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## REPORT OF THE UNIVERSITY OF HAWAII

## Summary of Accomplishments and Future Plans

Major Accomplishments. The major accomplishment during the past year, involving all of the institutions in the 211(d) Consortium on Tropical Soils, was a two-week workshop on teaching basic soils and learning firsthand about tropical soils. The workshop was held during July 1971 in Hawaii. Staff from all five Institutions were involved. Travel and per diem funds came from the 211(d) Grants. The Department's basic soils course, Introduction to Tropical Soils, was restructured from a course taught by the conventional lecture-lab method to one which includes audio-visual-tutorial methods as the major teaching technique. Three new courses were added to the Department's curriculum. A series of printed "Illustrated Concepts of Tropical Agriculture" was initiated using both State and 211(d) funds.

The Department's program in soil mineralogy research which is emphasized by the 211(d) Grant has been greatly strengthened not only by the 211(d) funds but by State funds. For example, x-ray diffraction analyses has indicated that Hawaiian soils vary from principally crystalline to completely non-crystalline in form. The 211(d) Grant has provided "seed" money to augment State and Federal funds which support the remainder of our tropical soils research.

Dr. John Coulter from the Rothamsted Experiment Station and an expert on tropical soil-plant systems spent July 1 to 9, 1971 visiting the Department. The visit was made possible by the 211(d) Grant. Dr. Goro Uehara at the invitation of the Thailand AID Mission visited Thailand and Vietnam to discuss the possibility of research contracts involving the Mekong Delta.

The great interest on the part of the Consortium in the phosphorus research of Dr. Robert Fox has resulted in improved funding of this project by

College Administrators. The Administration also provided a State position for a soil mineralogist which freed 211(d) funds which were earmarked for this position. Using State and Federal funds the College purchased an x-ray fluorescence quantometer which will greatly benefit the Department's programs in soil mineralogy, soil chemistry and soil-plant relations.

Plan of Work for Next Year. If there is sufficient interest on the part of other members of the consortium, Hawaii will host a two-week workshop on teaching and research aspects of soil fertility. As a service to various AID Bureaus and Missions in Asia and the Pacific, Hawaii plans to have at least three of the soils staff travel in Asia and the Pacific. Two new graduate courses will be added, one on Directed Teaching, and another an intensive six-week summer course in Tropical Crop Production.

The x-ray fluorescence quantometer will be in operation by January 1972 at which time a Soil, Tissue, and Forage Analyses Laboratory will be established to service not only the public in Hawaii but also to some extent individuals from the Pacific Basin and East Asia. Provided sufficient funds are made available from other sources to purchase a scanning electron microscope, 211(d) funds will be used to purchase a electron micro-probe attachment for the instrument. This should greatly improve our research capabilities in soil mineralogy, and soil-plant relations at the root-soil interface.

With the combined support of 211(d) funds from Puerto Rico and Hawaii, Dr. Fred Beinroth will spend six weeks in Hawaii initiating cooperative work in geomorphology-pedogenesis, soil classification and soil characterization. Dr. Anthony Sayegh from the American University in Beirut will spend the year working on amorphous materials of Hawaiian and Lebanese soils. Dr. Sayegh is partly supported by 211(d) funds. Dr. William Sakai has joined the staff as a 211(d) Post Doctoral Fellow and will work with Dr. Jones on soil mineralogy

research. Dr. Gordon Tsuji will continue as a 211(d) Post Doctoral Fellow working on soil physics with Dr. Goro Uehara. A technician will be hired on 211(d) funds to do soil and plant analyses for the soils staff. At least two graduate research assistants will be supported by the grant.

Overseas travel will include in addition to the three proposed Asian trips, one trip to Europe to attend a Symposium on Acid Sulphate Soils and another trip (two persons) to IITA in Nigeria and other parts of Africa to consult with local soil scientists and to get a firsthand look at soil problems in Africa.

Negotiations will be initiated to develop faculty and student exchange program between Hawaii and the other four institutions.

#### Goals

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 to 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 tropical 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.

#### Major Accomplishments

Teaching. A major portion of the time covered by this report was devoted to preparations for a workshop which was held July 10 to 24, 1971. The workshop brought together all of the staff from the cooperating institutions who are involved in teaching basic soils in order that they could exchange ideas regarding the teaching of basic soils and to give those from the Temperate Zone an opportunity to learn more about tropical soils. The workshop involved considerable advanced preparation by the participants, particularly

Dr. Richard Green, Dr. H. Ikawa and Dr. Goro Uehara of the University of Hawaii staff. Those attending from other institutions were Dr. Thomas W. Scott and Mr. Gordon L. McCaskill from Cornell, Dr. Maurice G. Cook from North Carolina, Dr. James I. Kirkwood from Prairie View, Dr. Murray H. Milford from Texas A&M (sponsored by Prairie View), and Dr. Fred Beinroth from Puerto Rico. All of the soils staff and some graduate students from Hawaii participated in the workshop. Dr. Hank Foth, a visiting professor from Michigan State University well-known for his innovative teaching capabilities, was a very active participant. The workshop was held on three Islands, two days on Hawaii, seven days on Oahu at the Manoa Campus and six days at the Hawaii Agricultural Experiment Station's Branch Station on Kauai. Four days were devoted to field trips, one day on paddy soil training, and seven days to workshop sessions. The group was enthusiastic and the discussion lively and pertinent. It was the concensus of the group that the workshop had strengthened the teaching capabilities of the five institutions. Funds from the 211(d) Grants were used to provide travel, per diem, and for incidental expenses.

Dr. H. Ikawa, with the help of Dr. Foth, spent the summer restructuring the Department's basic soils course, Introduction to Tropical Soils, from a conventional 3-lecture, 1-laboratory course to a 2-lecture, 1-audio-visual-tutorial system with or without a laboratory section. The revamped course is being taught in the Fall of 1971. The introduction of audio-visual-tutorial techniques and the inclusion of information from the workshop has improved our ability to teach basic soils. Three new courses were offered in 1970-71, two in soils and one in crop science. An introductory course entitled "Soils and Man" was offered for non-soils majors within and outside the College of Tropical Agriculture. Soil Microbiology which has not been offered for a

number of years was given. A new course in "Plant Tissue Culture" was made available in crop science. State funds and a limited amount of 211(d) funds were used to get these courses underway.

A series of printed, single page handouts of "Illustrated Concepts in Tropical Agriculture" was initiated. Each sheet carries a single concept which should be emphasized in the teaching of tropical soils and plant nutrition. Three have been printed and are available to the members of the Consortium or to other Universities upon request. These should be particularly useful to members of the Consortium who are located in temperate climates.

Research. Soil mineralogy research has received strong support from the 211(d) Grant. Under the leadership of Dr. Rollie Jones research has indicated that Hawaiian soils analyzed by x-ray diffraction vary from systems which are principally crystalline to those which are almost completely non-crystalline in nature. Many of the soils previously analyzed by x-ray diffraction were examined by electron microscopy. An M.S. program was initiated to chemically characterize the non-crystalline properties of the soils studied. As a means of comparing techniques, x-ray diffraction analysis and electron microscopy were made of soils from Arizona, California, Montana, New Mexico, Oregon, and Wyoming. The mineralogical characterization of off-shore sediments was also initiated.

Hawaii, unlike other institutions in the consortium except Puerto Rico, does research on all phases of tropical soils. This research is supported by State and Federal funds as well as some "seed" money from the 211(d) Grant. A brief summary of research accomplished during the year follows. In the case of soil classification, emphasis was on completing the chemical and mineralogical characteristics of the soils of the 15 branch stations of

the Hawaii Agricultural Experiment Station. This was done so that the large volume of existing yield data can be correlated with these soil characteristics. If successfully correlated these data might be used on similar soils elsewhere in the tropics.

Soil fertility research emphasized the phosphate requirements of crops grown in highly weathered soils and on phosphate adsorption by these soils. This research has a strong tie to the Latin American programs of Cornell, North Carolina, and Puerto Rico. Studies were initiated on sulfate adsorption, particularly by acid subsoils where several thousand pounds of sulfur may be present but very little is available to plants. Soil amendment research dealt with the interactions among calcium silicate, lime, and phosphorus fertilizer. Nitrogen research centered around the movement of nitrogen, especially nitrate, with infiltrating water as this movement is related to the chemical and physical properties of Oxisols.

Soil physics studies involved the degradation and movement of pesticides in highly weathered soils, salinity relations and management in tropical soils (it was found that salinity had less effect on the physical properties of tropical Aridisols and Oxisols than arid soils from temperate regions) and with evapotranspiration studies to determine the consumptive use of water by sugarcane comparing sprinkler and drip irrigation. An interesting computer study compared the yields of sugarcane over a long period on alluvial soils versus Oxisols on the same plantation. In earlier years when fertility was a limiting factor, the very fertile alluvial soils outyielded the highly weathered Oxisols. With the initiation of heavy fertilization fertility has been all but eliminated as a primary limiting factor and the Oxisols have outyielded the alluvial soils in recent years. It is believed that this is because of their ability to resist compaction by heavy equipment.

Dr. John Coulter from the Rothamsted Experiment Station visited the Department from July 1 to 9. Dr. Coulter talked individually with the staff, presented a seminar on Soil-Plant Systems, and visited Branch Stations on the Islands of Kauai and Hawaii. His visit was stimulating and his written report has helped to strengthen our research program. His visit was made possible by 211(d) funds.

Dr. Goro Uehara at the invitation of the Thailand AID Mission spent two weeks in Thailand and Vietnam to discuss possible research contracts on silting and soil-water-plant research in the Mekong Delta. On his way back he visited IRRI and Central Luzon University. This also gave him the opportunity to see how former University of Hawaii graduates are doing in the Philippines and Thailand.

Involvement of Other University Resources. The 211(d) Grant has stimulated the College of Tropical Agriculture interest in overseas tropical agriculture. Although the College has been actively involved in the training of foreign students from tropical countries, its research program on the whole has been restricted to Hawaii. The implementation of comparative studies involving both Hawaii and other tropical areas should be of mutual benefit.

The great interest on the part of the Consortium in the phosphorus research of Dr. Robert Fox has resulted in a substantial increase in the financial support of this research by the Administration of the College of Tropical Agriculture. The Administration also allowed the Department to hire a soil mineralogist on State funds thus freeing the 211(d) funds earmarked for this position. This will give additional support to the mineralogical research and other soils research.

With State and Federal funds an x-ray fluorescence spectrometer has been purchased. Its ability to analyze rapidly and directly plant tissues and

soil samples should greatly accelerate the program of the Department particularly in soil mineralogy. Some attachments to this equipment were purchased with 211(d) funds.

With University and personal resources Dr. Robert Fox and Dr. James Silva attended the International Symposium on Soil Fertility in India in January-February. During this trip they traveled extensively in India, Thailand, Malaysia, Taiwan, and the Philippines. The symposium and the field trips should give both of these staff members a better appreciation of soil fertility problems in the tropics.

Resources of the University in terms of staff time were used to handle the many visitors that stop in Hawaii between Asia and mainland U.S. The number of visitors averages about one per week and time spent in the Department varies from one day to two weeks.

Personnel.

Students - Undergraduates

<u>Name</u>	<u>Major</u>	<u>B S. Date</u>
Bouchereau, Shenal	Soils	1971
Bin Tah, Saidin	Soils	
Ching, Patrick C.	Soils	
Hoshmand, Ahmad	Agron	1971
Oya, Jean C.	Soils	
Ravenhorst, Charles	Agron	
Tengah, Abdula B. C.	Soils	
Toma, Kato	Agron	
Toshikiyo, Dennis A.	Soils	
Young, Antoine	Soils	

## Graduates\*

<u>Name</u>	<u>Arrival Date</u>	<u>Advisor</u>	<u>Home Country</u>
<u>Agronomy M S</u>			
Ayers, Dennis	Fall 71	H. Y. Young	U.S.
Chaudhury, A. J. H.	Spring 70	D. Bartholomew	Pakistan
Dollah, Abdul A. B.	Spring 70	P. Rotar	Malaysia
Golingai, Sylvester	Fall 70	D. Plucknett	Malaysia
Pellek, Richard	Fall 71	Y. Tamimi	U.S.
Saito, Ronald Y.	Spring 71	D. Bartholomew	U.S.
Santo, Lance T.	Summer 71	G. Uehara	U.S.
Watanabe, Winifred	Fall 70	D. Bartholomew	U.S.
<u>Agronomy Ph D.</u>			
El-Tahr, Awad	Spring 70	J. Silva	Sudan
Escalada, Rodolfo	Fall 70	D. Plucknett	Phil.
Ezumah, Humphrey	Spring 70	D. Plucknett	Nigeria
Floresca, Emmanuel	Fall 71	P. Rotar	Phil.
Guevarra, Anacleto	Fall 71	P. Rotar	Phil.
Nangju, Dimyati	Spring 70	D. Plucknett	Indonesia
Nicholls, Douglas	Fall 70	D. Plucknett	Australia
Ravoof, Abdul	Fall 69	W. Sanford	India
Seng, Tee	Spring 68	W. Sanford	Malaysia
Shin, Han Poong	Summer 70	P. Rotar	Korea
<u>Soil Science M S</u>			
Asghar, Mohammad	Fall 70	Y. Kanehiro	Pakistan
Bajar, Antonio M.	Fall 71	R. Fox	Phil.
Boonduang, Ampan	Summer 70	Y. Kanehiro	Thailand
Braide, Jonathan O.	Fall 68	G. Uehara	Nigeria
Chan, Jenn K.	Spring 70	R. Jones	Malaysia
Keng, Johnny C. W.	Summer 71	G. Uehara	Taiwan
Nishima, Melvin S.	Fall 71	P. Rotar	U.S.
Periaswamy, Sirapalli	Summer 70	H. Ikawa	India
Syed Fadzi, Syed	Spring 70	J. Silva	Malaysia
Tianco, Antonio	Fall 70	D. Bartholomew	Phil.
Uchida, Raymond S.	Fall 71	Y. Tamimi	U.S.
Wambiji, Henry	Fall 69	S. El-Swaify	Kenya

\*Supported by State, East-West Center (U.S. State Department), Rockefeller and Ford Foundations, Country of Origin, FAO, etc.

## Graduates (Cont.)

<u>Name</u>	<u>Arrival Date</u>	<u>Advisor</u>	<u>Home Country</u>
<u>Soil Science Ph.D.</u>			
Balasubramanian, V.	Fall 69	Y. Kanehiro	India
Dangler, Edgar	Summer 67	S. El-Swaify	U.S.
Goswami, Kishore	Fall 67	R. Green	India
Hirunburana, Niwat	Fall 69	R. Fox	Thailand
Jellinger, Alice	Spring 69	P. Ekern	U.S.
Juang, Tzo-chuan	Fall 69	G. Uehara	Taiwan
Khalid, Rashid	Summer 67	J. Silva	India
Osman, Abeld-Fatah	Summer 68	S. El-Swaify	UAR
Rao, Palakurthi	Spring 70	R. Green	India
Sinanuwong, Somsri	Fall 69	S. El-Swaify	Thailand
Syed, Muhammad M	Fall 69	S. El-Swaify	India
Watanabe, Roger	Fall 59	G. Uehara	U.S.

Supported by 211(d) Grant:  
Post Doctoral Fellowship

	<u>Speciality</u>
Gordon Tsuji, Ph D Purdue University	Soil Physics

Supported by State Funds  
Research and Teaching Staff

<u>Soils</u>	<u>Speciality</u>
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
Goro Uehara	Soil Physics, Mineralogy, Water Science
Roger T. Watanabe	Soil Testing

\*\*On sabbatical leave at University of Florida during 1970-71.

## Research and Teaching Staff (Cont.)

<u>Agronomy</u>	<u>Speciality</u>
Duane P. Bartholomew	Crop Physiology, Plant Nutrition
Peter P. Rotar	Plant Breeding, Cytogenetics
Wallace G. Sanford	Plant Nutrition, Physiology
Donald 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

Ramon de la Pena	Root Crop Production, Crop Physiology
Marion Mapes	Tissue Culture
Santiago Obien	Weed Control
Helen Mishima - Research Associate	
Gordon Shibao - Research Associate	

\*\*\*On sabbatical leave at Puerto Rico Experiment Station.

## Plan of Work for 1971 - 1972

Teaching and Extension Services Because the workshop on teaching basic soils provided such a fine climate for learning (aided greatly by the facilities available, particularly the dormitory and conference facilities, on the Kauai Branch Station), depending upon demand from other members of the Consortium, Hawaii will be pleased to host another workshop in the summer of 1972. This workshop will deal with teaching and research aspects of soil fertility.

With the concurrence of other members of the Consortium, Hawaii would recommend that the people involved in each workshop should follow-up their workshops with annual meetings of shorter duration preferably in foreign tropical areas. Such meetings would serve three purposes: (1) to discuss advances in teaching and research, (2) to obtain firsthand knowledge of problems in tropical soils, and (3) to act as a service group which would be

available as consultants to AID Bureaus and Missions in the countries being visited.

Hawaii plans to budget travel funds for three overseas trips for three members of the soils staff. Where these individuals will go will depend on negotiations with the various AID Bureaus. Due to its closer proximity to the Pacific Basin and East Asia and the fact that there are large numbers of UH graduates in this area, it would seem logical for Hawaii to devote its efforts to this area of the World. The trips are budgeted accordingly.

Two new courses will be added to our curriculum. Both courses have a direct implication in the 211(d) program. One course will be a variable credit course on Directed Teaching. Hopefully such a course should better train foreign students in teaching and extension methods. The second course will be an intensive six-week course in Tropical Crop Production during the summer. It will involve tropical root and tuber crops, rice, and other grain crops, vegetables, and fruit crops. Emphasis will be placed on soil problems, physiology, and pest control. The course should be a useful service to AID and other similar agencies as well as to graduate students in this Department.

The series on "Illustrated Concepts in Tropical Agriculture" will be continued using 211(d) funds in part.

Research and Extension Services The x-ray fluorescence quantometer has been received and will be in operation by January 1972. At this time a Soil, Tissue, and Forage Analysis Laboratory will be established to serve the public and scientists within the department. It is expected that this laboratory will also be able to handle some samples from the Pacific Basin, the East Asia and from members of the Consortium. 211(d) funds will be used to hire a technician to handle the research samples and those coming in from foreign areas. State funds provide the supervisory personnel, stenographic

help, the research required to back up the recommendations given, student help, and supplies.

The purchase of the above equipment eliminated the need of updating our x-ray equipment to provide for elemental analysis which was a part of our original budget. For this reason, we will be negotiating with biological and physical science units within the University to determine if enough funds can be gathered to either purchase or lease a scanning electron microscope. If this is feasible, we will plan to use 211(d) funds to purchase an electron micro-probe attachment for the instrument. Such an instrument would be extremely useful in soil mineralogy studies and studies on mechanisms involved in the uptake of nutrients by roots and leaves.

Dr. Fred Beinroth, who is supported by 211(d) funds from Puerto Rico, will spend six weeks in Hawaii sometime in November-December period. The purpose of his trip will be to initiate a geomorphic-pedogenetic study in Hawaii, to start a cooperative project whereby soils of Hawaii and soils of Puerto Rico will be classified according to the FAO system, and to correlate the chemical and physical characteristics and behavior of soils in Puerto Rico and Hawaii which have been similarly classified under the U.S. system. He will be supported by both Puerto Rican and Hawaiian 211(d) funds.

Dr. William Sakai, a 211(d) Post Doctoral Fellow, will be helping Dr. Rollin Jones with his soil mineralogy work particularly in relation to the use of the electron microscope which is Dr. Sakai's specialty. Dr. Gordon Tsuji, another 211(d) Post Doctoral Fellow, is doing soil physics research under Dr. Goro Uehara.

Dr. Anthony Sayegh a soil scientist from the American University in Lebanon will be spending his sabbatical leave in this Department from September 1, 1971 to May 31, 1971. He will be partially supported by 211(d)

funds. He will be working on amorphous materials of Hawaii and Lebanon soils in cooperation with Dr. Rollin Jones, Dr. Samir El-Swaify, and Dr. H. Ikawa.

In addition to the soil mineralogy studies indicated, micromineralogy capabilities of tropical soils utilizing x-ray diffraction, x-ray fluorescence, scanning electron microscopy, electron probe, and transmission electron microscopy will be continued. Montmorillonites and halloysites formed under tropical conditions will be studied. An electron microscope comparison of soils from other tropical regions will be conducted with Hawaiian soils, starting first with Puerto Rican soils.

In addition to the ongoing research program the following new projects are being initiated which may be of interest to other members of the 211(d) Consortium. A project will be commenced on the shallow organic soils (Tropofolists) of Hawaii to determine whether these soils should be cleared for other crops or left as forest. Another project involves a study of slow release nitrogen compounds and materials including wastes is being initiated. A third project will involve research on the physical, chemical, and biological factors which influence the uptake of nutrients by plants.

The project leader from Hawaii plans to visit the campuses of all the other cooperating Universities to determine how Hawaii might better mesh its program into those of the others and to determine the best means of implementing a program in the exchange of faculty and students. Dr. James Silva from this Department will be spending his sabbatical leave at Cornell this year. Dr. Sheldon Whitney is spending his sabbatical leave at the Puerto Rico Experiment Station working on tropical pasture management.

Foreign travel contemplated in addition to the three trips mentioned under Teaching and Extension Services will include a trip to Wageningen, Netherlands from August 15 to 20, 1972 by Dr. Robert Fox to attend a

Symposium on Acid Sulphate Soils. Dr. Fox will present a paper and will plan to make visits to Prairie View A&M and to Puerto Rico on the way to this meeting. Dr. W. G. Sanford and G. Uehara will attend the 211(d) Executive Committee which tentatively is to meet at IITA in Ibadan, Nigeria probably in March-April of 1972. They will probably visit some other African countries to consult with local soil scientists.

Personnel. In addition to the staff listed under Major Accomplishments, the following staff and students will be supported by 211(d) funds:

<u>Position</u>	<u>Name</u>	<u>Specialty</u>
Professor	Not selected	Soil Classification
Post Doctoral Fellow	Gordon Tsuji, Ph D.	Soil Physics
Post Doctoral Fellow	William Sakai, Ph.D.	Electron Microscope
Technician	Mrs. Annie Chang, M.S.	Analytical Chemistry
Graduate Res. Asst.	Wayne Hudnall	
Graduate Res. Asst.	Mayo E. Ryder	
Graduate Res. Asst.	Raymond Uchida	

## Expenditures 1970-71

Salaries and Wages	\$ 4,026
Supplies and Library Acquisitions	5,362
Equipment*	11,316
Travel	<u>3,499</u>
Total	\$24,203

\*Itemized as follows

<u>Vendor</u>	<u>Description</u>	<u>Cost</u>	<u>Justification</u>
Hawaii Audio-Visual Center, Inc. Honolulu, Hawaii	Compact wide angle lantern slide projector, Buhl Model LS-1 with slide guide - 16 lbs.	\$ 273.64	Projector is required for virtually constant use in viewing electron microscope plates to determine quality, subject matter content, and planning additional work without printing plates.
Controls, Inc. Honolulu, Hawaii	103-PW Darkroom Fan, 234 cfm I.L.G. Electric Ventilating Co.	147.16	Hood fan for darkroom.
Packard Instrument Burlingame, California	Model 2111-04 Tri-Carb Automatic Liquid Scintillation Spectrometer System (line voltage and frequency: 115V 60 cycles)	5,220.00	Water relations of tropical soils, ionic equilibria in tropical soils and sulfur and phosphorus behavior in soils.

<u>Vendor</u>	<u>Description</u>	<u>Cost</u>	<u>Justification</u>
Anderson's Camera House Honolulu, Hawaii	404-820 D-6 Triple Condenser Lamp House	202.50	Darkroom equip- ment for black and white and color photo- graphy for 211(d).
Central Camera Inc. Honolulu, Hawaii	Tripod, Linhoff Nu-Line 111	135.00	same as above
Central Camera Inc. Honolulu, Hawaii	Arkay Model 150 Print Dryer	425.00	same as above
Anderson's Camera House Honolulu, Hawaii	Arkay-81-4DL Developing Tanks; Stainless Steel 2 1/2 x 10 1/2 x 9 x 13/16 with lids	142.35	same as above
Applied Research Lab. Sunland, California	Specimen Briquetting	2,350.00	Accessory equipment and supplies for the ARL 72000 Vacuum x-ray Quantometer system
Applied Research Lab. Sunland, California	Bleuler Rotary Mill	1,500.00	same as above
	Subtotal -	<u>\$10,395.65</u>	
Miscellaneous (Less than \$100.00 per item)		<u>920.35</u>	Equipment for darkroom
	Total -	\$11,316.00	

## Projected Expenditures 1971-75

	<u>71-72</u>	<u>72-73</u>	<u>73-74</u>	<u>74-75</u>
<u>Salaries and Wages</u>	\$ 83,000	\$102,448	\$ 83,973	\$ 67,520
<u>Supplies and Library Acquisitions</u>	13,600	17,600	13,600	10,600
<u>Equipment</u>				
Microprobe Attachment for scanning electron microscope <sup>1</sup>	26,000			
Miscellaneous	<u>3,000</u>	<u>          </u>	<u>          </u>	<u>          </u>
Subtotal	\$ 29,000	\$ 8,100	---	---
<u>Travel</u>				
Inter-island and Out-of-State	3,000			
Overseas				
2 trips to Africa <sup>2</sup>	4,000			
3 trips to Asia <sup>3</sup>	<u>7,500</u>	<u>          </u>	<u>          </u>	<u>          </u>
Subtotal	\$ 14,500	\$ 11,856	\$ 10,000	\$ 10,000
Total	\$140,100	\$140,004	\$107,573	\$ 88,120

Four Year Total	\$475,797
First Year Total	\$ 24,203
Five Year Total	\$500,000

<sup>1</sup>Dependent on matching University funds to purchase scanning electron microscope (\$90,000).

<sup>2</sup>Two persons to attend Executive Meeting at IITA in Ibadan, Nigeria

<sup>3</sup>Three trips for staff members to do consulting in Asia.