency distribution of EC values of Beni Magdul farms

Nitrates

About 70% of the surface soil samples contained less than 10ppm NO_3-N while 22% of samples had values between 10 and 20 ppm. About 8% of samples tested more than 20 ppm in NO_3-N (Fig. II-3). There was no significant difference between mean NO_3 values in surface and subsoil samples.

The data indicate that there was no significant difference between the reaches along the Beni Magdul canal where the mean NO_3-N values were 5, 7, and 6 ppm for the first, middle and last reaches, respectively. Also, there was no significant difference between the NO_3-N values of the sites located in every reach and of farms located in every site.

Nitrates are subject to leaching and denitrification. Therefore, field studies are required to determine the usefulness of nitrate soil test for Beni Magdul farmers.

Phosphorus

There was a significant decrease in the soil P content with depth (see Fiv. IV-4). The mean P contents were 20.0, 9.4 and 8.9 ppm for the 0-20, 20-40, and 40-60 cm depths, respectively.

About 15% of the surface samples tested very low and 27% low in their P content (Fig. II-4). If root depth is limited to the surface soil, then probability of crop yield response to fertilizer P will be large in soils with low P levels in surface layer.

The analysis of variance showed no significant difference between the phosphorus level of different canal reaches but the site differences were significant (Table II-3). The soil P level in farms within every site were not different statistically.

Potassium

The high amounts of available potassium found in these soils indicated that availability of K is not limiting crop production in this area. Due to high clay content and the existence of K-bearing minerals in soils of this area, the mean K values were 576, 397, and 392 ppm for the 0-20, 20-40 and 40-60 cms, respectively. The potassium values significantly decreased with depth.

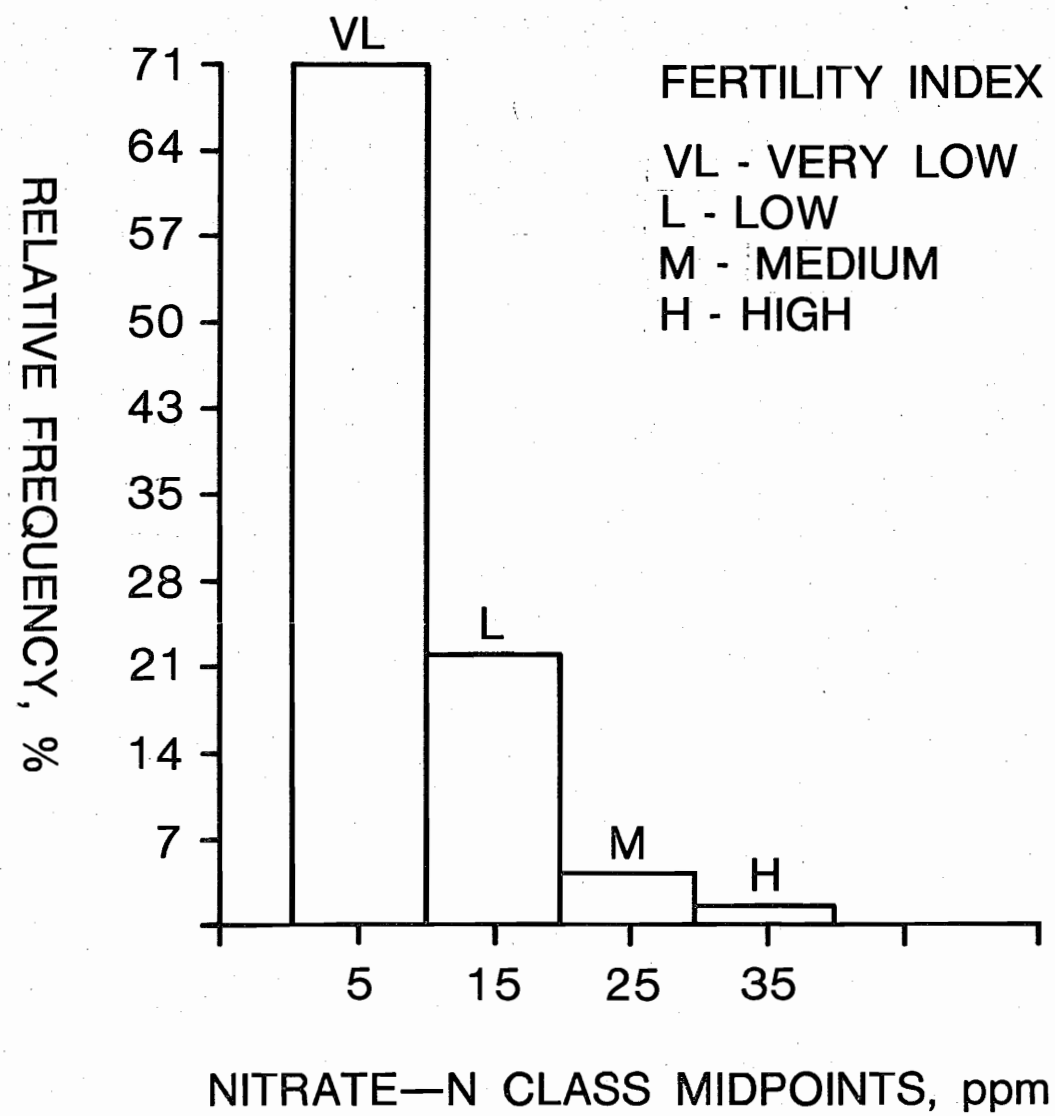

Fig. II-3 Frequency distribution of Nitrate-N values of Beni Magdul farms

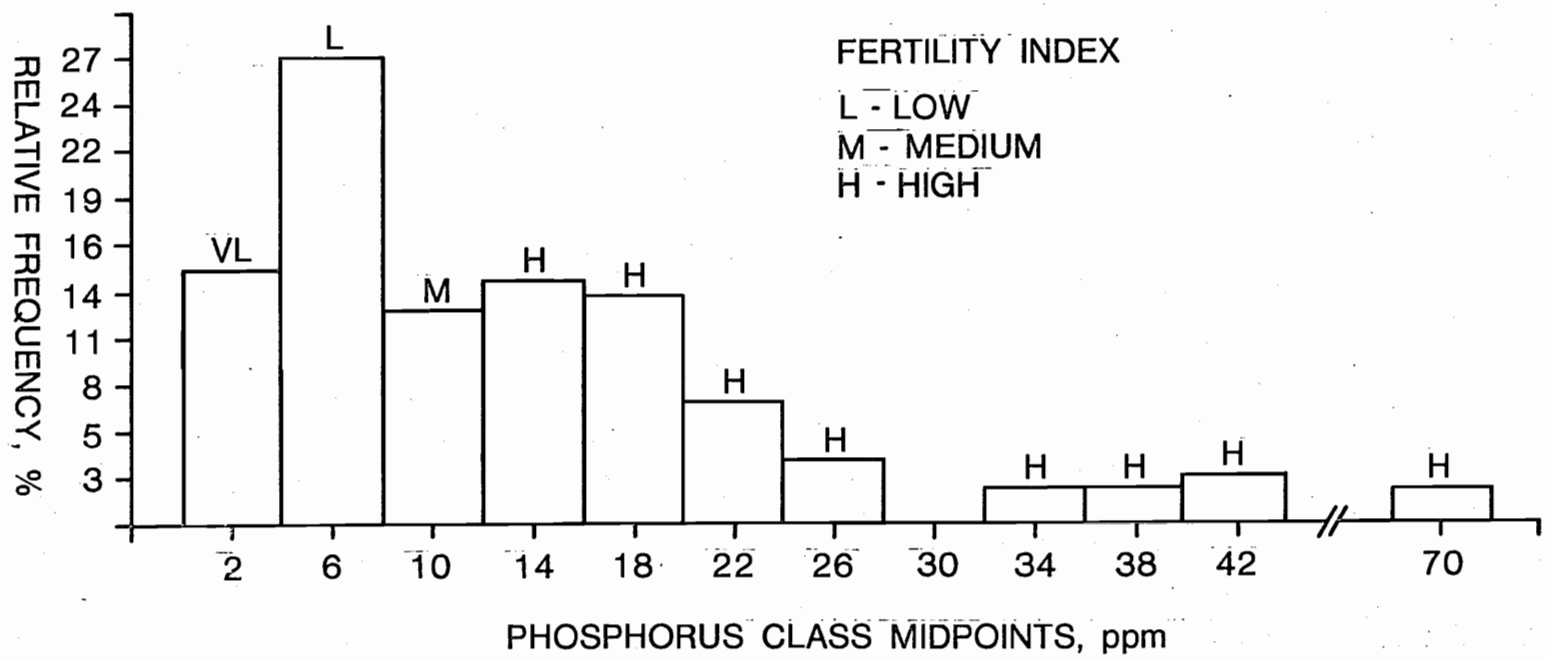

Fig. II-4 Frequency distribution of phosphorus values of Beni Magdul farms

Table II-3. The mean phosphorus values of Beni Magdul Canal reaches and sites*

Reaches/sites	(1)	(2)	(3)	(4)	(5)	Mean
			PPM			
First reach	10.5	9.6	10.2	11.0	9.3	10.2
Middle reach	8.3	7.1	10.1	10.7	10.1	9.4
Last reach	3.2	3.5	7.0	12.0	14.1	7.8

* The F test for sites was significant at the 1% level.

The reaches varied significantly in their soil potassium levels (Table II-4). The highest values of the available potassium existed in the last reach which is probably due to the higher clay content of this reach. Also, the sites within every reach varied in their soil K level. However, no significant differences existed between the farms in each site.

Table II-4. The mean potassium values of Beni Magdul Canal reaches and sites*

Reaches/sites	(1)	(2)	(3)	(4)	(5)	Mean
			PPM			
First reach	550	468	513	646	617	550
Middle reach	468	417	575	447	550	490
Last reach	631	550	602	631	575	603

* The F testes for reaches and sites were significant at the 10% and 1% levels respectively.

Zinc

The available zinc was determined in 41 soil samples. The mean value of available zinc amounted to 2.6 ppm which could be considered adequate for crop production. The data show that 18% of the analyzed samples tested low to marginal in Zn, whereas, the rest of them contained more than 1.5 ppm Zn (Fig. II 5).

The statistical analysis revealed that the canal reaches were similar in their Zn availability (Table II-5). The sites within every reach differed significantly in their Zn values, whereas no difference existed between farms located in each site.

Table II-5. The mean zinc values of Beni Magdul canal reaches and sites*

Reaches/sites	(1)	(2)	(3)	(4)	(5)	Mean
			PPM			
First reach	3.2	2.0	2.0	2.6	2.3	2.4
Middle reach	1.9	2.9	2.4	1.8	1.9	2.2
Last reach	2.5	1.8	3.8	0.8	2.9	2.3

* The F test for sites was significant at the 1% level.

Iron

The available iron was determined in 55 soil samples. Frequency distribution is shown in Fig. II 6. Only 2% of samples (1 out of 55) tested low in Fe and 10% tested marginal. The mean index of Fe availability was 7.5 ppm and all values ranged from 2.8 to 17.0 ppm.

The mean soil Fe level was high but less than that of the heavy textured soils in Karf El Sheikh location. The reaches did not differ significantly in their iron availability (Table II-6). Significant differences existed between the sites located in every reach. On the other hand, no significant difference was found between farms selected within every site.

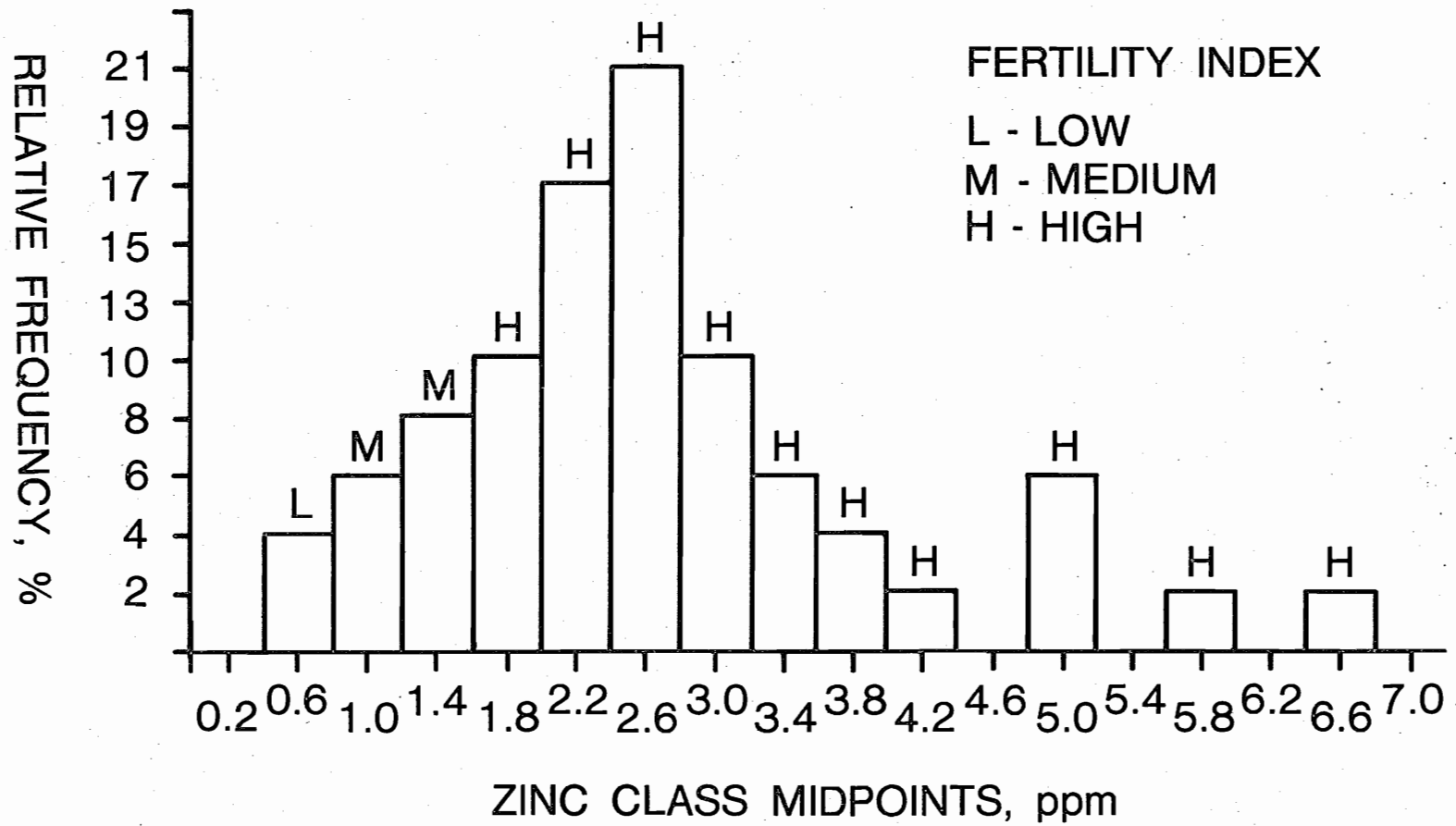

Fig. II-5 Frequency distribution of zinc values of Beni Magdul farms

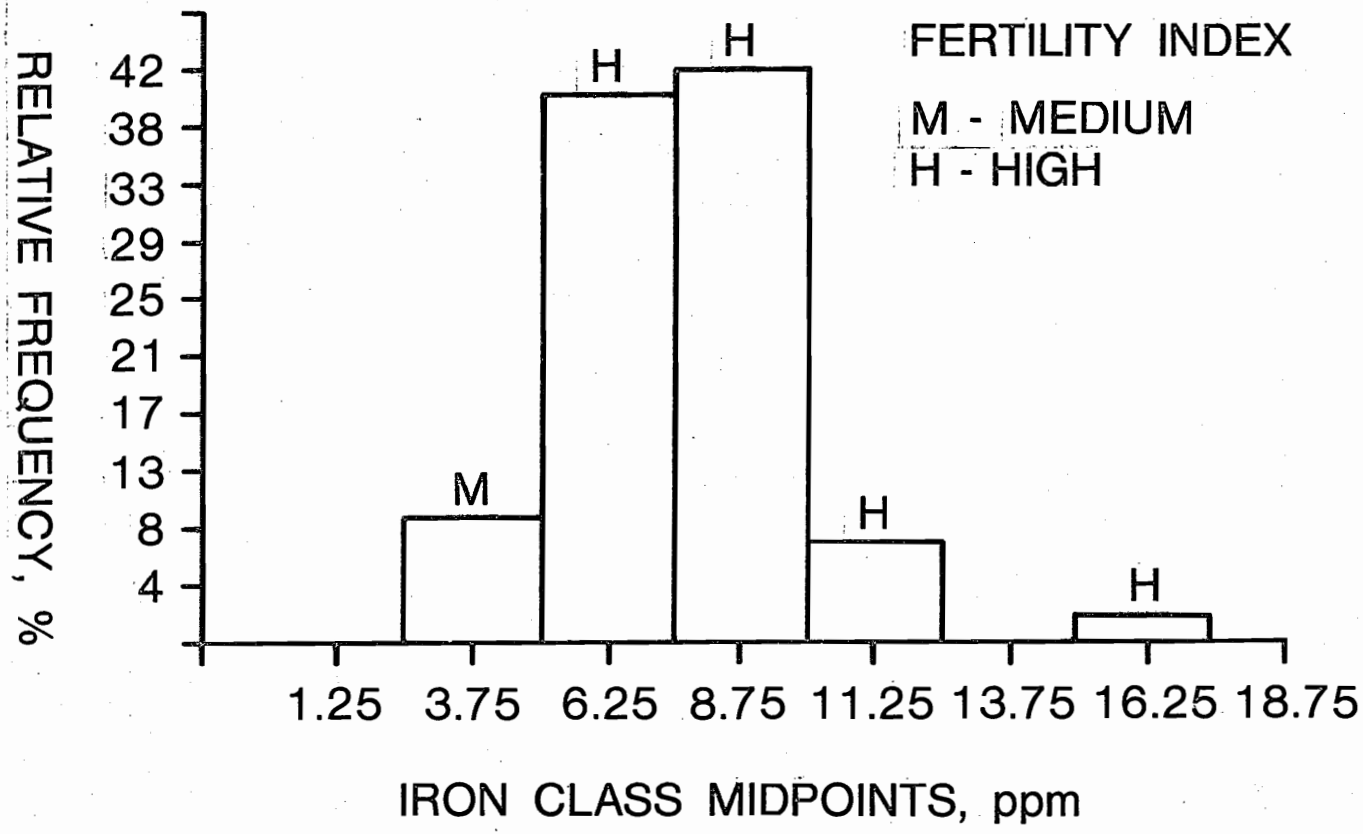

Fig. II-6 Frequency distribution of iron values of Beni Magdul farms

Table II-6. The mean iron values of Beni Magdul canal reaches and sites*

Reach/site	(1)	(2)	(3)	(4)	(5)	Mean
			PPM			
First reach	7.9	6.3	9.3	5.2	4.6	6.5
Middle reach	6.5	9.8	9.1	8.3	6.6	7.9
Last reach	5.8	5.8	6.5	7.2	8.1	6.6

Organic matter

The organic matter content of this area showed a wide range. The lowest value was about 0.3 and the highest value was 3.8%.

About 32% of the samples contained less than 2% organic matter. Only 10% of the samples had a value of more than 3.0 up to 3.8% (Table II-7).

El-Hammami area

The soils in this area are generally sandy in texture throughout the profile. The topsoils, in many cases, are of a loamy sand texture to 30 cm depth. The distributions of pH, conductivity and K values were tested for normality. The conductivity and potassium distributions deviated from a normal one while pH distribution approximated that of a normal one. A logarithmic transformation made the conductivity and potassium distributions closer to a normal one. The results of soil analysis are discussed below:

pH

The obtained data revealed that pH values increased significantly with depth (see Fig. IV-1). The means of pH values were 8.8, 9.0 and 9.0 for the 0-20, 20-40, 40-60 cm depths, respectively. Most of the soil samples were of pH values exceeding 8.5. A small number of samples reached a pH value of about 10.0 (Fig. II-7).

Table II-7. Percent frequency distribution of organic matter in soils of Beni Magdul*

% Class	% Relative Frequency
0.3-1.0	5
1.0-1.6	10
1.6-2.0	17
2.0-2.6	42
2.6-3.0	16
3.0-3.8	10

* Mean = 2.2%

The analysis of variance revealed that the ten selected sites of El-Hammami pilot area differed significantly in their pH. On the other hand, no significant difference existed between farms surveyed within each site (Table II-8).

The pH values may indicate prevalence of high sodium levels in soils. Unfortunately, SAR values for a better evaluation of sodium problem, were not determined. The results of Dotzenko, et al. show that 15% fo samples had SAR values of more than 15.

Soil Conductivity

Conductivity measurements were made in 1:5 soil:water extracts. Assuming a saturation percentage of 25% one should multiply these values by 20 to get the equivalent EC values for saturation extracts.

About 65% of the surface samples were non-saline, whereas 10% of them could be considered as strongly saline and 25% as moderately saline (Fig. II-8). The different depths were similar in their conductivity values and their distribution (see Fig. IV-2).

The analysis of variance revealed that the ten selected sites differed significantly in their conductivity values, whereas no significant difference occurred between farms within each site (Table II-8).

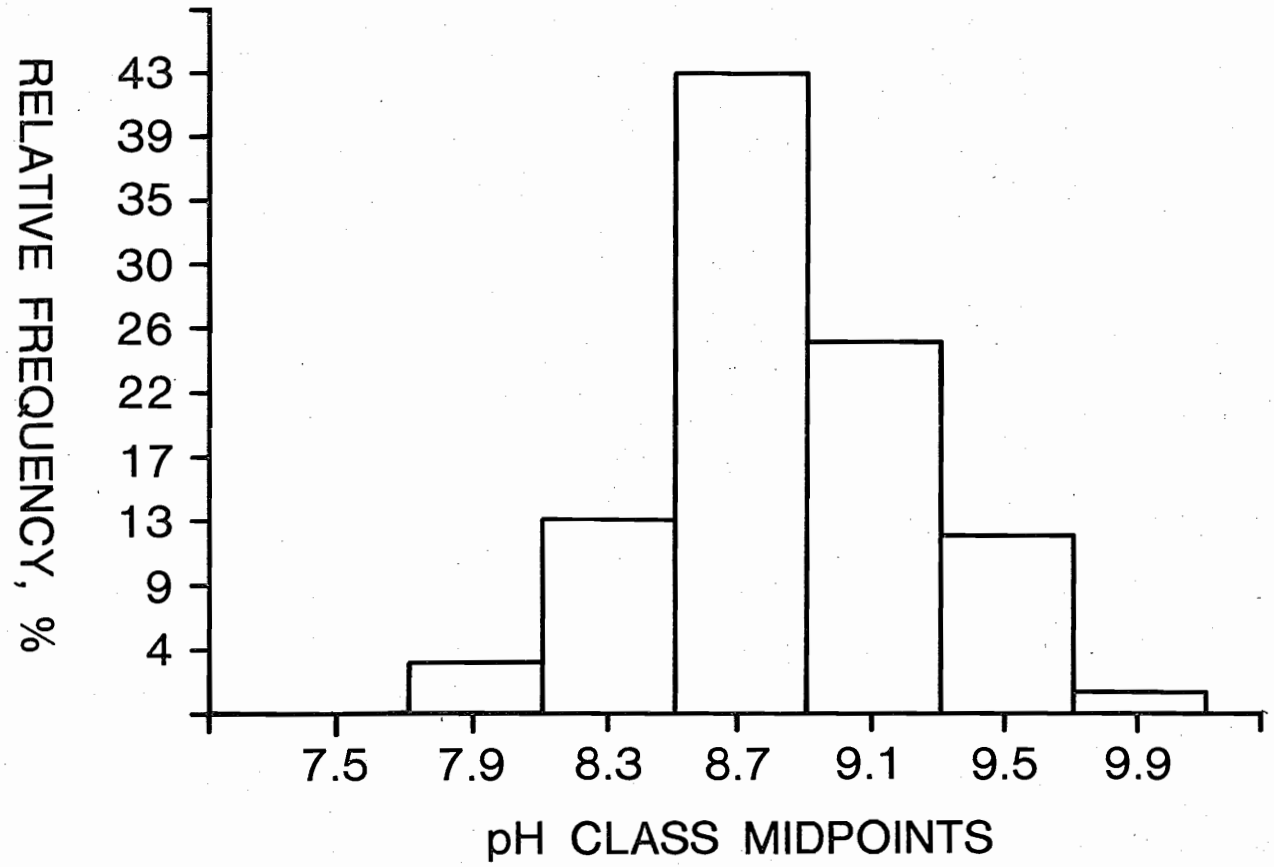

Fig. II-7 Frequency distribution of pH values of El-Hammami farms

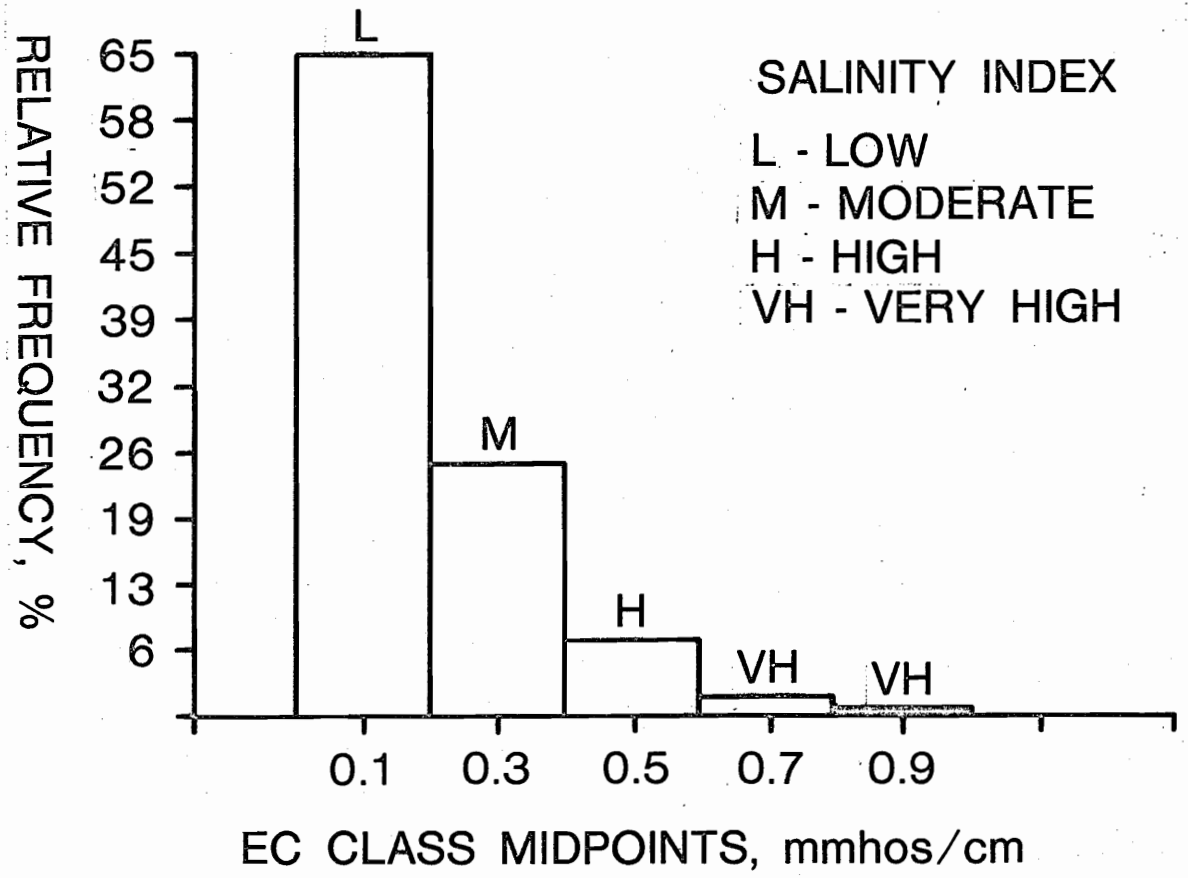

Fig. II-8 Frequency distribution of EC (1:5) values of El-Hammami farms

Table II-8. The mean values of pH, conductivity, and potassium of El-Hammami

Site	pH	Conductivity values	K
		mmhos/cm	ppm
1	8.71	0.15	208
2	8.81	0.15	306
3	8.61	0.15	226
4	8.91	0.14	296
5	8.61	0.13	296
6	8.71	0.25*	659
7	9.41	0.44*	617
8	9.11	0.21	453
9	9.01	0.17	948
10	9.01	0.71*	540
Mean	8.81	0.17	352
C.V.,%	2	19	6
F test significant for sites	1%	1%	1%

* Saline sites

Potassium

The mean values of exchangeable K were 405, 392, and 348 for the 0-20, 20-40 and 40-60 cm depths, respectively.

Only three surface soil samples tested 80, 80 and 100 ppm in available K. It seems even in these sandy soils of low CEC, potassium level is sufficiently high for crop production probably due to presence of K bearing minerals and their weathering. Based on the data, no response to potassium fertilizers is expected in almost all soils and even for crops requiring high levels of potassium.

The analysis of variance indicated that the ten selected sites in El-Hammami varied significantly in their potassium values, whereas no significant difference existed between farms within each site.

Nitrates

Nitrate levels in soil decreased significantly with depth. The NO_3-N values were 24, 10 and 6 ppm in 0-20, 20-40, and 40-60 cm depths, respectively (see Fig. IV-3).

About 46% of the surface samples had NO_3-N values of 10 ppm or less (Fig. II-9). This percentage increased considerably with depth, whereas, 69% and 88% of the 20-40 and 40-60 cm had NO_3-N values of 10 ppm or less. About 20% and 14% samples had values between 10-20, and 20-30 ppm, respectively. About 17% of samples had very high levels of NO_3-N. Considering the wide variation in nitrate levels in these soils, it is important to do research on the effect of soil nitrate levels on crop nitrogen requirements.

Phosphorus

The soil phosphorus level decreased significantly with depth (see Fiv. IV-4). The mean phosphorus values were 18.2, 15.3, and 12.6 ppm for the 0-20, 20-40 cm depths, respectively.

The distribution of available phosphorus (Fig. II-10) indicated that 46% of the surface samples tested low in their available P levels. Probability of response to phosphorus depends on crop species. Also, subsoil P levels should be considered when making recommendations.

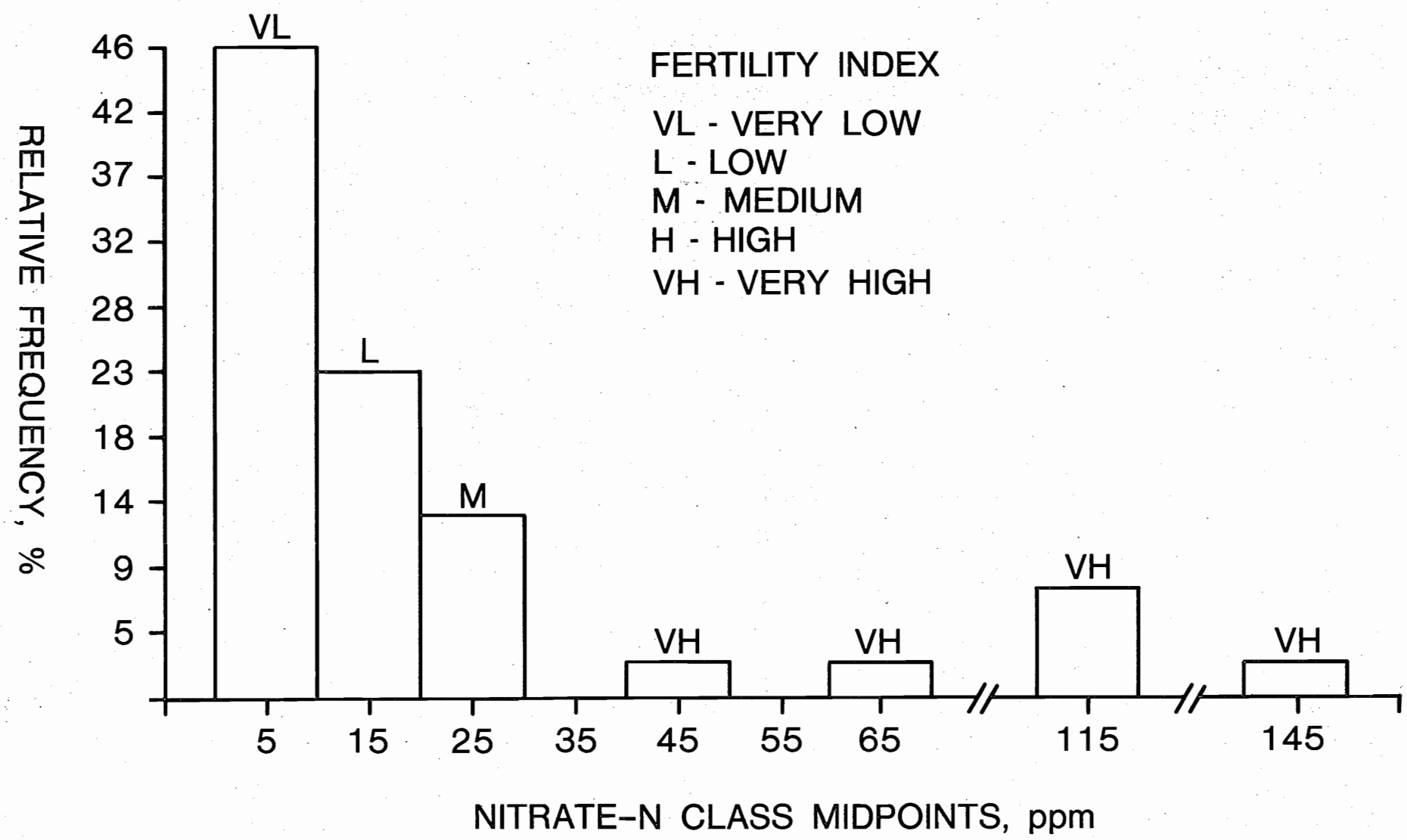

Fig. II-9 Frequency distribution of Nitrate-N values of El-Hammami farms

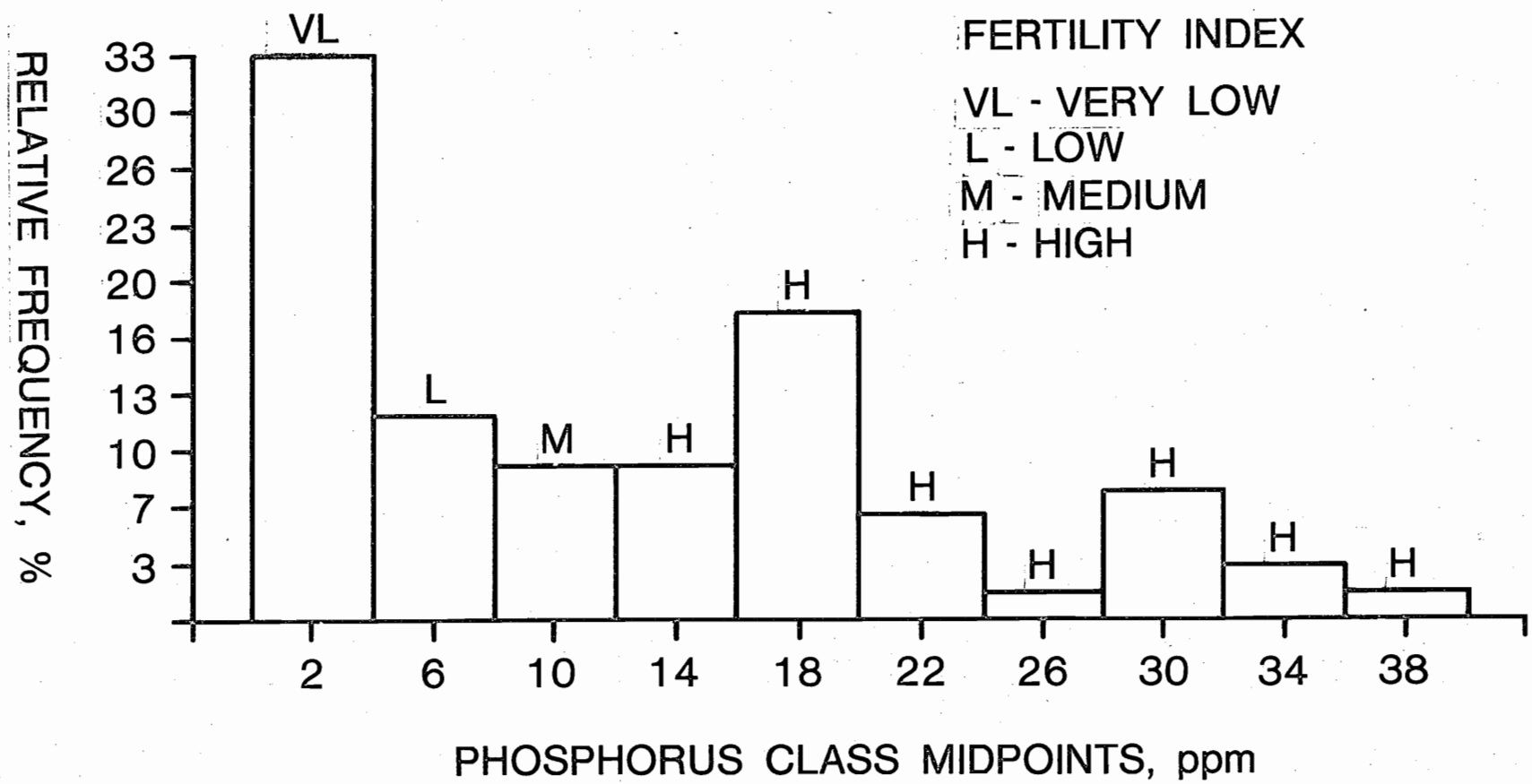

Fig. II-10 Frequency distribution of phosphorus values of El-Hammami farms

Table II-9. Percent frequency distribution of organic matter in soils of El-Hammami*

% Class	% Relative Frequency
0.1-0.5	32
0.5-1.0	56
1.0-1.5	6
1.5-2.1	6

* Mean - 0.7%

Zinc

Zinc could be considered as a limiting nutrient for crop production in El-Hammami site, where 52% of the 33 surface samples tested low to marginal in zinc availability (Fig. II-11). The results indicate the importance of zinc fertilization of zinc sensitive crops.

Iron

The lowest values of available iron existed in El-Hammami site where 53% of the surface samples (35 samples) tested marginal in iron availability (Fig. II-12). The highest iron level was 8.2 ppm and the mean value was 4.6 ppm. Iron could be considered as a limiting nutrient in El-Hammami soils for sensitive crops.

Manganese and Copper

Manganese and copper levels were found in adequate supply in El-Hammami site. The mean for Mn and Cu were 4.6 and 1.2 ppm, respectively (Table IV-2).

Organic matter content

This area could be considered the lowest in its organic matter content compared to other studied locations. About 86% of the samples were of 1.0% organic matter or less (Table II-9).

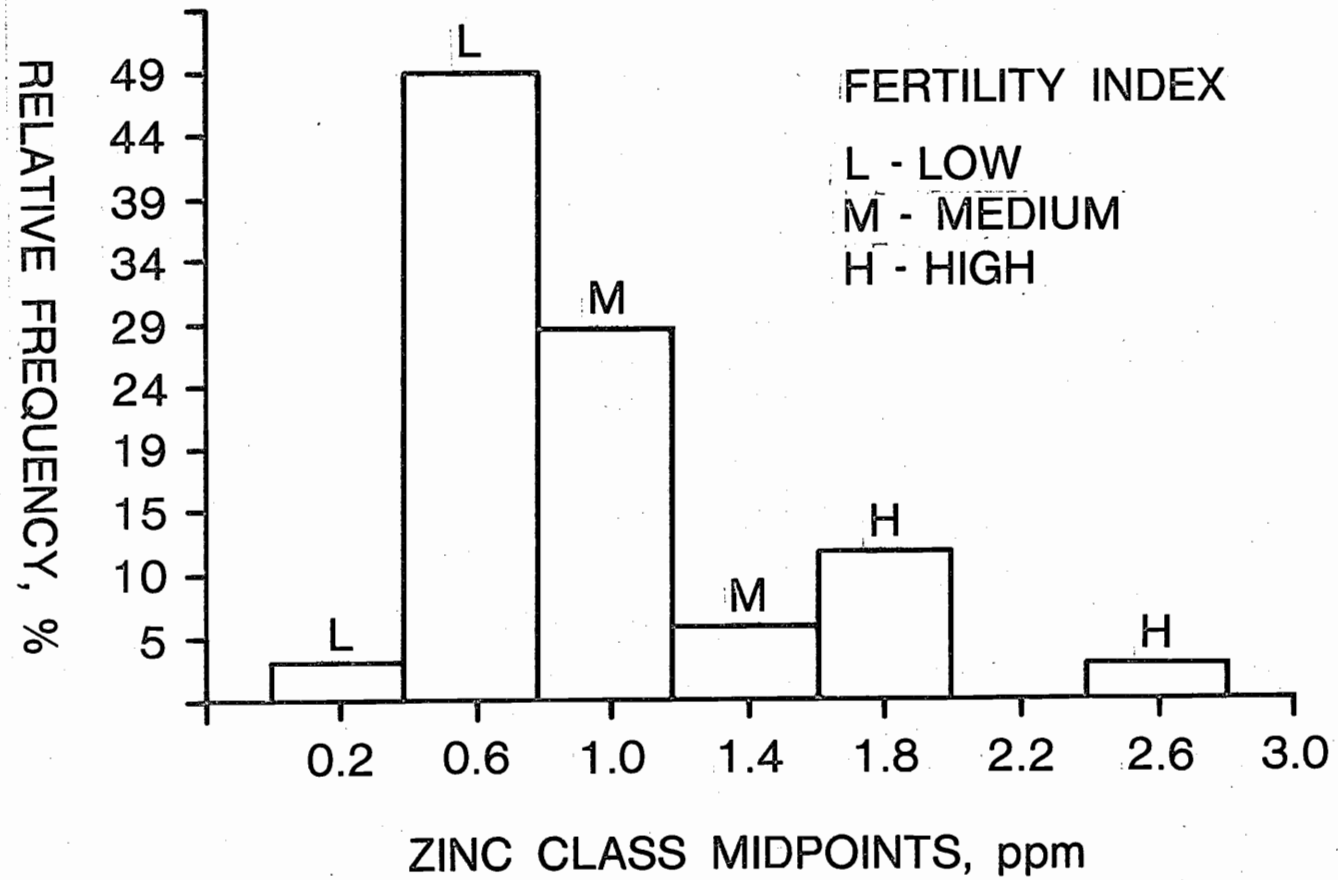

Fig. II-11 Frequency distribution of zinc values of El-Hammami farms

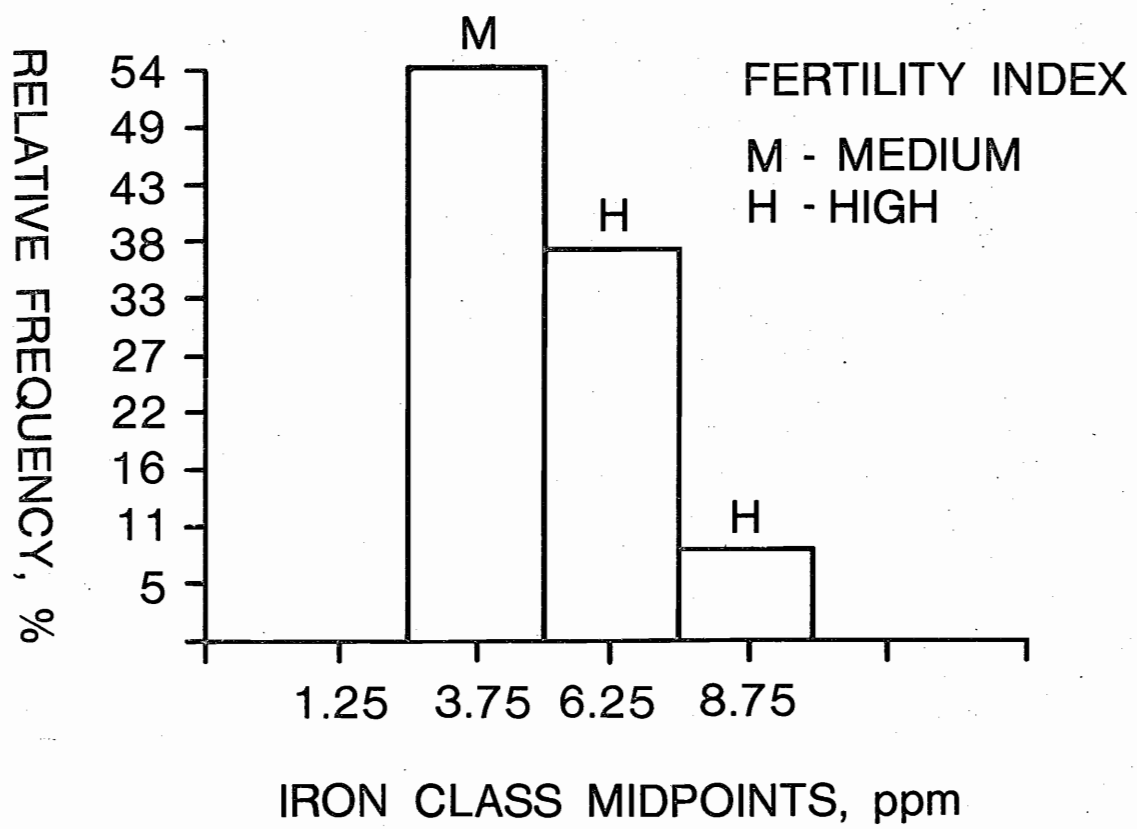

Fig. II-12 Frequency distribution of iron values of El-Hammami farms

SAMPLING PLAN AND INTENSITY (Beni Magdul and El-Hammami)

In Beni Magdul site, the canal reaches were different in their soil fertility and EC values. The sites within each canal reach were also significantly different in soil fertility and EC. However, the farms within each site were not statistically different. But, compared to Kafr el-Sheikh and El-Minya, the soil fertility indices within each site were more heterogeneous.

If 30 sampling units per site (10 feddan in area) are obtained in Beni Magdul, the 95% CI of geometric mean will be ±23% for EC, ±37% for NO_3-N, ±31% for P, and ±17% for Zn (Table 10). However, one should be aware that vegetable crops are intensively grown in Beni Magdul. Therefore, the risk of fertilizer recommendations based on an "average" soil fertility index of a site may be large. Another alternative is to test the soils on a village basis and make interpretive results available to farmers. Then let farmers decide what nutrients they wish to apply to their farms.

In El-Hammami site only pH, EC and K values were obtained for all farms within all 10 sites. For NO_3-N, Zn, Fe, and P only 39, 35, 35, and 67 samples were analyzed.

To calculate error variance for NO_3-N, Zn, Fe and P, a logarithmic transformation was made. Then error variances were calculated and used in calculating sampling intensities. Since these estimates include within farm, among farms and among sites error variances, they are large.

Based on the available data, to obtain a 95% CI of ±31% of the geometric mean, 103, 58, 9, and 13 sampling units should be obtained for NO_3-N, P, Zn, and EC, respectively (Table II-10). The large number of sampling units (cores) required for NO_3-N and P may be due to the fact that the whole El-Hammami area is to be characterized.

Table II-10. Number of cores to composite to get a 95% confidence interval (CI) expressed as % of geometric mean

	CI					
Nutrient	91-110 %	87-115 %	83-120 %	80-125 %	77-130 %	74-135 %
Beni Magdul			Number of Cores			
No_3-N (for each site)	430	200	117	78	56	43
P "	307	143	84	56	40	31
K "	33	15	9	6	4	3
Zn "	87	40	23	15	11	8
Fe "	34	15	9	6	4	3
EC "	182	85	49	33	24	18
El-Hammami						
No_3-N (for El-Hammami)*	1024	476	279	186	135	103
P (for El-Hammami)*	578	269	158	105	76	58
K (for each site)	99	46	27	18	13	10
Zn (for El-Hammami)*	91	42	24	16	12	9
Fe (For El-Hammami)*	15	29	17	11	8	6
EC (For each site)	137	64	37	25	18	13
O.M. (for El-Hammami)*	35	16	9	6	4	3

* Due to limited number of samples taken, each site could not be analyzed separately.

SUMMARY AND CONCLUSIONS

Beni Magdul and El-Hammami areas in Mansuriya were selected as study sites for Egypt Water Use and Management Project (EWUP). One of the objectives of EWUP is to survey soil fertility status of its sites in order to determine the nutrient needs of crops in small farms and feasibility of providing soil testing service for small farmers.

Beni Magdul soils are mainly of alluvial origin and have a much higher clay content than El-Hammami soils which are sandy in texture and have a very low CEC and water holding capacity.

Winter crops in Beni Magdul and El-Hammami are berseem, wheat and vegetables in rotation with maize and vegetables as summer crops. Berseem is the number one crop in acreage among winter crops as vegetables are among summer crops. Intercropping is also practiced in this area to some degree. The farm size in Mansuriya is small with a mean of 0.93 and 1.27 feddans for Beni Magdul and El-Hammami respectively. About 42% of farms are 0.01 to 0.50 feddans in area.

In Beni Magdul, five sites per every reach (first, middle, and last) of the lined Beni Magdul canal were selected. Each site was selected to represent the area considering the cropping patterns, farm size and soil texture. From 5 to 10 randomly determined farms per site were sampled in January, 1978, which amounted to 10% of all farms in this area. Two cores per farm were obtained to a depth of 20 cms. Every fifth farm was sampled in 20 cm increments to a depth of 60 cm.

In El-Hammami ten sites were selected. Each site was 10 feddans in area. From 11 to 24 randomly-determined farms per site were sampled in February, 1978, which amounted to 15% of all farms in El-Hammami area. Two cores per farm were obtained to a depth of 20 cm. Every fifth farm was sampled in 20 cm increments to a depth of 60 cm.

Beni Magdul

The pH values ranged from 7.3 to 9.1. The results showed that 23% of the surface soil samples were saline and salinity did not change with depth. The first and the last reaches of the Beni Magdul canal were higher in salinity than the middle reach. These results indicate that irrigation management practices should be aimed at keeping salinity levels within a range that will not result in yield reduction. Also, it is recommended that periodic salinity measurements be made for better understanding of the dynamics of salt build up and leaching in these soils.

About 70% of samples tested low in nitrate nitrogen, but 30% of samples had enough nitrate at the time of sampling to reduce fertilizer nitrogen needs assuming they are not leached or denitrified before crops reach a competitive stage. It is highly recommended that field studies be carried out to determine the significance of residual nitrogen for crop production.

About 42% of the surface soil samples were low in available phosphorus. However, the subsoil phosphorus fertility was relatively high on the average. Field fertilizer experiments are required for calibration of soil test results. Zinc was found to be low to marginal in 18% of the soil samples and zinc sensitive crops may respond to zinc fertilization when grown in these soils.

About 10% of samples tested marginal in iron availability, while potassium availability was very high and no response to potassium fertilizers is expected.

El-Hammami

The pH values increased significantly with depth and most of them had values exceeding 8.5 which may indicate a sodicity problem. However, because of sandy texture of soils sodicity does not reduce infiltration rate but causes a reduction in nutrient availability.

About 35% of surface soils were saline and salinity did not change with depth.

About 46% of samples had a low level of nitrate nitrogen while 54% of the samples had enough residual nitrate nitrogen at the time of sampling to reduce fertilizer nitrogen needs assuming nitrates are

not leached or denitrified.

About 46% of the surface soil samples had a low phosphorus availability. Subsoil fertility was high on the average. Field experiments are needed for calibration of soil tests.

Zinc availability was low to marginal in 52% of the El-Hammami soil samples. The prevalence of zinc deficiency necessitates making zinc fertilizers available to the farmers.

Iron availability was marginal in 53% of the soil samples. This makes iron limiting for production of iron-sensitive crops.

Potassium availability was very high in El-Hammami soils, and there is very little need for potassium fertilization.

In summary, N, P, Zn, and Fe are the nutrients that were found to be deficient in Mansuriya soils.

It is imperative that salinity levels of soils be monitored regularly, preferably by use of portable meters to evaluate the effectiveness of existing irrigation management methods.

Sodium adsorption ratio (SAR) should be determined if pH of saturated paste is greater than 8.5 or if pH is less than 8.5 and EC of saturation extract is greater than 4 mmhos/cm. Gypsum requirement should be determined if SAR is greater than 12.

Soil Sampling and Testing Strategy

The small size of farms and diversity of crop rotations in Mansuriya make soil testing very difficult.

If each farm was sampled and soil tested, the cost of soil testing per feddan will be very high due to the small size of farms. Therefore, at this time it is recommended that soil testing on a village basis be carried out periodically by the Ministry of Agriculture to diagnose fertility needs of Mansuriya farms. These results, along with visual symptoms, should be used to encourage farmers to use needed nutrients such as nitrogen, phosphorus and zinc. In case of iron wherever soil tests show deficiency and iron deficiency symptoms are observed, the farmers should be encouraged to plant non-sensitive crops and use animal and plant manure if available.

Part III - Soil Fertility Survey

of Abyuha, El Minya

SOIL FERTILITY REPORT OF ABYUHA, EL-MINYA

BACKGROUND INFORMATION

El-Minya governorate was selected for conducting the water use and management studies in the Nile Valley. It lies almost midway between Alexandria and Aswan and is representative of the Central Valley soils. Abyuha site in El-Minya governorate was selected to carry out the Soil Fertility Survey with the following objectives;

1. To obtain information on the available nutrient levels and their variability in the soils of EWUP sites.
2. To determine the feasibility of providing soil testing services for Egyptian farmers.

Soil Classification

The Abyuha site covers about 1000 feddans on the western side of El Ibrahimia main canal. This area is flat and slopes very gently toward the northwest.

The soil survey Report (Abdel Wahed, et al., 1980) indicates that a striking homogeneity exists in all soil characteristics of the study area. These are Typic-Torrerts of Vertisol order with a deep, uniform, moderately permeable clayey profile. The salinity level is low, the soil pH is on the basic side of neutrality. These soils have a high cation exchange capacity and water holding capacity.

The deep water table and absence of any gleying signs are indications of the adequacy of natural drainage. The major concern appears to be the relatively high SAR levels in the subsoil. The soil texture is clayey throughout the profile, but tends to be more clayey in the subsoil. Wide cracks, characteristics of Vertisols, are formed in these soils upon drying.

Cropping System

The Abyuha area follows the two-year rotation system where half of the area is planted to winter crops followed by maize as summer crop. The other half is planted to a temporary cash crop of clover from which one or two cuttings are taken and then followed by cotton as summer crop. In case of Abyuha area, many farmers

replace the temporary clover by broadbeans, which mature in April, consequently, delaying the planting date for cotton until the early days of May. This delay will result in lower cotton yields, but EWUP economists have shown higher net income with broadbeans before cotton even with planting delays and penalties.

Maize is considered the main summer crop following winter cereals and legumes. Sugarcane may be planted instead of cotton as the cash crop in some parts of Abyuha. Sugarcane rotations may last from 3 to 6 years, depending on the number of annual ratoons.

Farm Size Distribution

In this report, a farm is defined as contiguous fields cultivated by one household. The total area of Abyuha pilot area is about 1000 feddans divided into approximately 1300 farms with a mode value of one-half of one feddan per farm. This mode value is the same for most of the hôds located in this area (Tables III-1 and III-2).

The smallest farm size in this area is 0.04 feddans and the largest is 10 feddans. The data shown in Table III-2 indicate that more than 50% of the existing farms lie in a range of 0.04 to one-half of one feddan in area.

MATERIALS AND METHODS

Field procedures

The soil samples were obtained from all 14 hôds located in Abyuha pilot area at the beginning of the agricultural year in September 1979 (map 3, Appendix 1). Ten farms were selected at random in each hôd amounting to 125 farms (about 10% of total farms). Two surface soil samples (0-20 cm) per farm were taken. Deep samples (0-20, 20-40, 40-60 cm) were obtained from two farms in each hôd.

Laboratory Procedures and Statistical Methods

Laboratory procedures and statistical methods were the same as those for Abu Raya, Kafr el-Sheikh.

Table III-1. The mean, mode and range of farm size, farm number and the total area of the hôds located in Abyuha site.

hôd	Mean	Mode	Class	Area	Number of Farms
	Feddan				
El-Higr (North)	1.91	0.50	0.33 - 8.00	59.23	31
El-Nezela (South)	0.50	0.29	0.13 - 2.08	40.33	80
El-Sabil	1.32	.50	0.21 - 8.50	73.10	55
Sharaf El-Din	0.88	.50	0.25 - 5.67	64.40	73
Botros	0.93	.50	0.17 - 4.13	70.39	75
Mohamed Yossef (North)	1.22	.50	0.25 - 9.13	58.94	48
Mohamed Yossef (South)	1.02	1.00	0.17 - 5.00	101.36	99
Essawy	0.59	0.50	0.17 - 2.13	64.67	109
Osman	0.70	0.50	0.17 - 2.13	74.59	106
Abdel-Latif	0.54	0.50	0.17 - 1.54	66.16	122
Mehanna	1.50	0.50	0.33 - 8.00	91.76	61
El-Higr (South)	0.89	0.50	0.08 -10.00	92.68	104
Dayer El-Nahia (West)	0.45	0.17	0.04 - 3.50	59.30	129
El-Nezela (North)	0.53	0.21	0.08 - 4.17	99.77	186
Total Area	0.79	0.50	0.04 -10.00	1016.	1278

Table III-2. The relative frequency of the farm size in Abyuha site.

Class (Feddan)	Relative Frequency (%)
0.04 - 0.25	16
0.25 - 0.50	38
0.50 - 0.75	15
0.75 - 1.00	15
1.00 - 1.50	8
1.50 - 2.00	3
2.00 - 2.50	2
2.50 - 3.00	1
3.00 - 5.00	1
5.00 - 10.00	1

RESULTS AND DISCUSSION

The distributuion of pH, conductivity and available P values of the surface samples were tested for normality. All the distributions except the one for pH deviated from normality. A logarithmic transformation made the conductivity and phosphorus distributions closer to a normal one.

pH

The pH distribution of surface soils is given in Fig. III-1. About 37% of samples had pH values of over 8.5. Since a 1:2.5 soil: water suspension was used to determine pH, a dilution effect could be responsible for an increase in pH. In this case, probably soil samples with a pH of over 8.9 could be considered sodic. Therefore, 7% of surface samples and most of deep samples could be considered sodic. However, SAR should be determined for a direct determination of sodicity problem of soils.

The data indicated that pH increased significantly with depth (see Fig. IV-1). Most pH values exceeded 9.0 in the deep samples. The C.V. values for pH distribution were about the same for surface and deeper soil samples.

The analysis of variance indicated that both the hods and farms within each hod were similar in their pH values (Table III-3). No significant difference existed between either the hods located in Abyuha area or the farms within each hod.

Conductivity

The data indicated that the soil salinity status changed very little with depth (see Fig. IV-2). The mean conductivity values were 0.44, 0.50, and 0.57 mmhos/cm for the 0-20, 20-40, and 40-60 cm. Considering that conductivity values were measured in 1:5 soil water suspensions, and assuming a saturation percentage value of 100, one may multiply the EC values by 5 to approximate their equivalent saturation extract values. For most crops, the soils of Abyuha site can be considered as non-saline (Fig. III-2).

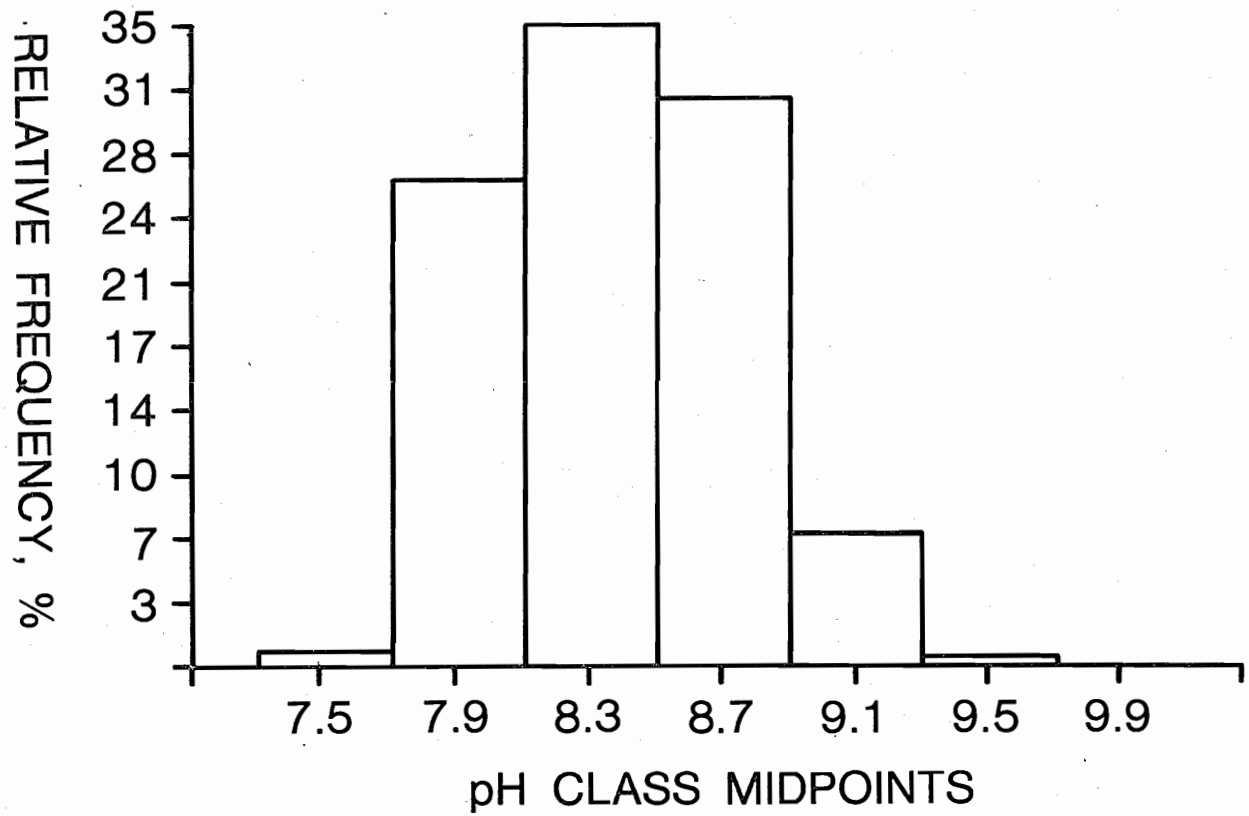

Fig. III-1 Frequency distribution of pH values of Abyuha farms

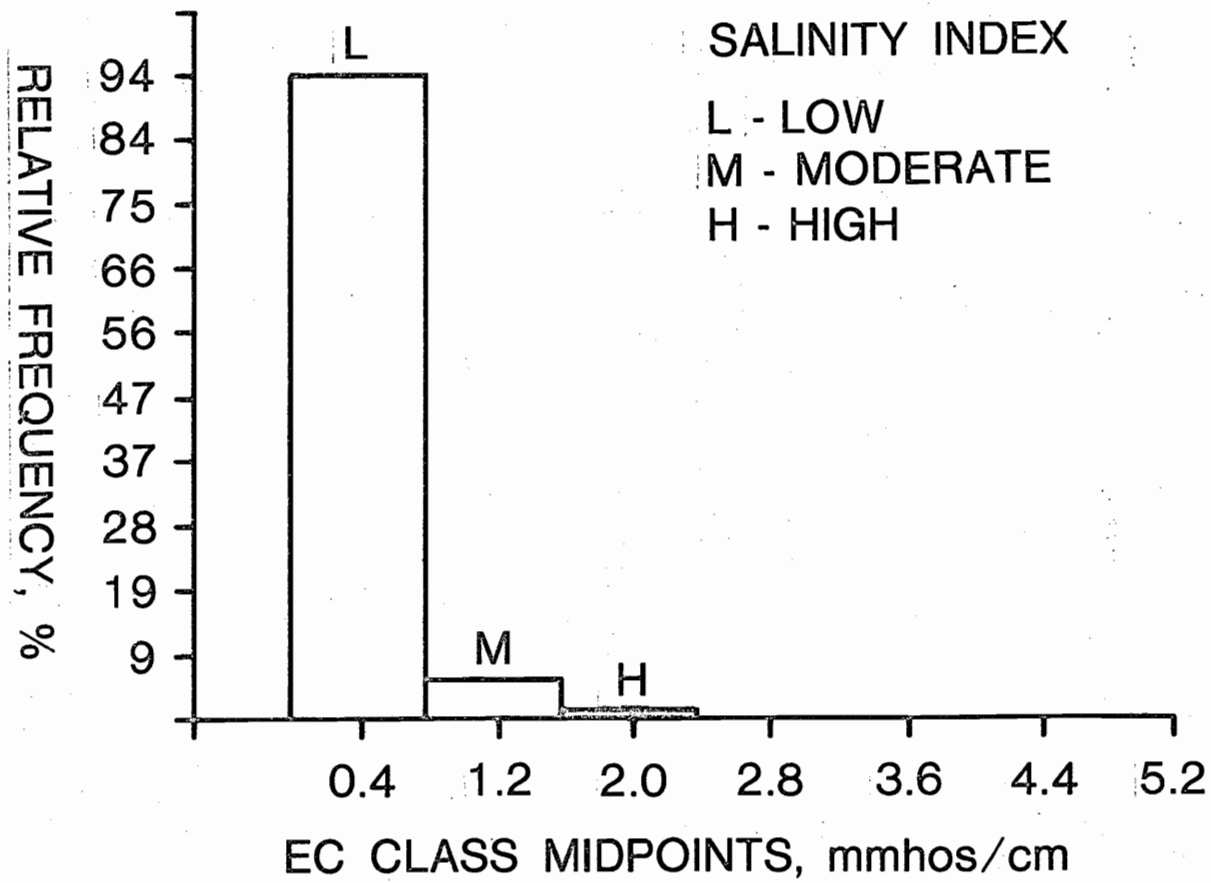

Fig. III-2 Frequency distribution of EC (1:5) values of Abyuha farms

A significant difference at 1% level of probability was found between conductivity values of hôds, whereas differences between the farms within each hod were not significant (Table III-3).

Phosphorus

The distribution of phosphorus values indicated that most of the surface soils could be considered low in P availability (Fig. III-3). About 84% of the surface samples tested low in phosphorus. The average P levels were 5.4, 4.6 and 4.2 ppm in 0-20 20-40, and 40-60 cm deep samples, respectively (see Fig. IV-4).

Considering low phosphorus availability in the profile response to P fertilization will probably be observed for responsive crops. However, field experiments should be carried out to verify response.

The analysis of variance indicated that both the hôds and farms within each hôd were similar in their available phosphorus levels. No significant difference existed between either the hôds located in Abyuha area or the farms within each hôd.

Potassium

The soil survey report (Abdel Wahed et al.) indicated that soluble potassium levels were high in these soils. Considering that these soils are of clay texture and there is an equilibrium between exchangeable and soluble potassium, one reaches the conclusion that potassium levels are generally adequate for crop production.

Zinc

Most (81%) of Abyuha soils were low in zinc availability (Fig. III-4). About 14% of surface soil samples were marginal in zinc availability. EWUP personnel and agronomists of the Ministry of Agriculture have obtained response to zinc for most crops.

The mean zinc values were 0.6, 0.12, and 0.18 ppm for samples taken from 0-20, 20-40, and 40-60 cm depths, respectively.

Table III-3. The mean values of pH, conductivity, and available phosphorus of the hôds located in Abyuha site.

hôds	pH	Conductivity (mmhos/cm)	P (ppm)
El-Higr(North)	8.4	0.31	5.6
El-Nezela (South)	8.3	0.41	5.6
El-Sabil	8.4	0.42	5.5
Sharaf El-Din	8.4	0.44	5.5
Botros	8.3	0.41	5.9
Mohamed Yossef (North)	8.3	0.44	5.8
Mohamed Yossef (South)	8.5	0.44	6.5
Essawy	8.3	0.43	6.5
Osman	8.4	0.44	4.2
Abdel-Latif	8.3	0.46	5.1
Mehanna	8.3	0.36	5.4
El-Higr(South)	8.3	0.50	5.3
Dayer El-Nahia (West)	8.3	0.44	6.2
El-Nezela (North)	8.2	0.60	6.5
Mean	8.4	0.44	5.7
C.V.	4.2	29.27	21.4
F %	n.s.	1%	n.s.

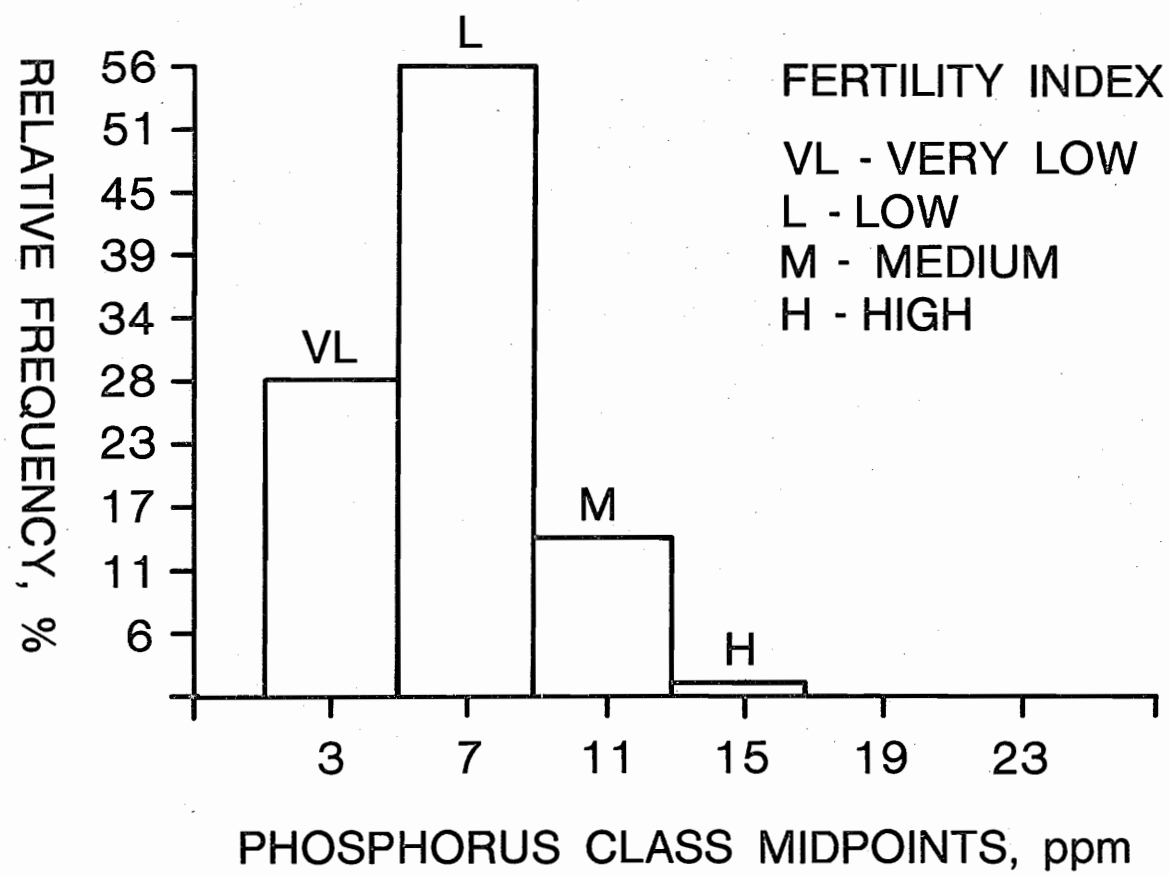

Fig. III-3 Frequency distribution of phosphorus values of Abyuha farms

Iron

Only 39 surface samples were analyzed to describe iron availability levels in Abyuha site. Ninety-nine percent of samples analyzed showed high levels of available iron existing in this area (Fig. III-5). The mean value of iron was 10.6 ppm.

Copper

Copper levels in soils of Abyuha site were adequate for crop production. Copper availability varied with depth. The mean values were 3.1, 2.1 and 2.0 ppm for the 0-20, 20-40, and 40-60 cm depths, respectively (Table III-4).

Manganese

Manganese availability was adequate for crop production in Abyuha site. Manganese levels decreased with depth. The mean values of Mn were 7.9, 7.2 and 3.6 ppm for the soils taken from the 0-20, 20-40, and 40-60 cm depths, respectively (Table III-5).

Sampling Plan and Intensity

The differences between soil phosphorus and EC of farms within a hôd were not large and were not statistically significant. However, the soil EC values were different among hôds. Therefore, it is recommended that each hôd be sampled separately. The soils should be sampled to a depth of 60 cms at this time until more information is obtained.

Obtaining 30 samples per hôd will yield a 95% CI of ±14% for P, ±23% for Zn and ±12% for EC (Table 6). Only 48 samples were analyzed for Zn. Variance of Zn values was calculated for this population and used in determining sampling intensity. It is likely that the CI for Zn would have been smaller if error variance of each hôd could have been used.

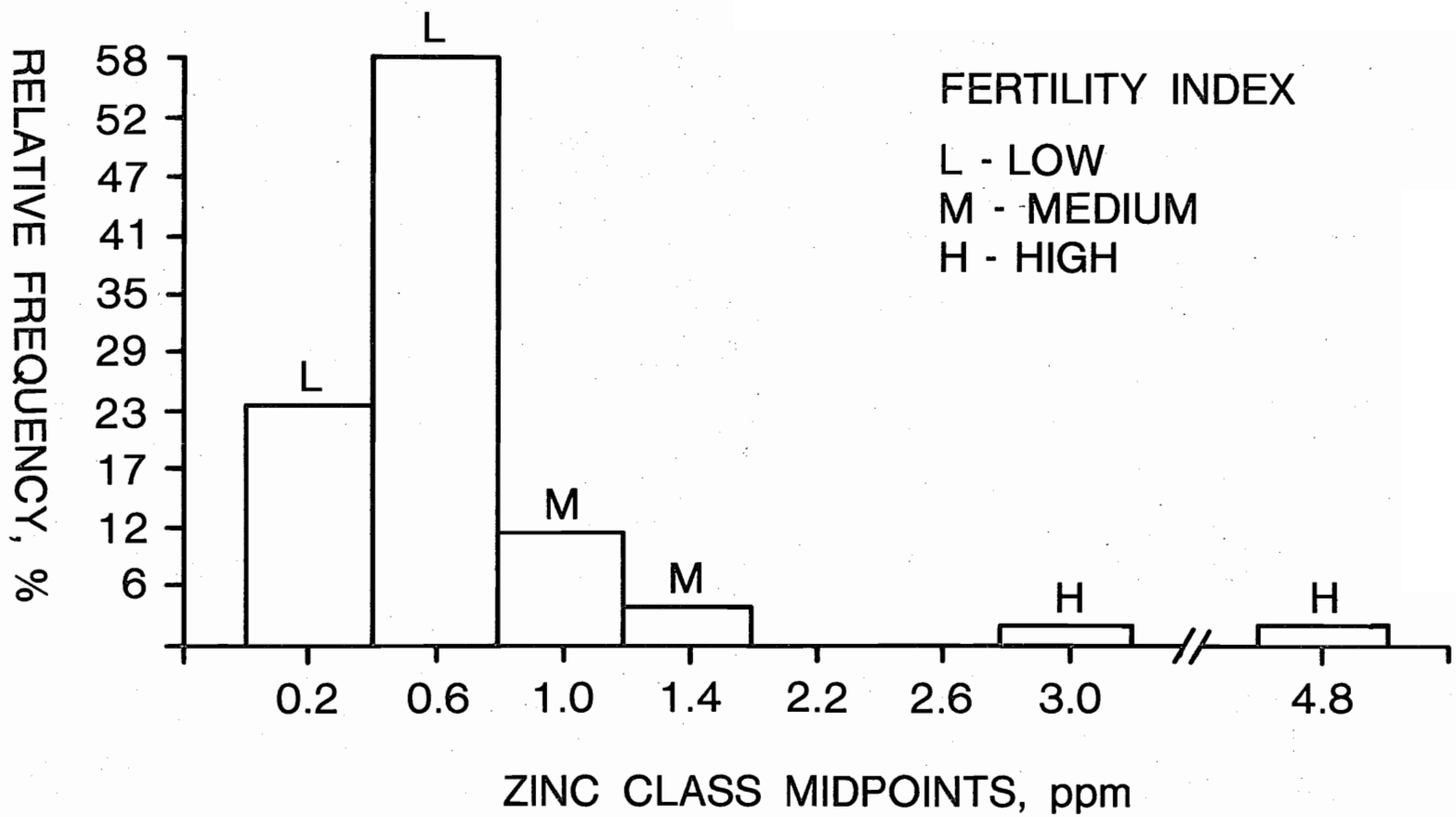

Fig. III-4 Frequency distribution of zinc values of Abyuha farms

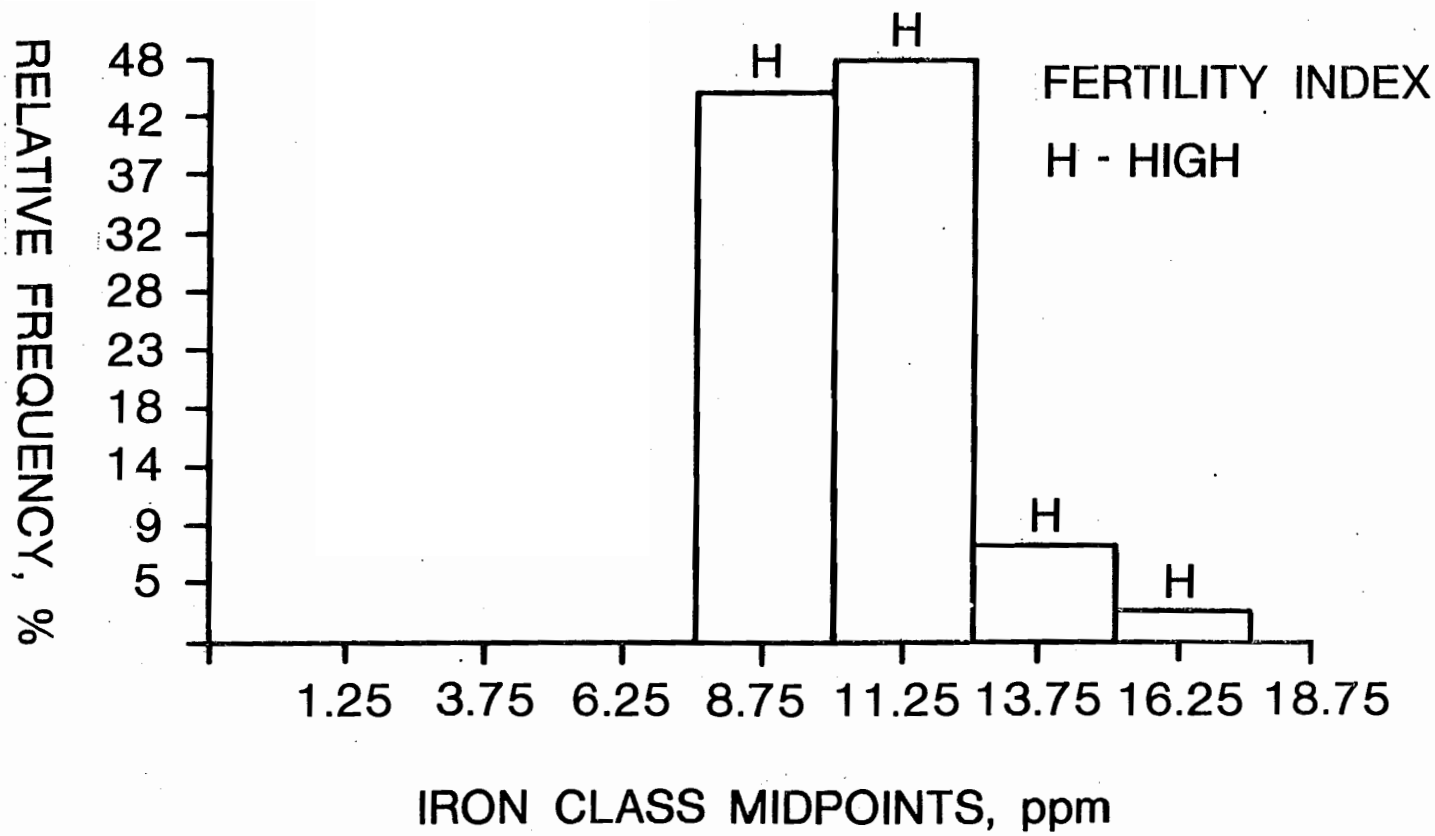

Fig. III-5 Frequency distribution of iron values of Abyuha farms

Table III-5. Percent frequency distribution of manganese levels in soils of Abyuha site.

		Class	Relative Frequency
		PPM	%
0-20 cm depth			
		1.8-6.0	42
		6.0-18	58
	Mean	7.9	
20-40 cm depth			
		2.3-6.2	50
		6.2-14.0	50
	Mean	7.2	
40-60 cm depth			
		2.3-5.0	100
	Mean	3.6	

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Table III-6. Number of cores to composite to get a 95% confidence interval (CI) expressed as % of geometric mean.

Nutrient	CI 91-110 %	87-115 %	93-120 %	80-125 %	77-130 %	74-135 %
	Number of Cores					
P (for each hôd)	74	34	20	13	9	7
Zn (for Abyuha)*	156	72	42	28	20	15
Cu (for Abyuha)*	147	68	40	26	19	14
Mn (for Abyuha)*	135	62	36	24	17	13
Fe (for Abyuha)*	11	5	3	2	1	1
EC (for each hôd)	42	19	11	7	5	4

* Due to limited number of samples taken, each hôd could not be analyzed separately.

SUMMARY AND CONCLUSIONS

Abyuha area in El-Minya governorate was selected as the project site in the central part of Nile Valley. One of the objectives of EWUP was to survey soil fertility status of its sites in order to determine nutrient need of crops in small farms and feasibility of providing soil testing service for small farmers.

Soils of Abyuha are typic-Torrerts of Vertisols order. They have a deep, uniform, moderately permeable clayey profile. Clay minterals in these soils are mainly montmorillonite which cause deep and wide cracking of soil upon drying.

Farm size in this area varies from 0.04 to 10 feddans. The average farm size is 0.79 feddan.

Summer crops in rotation are cotton and maize, but sugar cane replaces these crops in some parts of Abyuha. Winter crops planted are cereals, temporary clover and broad beans.

Abyuha cooperative consists of 14 hôds. Ten farms were selected at random in each hôd. Two surface (0-20 cm) samples were obtained from each selected farm in September 1979. Two farms per each hôd were sampled to a depth of 60 cm in 20 cm increments.

The distribution and variation of pH, electrical conductivity and fertility index values of soil samples will be discussed below. Soil salinity and fertility are interpreted in terms of moderately sensitive and sensitive crops, respectively. These interpretations will change for different crop species and varieties having different physiological characteristics.

The pH values ranged from 7.7 to 9.5 with a mean of 8.3. A small number of surface samples and most of deep samples had pH values of over 8.9 which could be attributed to sodicity. In this case, SAR values should be determined and if found to be greater than 12, gypsum requirement of soils should be determined.

Most of the soils were non-saline at the time of sampling.

About 28% and 56% of surface soil samples tested very low and low in phosphorus availability, respectively. Phosphorus fertility index did not change with depth.

About 81% of samples tested low and 14% tested marginal in zinc availability.

Iron, manganese and copper levels were not found at deficient levels for crops.

Soils were very uniform in their fertility and for sampling purposes one may sample at the hôd level. Taking 30 soil cores per hôd will result in a 95% confidence interval of ±14% for P, ±12% for EC evaluation. Sampling soils on a large area basis and taking 30 cores from all Abyuha area will result in a ±23% confidence interval for the geometric mean of zinc.

In conclusion, at the present time phosphorus and zinc, and in a very few cases iron, could be considered deficient in Abyuha soils. Nitrate nitrogen was not determined and no statement can be made about its distribution. However, responses to nitrogen fertilizers are obtained by farmers as expected in these soils of low organic matter content.

Part IV - Comparison of Farm Size, Soil Fertility and Salinity of Abu Raya, Beni Magdul, El-Hammami, and Abyuha Sites

Comparison of Farm Size, Soil Fertility and Salinity of Abu Raya, Beni Magdul, El-Hammami and Abyuha Sites

The data (Table VI-1) show that farm size means and modes for project sites. In El-Hammami most of the farms are less than 0.5 feddan in size. In Beni Magdul and Abyuha most farms are 0.5 feddan in size. In Abu Raya farms are bigger on the average with most of them being one feddan in size.

The mean pH, EC and fertility indices for the surface soil samples from Abu Raya, Beni Magdul, El-Hammami and Abyuha are given in Table IV-2.

The pH of surface soil samples was highest for El-Hammami and about the same for other sites. The higher pH in El-Hammami is probably due to higher exchangeable sodium percentage in these sandy soils of low buffering capacity.

The EC values for surface soil samples were lowest for Abyuha and the same for other sites. The lower EC's in Abyuha may be due to deeper water table depth and time of sampling. In Abyuha samples were obtained close to the harvest time of summer crops but in other sites they were obtained before planting summer crops.

Nitrate content of surface soil samples were the same in Abu Raya and Beni Magdul, but much higher in El-Hammami. The higher level in El-Hammami is probably due to heavy use of nitrogen fertilizers for vegetable production in these soils. This condition is found in many vegetable growing areas of the world. Vegetable farmers have high investment costs and they usually over-fertilize to prevent nutrient deficiency in any part of their farms. Field studies should be carried out to study the important of nitrate soil testing for the purpose of fertilizer recommendations to the farmers.

The phosphorus levels were about the same in Beni Magdul, and El-Hammami surface soils, but were lower in Abu Raya and Abyuha soils. Again, its seems that vegetable farmers use higher rates of phosphorus fertilizers.

Potassium levels are invariably high in project sites. Some

Table IV-1. Comparison of means, modes, and ranges of farm size in each EWUP site

	Mean	Mode	Range
	----------	feddan	----------
Abu Raya	1.99	1.00	0.13-30
Beni Magdul	0.93	0.50	0.01-10
El-Hammami	1.60	0.19	0.01-42
Abyuha	0.79	0.50	0.04-10

Table IV-2. Comparison of means of pH, EC, NO_3-N, P, K, Zn, Fe, Cu, and Mn in surface soils of EWUP sites.

	Abu Raya	n***	Beni Magdul	n	El Hammami	n	Abyuha	n
pH	8.4	245	8.3	211	8.8	198	8.3	251
EC (mmhos/cm)*	4.0	241	4.3	204	4.2	198	2.4	250
NO_3-N (ppm)	10	246	9	78	30	39	n.d.	---
P (ppm)	7.0	246	13.0	114	11.8	67	6.2	261
K (ppm)**	n.d.	---	548	114	352	67	n.d.	---
Zn (ppm)	1.4	39	2.6	48	0.9	35	0.6	55
Fe (ppm)	31.0	42	7.5	55	4.8	35	10.4	39
Mn (ppm)	16.3	61	n.d.	--	4.6	51	7.9	24
Cu (ppm)	7.1	42	n.d.	--	1.2	51	3.1	24

n.d. = not determined

* The above EC values are for saturation extract and were calculated from 1:5 extract EC values.

** Soil survey report by Abdel-Wahed et al. shows very high levels of soluble K in all sites.

*** n represents the total number of samples analyzed for a given index in a given site.

sandy soils in El-Hammami (3%) had medium levels of potassium and these soils may require potassium fertilization for crops with high potassium requirement.

Zinc levels were lowest in Abyuha and increased in order of Abyuha, El-Hammami, Abu Raya and Beni Magdul.

Iron levels were lowest in El-Hammami soils and increased in order of El-Hammami, Beni Magdul, Abyuha and Abu Raya. The lowest iron levels in El-Hammami soils are due to high pH values observed in these soils. The very high iron values in Abu Raya soils are probably due to flooding of soils during rice production.

Manganese and copper levels were adequate in all sites, and increased in the order of El-Hammami, Abuyha and Abu Raya. The higher manganese level in Abu Raya soils are probably due to flooding of soils during rice production.

The distributuions of pH, EC, NO_3-N and P in the soil profile are shown in Figures IV-1 to IV-4. These figures are based on a small number of deep samples taken from each site.

The pH values increased with depth in El-Hammami and Abyuha but stayed constant for other sites. An increase in pH with depth may indicate that sodicity increases with depths.

The EC values increased with depth in Abu Raya soils. The data show that after a rice crop, soluble salts have been leached out of the 60 cm profile and are lower than those found after a cotton crop.

Nitrate levels decreased with depth comparing 0-20 to 20-40 cm deep samples. In El-Hammami nitrate levels continued to decrease to a depth of 60 cm. In other sites nitrate levels did not change from 20-40 to 40-60 cm.

Phosphorus decreased with depth in El-Hammami and Beni Magdul, but increased with depth in Abu Raya soils after rice.

Availability of other nutrients decreased with depth in the soil profile.

The low levels of available zinc found in most of Abyuha and El-Hammami soils and some soils of Beni Magdul and Abu Raya are testimony to the importance of zinc fertilizers to Egyptian agriculture. Egypt Academy of Scientific Research and Technology (1979, 1980) reported low levels of zinc in the western part of the Nile

Delta, North and Middle Sinai, North Tahrir Province and Governorates of Assiut, Qualiobia, and Dakahlia. They also found low levels of available iron in North Tahrir Province, and Qualiobia Governorate. The data reported in this paper show that sandy soils of El-Hammami with very high pH levels have the lowest levels of available iron.

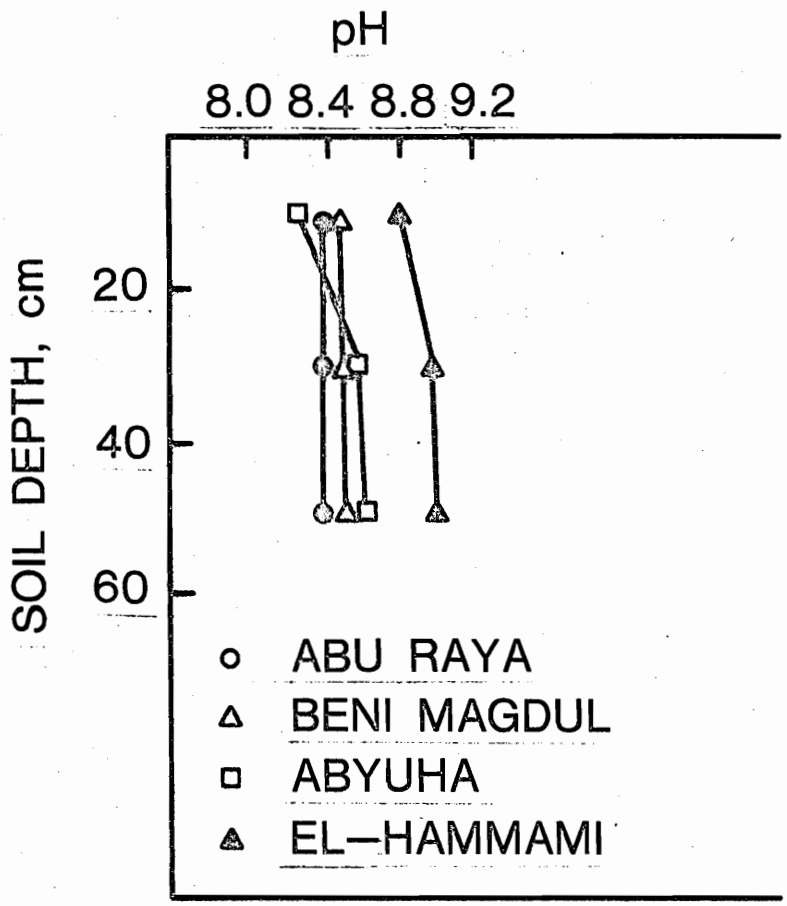

Fig. IV-1 Mean pH values (1:2.5) as a function of soil depth

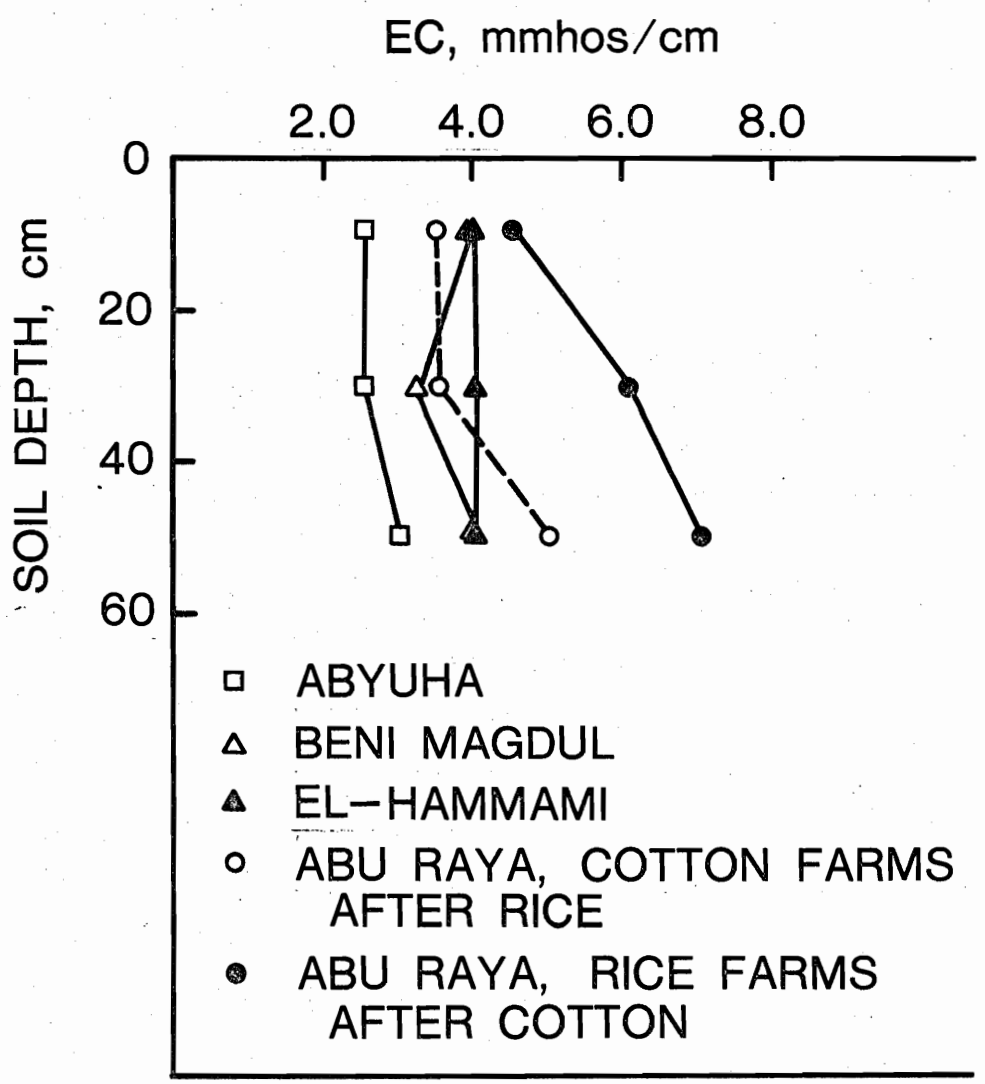

Fig. IV-2 Mean electrical conductivity (EC) values as a function of soil depth. (EC values of 1:5 soil: water extract were converted to EC of saturation extract)

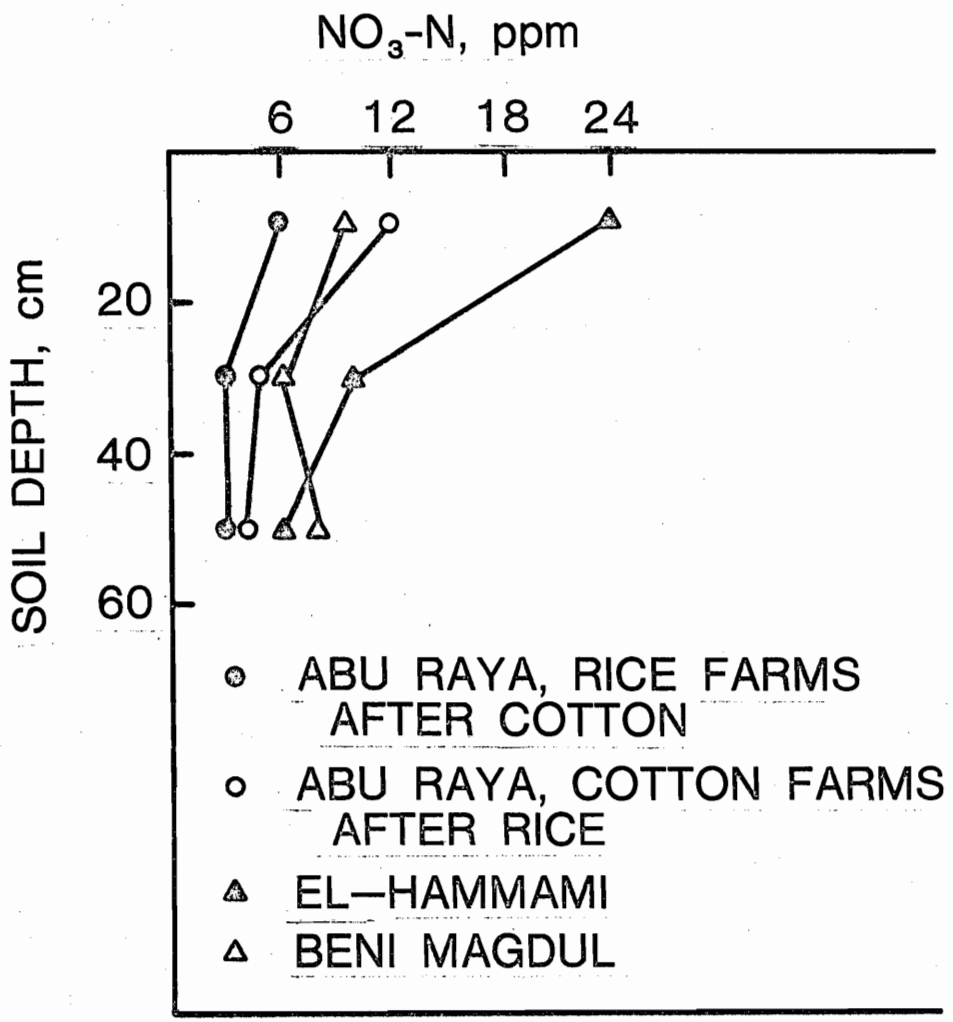

Fig. IV-3 . Mean nitrate-nitrogen concentration as a function of soil depth

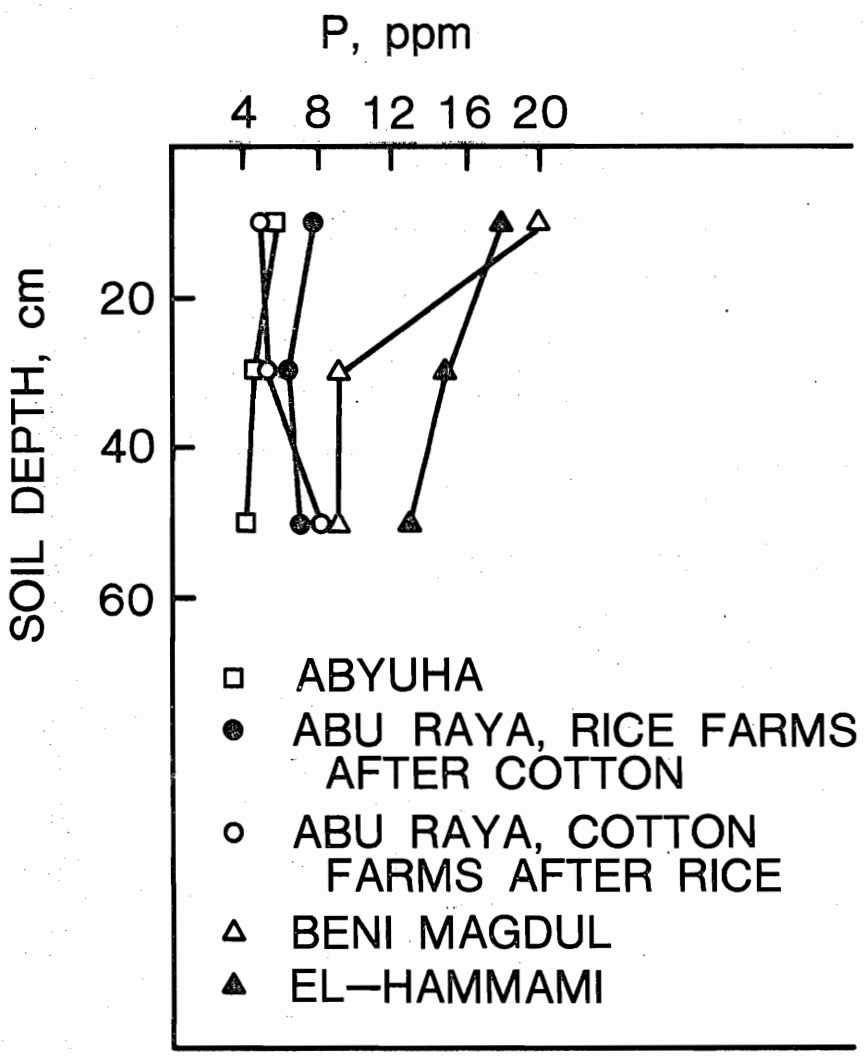

Fig. IV-4 Mean phosphorus fertility index as a function of soil depth

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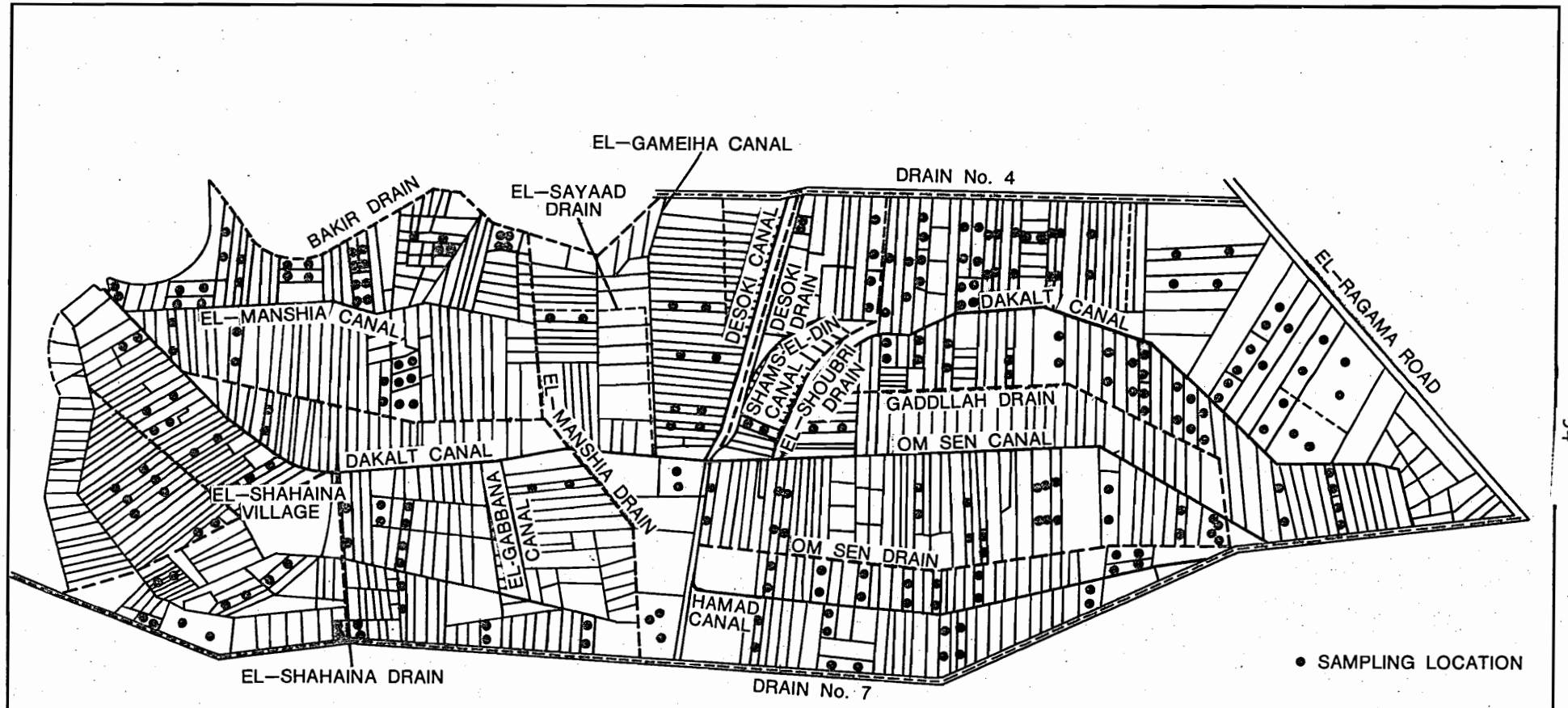
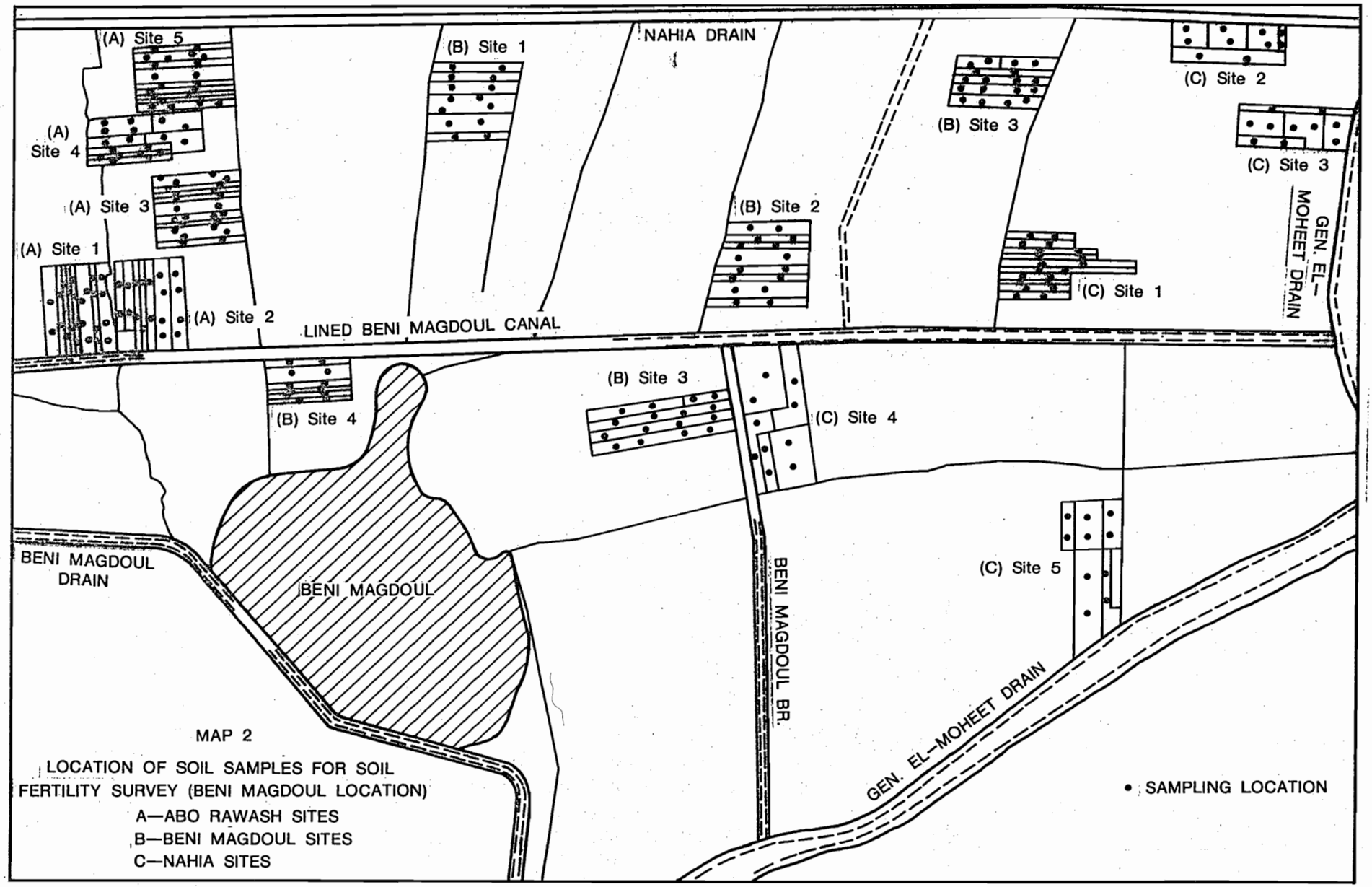
APPENDIX I

MAPS OF SAMPLING LOCATIONS



MAP 1

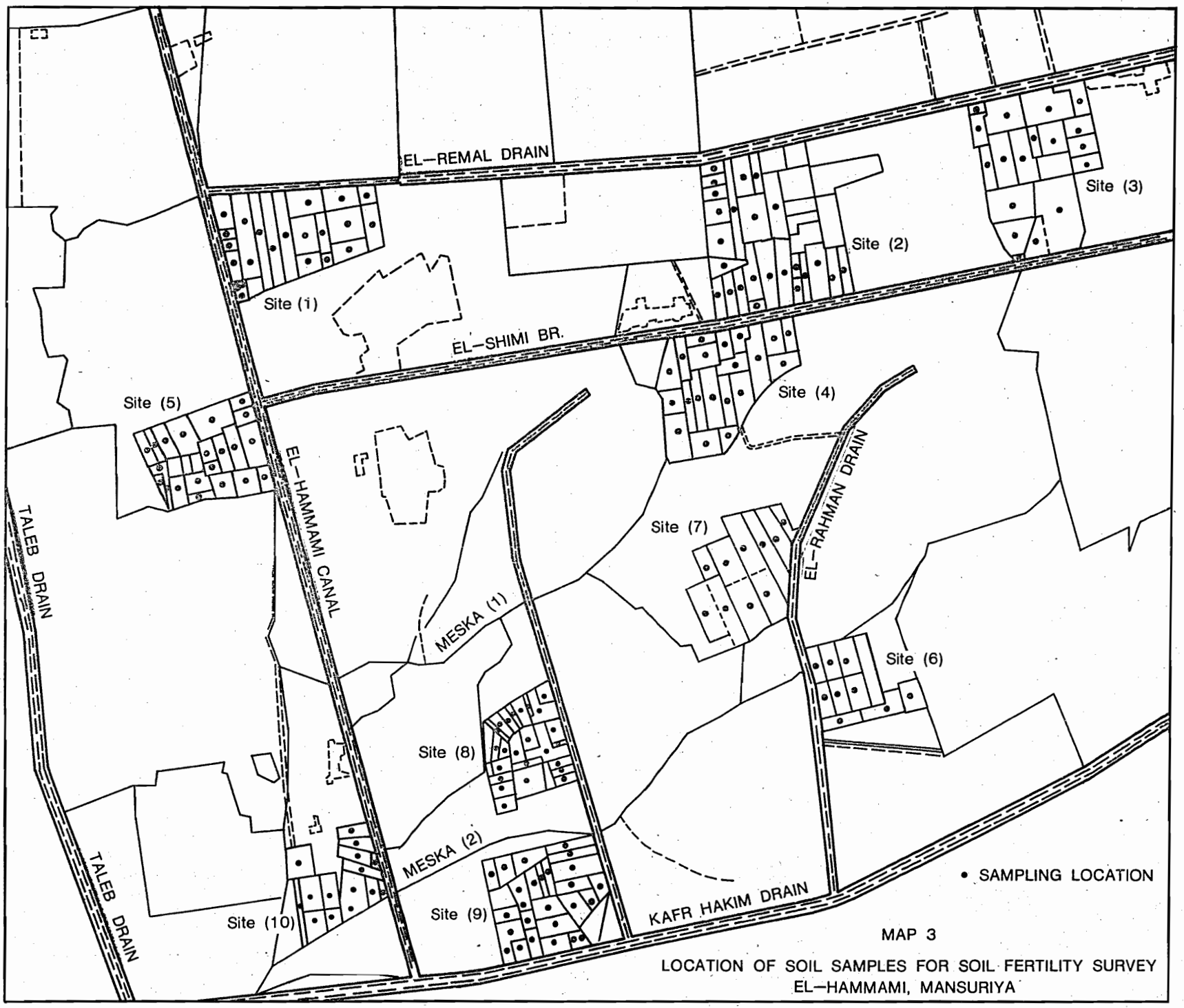
LOCATION OF SOIL SAMPLES FOR SOIL FERTILITY SURVEY
ABURAYA, DAFR EL–SHEIKH



MAP 2

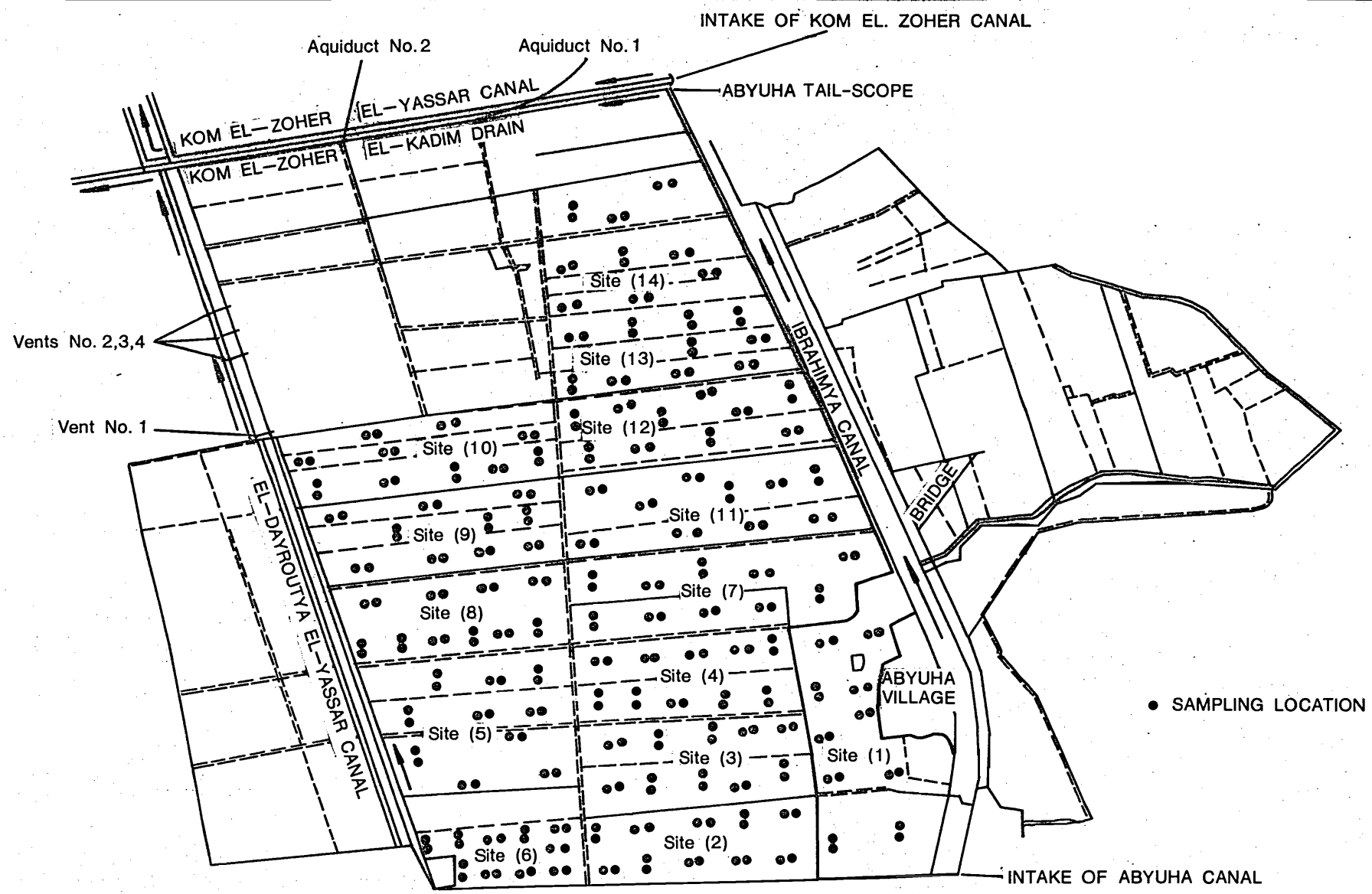
LOCATION OF SOIL SAMPLES FOR SOIL FERTILITY SURVEY (BENI MAGDOUL LOCATION)

A—ABO RAWASH SITES
B—BENI MAGDOUL SITES
C—NAHIA SITES



MAP 3

LOCATION OF SOIL SAMPLES FOR SOIL FERTILITY SURVEY
EL-HAMMAMI, MANSURIYA



MAP 4

LOCATION OF SOIL SAMPLES FOR SOIL FERTILITY SURVEY
ABYUHA, EL-MINYA

APPENDIX II

Ideas for Soil Testing in Egypt

Based on the experience gained in the EWUP Soil Fertility Survey it is recommended that a pilot soil testing program be considered. The objectives of this soil testing program would be to improve the allocation of fertilizers, micronutrients, and soil amendments to individual cooperatives and different regions of the country, based on regular multi-year soil analysis and crop needs. The improved allocation of fertilizer could substantially reduce the governments expense in subsidizing fertilizer, and assure a greater return for that investment.
In addition to improving the fertilizer allocation, the soil testing program could also evaluate the long term impact of fertilizer distribution and make recommendations on efficient fertilizer application techniques. The Soil and Water Research Institute, which actively participated in the EWUP Survey, could easily carry out this pilot soil testing program from a centralized laboratory.

Since the EWUP data consistantly showed samples within "hods" to be statistically similar, while samples between "hods" to be statistically different, the "hod" could be the most practical sampling unit. A composite sample could be periodically obtained from each "hod" by a sampling team from the testing laboratory. These samples could be analyzed for various properties. For multi-year analysis, possible initial determination may include pH, EC, phosphorus, potassium plus certain micronutrients. These determinations could be modified as conditions warrant. The results of these determinations would be the

identification of cooperatives which could profit from additional allocation of fertilizers, micronutrients, and areas the soil amelioration program or other programs may wish to consider for allocations of gypsum, etc. In addition the program should conduct simple on-farm trials to provide basic calibration data for soil testing methods, and the levels of various fertilizer combinations most appropriate for Egyptian crops and soils.