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REPORT OF UNIVERSITY OF HAWAII
FOR THE PERIOD
JULY 1, 1972 TO JUNE 30, 1973

A. TITLE: A Grant to Strengthen the Capabilities of the University of Hawaii in Special Problems of Tropical Soils (Grant AID/csd 2833)

B. GRANTEE: University of Hawaii

C. DIRECTOR: Dr. Wallace G. Sanford

D. STATISTICAL SUMMARY

1. Period of Grant: November 2, 1970 to November 2, 1975

2. Amount of Grant: $500,000

3. Expenditures

3.1 For report period: $167,599

3.2 Accumulated: $270,102

3.3 Anticipated for next year: $139,000

E. NARRATIVE SUMMARY

An objective of the 211(d) Grant is to strengthen the existing tropical soils program of the University of Hawaii so that it will be more useful to AID and other personnel involved with tropical soils, crop management and related activities in the less-developed countries. Staff from Hawaii's improved tropical soil program was used by AID to provide assistance and advice to the Government of Tanzania. Dr. L. D. Swindale and Dr. J. A. Silva of Hawaii made a reconnaissance survey of the land systems of the Arusha province, Tanzania, and consulted with AID and GOT personnel on devising a set

of proposals for soil survey and land capability evaluation. A number of soil samples were also collected for analysis in Hawaii. After detailed classification of the soils in Tanzania is complete, information concerning agricultural practices on similarly classified soils in Hawaii can be made available to the agriculturalist of Tanzania.

Dr. C. A. Bower, a recent addition to our staff with 211(d) funds, was also used in an advisory role by the Consultative Group on International Agricultural Research. Dr. Bower served as U.S. representative on a Near East and North Africa Agricultural Research Review Mission. The purpose of the Mission was to identify gaps and priorities in existing agricultural research in the region with the view of providing additional support for selectivities in research, training, information and related work.

Dr. W. G. Sanford in February, 1973, did consulting on the agronomy of pineapple and visited IFAC personnel. This was followed by a week's visit to the United Republic of the Cameroons at the invitation and expense of IFAC. The purpose of the trip was to get acquainted with agricultural problems in this area and to discuss possible cooperation with IRAT personnel. The trip was followed by a visit to Paris where Dr. Sanford talked to personnel in the Soils Division of ORSTOM.

The University of Hawaii will also provide technical assistance

and personnel for a project to study management of heavy delta clay soils of the Mekong Delta. This project, headed by Dr. G. Uehara, will study river silt and delta soils to aid in the planning of the control of the Mekong River.

In research, the joint project with Puerto Rico, in classifying the soils of Hawaii and Puerto Rico according to the FAO system, and correlating the chemical and physical characteristics of these soils at the family level, is progressing rapidly. A four part publication should be completed this year. Additional studies of soil nitrification and zero point of charge on these Puerto Rican and Hawaiian soils are also nearing completion.

A cooperative project with Prairie View A&M was also initiated. This project will compare the external phosphorus requirements of crops on soils of similar texture. Results on Hawaiian soils have shown that there is a large variation in amount of fertilizer required to reach a prescribed level of P in soil solution, but the prescribed level is the same (dependent on the crop) for most of the diverse soils of Hawaii.

Research in mineralogy has centered on halloysite and imogolite. It was discovered that these two minerals are present in the same soil, which was a particularly interesting find. Other work concerned the amorphous portion of the soil. Techniques were also developed to prepare holey support films and films of silicon monoxide. These

films are of aid in the study of soil minerals.

Work in soil biology by Dr. Burton Koch with non-symbiotic nitrogen fixing bacteria, resulted in the isolation of five facultative anaerobes. These bacteria apparently undergo a seasonal variation in number. However, their high fixation rate suggested a significant contribution to total soil nitrogen by these bacteria. Other work has shown that s-triazine herbicides were rapidly degraded in Hawaiian soils, but the substituted urea, Diuron, persists for several years in a non-bioactive form, apparently adsorbed to soil organic matter.

Much work was accomplished in soil chemistry. Studies of nitrogen transformation and movement have shown that NO_3^- moves rapidly down the soil profile and movement is enhanced by reducing plant population density. Also, the low concentration of mineral nitrogen in soils with high organic matter was shown probably to be caused by nitrogen immobilization. A critical evaluation of chemical methods for determining the lime requirements of soils was performed by Dr. S. Reid who visited our department from Cornell. A similar study by Dr. Silva on aluminum, showed that $\underline{N}$ $BaCl_2^-$-extracted Al closely correlated with plant yield and plant Al. Since the method was tested on soils with a range of mineralogy and pH, it is expected to have wide application to tropical soils. Also, studies on calcium silicate showed that over a five year period, plant uptake accounted for about 20 percent, soil extraction with phosphate about 20 percent, and resi-

dual in the soil about 60 percent of the applied silicon. Since there was no evidence of Si movement below 18 inches it appears that much of the applied Si is in a form in the soil which is not readily displaced by phosphate.

Research in all phases of tropical agriculture has benefited greatly by the installation and calibration of the x-ray fluorescence quantometer. Plant tissue and soil and mineral samples can now be analyzed for sixteen elements simultaneously. Although techniques of application of this instrument are still being developed, it is believed that many previously unanswered questions concerning interaction of elements in both soils and plants can be answered by simultaneous quantitative analysis.

In soil physics, soil water hysteresis has been measured in aggregated Oxisols in the zero to 0.2 bar suction range, and mathematical models to predict hysteresis based on the hydraulic properties of the soil are being developed. One dimensional infiltration of water in laboratory columns of aggregated Oxisols has also been measured for several initial water content and boundary conditions. Measurement was also made of zero points of charge for most of the soils of Hawaii. Relative to zero points of charge measured in NaCl, the zero points of charge shift to lower pH values with $CaCl_2$ and higher pH values with Na_2SO_4.

In teaching, Drs. R. Green and H. Ikawa have made use of the in-

structional techniques evaluated during the Soils Teaching Workshop in Hawaii in 1971. The methods evaluated in the workshop were well accepted by the students of Dr. Green's course. The value of these workshops should be stressed. Two new courses now taught in our department are in Soil Microbiology and Techniques of Electron Microscopy. The former course benefited greatly by the visit of Dr. M. Alexander of Cornell. In soil physics, teaching has been improved by the completion of a laboratory manual that is applicable to tropical soils. Other Consortium members may wish to consult with Drs. G. Tsuji and G. Uehara concerning their approach.

Several members of our department have also participated in teaching of short courses and workshops held at other Consortium institutions. Drs. Uehara and P. Ekern lectured on South East Asian agriculture and applications of soil physics to agricultural practice at the Soil Workshop held at Prairie View A&M, and Dr. Fox and Uehara participated as speakers and group discussion leaders at the Tropical Soils Short Course held in Mayaguez, Puerto Rico.

One of our most important accomplishments during this last year has been the development of a system of information retrieval for the wealth of information on Hawaiian soils and agricultural practices. Ms. Thompson has indexed and ordered information gathered on tropical soils, and has also abstracted technical papers, theses, and dissertations of this department. These will be published

and distributed to Agronomy and Soil Science Departments of all Land Grant Universities as well as other interested institutions. Plans have also been made to acquire new books and journals to upgrade the Departmental library in the next fiscal year.

One of Dr. Sanford's students has reproduced boron, nitrogen, and magnesium visual deficiency symptoms on the leaves of macadamia and papaya, two crops of potential value in the tropics.

Future plans include a Mineralogy Workshop for members of the Consortium in July, 1973, and a Tropical Soils Institute to be held in the Philippines in June, 1974. Dr. A. R. Southard from Utah State University will spend his sabbatical leave in Hawaii during 1973-74. In addition to teaching, he will help to strengthen our soil classification program.

All staff presently housed in Gilmore Hall will move to the St. John and Pope Plant Science Laboratories during July and August 1973. This should strengthen our program by creating a closer working relationship with other staff working on tropical food and fiber production.

F. DETAILED REPORT

1. General Background and Purpose of the Grant: In making this grant, the principle criterion used was the degree of commitment a

university is making or willing to make in increasing its competence in tropical agriculture. Development of this competence would lead to a better understanding of significant agricultural problems relevant to emerging nations in the tropics. To this end, AID awarded five-year grants to establish centers of competence in tropical agriculture at existing institutions with permanent sources of funding and commitments on problems of international development.

2. Objectives of the Grant

2.1 Objectives restated: This grant will strengthen the existing competency of the University of Hawaii by means of a collaborative effort with Cornell University, North Carolina State University, Prairie View A&M College, and the University of Puerto Rico, to provide training, related research, technical assistance and consultation, and conduct related research in soil science for increasing food production in soils of the tropics. The grant will be used to:

(1) Further strengthen the soil mineralogy group at the University by the addition of a soil mineralogist, a technician, and appropriate support and equipment.

(2) Provide for visiting professorships to be used to bring the University of Hawaii additional expertise and experience from either the cooperating institutions or from other services

(3) Provide graduate assistantships in order that students of the other four cooperating institutions may have access to the special strength of Hawaii

(4) Provide graduate assistantships to conduct research in tro-

pical soils toward advanced degrees at the University of Hawaii

(5) Provide funds for travel by assistantships that are exchanged among the institutions, for visiting professorships, and for staff to consult with other cooperating institutions

(6) Strengthen the existing curriculum in tropical soils so that it will be more useful to AID and other personnel involved with tropical soils, crop management, and other related activities in the less-developed countries.

(7) Strengthen library and other information services with special emphasis on the preparation of manuals or other training materials on tropical soils and other related fields.

2.2 Review of the objectives: The objectives listed above will remain essentially the same except more emphasis will be placed on extension work particularly when such work, is compatible with the work being done in teaching and research. In meeting the fulfillment of this objective, section 5 of this report should be perused. In the future, individuals traveling to other areas whether on 211(d) or other funds, will continue to make available their services as experts when requested by appropriate individuals.

3. Accomplishments

3.1 Teaching: Instructional techniques evaluated during the Soils Teaching Workshop in Hawaii in 1971, were incorporated into two introductory soils courses: "Tropical Soils" by Dr. H. Ikawa, and "Soils and Man" by Dr. R. E. Green. Instructional sheets were prepared for distribution to students for every lecture; these specified

the overall objective of the activity, detailed instructional objectives, and reading assignments. An evaluation at the end of the semester indicated that students thought the specific objectives aided them in learning the subject matter.

A new course, Soil Microbiology, was taught in our department by Dr. Burton Koch. This course has an emphasis on population, mineral metabolism, and plant microbial interrelations. This course benefited by the visit and lectures of Dr. M. Alexander of Cornell University under the provisions of the 211(d) grant. Dr. Alexander's lectures contributed to the subject matter of the course, and they also increased student interest in this area of tropical soils research.

A second new course, Techniques of Electron Microscopy, was offered to agronomists and soil scientists in the fall of 1972 and summer of 1973. This course, taught by Dr. Sakai (paid by 211(d)), will allow graduate students to use this valuable tool in their studies. Methods of fixing, embedding, and sectioning plant material, observation of particulate matter (bacteria, clay), and embedding and sectioning of soil minerals were described.

One of the objectives of the grant is to prepare manuals or other training materials on tropical soils. With this in mind, Dr. Tsuji assited by Mr. L. Santo, prepared a laboratory manual for the course in soil physics. The manual (financed by 211(d)) will greatly upgrade the course, espe-

cially in the area of soil water, which is Dr. Tsuji's area of specialization. The manual will also be applicable to the soil physics of most tropical soils.

Another objective of the grant is to provide funds for travel by staff to consult with other cooperating institutions and to bring to Hawaii persons with additional expertise and experience. These funds enabled the University to bring to Hawaii Dr. John Coulter of the Rothamsted Experiment Station. During the period July 10-21, 1972, Dr. Coulter presented a series of seminars on international agriculture. In addition, Dr. Coulter consulted with staff and helped moderate a series of discussions with faculty and students on "Improving the Agronomic and Educational Conditions in the Tropics."

Dr. G. Uehara and Dr. R. Fox, also using these funds, participated in the Tropical Soils Institute held in Mayaguez, Puerto Rico, during July of 1972. While there, they consulted with University of Puerto Rico staff on research as well as teaching certain parts of the Short Course. Dr. Fox presented lectures and helped with the discussions on "Soil P and S" and on "Soil Management for Tropical Crop Production", using sugarcane and banana to illustrate the lectures. Dr. Uehara lectured and helped with the discussion on "Mineralogy of Oxide Systems" and "Physics of Tropical Soils". On the return trip to Hawaii, Dr. Fox also presented seminars and

lectures at Prairie View and Texas A&M on "Some Aspects of Soil Fertility in the Tropics," and a seminar at Colorado State University on "Relationships Between Yields and the External and Internal Phosphorus Requirements of Crops."

Dr. Y. Kanehiro, while on a 211(d) funded trip to Pasto, Colombia, for a volcanic soils meeting in June, 1972, collected soils with the specific objective of studying these soils in the laboratory exercise on chemical analysis in his Soil Chemistry course in Fall, 1972. The students thus benefited by comparing these data with data from Hawaiian soils.

Drs. Uehara and Ekern of this department participated in a soil workshop at Prairie View A&M College from October 2-6, 1972. Lectures were given in the area of "Probable transition trends in South East Asian agriculture, based on the experience in Hawaii," and "Application of Soil Physics and Water Relations to Agricultural Practices." The travel was financed by 211(d) funds.

Another Illustrated Concept in Tropical Agriculture has been published with 211(d) funding. It is "Symptoms of Plant Nutritional Deficiency--Visual Symptoms and Incipient Malnutrition." Another has been prepared and should be published soon. It deals with "Low Soil Temperatures Depress Root Activity in the Tropics." To reiterate, these single page prints will be distributed in courses offered in this department and are available to members of the Consortium.

3.2 Research: Good progress has been made on the cooperative project with the University of Puerto Rico in classifying the soils of Hawaii and Puerto Rico according to the FAO system and correlating the chemical and physical characteristics of these soils at the family level. This is a collaborative effort of Drs. Fox, Jones, Uehara, Ikawa, and Sakai of Hawaii, and Dr. Beinroth and Professor Pietri of Puerto Rico, to determine if similarly classified soils in Hawaii and Puerto Rico behave similarly. If predictions concerning management can be made through proper classification, recommendations can be made to agriculturalists using similarly classified soils. The results of a portion of this work are being prepared for publication in four papers to be published in one journal. The work is funded by 211(d).

Additional studies by Dr. Fox and Mrs. Annie Chang (paid by 211(d) on nitrogen mineralization were made on 11 surface soils of Puerto Rico. In general, nitrification rates were very low in comparison with ammonification rates. Extremes in the ratio NH_4: NO_3 produced, seemed to be related to high rainfall and cool temperatures. These in turn were associated with high levels of extractable aluminum.

Studies were also made of the point of zero net charge in surface soil and subsoil of the Puerto Rican soils. Only one instance out of 8 investigated showed evidence of significant net positive charge. That was in the Nipe subsoil at pH below about 5.3.

Cooperative work has also been started by Dr. Fox of Hawaii with

Prairie View A&M. This research will compare the external phosphorus requirements of crops on coarse-textured soils with those on fine-textured soils, permitting the transfer of data on a wide scale. One experiment using corn as the experimental crop is in progress at Prairie View. In Hawaii, 6 locations with soils having diverse mineralogical properties are being used to determine the external and internal phosphorus requirements of crops. Results of experiments completed this year indicate that the external requirement for corn and sorghum are similar, and that the amount of phosphorus required in solution is approximately the same for diverse soils of Hawaii. Amounts of phosphate fertilizer required to establish a prescribed level of P in solution varies greatly. It is dependent primarily on soil mineralogy and texture.

Recent work in mineralogy was concerned with volcanic ash soils described as allophanic. Soils collected in Hawaii, Japan, Oregon, Tonga, and Costa Rica, were studied by Mr. Delmar Dingus of Oregon State University, and Drs. Jones and Sakai of Hawaii. Transmission electron micrographs showed an abundance of gelatinous material in the soils investigated along with varying ratios of imogolite-like strands and spherical halloysite. Soils containing high concentrations of the spherical halloysite produced halloysitic x-ray diffractograms. It appears from these studies that allophane is not present as a mineral species or that the portion of the soil referred

to as allophane was part of the gelatinous material. Partial support was provided by 211(d).

Mr. Wayne Hudnall, a graduate student supported by 211(d), after taking Dr. Sakai's course in electron microscopy, has been experimenting with various techniques for producing ultra thin cross sections of halloysite and spherical halloysite. By sectioning the material, the layering of the mineral can be seen. Standard A. P. I. halloysite has been observed using this method. Mr. Hudnall has also developed methods for preparing SiO substrate films which are very fine grained and are superior to the carbon substrate films which are normally used in the observation of clay minerals with the electron microscope. A simple method for preparing both carbon and silicon holey support films was also developed. Clay minerals can be observed over the holes on these films without the interfering substrate.

In soil biology, a project headed by Dr. Koch, related to non-symbiotic nitrogen-fixation in selected Hawaiian pasture soils, has resulted in the isolation of 5 facultative nitrogen-fixing bacteria. At least 3 of these bacteria have not been previously isolated or identified. Estimates of numbers of these bacteria over a two year period indicated a relatively low population with definite seasonal variations. Examination of soil samples from these pastures with the acetylene assay indicated nitrogen-fixation rates of 0 to 0.1 μg N_2 fixed per gram soil per day, depending on the soil and moisture content. Although these bacteria were generally low in numbers, some have a fixation rate in pure culture higher than previously encountered

with facultative anaerobes. These results suggest a significant contribution of total soil nitrogen by these facultative bacteria, especially during certain times of the year. Some graduate student support was provided by 211(d).

Mr. Okazaki (paid by 211(d)) and Dr. Jones have progressed in calibrating the x-ray fluorescent quantometer. Matrix corrections were handled by multiple regression techniques. Plant tissues can be quantitatively analyzed for Mg, Si, P, S, K, Ca, Mn, Cu, and Zn. Additional elements which are still in the calibration stage are Na, Al, Cl, Fe, Br, and Mo. The Br is of interest because of its high level in many plant tissues, the source being a contaminant in fertilizers or from the bromide fumigants for nematode control or sea spray. Br is important in analysis because its presence affects matrix absorption and fluorescence. The 15 elements are analyzed simultaneously and the analysis of each sample is completed in two minutes.

Mr. Grant Gribble, a graduate student supported by 211(d), who works with Drs. Jones and Uehara, has developed a method for total soil and rock silicate analysis using the x-ray fluorescence quantometer. Matrix effects were accounted for by a multiple correlation equation which related the amount of a particular element to the x-ray intensities of the interfering elements. This method was successful because the intensities of 16 elements were measured simultaneously. Elements analyzed in soil and rock samples were Na, Mg, Al, Si, P, K, Ca, Ti, Mn, and Fe.

Mr. Johnathan Braide, a graduate student from Nigeria, is currently developing a soil testing method using ion exchange discs. The disc is allowed to equilibrate with moist soil and the adsorbed ions are measured on anion exchange resin. This method shows promise as a technique for accurate assessment of soil fertility in all types of soil.

Dr. W. S. Reid, from Cornell, engaged in a study with Drs. Silva and Fox of Hawaii, on the estimation of the lime requirements of tropical soils. The numbers of soil profiles (taken by horizons to a depth of approximately 3 feet) and the State or Country where they were obtained were as follows: Brazil - 3, Colombia - 1, Hawaii - 13, Mississippi - 5, Puerto Rico - 2, New York - 1, Mekong Delta - 10, Tanzania - 5. Dr. Reid has evaluated several chemical methods for estimating the lime requirement of acid soils and will compare results obtained on soils from tropical vs. non-tropical regions. The chemical methods selected for evaluation were (a) barium chloride-triethanolamine method used by the Cornell Soil Test Laboratory, (b) Adams and Evans' buffer, (c) Woodruff's buffer, (d) Shoemaker, Pratt & McNeal's buffer, (e) neutral salt extractable aluminum method of Kamprath, (f) Ca and Na hydroxide titration curves and (g) subtraction of summation of bases from the cation exchange capacity. Dr. Reid was supported in part by 211(d).

Dr. Silva made a comparison of six methods for extracting Al from

tropical soils and has compared extractable Al with plant Al and plant growth. Soil Al extracted with N $BaCl_2$ was more closely correlated with plant yield and plant Al than soil Al by other extractants. Since the method was tested on soils with a range of mineralogy and pH, the method is expected to have wide application to soils in the tropics. The three plant species, corn, *Desmodium intortum*, and white clover, used in the experiment were comparable in their tolerance to Al.

Long term effects of applied calcium silicate were investigated during five years of cropping successively with sugarcane, corn, and kikuyugrass. Plant uptake accounted for 12 to 21% of the applied Si while exhaustive extraction of profile samples at the end of five years recovered 14 to 28% of the applied Si. Apparently, about 57 to 72% of the applied Si remained in the soil in some form not readily displaced by phosphate extraction since there was no evidence that applied Si moved below 18 inches.

Energy dispersive x-ray analysis of sugarcane leaves grown on soils of high available silicon showed that although silicon was deposited selectively in silica cells, prickles, basal cells of microhairs, and stomata in very young leaves, silicon in mature leaves occurred in all of the epidermal cells except the upper cells of microhairs. Other studies by Dr. Sakai have been concerned with the location and the form of calcium and magnesium crystals in plants.

The secretion of hydrated magnesium carbonate (nesquehonite) by plant glands was first described. Also, electron micrographs were presented that showed the formation of calcium oxalate crystals in plants could be at the expense of calcium in the calcium pectate middle lamella.

Mr. Lance Santo has soil water hysteresis in aggregated Oxisols in the zero to 0.2 bar suction range and is currently working on a mathematical model to predict hysteresis based on the hydraulic properties of the soil. One dimensional infiltration of water in laboratory columns of aggregated Oxisols has been measured for several initial water content and boundary conditions by Dr. Tsuji. Research on the distribution of water and solutes under drip irrigation is in the planning stages. Measurement was also made of zero points of charge for most of the major soils of Hawaii by Mr. Johnny Keng. With minor exceptions most of the soils show well defined zero points of charge measured in NaCl, the zero points of charge shift to lower pH values with $CaCl_2$ and higher pH values in $NaSO_4$.

Research on nitrogen transformation and movement by Dr. Kanehiro using urea in a Vertic Haplustoll, showed that increased trickle irrigation moved transformed NO_3^- deep into the profile, whereas there was no such NH_4^+ movement under the same conditions. The downward movement of NO_3^- was enhanced by reducing the plant population density. In another study it was found that NO_3^- sorption capacity of Hydrandepts was substantially reduced when the soil was air-dried or oven-

dried. In a study comparing the slow release nitrogen fertilizers with corn and bermuda grass on a Typic Eutrustox, it was found that Osmocote was most effective for corn and Osmocote, sulfur-coated urea and IBDU were equally effective for Bermuda grass. In a study by Mr. Asghar, organic matter from pineapple residue and sugarcane trash were incorporated into a Typic Torrox at different levels and changes in nitrogen status were followed up to 16 weeks. The concentration of available forms of nitrogen (NH_4-N and NO_3-N) remained low during the first three months of incubation with no noticeable loss of nitrogen as indicated by total nitrogen concentration. In a separate experiment with the same soil, the critical redox potential range for nitrate stability was found to be between 300-400 mv. However, the redox potential of the soil, even at 100 tons/acre organic matter, was found to be well above the critical range for nitrate stability. Thus the low concentration of mineral nitrogen was most probably due to nitrogen immobilization.

Research by Dr. Green on herbicide persistence in soils cropped to sugarcane for several years, revealed that while s-triazine herbicides degrade relatively rapidly, the substituted urea, diuron, persists for several years in some soils. The relatively high organic matter content of some of Hawaii's soils may account for the apparent irreversible adsorption of diuron. The adsorbed chemical

is probably not bio-active.

Dr. Bower's research (211(d) supported) has been concerned with salinity problems in highly-aggregated tropical soils. Whereas the soil water content at saturation is usually about twice that at the field capacity, it was found in a Low Humic Latosol that the water content at saturation was only slightly higher than at field capacity. The implication was that with highly-aggregated soils EC_e values ordinarily associated with a given percentage decrease in crop yield should be reduced by nearly one-half. It was also found that leaching by drip irrigation was more effective in reducing the salinity than ponding. The low leaching efficiency under ponding resulted from the rapid movement of water through the large pores of the highly-aggregated soil during saturated flow, leaving the salt in the small pores of the aggregates behind.

While Dr. S. El-Swaify is on sabbatical leave, Drs. Ahuja and Dangler have served as research leaders on two U.S.D.A. funded projects on forest hydrology and soil erosion. Dr. Ahuja has set up field experiments to measure the hydrologic properties of forested areas in the state. Dr. Dangler, with the initial assistance from A. P. Barnett, U.S.D.A.-A.R.S. Georgia, have completed erosion studies on four different soils sites on Oahu. Several sites on the island of Hawaii are currently being considered for future erosion studies.

One of Dr. Sanford's students, Mr. N. Hirunburana, was able to

reproduce both visual deficiency sypmtoms of boron and magnesium on papaya and macadamia, as well as establish tentative critical values for these two elements within the plants. He also established tentative critical values for N in papaya and macadamia leaves. Both boron soil and tissue levels were also established for boron toxicity of papayas. Mr. Hirunbwiana was supported by 211(d).

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Yuan, T. L., W. S. Sakai, R. C. Jones, and G. Uehara. 1974. Mineralogical and electron optical studies of colloidal fractions from selected Florida soils. Soil Sci. Soc. Amer. Proc. (submitted).

THESES AND DISSERTATION

Asghar, M. 1972. Organic matter decomposition, nitrate reduction and redox potential relationships in a Hawaiian oxisol. M.S. Thesis.

Boonduang, A. 1972. Some studies on slowly available nitrogen sources in Hawaiian soils. M.S. Thesis.

Chan, J. K. 1972. Chemical and morphological characterization of the non-crystalline fraction in the Hilo soil (Typic Hydrandepts). M.S. Thesis.

Dangler, E. 1973. Comparative rheological behavior of suspended clays with varying ionic concentration. Ph.D. Dissertation.

Ezumah, H. C. 1972. The growth and development of taro, Colocasia Reculenta (L) Schott, in relation to selected cultural management practices. Ph.D. Dissertation.

Periaswamy, S. P. 1973. Agricultural potential of forested lava lands (Tropofolists). M. S. Thesis.

Ravoof, A. A. 1973. Effects of root temperatures and nitrogen carriers on nutrient uptake, growth, and composition of pineapple plants, Ananas comosus (L) Merr. Ph.D. Dissertation.

Sinanuwong, S. 1972. Cation exchange equilibria in irrigated tropical soils. Ph.D. Dissertation.

Syed-Fadzil, Syed Farooq. B. 1972. Ion retention and movement in soils with variable charge colloids. M.S. Thesis.

Wambiji, H. 1972. Salinity tolerance of the pineapple plant, Ananas Comosus (L) Merr. M.S. Thesis.

Uchida, R. S. 1973. The effect of calcium silicate on cation exchange capacity and on exchangeable potassium, calcium and magnesium in a field trial on a Hydric Dystrandept. M.S. Thesis.

4. Impact of Grant Supported Activities in Developing Institutional Capabilities: As reported in the last fiscal year, the 211(d) grant has had a tremendous impact in increasing the instrumental capabilities in biological, mineralogical, and chemical research in tropical soils. This was due largely to the purchase of an x-ray flourescence quantometer and a scanning electron microscope with a micro probe attachment through other funds, augmented by some 211(d) funds.

This grant has permitted the Department of Agronomy and Soil Science to increase its professional staff with the addition of post-doctoral associates, technicians, and visiting professorships. It has also provided assistantships for graduate students in dis-

ciplines associated with the 211(d) grant. The staff and graduate student additions have increased capabilities in the lesser developed areas of research in tropical soil science.

Furthermore, Ms.Dianne Thompson has been employed under the 211(d) grant to index information gathered on tropical soils and to place them in some logical order so that they will be more readily accessible to interested parties. Abstracts of technical papers, theses, and dissertations from the Department of Agronomy and Soil Science will be published and distributed to Agronomy and Soils Departments of all Land Grant Universities as well as other interested institutions. Ms. Thompson will also be responsible for cataloging all existing books, journals, etc. in the Departamental library. Under the auspices of the 211(d) grant, the Department has expended approximately $800.00 in new book acquisitions and $2800 in bound series of journals purchased from the now defunct Pineapple Research Institute of Hawaii. Plans have already been made to acquire more new books and journals to upgrade the Departmental library in the next fiscal year.

5. Utilization of Institutional Resources in Development: At the request of the AID, Dr. L. D. Swindale, Associate Director of the Hawaii Agricultural Experiment Station, and Dr. J. A. Silva, Associate Professor of Agronomy, traveled to Africa to provide the Government of Tanzania with information on development of a land

capability system for the Arusha District. A brief reconnaissance survey of the land systems in the Arusha province, covering some 30,000 square miles, was made over a period of 10 days. A number of soils were sampled and shipped to Hawaii for analysis.

Enroute to and from Tanzania, Dr. Silva stopped at Mauritius and Ethiopia, on 211(d) funds, to learn of the soil and crop management systems in these countries. Contacts with scientists at the Mauritius Sugar Industry Research Institute were established and arrangements were made to have samples of important soils used in sugarcane culture sent to the University of Hawaii. Discussions were held with scientists at the Institute of Agriculture Research at Holetta, and at the Debre Zeit Experiment Station in Ethiopia. Problems in soil chemical analyses and in soil fertility were explored and possible solutions proposed. Management problems of the Black Vertisols, which are the principal agricultural soils of Ethiopia, were discussed and research to develop management practices to improve the physical properties of this soil was suggested. Consultation with the staff from the Department of Agronomy and Soil Science the University of Hawaii was proposed.

Dr. Swindale also traveled to London and Gent to discuss the possibility of obtaining information in England and Belgium on tropical soil management for the AID/UH 211(d) Tropical Soils program. The development of communication ties with officers of the Common-

wealth Agricultural Bureaux, the Rothamsted Agricultural Experiment Station, and the Geological Institute of the University of Gent, would enable the 211(d) Consortium to obtain access to both published and non-published reports which these institutions possess on tropical soil science. The opportunity was also taken in Gent to discuss the possibility of finding common soil families in Hawaii and the Republic of Zaire that could be used in linked experiments in soil management.

Dr. Goro Uehara and Dr. Robert L. Fox were participants in the Tropical Soil Institute held in Mayaguez, Puerto Rico, in August, 1972. Dr. Uehara lectured on the mineralogy of oxide systems and physics, of Tropical soils. Dr. Fox presented lectures, and helped with the discussion on soil phosphorus and sulfur, and on soil management for tropical crop production. Dr. Fox also visited the Puerto Rico Agricultural Experiment Station to discuss possible collaboration on a comparative study of Puerto Rico and Hawaii soils. While in the Caribbean area, Dr. Fox attended a symposium on Soils of the Tropical Savanna in the Dominican Republic, and visited the Windward Islands Banana Research Scheme, St. Lucia, and Banana Board and Citrus Research Personnel on Jamaica.

In January, Dr. Fox presented a paper "Examples of Anion and Cation Adsorption by Soils of Tropical America" at the Conference on Soils of the Caribbean and Tropical America at the University of

the West Indies, Trinidad. Field trips to Barbados, St. Vincent and Granada were also included as a side light to the conference.

Dr. Uehara, principal investigator for the Mekong River Silt Project and Melvin Nishina, graduate student, visited Viet Nam in March to collect silt and soil samples on the Mekong Delta. Dr. Uehara also attended the first annual meeting of The Heavy Clay Delta Soils Project which was held in Saigon and Can Tho University, between June 11, and June 15, 1973. His attendance at this meeting was a result of a memorandum of understanding signed by Vietnamese government agencies, AID-Washington, the AID mission in Viet Nam, the Regional Economic Development Office in Bangkok, Thailand, and Can Tho University, to study management of heavy clay delta soils. The University of Hawaii and Colorado State University will provide technical assistance and personnel for this project. This project, along with the one year research contract between the Department of Agronomy and Soil Science of the University of Hawaii and the Committee for the Coordination of the Development of the Lower Mekong Basin to study river silt and delta soils in the Mekong Delta, will aid in the overall planning of the control of the Mekong River.

Dr. W. G. Sanford traveled to the Ivory Coast to do consulting on the agronomy of pineapple and met with personnel of the IFAC. At the invitation of IFAC, he also spent one week in the United Republic of Cameroon where he visited the staff of the National Agricultural

Research Centre at Ekona, met the local Director of IRAT (basic food crops) at Yaounde, and the local Director of IRCT (fiber crops) at Maroua, and got a general look at the agricultural problems, particularly under extremely dry conditions. Seeds of a sorghum variety that are either extremely drought tolerant or deep rooted have been received from the Cameroons as a result of this trip. The trip ended in Paris where Dr. Sanford met and discussed with soils officials of the main headquarters of ORSTOM the possibility of cooperative research with the University of Hawaii. Funds for this trip were provided by a private firm and IFAC.

During March and April 1973, Dr. C. A. Bower served as U.S. representative on a Near East and North Africa Agricultural Research Review Mission sponsored by the Consultative Group on International Agricultural Research. The purpose of the Mission was to identify gaps and priorities in existing agricultural research in the region, with the view of providing additional support for selected activities in research, training, information and related work.

In early June, Dr. Y. N. Tamimi traveled to Indonesia, the Philippines, and Australia on 211(d) funds. In Indonesia he assisted Richard Pellek, graduate student, on his thesis problem of soil site-productivity evaluation of tropical tree species. Dr. Tamimi also studied various soil profiles in the investigation area of Udjong Kulon Natural Reserve on the island of Java, and visited the College

of Agriculture and School of Forestry and the National Soil Research Institute. In the Philippines, he presented a seminar on phosphorus problems and liming of tropical soils at the University of the Philippines, College of Agriculture at Los Baños. Dr. Tamimi also visited with scientists at the International Rice Research Institute and observed rice culture and multiple cropping systems. In Australia, he spent time at the C.S.I.R.O. in Brisbane, visited an agricultural experiment station in Beerwa, and discussed practices and problems associated with forest soils and forest tree planting with members of the Forestry Department in Queensland.

A possible contract for the coming year includes a proposal submitted by Dr. Swindale to the AID on the relation of soil families to crop productivity in the tropics. Dr. Swindale reported that the pending University of Hawaii research contract on tropical soil families has achieved some noteworthy progress by being unanimously endorsed by the Research and Institutional Grants Council of AID, and now will be presented to the external Research Advisory Committee in the very mear future. Other staff that may participate in this contract are Drs. Sanford, Silva, Ikawa, and Bartholomew. Dr. Swindale also reported that the UH/AID 211(d) contract on animal production is being included in tentative AID plans for fiscal year 1974, and that a proposed University of Hawaii research contract on root crops is considered interesting but needs considerable further revision.

Following are students and faculty in the Department:

Graduate students [supported by State, East-West Center (U.S. State Department), Rockefeller and Ford Foundations, Country of Origin, FAO, etc.]

Name	Arrival Date	Advisor	Home Country
Agronomy--M.S.			
Aragon, Ernesto L.	Fall '72		Philippines
Arian, Mohammad S.	Fall '72	R. Fox	Pakistan
Ayers, Dennis	Fall '71	H. Y. Young	U.S.
Chaudhury, A. J. H.	Spring '70	D. Bartholomew	Pakistan
Hurdus, Alan R.	Fall '72	P. Rotar	U.S.
Kagbo, Robert	Fall '72	W. Sanford	Sierra Leone
Pellek, Richard	Fall '71	Y. Tamimi	U.S.
Pyon, Jong-Yeong	Fall '72	D. Plucknett	Korea
Saito, Ronald Y.	Spring '71	D. Bartholomew	U.S.
Tama, Kato	Fall '72	D. Bartholomew	Cook Islands
Watanabe, Winifred	Fall '70	D. Bartholomew	U.S.
Agronomy--Ph.D.			
El-Tahir, Awad	Spring '70	J. Silva	Sudan
Escalada, Rodolfo	Fall '70	D. Plucknett	Philippines
Ezumah, Humphrey	Spring '70	D. Plucknett	Nigeria
Floresca, Emmanuel	Fall '71	P. Rotar	Philippines
Guevarra, Anacleto	Fall '71	P. Rotar	Philippines
Nicholls, Douglas	Fall '70	D. Plucknett	Australia
Ravoof, Abdul	Fall '69	W. Sanford	India
Seng, Tee	Spring '68	W. Sanford	Malaysia
Soil Science--M.S.			
Alvarez, Robustiano	1967	J. Silva	Argentina
Asghar, Mohammad	Fall '70	Y. Kanehiro	Nigeria
Braide, Jonathan O.	Fall '68	G. Uehara	Nigeria
Elder, Vincent	Spring '73		U.S.
Furukawa, Michael N.	Spring '73	R. Green	U.S.
Gribble, Grant	Fall '72	G. Uehara	U.S.
Keng, Johnny C. W.	Summer '71	G. Uehara	Taiwan
Mukhtar, Muhammad	Fall '72	R. Green	Pakistan
Nishina, Melvin S.	Fall '71	P. Rotar	U.S.

Graduate students (Cont.)

Name	Arrival Date	Advisor	Home Country
Soil Science--M.S.			
Oya, Jean	Fall '72	B. Koch	U.S.
Periaswamy, Sirapalli	Summer '70	H. Ikawa	India
Prasomsook, Suwit	Fall '72	R. Fox	Thailand
Santo, Lance T.	Summer '71	G. Uehara	U.S.
Teh, Saidin Bin	Fall '72	S. El-Swaify	Malaysia
Tengah, Abdullah B. C.	Fall '72		Malaysia
Uchida, Raymond S.	Fall '71	Y. Tamimi	U.S.
Soil Science--Ph.D.			
Asghar, Mohammad	Fall '70	Y. Kanehiro	Pakistan
Balasubramanian, V.	Fall '69	Y. Kanehiro	India
Dangler, Edgar	Summer '67	S. El-Swaify	U.S.
Hirunburana, Niwat	Fall '69	R. Fox	Thailand
Hudnall, Wayne	Spring '72	R. Jones	U.S.
Jellinger, Alice	Spring '69	P. Ekern	U.S.
Khalid, Rashid	Summer '67	J. Silva	Pakistan
Rao, Palakurthi	Spring '70	R. Green	India
Sinanuwong, Somsri	Fall '69	S. El-Swaify	Thailand
Stoop, Willem	Fall '71	R. Fox	Netherlands
Syed, Muhammad M.	Fall '69	S. El-Swaify	India
Watanabe, Roger	Fall '69	G. Uehara	U.S.

Research and teaching staff (supported by State Funds)

Name	Speciality
Soils	
Paul C. Ekern, Jr.	Soil Management, Physics
Samir A. El-Swaify	Soil Physics, Irrigation
Robert L. Fox	Soil Fertility, Crop Management
Richard E. Green	Herbicides, Soil Physics
Haruyoshi Ikawa	Soil Mineralogy
Rollin C. Jones	Soil Mineralogy Characterization
Yoshinori Kanehiro	Soil Chemistry, Fertility
Burton Koch	Soil Microbiology
Wade W. McCall	Soil Fertility
James A. Silva	Soil Fertility, Soil Chemistry
Leslie D. Swindale	Soil Genesis & Classification
Goro Uehara	Soil Physics, Mineralogy, Water Science
Roger T. Watanabe	Soil Testing

Research and teaching staff (Cont.)

Name	Speciality
Agronomy	
Duane P. Bartholomew	Crop Physiology, Plant Nutrition
Richard Bullock	Tree Physiology
Ramon de la Pena	Root Crop Production, Crop Physiology
Peter P. Rotar	Plant Breeding, Cytogenetics
Wallace G. Sanford	Plant Nutrition, Physiology
Donald L. Plucknett	Crop Management, Weed Control
Yusuf N. Tamimi	Forest Soils, Nutrition
John R. Thompson	Crop Production
Ukio Urata	Plant Breeding
A. Sheldon Whitney	Plant Nutrition, Crop Physiology
Hong Yip Young	Plant Nutrition, Chemistry
Dennis Matsuyama	Research Associate
Ronald Yoder	Research Associate

Contractual

Name	Title
Lajpat Ahuja	Assistant Soil Scientist
Ayers, Dennis	Research Associate
Charles Bower	Soil Scientist
Annie Chang	Junior Researcher
Edgar Dangler	Junior Soil Scientist
Kishore Goswami	Junior Soil Scientist
Marion Mapes	Assistant Agronomist
Helen Mishima	Research Associate
Douglas Nicholls	Junior Agronomist
Ernest Okazaki	Junior Soil Scientist
William Sakai	Assistant Soil Scientist
Gordon Shibao	Research Associate
Gordon Tsuji	Assistant Soil Scientist

Staff and students [supported by 211(d) funds]

Position	Name	Speciality
Graduate Res. Asst.	Robustiano Alvarez	Soil Fertility
Soil Scientist	Charles Bower	Soil Chemistry
Jr. Researcher	Annie Chang	Analytical Chemistry
Graduate Res.Asst.	Vincent Elder	

Staff and students (Cont.)

Position	Name	Speciality
Graduate Res. Asst.	Michael Furukawa	Soil Physics
Graduate Res. Asst.	Grant Gribble	Soil Mineralogy
Graduate Res. Asst.	Niwat Hirunburana	Soil Fertility
Graduate Res. Asst.	Wayne Hudnall	Soil Mineralogy
Graduate Res. Asst.	Rashid Khalid	Soil Fertility
Jr. Soil Scientist	Ernest Okazaki	Soil Chemistry & Mineralogy, X-ray Fluorescence Quantometer
Graduate Res. Asst.	Jean Oya	Soil Microbiology
Post Doctoral Fellow	William Sakai	Electron Microscope
Graduate Res. Asst.	Lance Santo	Soil Physics
Post Doctoral Fellow	Gordon Tsuji	Soil Physics

6. Other Resources Used for Grant-Related Activities. Because of Hawaii's location in the tropics, much of the research in soil science is focused on the tropics. Thus, approximately fifteen researchers and an equal or larger number of graduate students that are supported by state or federal funds, are carrying on 211(d) grant-related activities. This amount exceeds $ 200,000 annually.

The department has signed a year contract with the Committee for the Coordination of the Development of the Lower Mekong Basin to study river silt and soils in the Mekong Delta. Dr. Uehara, principal investigator in this project, has used funds from this project to travel to South East Asia. Funds from this project were also used to provide travel expenses for a graduate student as well as the provision of support during the study. This non 211(d) funded study will increase our competence in tropical Asian soils.

A grant-in-aid of $1000 was also received by Dr. Green from

private funds for research on the behavior of herbicides in tropical soils.

Resources of the University in terms of staff time were also used to handle many visitors who came to Hawaii for research and consultation, or on short stops in travel between Asia and the mainland U.S., including Dr. John Coulter, Rothamsted Experiment Station; Dr. John Replogel, Mr. Gary Frasier and Mr. John Griggs, U.S. Water Conservation Laboratory; Dr. Joe Kubota, USDA-ARS, Ithaca, N.Y.; Dr. K. R. Stockinger, Washington, D.C.

7. Next Year's Plan of Work

7.1 Teaching and Extension Services: A clay mineralogy workshop involving all Consortium institutions will be held in Hawaii starting July 14, 1973. The two week workshop will allow members of the Consortium staff involved in soil mineralogy teaching and research to become familiar with the capabilities of the x-ray flourescence quantometer and the scanning electron microscope. Field trips to the islands of Kauai, Maui and Hawaii are also on the agenda.

Audio visual tutorial techniques, successfully established two years ago, will continue to play a vital role in teaching the basic soils course offered by Dr. Ikawa and Green. Another in the series of Illustrated Concept in Tropical Agriculture will be prepared by Dr. Fox. The new series will be entitled "Low Soil Temperatures

Depress Root Activity in the Tropics." Photographic work for still another concept which will deal with nitrogen nutrition of banana has been completed.

New instructors for courses presently offered in the department are Dr. Wade McCall (Tropical Crop Production) and Dr. Al Southard, (Soil Genesis and Classification) from Utah State University. A special course entitled, "Chemistry of Submerged Soils" is currently being planned to be offered during the summer of 1974. Dr. W. Patrick of Louisiana State University will be the guest instructor. Other course offerings in the Department of Agronomy and Soil Science will remain unchanged.

Dr. Uehara will be on sabbatical leave for a year starting September, 1973. He will be at Cornell till December, 1973 to assist Drs. Matthew Drosdoff and Marlin Cline in the instruction of "Management of Tropical Soils." From January to August, 1974, Dr. Uehara will be at North Carolina State University to work with Dr. C. B. McCants and associates on a text on the management of tropical soils.

A second Tropical Soils Institute will be held in the Philippines at the Southeast Asian Regional Center for Graduate Study and Research in Agriculture. It will be held in the month of June, 1974, and will be organized by the University of Hawaii.

Several of the staff will participate in the Seminar to be

held at CIAT, Colombia, in February, 1974.

7.2 Research: Comparison of similar classified Hawaiian and Puerto Rican soils by means of chemical measurements, electron microscopy, and X-ray diffraction analyses will continue to be made by Drs. Ikawa, Jones, Sakai and Fox. Of primary interest will be comparisons of the Tropeptic Eutrorthox of Puerto Rico (Bayamon and Matanzas) with that of Hawaii (Puhi), the Acrorthox of Puerto Rico (Nipe) with that of Hawaii (Kunuweia), and the Orthoxic Tropohumults of Puerto Rico (Cidra and Vicente) with that of Hawaii (Alaeloa, Halawa, Hamakuapoko, Laleau, and Manana). Emphasis will be given to those properties of soils which can be related to management practices.

The highest priority for the quantometer project in the future is to develop methods for the analysis of soil extracts. This will involve both students and staff in assessing extraction techniques, preparation of extracts for analysis by the quantometer, and correlation of the results with field data.

Depending on the availability of outside funds, Dr. Koch plans to undertake research in the areas of diuron degradation in Hawaiian soils and Rhizobium-legume relationships. The latter project would involve the establishment of a Rhizobium collection for test inoculation of various legumes common to Hawaii and would evaluate environmental conditions which might effect the inoculation process

and corresponding rates of nitrogen fixation. Studies on soil denitrification and redox conditions, especially as related to the removal of nitrate from the soil environment, and on organic matter residue decomposition will be conducted by Dr. Kanehiro.

Dr. Green will continue his work in herbicides. The adsorption on soil of diuron and bromacil will be related to the properties of both inorganic and organic constituents of a number of Hawaiian soils in an attempt to understand the factors determining the persistence of these compounds. Herbicide and nitrate movement under drip irrigation of sugarcane will be examined. Studies of this nature will be aimed at relating solute dispersion to the structural characteristics of an Oxisol and a Hydrandept.

Dr. Kenneth Doxtader, Associate Professor in the Agronomy Department, Colorado State University, will spend a six month sabbatical in Hawaii. As a soil microbiologist, he has been involved in research and teaching in microbial ecology, nutrient recycling, and pesticide metabolism. While in Hawaii he will work with Dr. Green on the application of computer simulation techniques to kinetics of pesticide breakdown. He will also organize and participate in a series of seminars dealing with the biology and biochemistry of natural systems.

Collection of basic soil water parameters that describe the retention and movement of water in Hawaiian soils will continue to be of primary interest to Drs. Uehara and Tsuji. Soil water transport

coefficients of two Oxisols will be determined from experimental vertical infiltration data and compared to those previously obtained from outflow methods and simulation models. Similarly, a mathematical model to describe soil water hysteresis in Oxisols is being studied. Computed data will then be matched to experimental data. A new project proposal to study the distribution of water and solutes in soils under drip irrigation has been submitted for funding.

Dr. Silva will carry out experiments on the pH requirement of sugarcane harvested in the fall. Complete plant and soil sampling will be made. A nutrient culture experiment designed to further clarify the role of pH in sugarcane growth and nutrient uptake will be undertaken. The fate of silicon applied to soil and the reactions of calcium silicate in tropical soils will continue to be studied. Results of lime requirement study should be available for interpretation and recommendation.

The research program for 1973-74, will be disturbed to some extent by the move of all staff housed in Gilmore Hall into the St. John and Pope Plant Science Laboratories. However, this has the brighter side of a better working relationship with staff in Botany, Horticulture, and Plant Pathology who are working on research to improve tropical and crop and fiber production.

The use of phosphate adsorption curves will evaluate phosphate requirements of sandy soils which will be done in cooperation with

Prairie View. In Hawaii, the emphasis will shift to evaluation of residual effects and side effects of phosphate fertilization, while at the same time information will be gathered on external and internal phosphorus requirements of important tropical crops which have received little attention. Availability of adsorbed sulfate in subsoils will be continued, and the internal and external S requirement of crops estimated by Dr. Fox. Nutritional requirement of banana will emphasize N and K requirements, but other elements such as sulfur and zinc will receive increasing attention. Dr. Fox will also initiate more continuous function experimental designs for soil fertility studies as examples of how this technique can be utilized to maximize information in areas with limited research facilities.

8. Other: No additional comments.

9. Report of Expenditures

9.1 Distribution of 211(d) grant fund expenditures and contributions from other sources of funding (see Table 9.1).

9.2 Expenditure report, actual and projected (see Table 9.2).

Table 9.1. Distribution of 211(d) grant fund expenditures and contributions from other sources of funding[a] (review period July 1, 1972 to June 30, 1973)

Object	Period Under Review	211(d) Source Cumulative Total	211(d) Source Projected Next Year	211(d) Source Projected to End of Grant	Non-211(d) Source[b]
Research	$144,340	$237,230	$107,200	$425,900	$600,000
Teaching	17,784	26,060	17,000	50,000	98,000
Libraries	750	935	4,000	5,000	--------
Consultation	3,000	3,609	5,000	10,000	--------
Publication	750	1,050	4,000	6,050	9,000
Other	1,218	1,218	1,800	3,050	51,000
TOTAL	$167,842	$270,102	$139,000	$500,000	$758,000

[a] These figures are our best estimates

[b] 1972-73 estimated State, Hatch, Regional, NSF, NDEA, and other special grant funds (does not include fringe benefits on salaries).

Table 9.2. Expenditure report, actual and projected (review period July 1, 1972 to June 30, 1973)

	Actual Period Under Review	Expenditure Cumulative Total	Projected Expenditures Year 4	Projected Expenditures Year 5	Total
Salaries & Wages (Total)	$126,018	$196,397	$120,000	$80,000	$396,397
Salaries	100,263	154,544			
Fringe Benefits	10,125	16,273			
Student Help	15,630	25,580			
Supplies (Total)	6,081	13,978	6,000	6,000	25,978
Supplies & Publications	6,052	13,042			
Library Acquisitions	750	935			
Equipment (Total)	22,020	36,933	5,000	-----	42,376
Travel (Total)	12,317	22,351	8,000	4,898	35,249
Inter-Island	1,865				
Out-of-State (U.S.)	7,409				
Foreign	3,044				
TOTAL	$167,156	$269,659	$139,000	$90,898	$500,000

Exhibit A: Individuals Under Salaries

Name	Title	Date Employed	% of Time	Amount 7/1/72-6/30/73
Bower, Charles	Soil Scientist	4/17/72	40	$ 7,917.48
Reid, W. Shaw	Assoc. Soil Sci.	10/1/71	75	7,335.26
Sakai, William	Asst. Soil Sci.	9/1/71	79	10,125.06
Tsuji, Gordon	Asst. Soil Sci.	7/15/70	75	8,270.50
Chang, Annie	Jr. Soil Sci.	10/1/71	75	9,108.00
Okazaki, Ernest	Jr. Soil Sci.	1/17/72	100	11,232.00
Rosenau, Andrew	Jr. Soil Sci.	7/24/71-10/13/72	100	2,763.64
Thompson, Dianne	Specialist	1/2/73	100	3,490.52
Tomlinson, Deane Jr.	Res. Assoc.	5/1/73	100	1,126.00
Nagasako, Gayle	Temp. Steno	2/1/72-7/31/73	100	1,968.89
Alvarez, Robustiano	Grad. Asst.	5/1/73	50	816.00
Asghar, Mohammad	Grad. Asst.	11/1/72	50	1,632.00
Ayers, Dennis	Grad. Asst.	9/1/72-2/28/73	50	2,268.00
Braide, Jonathan	Grad. Asst.	9/1/72	50	4,080.00
Elder, Vincent	Grad. Asst.	1/15/73	50	2,103.65
Furukawa, Michael	Grad. Asst.	1/1/73	50	2,268.00
Gribble, Grant	Grad. Asst.	9/1/72	50	3,780.00
Hirunburana, Niwat	Grad. Asst.	9/1/71	50	5,076.00
Hudnall, Wayne	Grad. Asst.	1/1/72	50	5,076.00
Nishina, Melvin	Grad. Asst.	9/1/72	50	1,701.00

Exhibit A: Individuals Under Salaries (con't)

Name	Title	Date Employed	% of Time	Amount 7/1/72-6/30/73
Oya, Jean	Grad. Asst.	9/1/72-1/31/72	25	945.00
Ryder, Mayo	Grad. Asst.	1/1/72-7/16/72	50	204.00
Santo, Lance	Grad. Asst.	10/1/71	50	2,448.00
Uchida, Raymond	Grad. Asst.	1/1/72-1/16/73	50	2,548.00
Coulter, John	Consultant	7/21/72	50	1,980.00
				$100,263.00

Exhibit B: Equipment Purchased Over $100

Vendor	Description	Cost	Justification
Electrical Distributors, Ltd. Honolulu, Hawaii	23,000 BTU air conditioner	$ 375.00	Air conditioning for the room having the x-ray flourescence quantometer
Perkin-Elmer Corp. Los Angeles, Calif.	Automatic null recorder	504.70	Micronutrient analysis of plant and soil
Haverhill's San Francisco, Calif.	Bowmar 901B electronic calculator	187.00	For research calculations
Spex Industries Metuchen, New Jersey	2 1/4" x 2 1/2" grinding container	205.77	Plant sample preparation for analysis
Hopaco Honolulu, Hawaii	36" x 12" steel storage	124.59	Storage of quantometer supplies
Van Waters & Rogers Honolulu, Hawaii	Demineralizer, solenoid, cartridge	369.82	To develop soil testing methods
Spex Industries Metuchen, New Jersey	Mixer, tungsten carbide	1,572.02	Sample preparation for x-ray flourescence analysis
Hunter's Inc. Honolulu, Hawaii	Bookcase, shelving	331.60	Departmental library use
Beckman Instruments Honolulu, Hawaii	Phasar-1 pH meter	556.40	For measurement of soil pH
Van Waters & Rogers Honolulu, Hawaii	Mill, lab, Wiley model ED-S, 5" x 2" oven, lab, utility	2,156.40	For gringing plant samples
Eberline Inst. Corp. Sante Fe, New Mexico	Portable Beta-gamma geiger, hand probe, SK-1 audio	420.30	For monitoring radioactive research
Rondikn Corp. Honolulu, Hawaii	3 1/4 mm diamond knife with boat to fit	884.00	For cutting mineral samples
Kent Cambridge Morton Grove, Ill	Cambridge S-4 stereoscan scanning electron mincroscope with the following accessories: LaB_6 configuration electron gun, microanalysis specimen stage, cathodoluminescence unit, video presentation unit, T.V. scanning system less monitor	12,500.00	For examination of mineralogy and plant samples

Exhibit B: Equipment Purchased Over $100 (con't)

Vendor			
Applied Research Labs Sunland, Calif.	Sola 4KVA regulator transformer	$ 878.54	Regulation of electrical power to quantometer
New Brunswick Scientific New Brunswick, NJ	Portable gyrotory shaker	285.29	For growth of various micro-organisms in liquid culture
Van Waters & Rogers Honolulu, Hawaii	Helium gas regulator 2 stage; oxygen regulator, 2 stage	257.98	For use with newly purchased gas cylinders (Project W-158)
Cole-Palmer Instrument Chicago, Illinois	Test tube support Max. tube dia. 20 mm and lab tool kit	59.60	Laboratory maintenance and upkeep
Central Camera Inc. Honolulu, Hawaii	Exhaust blower for condenser lamphouse and filter holder for zoom condenser lamphouse	88.00	Equipment will be used with Omega enlarger in preparing electron micrographs for 211(d) publications
Hunter's Inc. Honolulu, Hawaii	Storage cabinet with lock, 5 shelf, 36" x 78" x 24"	87.09	For storage and protection of spare parts and accessories for the x-ray quantometer
	Equipment purchased	$21,844.10	
	less $100	175.50	
	TOTAL	$22,019.60	

Exhibit C: Foreign Travel

Name	Place of Travel	Date Left	Date Return	Justification	Amount
Tamimi	Roundtrip-Hilo-Honolulu Hong Kong-Djakarta-Singapore Manila-Honolulu-Hilo	3-25-73	4-11-73	Assist graduate student in selecting sites, describing, and collection of soil samples from research study area at Udjon Kulon National Reserve in Indonesia. A stopover at Manila will allow for discussions on tropical soil properties pertaining to soil fertility and chemistry with scientists at the International Rice Institute in the Philippines.	$ 954.00
Silva	Additional airfare: Ethiopia and Mauritius			To collect soil samples and study management practices of tropical soils.	375.07
Swindale	Additional airfare: Brussels-London	4-13-73	5-11-73	To provide to government of Tanzania information on development of a land capability system for the Arusha District and to obtain information on tropical soil management for the AID/UH 211(d) Tropical Soils Program	349.05
Fox	Rountrip--Honolulu-Trinidad-Santo Domingo-Honolulu	1-04-73	1-27-73	Attend and present paper before conference on soils of Caribbean and Tropical America	1,365.88
				TOTAL	$3,044.00