Guam Soil Test Summary, 1984-1993

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1996

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Introduction

The Soil and Plant Testing Laboratory of the University of Guam's College of Agriculture and Life Sciences has been offering soil analytical services to the Guam community for approximately 20 years. The current objectives of this laboratory are:

1. To provide appropriate soil, plant and environmental analyses and fertilizer and lime recommendations within Guam and the region of Micronesia.

2. To develop information for the public on proper sampling methods, the role of plant nutrients in agriculture, and the need for sampling and appropriate management practices to improve nutrient efficiency and reduce harmful effects to the environment.

3. To provide the public with unbiased information on the nutrient content and potential effectiveness of soil amendments available on Guam.

4. To assist in the analysis of quarantined materials and in advising the Guam Department of Agriculture whether such materials should be allowed to enter into Guam.

5. To keep records of the results of soil and plant analyses for research purposes. These results will be periodically summarized and made available to the public.

6. To provide guidance to private and public soil, plant and environmental testing laboratories as to approporiate soil and plant testing methods and recommendations.

Establishing suitable soil testing procedures involves several steps including (1) selecting an extractant and analytical method for a given nutrient; (2) correlating the amount extracted with the amount taken up by the plant and; (3) calibrating the test value with plant yield or any other important growth characteristic (Corey, 1987). Fertilizer recommendations are based on the calibration information and fertilizer response curves. Proper sampling methods, sample preparation and analytical techniques are also critical for the success of any soil testing program. Soil test results should be accurate, have a high degree of precision and be returned to the client in a timely manner. Development and improvement of these soil testing components on Guam are an on-going process and will depend on the maintenance of active research and extension programs.

Soil testing promotes the efficient utilization of nutrients for optimal plant growth and productivity while minimizing environmental pollution. Soil test results indicate which and how much fertilizer or other soil amendments may be necessary for a given crop or plant. In this way, a grower can save on the cost of overfertilization and also decrease the risk of environmental pollution.

This publication summarizes the soil test results submitted to the Soil and Plant Testing Laboratory from 1984 to 1993. It supplements a previous report which summarized soil test results from 1975 to 1984 (Demeterio et al., 1986). This report also provides information on the performance of the Laboratory and the use of the Laboratory by the general public and the research community.

Performance of the Laboratory

From 1984 to 1993, the Soil and Plant Testing Laboratory has analyzed a total of 2926 soil samples. Figure 1 shows the relative number of samples analyzed each year. The lowest number of samples analyzed was 133 in 1988 and the highest was 444 in 1984. Fluctuations in the number of samples analyzed partly reflects problems the Laboratory has encountered in maintaining public confidence in the performance of the Laboratory and in demonstrating the need for soil testing on Guam. The amount of time the Laboratory takes for completing soil analysis of farmer samples has averaged approximately 15 days every year, except for 1990 and 1991 when response time was much higher (Fig. 2). This increase in analysis time during those years was possibly a result of a decrease in the number of Laboratory personnel. In general, most farmers request the routine analysis offered by the Laboratory, which includes analysis of soil pH, organic matter, extractable phosphorus (P), exchangeable potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na). Analyses for zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu) were previously also part of the routine soil analysis. Currently, these elements are analyzed by special request. Special tests for texture analysis and total nitrogen (N) are also offered by the Laboratory.

Sources of Soil Samples

Over 88% of all soil samples analyzed by the Laboratory from 1984 to 1993 originated from Guam (Fig. 3). Farmer samples made up 32.5% of total samples. Other sources of samples included researchers (42.6%), off-island samples (11.5%), golf courses (9.7%), landscapers and nurseries (2.3%), government agencies (0.8%) and private companies (0.1%). Off-island samples came from several locations in Micronesia including Saipan (25.6%), Pohnpei (21.9%), Kosrae (12.5%) and Yap (11.0%) (Fig. 4). The larger number of samples coming from these islands may be a result of the activities of extension personnel located at land-grant universities and of research projects originating from the University of Guam or from the Soil Conservation Service.

Analysis of the geographic origin of soil samples submitted by farmers on Guam indicates a relatively larger representation of samples from Northern Guam (Fig. 5 and 6A). In Northern Guam, the Dededo district has the largest number of submitted samples. Yona in the Central region and Talofofo in the South also have a relatively higher proportion of submitted samples. The geographic origin on Guam of over 27% of all submitted farmer samples was not indicated on the submission sheet. In contrast to samples originating from farmers, samples from golf courses came from a limited number of districts (Fig. 6B). The geographic distribution of submitted soil samples may be an indication of greater agricultural activity in a given district and also possibly a greater lack of awareness of the availability or value of soil testing in certain districts.

Soil Sample Analyses

Distribution of Farmer Samples: Figures 7-12 show the distribution of Guam farmer soil test results for soil organic matter, pH, P, K, Ca, Mg, Na, Fe, Zn, Mn and Cu. The number (n) of samples evaluated, the average (avg) and the standard deviation for each of the soil tests are also provided. The highest proportion of farmer soil samples tested 4-6% in soil organic, 7.0-8.0 in soil pH, 0-10 mg/kg P, 40-80 mg/kg K, 3600-4800 mg/kg Ca, 0-280 mg/kg Mg, 0-15 mg/kg Fe, 0-10 mg/kg Zn, 75-100 mg/kg Na, 0-50 mg/kg Mn, and 0-2 mg/kg Cu. These values suggest that a large proportion of farmers' fields may be experiencing deficiencies in P, K, Zn, and Mn. The large proportion of farmer soil samples with a relatively high pH also indicates that problems related to high pH such as low P, Fe, Zn, Mn, and Cu availability may also be common. The range in soil test values were generally high as indicated by the large standard deviations for each soil test relative to the mean value. This large variability indicates the wide range of soil test encountered on Guam.

Average Soil Test Results by Source and By Geographic District on Guam: Table 1 gives the average soil test results by source of sample for samples originating on Guam. These results show few striking differences in average soil test results among the major sources of samples. Although golf courses, landscapers and nurseries require high fertilizer maintenance, soil samples originating from this source were not on average higher than other sources, except for slightly higher P levels.

Table 1. Average soil test analysis by source on Guam.

	Chemical Analysis										
Source	pH	Organic Matter %	P	K	Ca	Mg	Na	Zn	Fe	Mn	Cu
			mg/kg soil								
Farmers	6.8	6.4	21.2	182	6453	664	169	27	102	167	8
Golf courses	6.8	4.2	28.7	150	4138	974	126	14	55	44	6
Landscapers	6.7	7.8	34.3	162	3666	687	128	3	96	241	5
Research	7.2	7.0	18.6	127	6541	680	109	12	60	189	11
Schools	6.6	4.2	10.1	471	5185	1631	214	20	284	245	16
Government Agencies	6.0	6.2	17.2	185	3458	1123	207	14	53	151	6

Soil test results for farmer samples by geographic district indicate some trends by region (Table 2). Soils submitted from northern districts generally had higher pH, organic matter and P content and lower K, Mg, Fe and Cu than soils submitted from the southern districts. Unusually low or high soil test recorded for districts such as Umatac may be a result of the relatively small number of samples received from these districts.

Table 2. Average soil test analysis for farmers by District on Guam.

District	pH	Organic Matter	P	K	Ca	Mg	Na	Zn	Fe	Mn	Cu
		Chemical Analysis									
		- %-				mg/kg soil					
					North						
Yigo	7.0	8.2	26.6	105	4819	406	93	65	52	198	7
Dededo	7.2	8.4	27.3	76	4913	175	100	23	19	233	2
Tamuning	7.1	6.4	32.0	182	5441	448	354	48	34	126	4
Barrigada	6.8	6.6	20.5	144	4582	271	103	40	37	200	7
Mangilao	7.0	6.0	17.7	180	30509	447	109	18	47	225	9
Average	7.0	7.1	24.8	137	10053	349	152	39	38	196	6
					Central						
Mongmong	7.3	5.9	31.0	111	3654	—	111	—	—	—	—
Agana Hts	6.6	4.7	26.3	118	3776	252	81	2	50	28	5
Asan	7.2	5.5	21.0	149	4782	482	95	15	29	164	6
Piti	7.1	12.1	2.2	123	10150	—	185	—	—	—	—
Yona	6.0	6.3	6.1	155	3832	500	118	14	74	121	12
Sinajana	6.9	6.2	8.1	206	5569	893	96	18	104	123	6
Chalan Pago	6.8	5.4	5.3	385	7329	1531	273	11	187	121	9
Agana	7.5	5.3	13.3	83	5378	235	85	140	22	213	7
Average	6.9	6.4	14.2	166	5559	649	130	33	78	128	8
					South						
Santa Rita	6.5	4.9	4.1	227	6680	1669	168	22	282	193	21
Agat	6.7	4.3	7.4	378	6399	1081	178	82	233	213	18
Talofofo	6.1	4.8	11.0	184	2870	575	210	13	148	119	11
Inarajan	6.4	4.2	6.4	367	4583	1839	315	7	378	216	13
Merizo	6.2	3.8	7.6	495	5818	1779	206	39	170	140	13
Umatac	7.0	1.4	1.3	1200	3357	3300	4129	4	568	184	6
Average	6.5	3.9	6.3	445	4951	1707	868	28	296	178	14
Not Known	7.0	7.3	35.3	128	6886	550	142	20	47	117	7

Conclusions

1. The Soil and Plant Testing Laboratory has performed an important service to the Guam agricultural community for approximately 20 years. However, the Laboratory needs to take steps to improve public confidence in the performance of the Laboratory and in increasing public awareness of the need for soil testing.

2. The Laboratory provides services to several sectors on Guam and Micronesia including farmers, landscapers, nurseries, golf courses, government agencies, schools, private companies and agricultural researchers. Each sector has special testing needs which may need to be further studied and included in the services provided by the Laboratory. Development of fertilizer recommendations should also be a top priority.

3. Special efforts need to be made to increase farmer participation in regular soil testing from all regions of Guam, perhaps through special public educational campaigns, extension programs or public media.

4. The relatively high proportion of farmer samples testing deficient in P, K, Zn, and Mn suggests the need for further research on nutrient management options for farmers on Guam. Informational programs, specifically targeted on managing deficiencies in these nutrients for various crops, may also be required.

5. Regional differences in soil test results reflect the general differences in soil properties between the Northern and Southern regions of Guam. However, the large variability in soil test results encountered on Guam indicates that regional management recommendations should possibly be avoided. Further research is required to develop a better understanding of the chemical and physical properties of Guam's soil resource.

6. Records of soil test results can assist in evaluating the performance of the Soil and Plant Testing Laboratory and in understanding potential soil problems encountered on Guam. It is recommended that these records continue to be maintained and that further information should be asked of people who submit soil samples. This information would include questions regarding previous nutrient management of the field, crops grown and yield estimates.

References

Corey, R.B. 1987. Soil test procedures: Correlation. p. 15-22. In J.R. Brown (ed.) Soil testing: Sampling, correlation, calibration, and interpretation. Soil Sci. Soc. Am. Special Publ. No. 21. Madison, Wisconsin.

Demeterio, J.L., F.J. Young and M.B. Yamanaka. 1986. Guam soil test summary. 1975-84. Agricultural Experiment Station Publication #58. College of Agriculture and Life Sciences, University of Guam, Mangilao, Guam.

Figure 1. Number of soils analyzed by year.

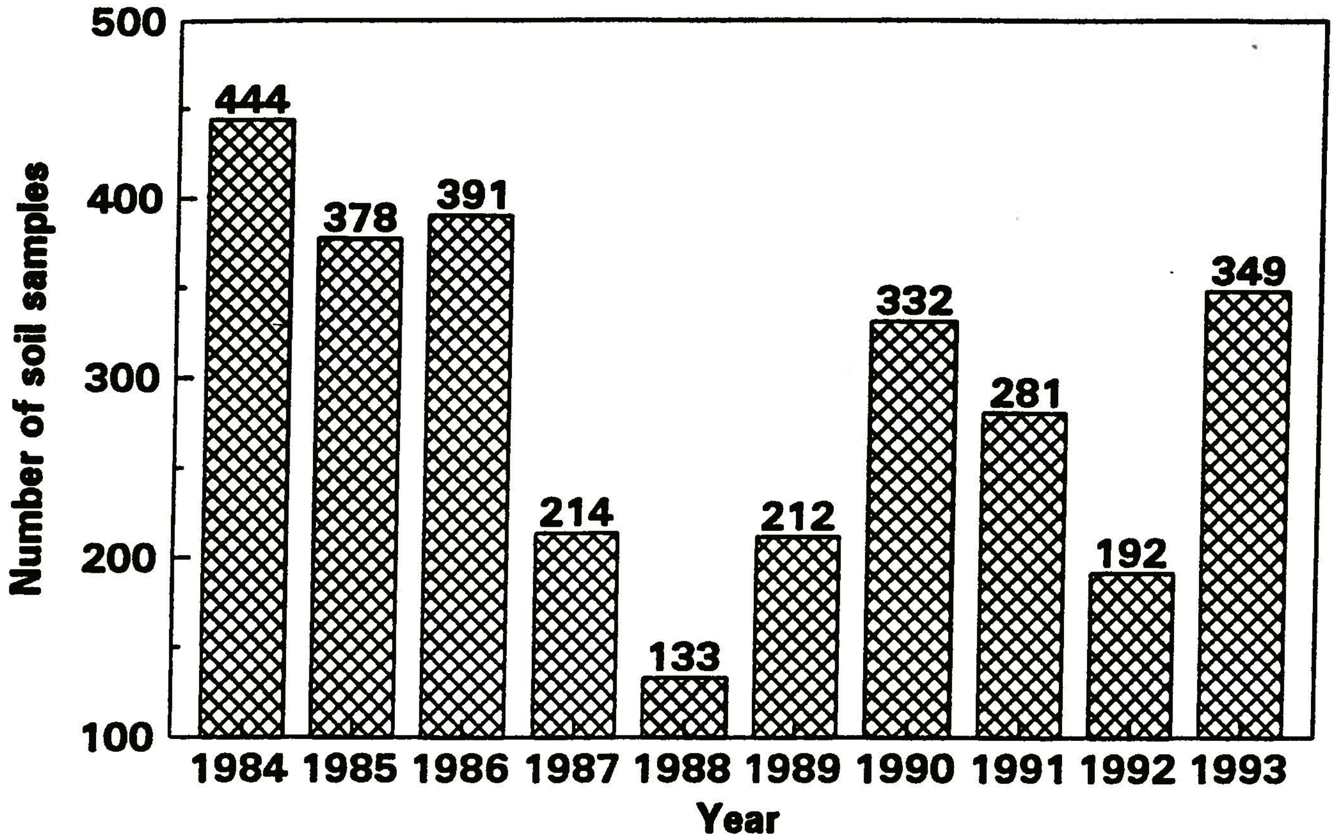


Figure 2. Average time of analysis for farmers samples.

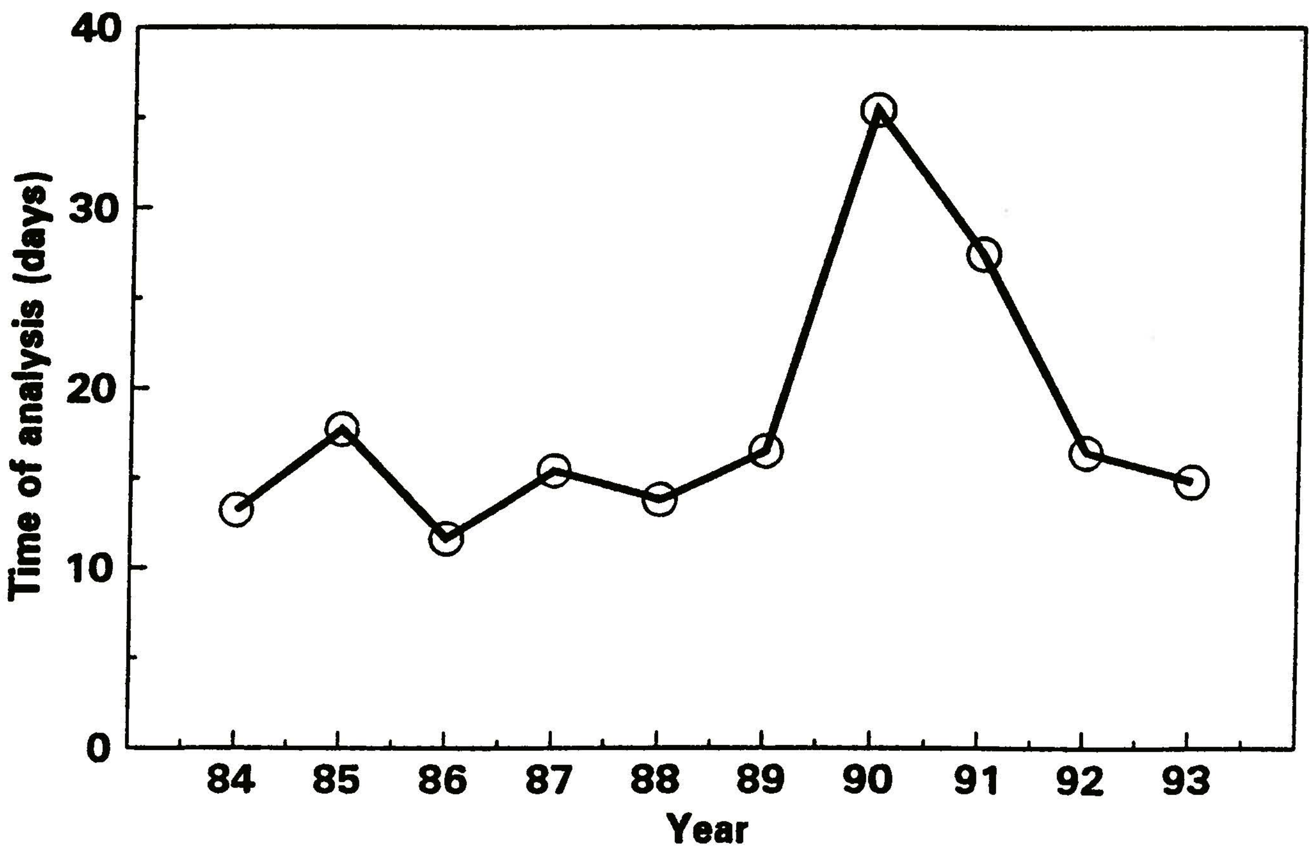


Figure 3. Source of soil samples.

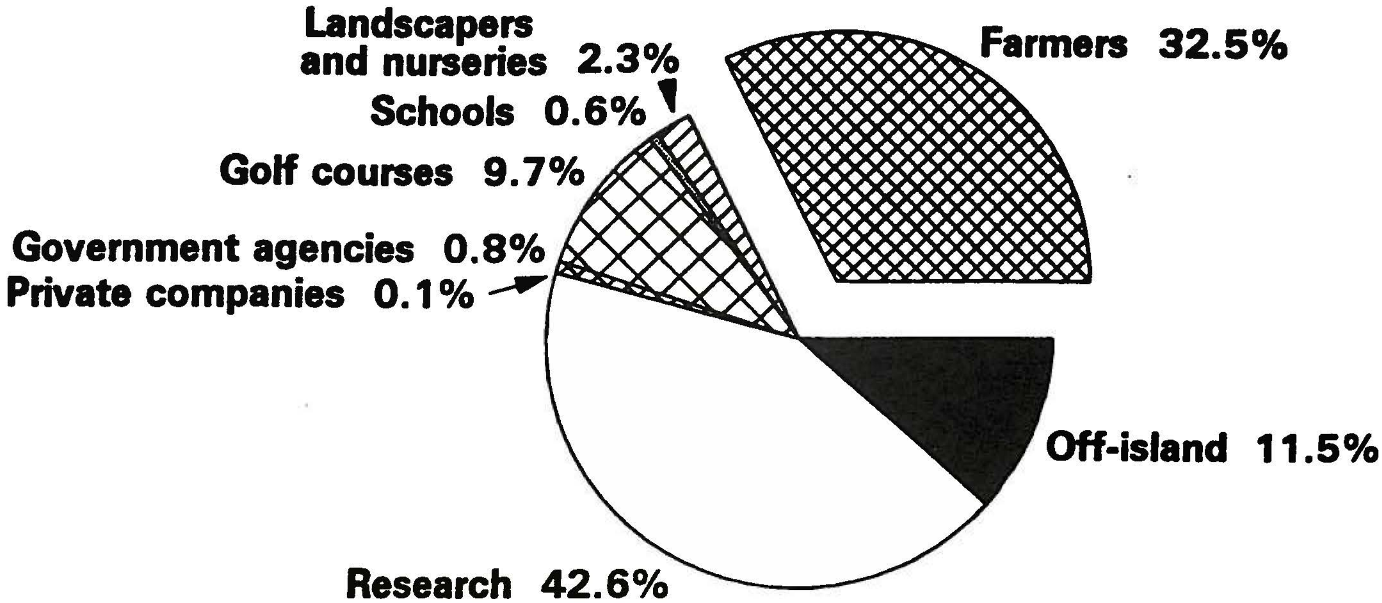


Figure 4. Source of off-island soil samples.

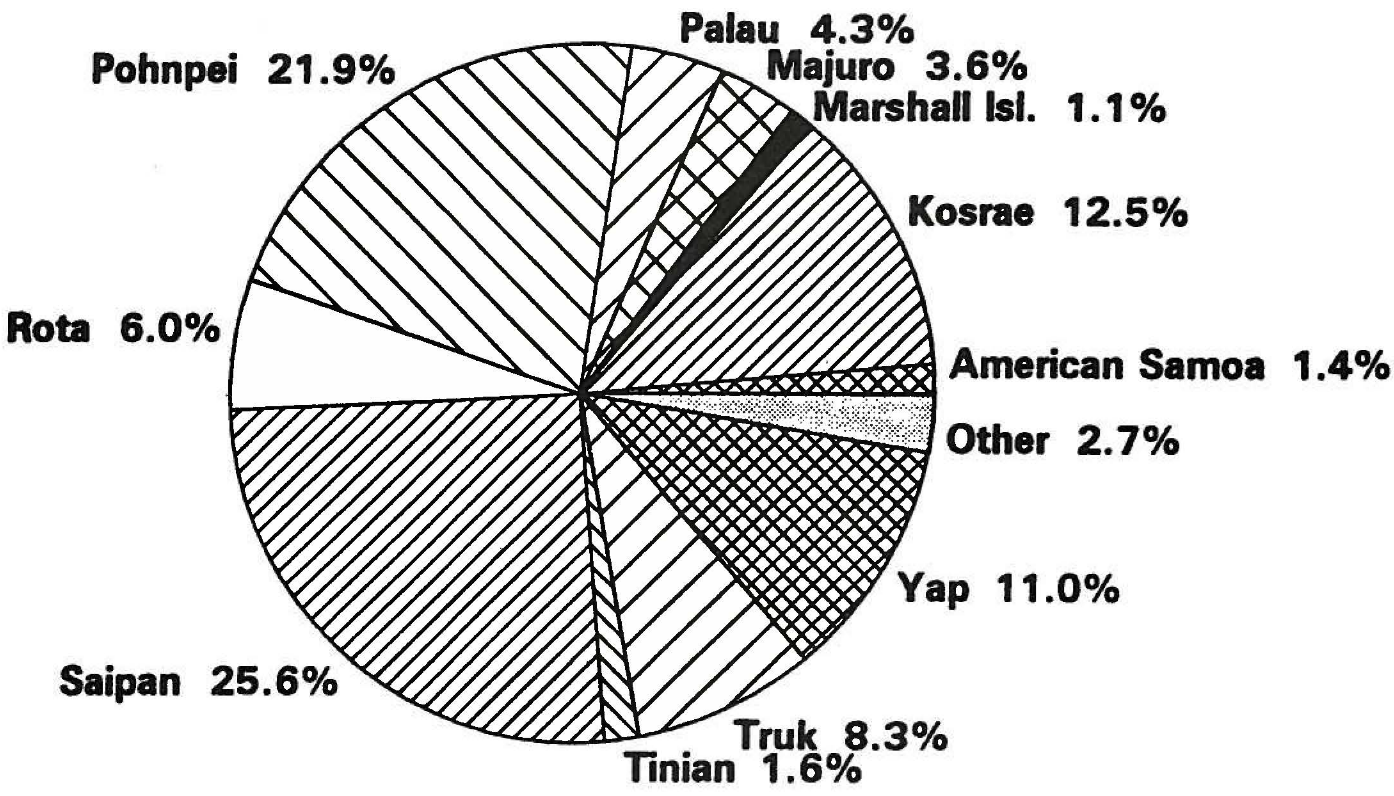


Figure 5. Map of Guam showing district and regional boundaries.

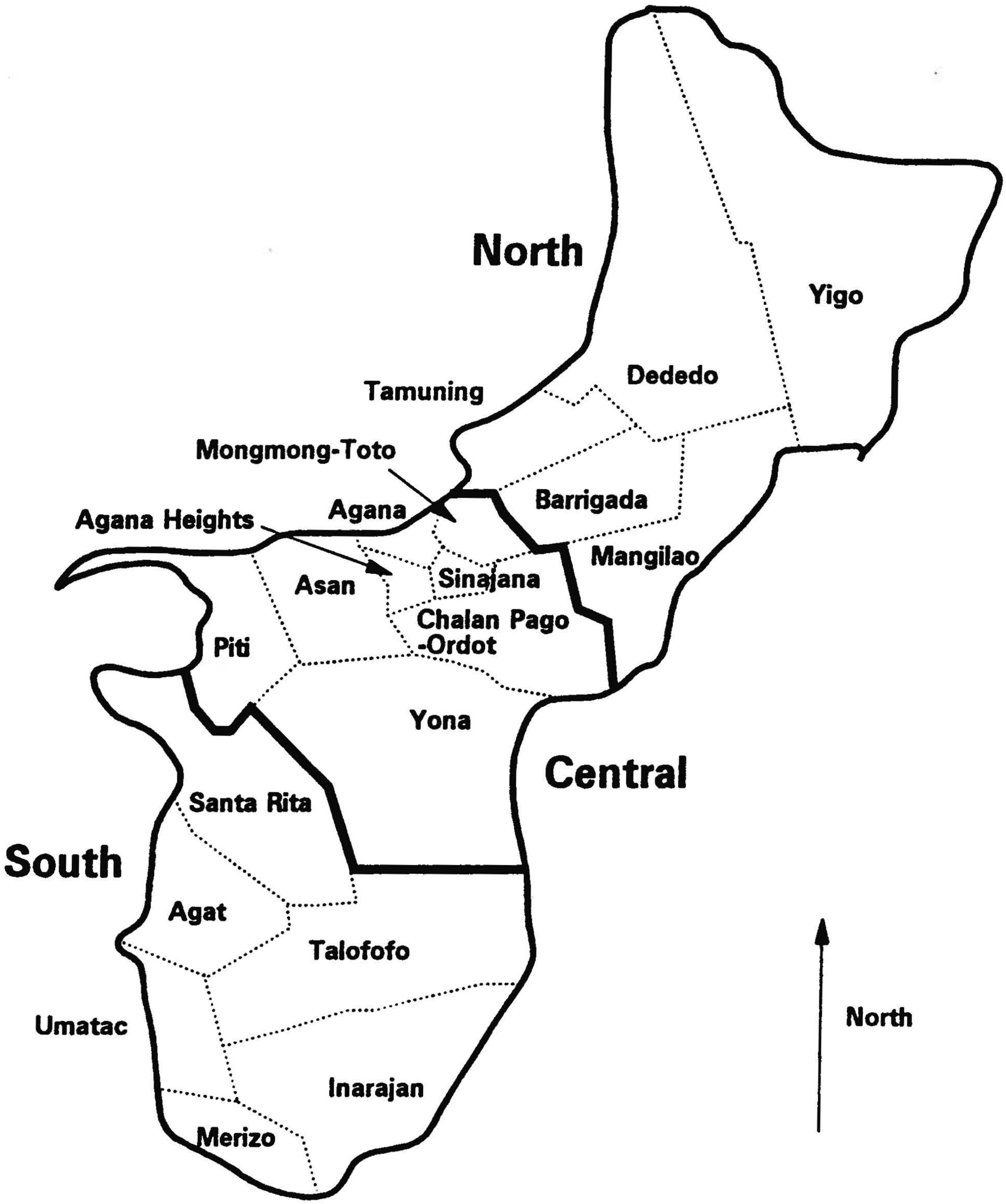


Figure 6. Proportion of soil samples by district and region for A) farmers and B) golf courses.

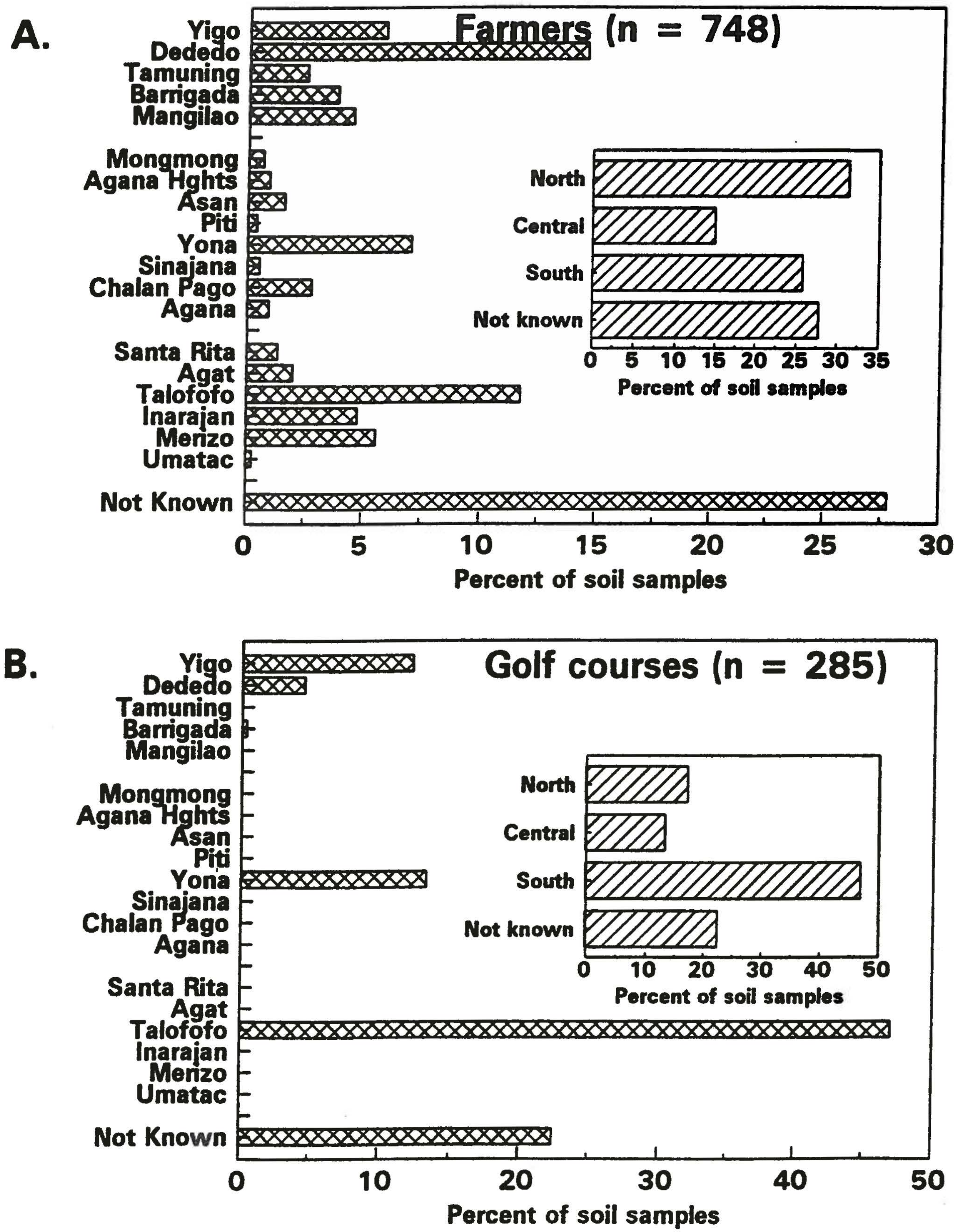


Figure 7. Distribution of A) soil organic matter and B) soil pH in Guam farmer soil samples.

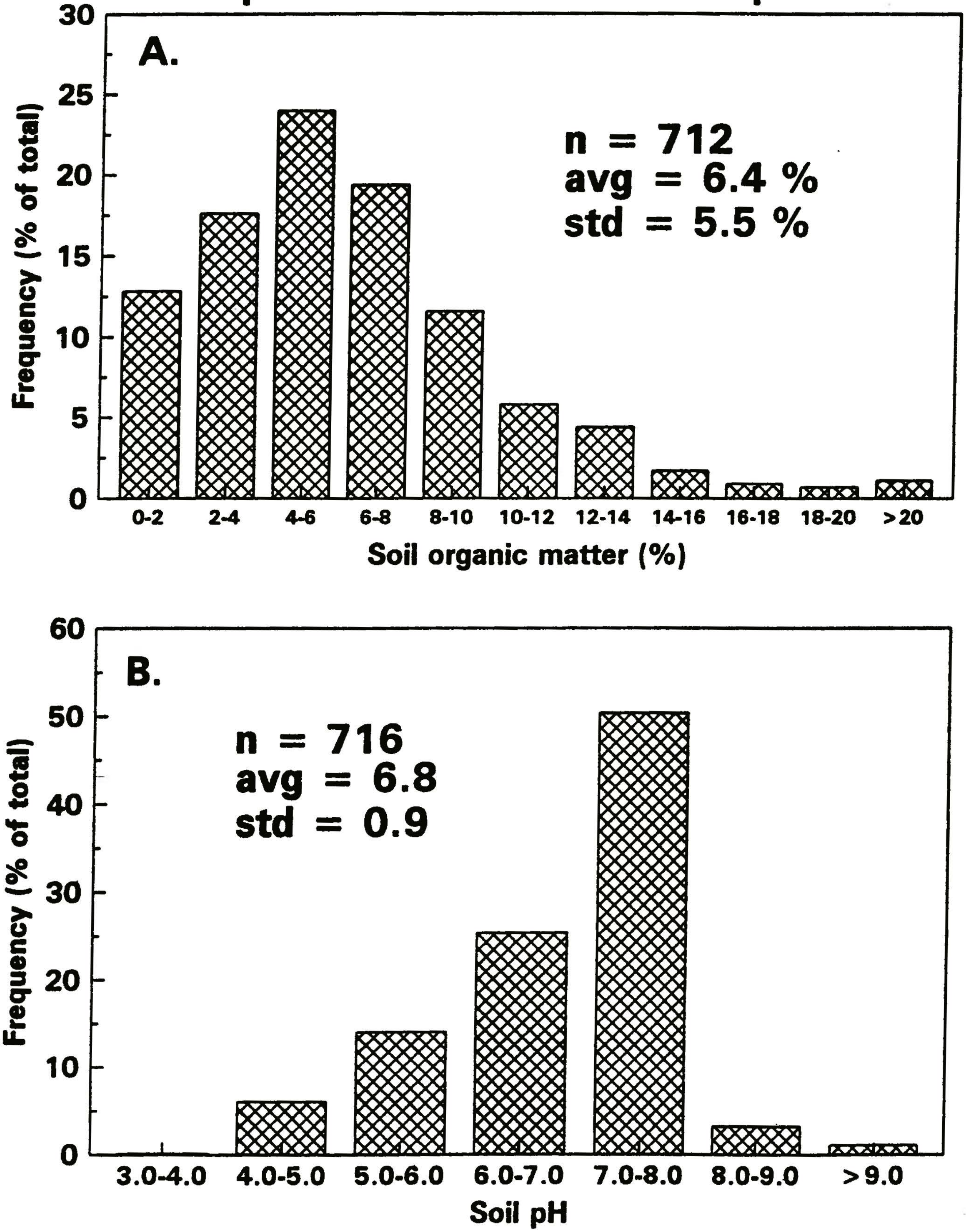


Figure 8. Distribution of A) extractable P and B) exchangeable K in Guam farmer soil samples.

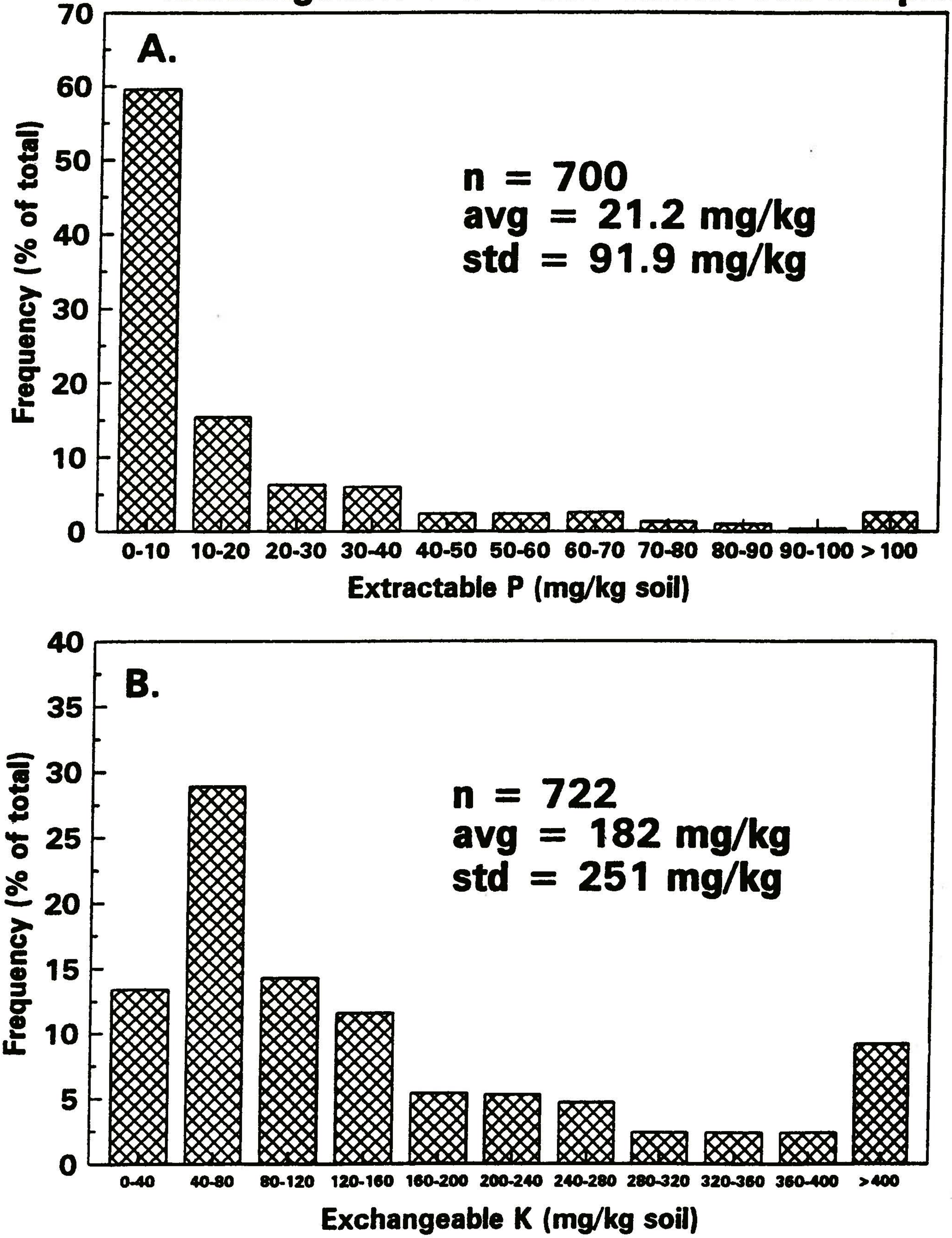
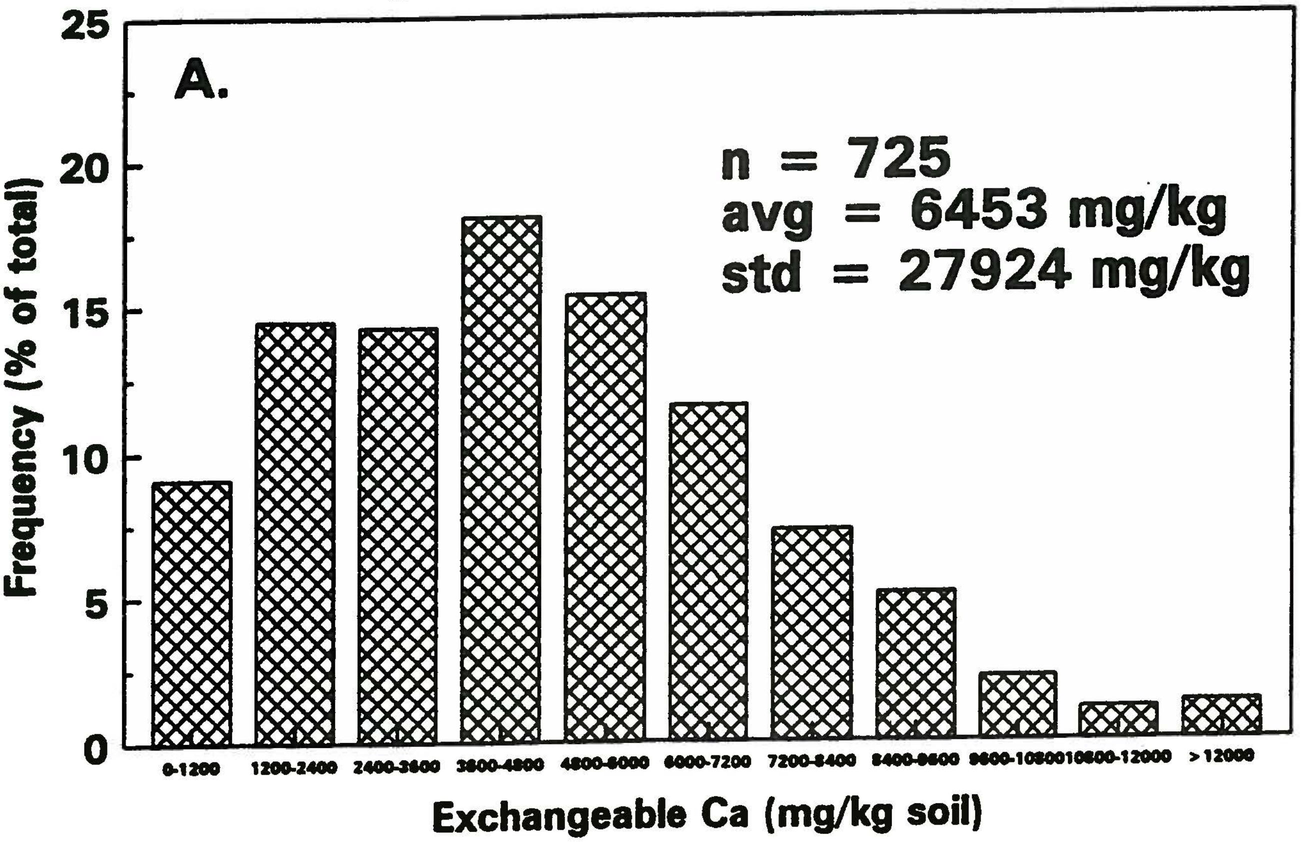


Figure 9. Distribution of A) exchangeable Ca and B) exchangeable Mg in Guam farmer soil samples.



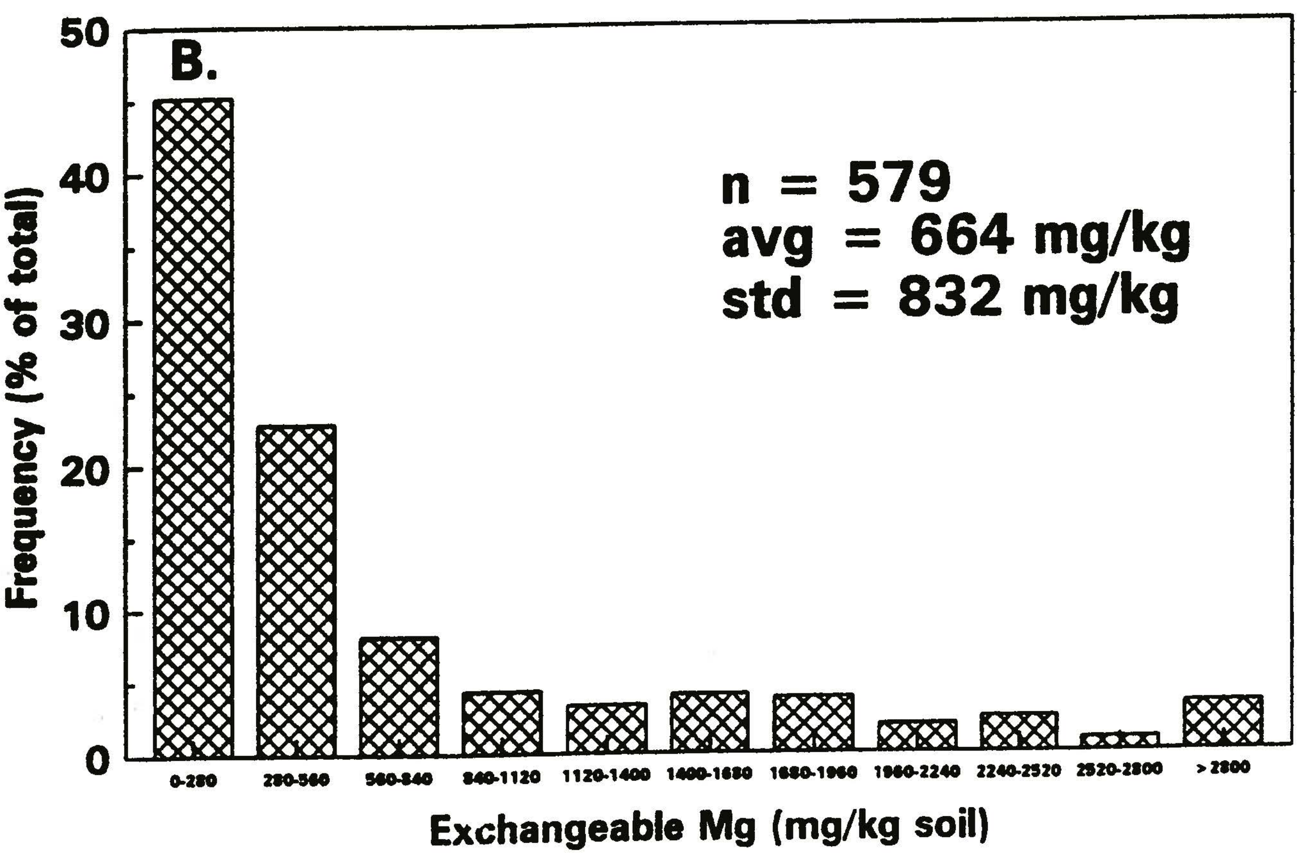


Figure 10. Distribution of A) extractable Fe and B) extractable Zn in Guam farmer soil samples.

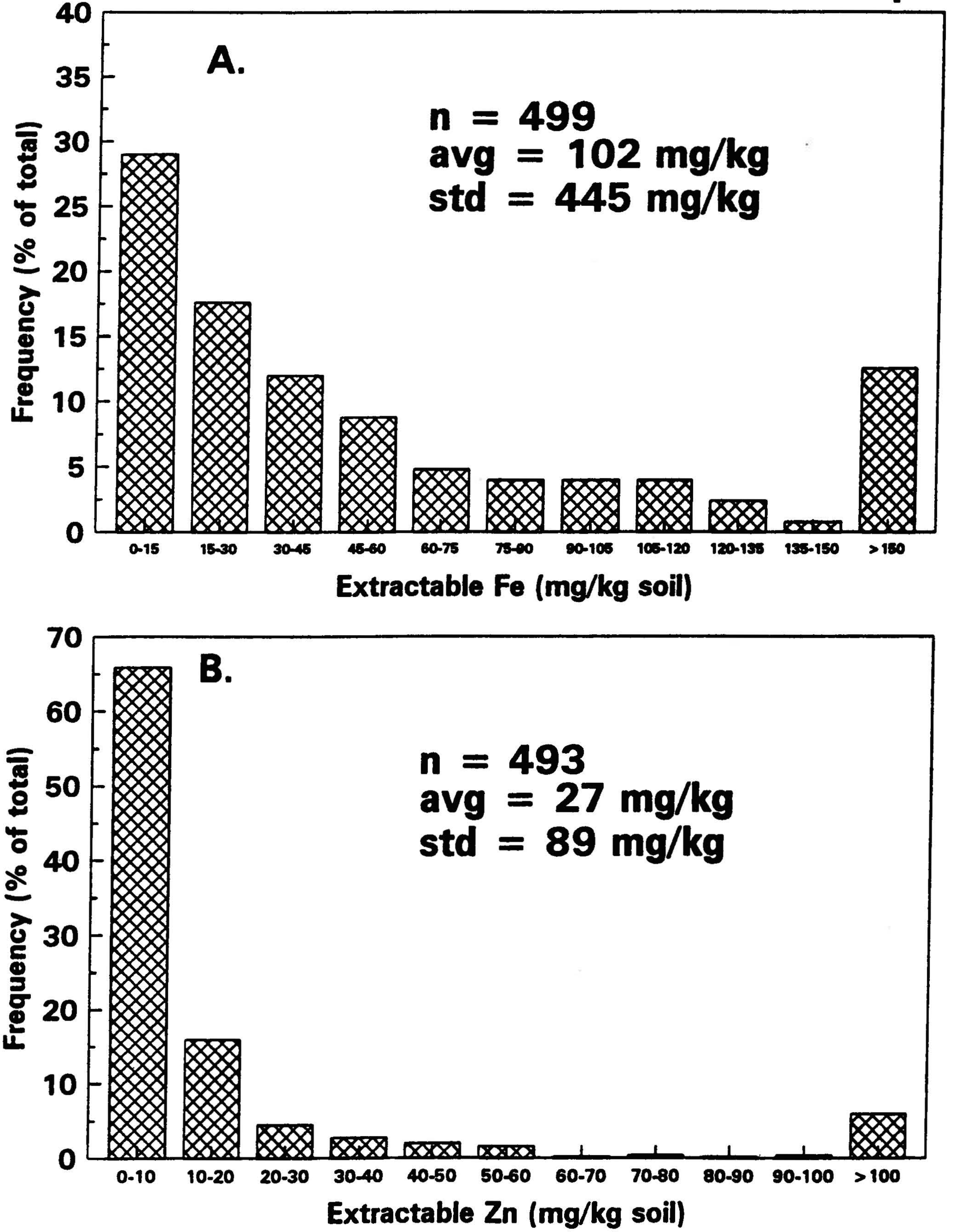


Figure 11. Distribution of A) exchangeable Na and B) extractable Mn in Guam farmer soil samples.

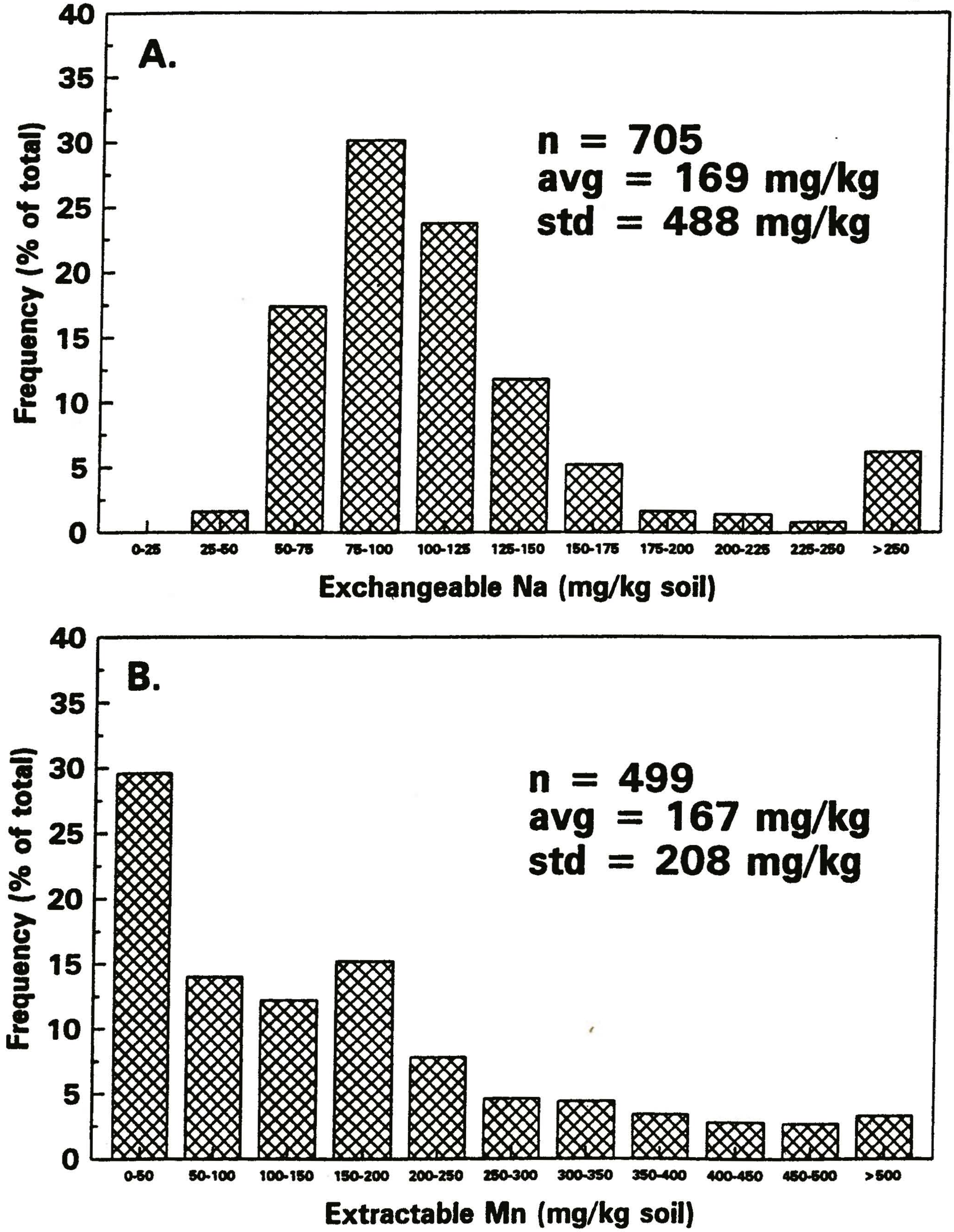


Figure 12. Distribution of extractable Cu in Guam farmer soil samples.