Final Report USAID Farmer to Farmer Assignment
between
School of Agriculture and Biotechnology, University of Eldoret, Kenya
and
Dr. Ronald Taskey and Mr. Craig Stubler
California Polytechnic State University, San Luis Obispo

Background

Members of the faculty and administration in the School of Agriculture and Biotechnology (SAB) at the University of Eldoret (UoE), Kenya, requested assistance from the United States Agency for International Development (USAID) to conduct an external assessment of their Soil and Land Use Management program and its infrastructure. While some University programs—most notably those in business, education, and engineering—benefit from high enrollments and adequate resources to meet minimum or better standards, others that are less visible but critical to land stewardship, environmental quality, and life sustenance are barely sustainable. Within SAB, the programs that focus on soil science, seed science, and food operations suffer most from declining student numbers, dwindling financial support, and deteriorating facilities (Catholic Relief Services, 2016).

The School's undergraduate program in soil science is in particular distress. In addition to undergoing financial difficulties and physical deficiencies, the program suffers from seriously declining enrollments, as heretofore prospective students increasingly gravitate toward more alluring fields of study. Concurrently, demand for Introduction to Soil Science (SSC 102), the Soil Science Department's critical support course, has rapidly outgrown laboratory facilities and reasonable teaching loads, as numbers approach nearly 400 students for only two faculty and one laboratory. As a result, the faculty feel that their program's effectiveness will fall short of what is needed to maintain essential and applicable curricula, support of the broader student population, and viable research efforts, and additionally trying to strengthen service to the public and private sectors.

Meanwhile, as these vital programs decline, the challenges of feeding Kenya's rapidly growing population escalate, and the country's most productive soils and related natural resources disintegrate. As one highly respected UoE faculty member, Dr. Caleb Othieno, put it, "Our soils are dying, and we need to act before it is too late."

To do their part in educating Kenyans for an improved quality of life UoE's agricultural faculty recognize that they must set a new course for their declining programs: they must revise their curricula, attract talented new students, and improve their services to the private sector, including the region's farmers and foresters. In collaboration with Dr. Michael Colegrove, an independent consultant, they requested assistance from the United States Agency for International Development (USAID) through its Farmer-to-Farmer (F2F) program. A memorandum of understanding (MOU) among UoE, USAID, and Catholic Relief Services (CRS—the implementing agency for USAID in East Africa) was approved.

In consequence, Dr. Ronald Taskey and Mr. Craig Stubler, from California Polytechnic State University, were recruited to collaborate with UoE faculty and administrators to assess current needs and conditions and to offer strategic and technical advice for enhancement of the soil science program. The remainder of this report outlines Dr. Taskey's and Mr. Stubler's findings and recommendations. It will be the University's responsibility to develop a detailed improvement plan and to seek further assistance to secure funding for implementation.

Final Scope of Work and Itinerary Dr. Ronald Taskey, Mr. Craig Stubler 2016			
Day	Date	Persons	Purpose/Activity
1	19 Feb Fri	Dr. Taskey, Mr. Stubler	Depart San Luis Obispo, CA, USA
2	20 Feb Sat		Arrive Nairobi, check in Zehneria Portico
3	21 Feb Sun		familiarization, national museum
4	22 Feb Mon	Martin Waweru, CRS	orientation, familiarization
5	23 Feb Tue	Univ of Nairobi. Faculty of Agriculture. Dr. George Chemining'wa, Dept head Plt Sci & Crop Protection; Mr. Daniel Gitonga, Administrative coordinator; Dr. Charles Gachene, prof. soil science; Mr. Kibet Staline, graduate student; Ms. Martha Kimani, technician.	orientation to programs and facilities
		KALRO, Nairobi Dr. Nieru Gachini	orientation to laboratory operations and facilities
6	24 Feb Wed	Martin Waweru, CRS	travel Nairobi-Eldoret, check in Hotel Noble
7	25 Feb Thurs	UoE soil science faculty: Dr. Wilson Ng'etich (head of department), Dr. Caleb Othieno, Dr. Julius Ochuodho, Dr. Abigael Otinga, Dr. David Chemei	introductions, orientation, and interviews
8	26 Feb Fri	Dr. Wilson Ng'etich; Dr. Elizabeth Omami, Dean SAB; Dr. Ruth Otunga, Dep. V-Chancelor UoE	overview of programs, enrollments, facilities, challenges
		Dr. Caleb Othieno, Dr. Julius Ochuodho	interviews
		Purdue University visitors: Dr. Darrell Schulze, Dr. Ji Qin Ni, and students (Mercy and Josh)	introductions
9	27 Feb Sat	Taskey, Stubler	review, interpret findings; revise schedule

10	28 Feb Sun	Dr. Darrell Schulze and Purdue students	local geology, soils, erosion; Sergoit Hill, Rift valley geography, land use
11	29 Feb Mon	Dr. Wilson Ng'etich, Dr. David Chemei, Dr. Abigael Otinga, Dr. Caleb Othieno Taskey, Stubler	interviews review, organize findings
12	01 Mar Tues	Dr. Nicholas Rop, Head, Seed, Crop, & Horticultural Science; Dr. Oliver Kiplagat, Head, Agricultural Biotechnology; several students in soil science	interviews
13	02 Mar Wed	Dr. Linnet Gohole, Director Research & Innovations; Dr. Violet Mugalavai, Director Industrial Relations; Dr. Vincent Sudoi, Dean School of Environmental Studies; Mr. David Samori, technician SES; Dr. Wilson Ng'etich	interviews, overview of programs, enrollments, need for soil science tour of facilities
14	03 Mar Thurs	Taskey, Stubler	findings review, preliminary recommendations, seminar preparation, Hotel Noble
15	04 Mar Fri	Dr. Lazare Etiégni, Dean Forestry and Wood Science; Dr. Wilson Ng'etich	interviews, overview of programs, need for soil science; seminar preparation
16	05 Mar Sat	travel Eldoret-Kisumu Dr. David Guerena, One Acre Fund research director	Kenya familiarization, relaxation
17	06 Mar Sun	travel Kisumu-Eldoret	Kenya familiarization, seminar preparation
18	07 Mar Mon	AM: Taskey, Stubler PM: UoE administrators, SAB dean, faculty, staff, students	finalize seminar Taskey, Stubler present seminars
19	08 Mar Tues	Dr. David Chemei, Mr. Johnson (surname), technician	field observations of local soils
20	09 Mar Wed	Taskey, Stubler	report preparation, Hotel Noble
21	10 Mar Thurs	AM: Taskey, Stubler Dr. Wilson Ng'etich, soil science faculty	report preparation HN exit meetings
22-28	11-17 Mar Fri-Th	Taskey, Stubler	depart Eldoret, visit Kenya, return to Nairobi 17 Mar.

29	18 Mar Fri	CRS & USAID staff, Nairobi	finalize & submit CRS/USAID report, exit interview, debriefing

PROGRAMME JUSTIFICATION AND NEEDS

Why does UoE need an undergraduate program in soil science?

Every person interviewed for this project agreed that soil degradation and soil loss have seriously degraded Kenya's environmental quality, decreased its ability to produce food and fibre, and limited its citizens' overall quality of life. They also affirmed that UoE must have a strong, high quality undergraduate program in soil science to address these, the country's most pressing problems. More specifically, a viable undergraduate program in soil science is needed for each of the following:

- ensure a forum and a framework for basic courses, not only in introductory soil science, but also in soil morphology and classification, fertility and fertilizers, water relations, soil resource inventory, and land rehabilitation. Without the undergraduate major, few undergraduate courses would be taught.
- provide practitioners who can assess physical, chemical, and biological soil conditions and anticipate soil responses to inputs and disturbances
- attract highly qualified faculty who are eager to attract talented students and teach undergraduate courses in soil science
- provide the fundamentals for graduate-level research in soil science.

What is needed to have a successful undergraduate program in soil science?

- a well-thought-out curriculum built on fundamental coursework in sciences, mathematics, communications, and the arts; that sets high but attainable standards; and that allows students some choice in the courses they take
- adequate infrastructure of laboratories, equipment, and supplies for practical learning and hands-on experiences
- faculty with expertise and commitment to the discipline and to students
- student numbers adequate to sustain Kenya's need for soil scientists
- support from stakeholders outside the program, including private companies and alumni

PROGRAMMATIC RECOMMENDATIONS

Turning around a declining university program requires faculty commitment, a carefully reasoned proposal, and administrative support. Administrators generally are more supportive if they see that an enhancement plan is being developed. The following recommendations are intended to help start the process of formulating such a plan.

Overview of programmatic recommendations for the BSc in soil science

Recommendations are summarized in the following seven points.

1. Inventories of programmes, courses, faculty, and students
2. Curriculum criteria, revision, and presentation
3. Hook students
4. Nature students
5. Make opportunities for graduates
6. Communicate, reach out, market
7. Implement

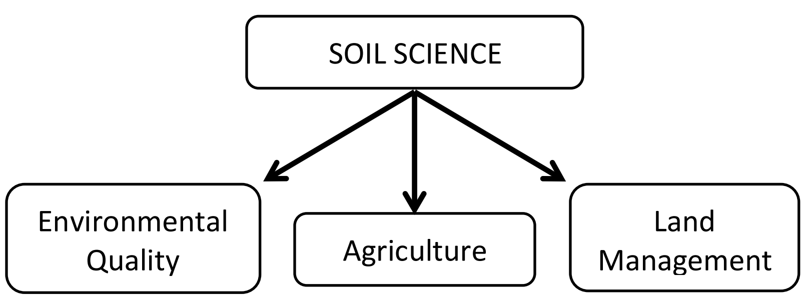
Recommendation 1: Inventory of programmes, courses, faculty, and students

1. Identify programmes university-wide that have a soil science component.
2. Identify all courses university-wide that teach soil science.
3. Identify courses that overlap or compete.
4. Identify faculty who teach soil science and who have soil science expertise but teach in a different discipline.
5. Characterize student populations and profiles.
6. Plot enrollment histories for soil science courses.

Recommendation 2a: Curriculum criteria and revision

The program would benefit from a revision of the current curriculum. Any revision should be based on criteria and goals, including the following:

1. Ensure strong basics in science, mathematics, communications, society, and arts, as well as soil science; incorporate critical thinking components into selected courses. Help students to build a foundation that will serve them well for life, no matter what their ultimate profession.
2. Help to meet Kenya's critical needs for agricultural and forest production, improving environmental quality, and enhancing land stewardship and management.
3. Offer programme options that prepare different students for different career paths. The options should rest on a set of common core courses, then branch to meet the needs of each option. Possible examples of options: food and fibre production (agriculture and/or forestry), environmental quality, land stewardship or management.



4. Allow students some flexibility (e.g., 15 percent of coursework) in choosing courses. Choices can be free electives (any class in the university, without restriction) and/or restricted electives (each student chooses from a list of approved courses).

5. The curriculum and faculty should be adaptable to change.
6. Design the curriculum and offer course options that encourage student-student mentoring.
7. Meet ISO standards (Note: We deem some ISO requirements (e.g., those that govern examinations) to be overly restrictive, wasteful of resources, and stifling of creativity; but this point is beyond the scope of our assignment.)

Recommendation 2b: Curriculum presentation and marketing

1. Create a website designed for the soil science students and potential students. Include the programme's mission, curriculum (including options), professional opportunities, faculty profiles, and photographs of active students and faculty. Ensure that the site is friendly, inviting, informative, and easy to use and navigate.
2. Create an inviting brochure of programme offerings and professional opportunities.
3. Hang a bulletin board about that displays soil science activities, and that is maintained regularly. Perhaps cover with glass for better control of content.
4. Create an on-line University catalog.

Recommendation 3: Hook students

We strongly suspect that many prospective soil science students can be found across Kenya's growing population as well as within UoE's student body. These people probably are unaware of the discipline and its rewarding opportunities. They can be attracted, but we doubt that simple advertising will bring any significant number to the soil science programme. We therefore emphasize the following:

1. Offer the introductory soil science course without prerequisites to first year students, and also allow more experienced students to take the course.
2. AAA: Awareness, Appreciation, Action. Make the three A's the cornerstone of the introductory soil science course. The premise is this: If students are made *aware* of and helped to *appreciate* the relevance, value, and beauty of soils and what soils do for life on earth, those students will be moved to *action* (e.g., develop and pursue stronger interests in soil science). This does not mean that the course material should be diluted (good students *want* substance); rather, it means that scientific information must be given an enticing and relevant context. It also means that the introductory course (in any discipline) should be taught by the best teachers—those who are enthusiastic, can establish high credibility with students, and have deep knowledge of the subject.
3. Ensure that all courses are exciting and relevant to students as well as informative.
4. In soil science, the best way to promote AAA, generate interest, and show relevance is to take students to the field multiple times, and to give them the opportunity to discover for themselves.
5. Faculty must be available to students, and they must be open and nurturing.
6. Most students want to be hooked by something, and when they are hooked, they want their fellow students to join them. Create the atmosphere for that to happen. When this happens, students will want to contribute to the good of the program, and they will remember it long after they graduate.

Recommendation 4: Nurture students

Faculty must nurture students, but also conditions should be created that encourage students to nature other students, thus taking advantage of natural tendencies for peer support and mentoring.

1. Again, let the "Three A's" work for you.
2. Faculty should hold daily open-door office hours, which are designated and posted.

3. Form a soil science club that is run by students, with student-elected officers and having a designated faculty advisor. The club could focus around three types of extracurricular activities: educational, community service, and social.
4. Provide students with opportunities to assume responsibilities, which can help give them a sense of worth, belonging, and ownership in the department.
5. Replace the cohort model of proceeding through the curriculum with a "family" model. Although the cohort model might be administratively logical and expedient, it does not foster a sense of community throughout the student body. A "family" model, in contrast, allows more "floating" of students among courses offered at various levels. Thus, for example, a qualified second-year student would be allowed to enroll in a course that traditionally is presented to third-year students. In other words, students would be allowed to "move up or down the ladder" with faculty advisement. Appropriate adjustments would be needed in administrative regulations and accounting.

Recommendation 5: Recruit opportunities for graduates

This is one of our most important recommendations. A common suggestion for a flagging programme is to recruit new students, but we cannot recommend this without FIRST identifying and recruiting opportunities for new graduates. How might this be done?

1. Identify relevant and urgent rallying issues or needs that might lie within or beyond the normal purview of soil scientists, but which can be addressed by properly trained soil scientists. Examples might include hazardous waste disposal or soil contamination, severe problems of soil erosion and degradation, a soil-testing programme, or a composting programme designed to turn a societal waste into a societal asset.
2. **Identify and recruit potential employers**, then recruit potential students. Initially, this should be done by one or two faculty members working in concert. After a time, students can be called upon to help, but their tasks must be concise and made clear to them. Reach out, think beyond the normal limits (which often are self-imposed). And when it comes to attracting new students, focus on women and men equally.

Recommendation 6: Communicate, reach out, market

Don't try to market something you don't have—create before you sell. Recommendations 2a and 5 should be undertaken early in the renovation process; then, once these are well on their way, give increased attention to the following:

1. website development and social media
2. question and answer sheets or brochures for students, parents, sponsors, and alumni,
3. strengthening alumni contacts, and encouraging alumni involvement and support
4. creating a group of student ambassadors to help promote their programme
5. reporting and outreach to the local community (student clubs and ambassadors can be very helpful with this)
6. forming an external advisory committee composed of professional leaders, former students, and selected stakeholders. (Forming the committee should be one of the last efforts; if it's not, too many cooks will be in the kitchen!)

Recommendation 7: Implement

Implementing many of the above recommendations will require **sharing and cooperation at several levels**: among soil science faculty; between the Department of Soil Science and other departments in the Schools of Agriculture and Biotechnology, Environmental Studies, and Natural Resource Management; and between the soil science faculty and students. In addition to the obvious benefits of sharing expertise and resources, cooperative linkages often generate synergistic outcomes and help to cultivate administrative support.

A few additional recommendations follow:

1. Try to make the job of strengthening the programme a concerted effort among all faculty who are willing to contribute. This might require the formation of an "enhancement committee" or equivalent. An organizational structure, even if informal, can boost group enthusiasm and assuage individual discontent when responsibilities are delegated.
2. Follow up with employers to see how graduates of the programme measure up to the employer's standards. The point is not to judge the performance of an individual worker, but to judge and adjust the performance of the programme.
3. The final recommendation perhaps is the most important of all: ***the program must have a champion within its ranks***—one or two dedicated, creative, and energetic faculty who are able and willing to command the efforts and carry forth the standard. This person or persons should be compensated for their efforts, perhaps by being relieved of some portion (e.g., 20 percent) of her or his regular duties.

   Most high-profile and product-driven programmes (e.g., business, computer science, wine making) do not need a strong internal advocate—these programmes generally are well-known and receive ample external and internal support. But lesser known programs that do not have a "commodity" to offer, including soil science, must generate their own energy by intensive effort from within.

Overview of infrastructure recommendations for the BSc in soil science

Recommendations are summarized in the following six points.

1. Compile field and laboratory needs lists for teaching, research, and service.
2. Build relationships and foster a collegial spirit among departments to encourage cross-discipline discourse and sharing of lands, facilities, equipment, and expertise.
3. Work to strengthen and standardize laboratory safety procedures across the university.
4. Seek collaborations with other departments and schools.
5. Seek funding as various parts of the overall enhancement plan near completion.

References

Catholic Relief Services. 2016. Farmer to Farmer East Africa. Volunteer Assignment Scope of Work. KE72 and KE71.

Develop laboratory and field needs lists for the following: teaching, research, and community service.

Evaluation of material resource needs is necessary for effective delivery of the Soil Science BSc., and should be accomplished before taking inventory of existing facilities and equipment within the Soil Science Department. This needs list should include the following areas: field sites, field equipment, laboratory facilities, laboratory equipment, and transportation. In developing a facility and equipment needs assessment and by performing inventories and investigating potential collaborations within and outside the soil science program, the department will have on hand a prioritized list of resources that will contain the background information necessary to seek funding for facility and equipment improvements, as those opportunities arise.

Teaching need: field sites

We were able to visit five separate field sites to investigate soils; all within easy walking distance of the Soil Science Department. We accomplished this with the help of Johnson, one of the department technicians. We were able to walk to each of these sites, and spend time investigating each soil, within just a few hours' time. Potential exists to develop several locations throughout UoE campus lands that provide the necessary diversity for introductory soils courses, as well as many upper-division courses. Soil morphological data, as well as chemical and physical data of these soils could be collected and archived for use in future class work, and for possible student research as well. Identifying off-campus sites for routine field visits is important too, but priority should be given to formally identify on-campus sites for soils investigations, and to the work necessary to develop these sites for class needs. This is the most time and cost-effective approach, as it does not require vehicle transportation resources and requisite driving time.

Teaching need: field equipment for soils investigations

Along with designated on-campus field sites, students need access to the basic equipment necessary for soils investigation and morphological description. Figure 1 lists the basic field tools and equipment we deem necessary to provide a comprehensive field practical for undergraduate students in soil science. Each kit could serve up to four students. Figure 2 shows the types of shovels commonly used for soils work; other tools may be preferred and appropriate as well.

Figure 1. Soil description kit.
Contents: Color book, clinometer, compass, sieve, water bottle, soil sample tray, cloth measuring tape, probing implement (trowel); pH reagent and acid, as necessary.

Figure 2. Shovels, tiling spades and augers soil investigation.

Teaching need: transportation

As a field-based discipline, soil science students need to access locations that require vehicle transportation. Offering field practicals at on-campus sites increases the opportunities for student engagement with lower costs than off-campus travel, but does not replace the need to visit off-campus field sites. It appears there are university procedures in place to this end, and that the Soil Science Department has systems in place to utilize these resources.

Teaching and research need: laboratory space and collaboration

The soil science department is in need of adequate space for delivering laboratory practicals. Although a department needs list will provide the best assessment of space needs, we recommend at least two laboratory rooms be dedicated to undergraduate instruction: one space dedicated to introductory soil science practicals, and another space dedication to higher level lab-based soil science courses that require more sophisticated equipment than that used in introductory soil science.

In addition to dedicated space for undergraduate practicals, having separate space for graduate and faculty research, and possibly community service (soil testing lab) is necessary. The specific activities to be carried out in such spaces will be defined through the needs assessment, and will dictate the necessary space allocation, but it is recommended that this space be in addition to the undergraduate teaching spaces.

There is potential to meet some of the department space (and equipment) need through laboratory collaboration with other programs within the School of Agriculture and Biotechnology, and outside the School; possibly with the Schools of Forestry Sciences and Environmental Studies. University-wide inquiries could be made to promote the chances of such collaborations that result in sharing of resources.

Teaching and research need: laboratory equipment

Much of the analytical equipment used in soil investigations is also common to other agricultural and environmental programs for analysis of food, fiber and earth materials. If an environment of collaboration among schools and programs could be fostered and supported by University administration, it may be possible to maximize the use and cost-share the consumables and maintenance of the more expensive analyzers, such as atomic absorption spectrometers and gas chromatographs, for example. These collaborations would appear attractive to potential funding entities by showing UoE commitment to efficient use of resources.

Other analytical equipment necessary for laboratory investigations of soils will be identified through the needs assessment and would best be purchased and controlled within the Soil Science Department. Examples of such items are bench-top pH/millivolt meters, EC meters, and UV/VIS spectrometers. Other programs use these as well, but having these distributed among multiple programs allows for sharing when there is an equipment breakdown in a particular department. The technical staff in many universities often serve as the main channel for such sharing, and policies and opportunities that foster university technician bonding and collaboration should be encouraged.

Within the department, funding of more than one bench-top meter (such as pH meters) for use in teaching and research labs is encouraged, as it will allow for a more efficient use of time in the teaching lab, and could provide a backup in the research or soil testing lab, where loss of productivity takes a toll on valuable research time and may compromise the sense of confidence stakeholders may have toward a university soil testing lab. This approach may help to achieve ISO laboratory quality assurance/quality control standards as well. The need for specific bench-top instruments, including those used in soil and water chemistry, soil physics, and soil microbiology studies will become clear through the needs assessment.

Safety: Field and Laboratory

Safety information presented here is not comprehensive, but is intended to provide examples of the range of safety matters in field and laboratory work, and ways of minimizing risk to workers. Necessary safety infrastructure should be considered in both needs assessment and inventory activities. In addition to enhanced worker health and safety, department and university dedication to a strong safety program will enhance opportunities for external funding.

Field safety

Following is a list of questions that serve as examples of safety considerations when taking students to the field. The needs assessment provides an opportunity to identify improvements in materials and supplies that enhance program safety.

- What equipment/supplies are to be provided by student?
- What equipment/supplies are to be provided by field trip leader?
- What physical activities are to be undertaken during field trip?
- What are the risks inherent in this field trip that may cause bodily injury (sprains broken bones)?
- Will there be any exposure to animals, insects or poisonous plants?
- Are site conditions or activities challenging (i.e., rough terrain, weather hazards, or activities involving the use of heavy machinery)?
- Has a near-by medical facility or medical provider been identified? Is first aid available at the site or with the field trip leader?
- Does the instructor have sufficient knowledge of the field trip site?

Laboratory safety

The common format for guidance in laboratory safety is generally found in two institutional (university-level) documents known in the United States as the Injury and Illness Prevention program (IIPP) and the Chemical Hygiene Plan (CHP). An internet search for these documents will provide many examples from academic institutions, and similar documents meeting ISO standards should be available as well.

Standard Operating Procedures (SOP)

Standard Operating Procedures should be developed for soil science laboratory procedures. The components of a comprehensive SOP are as follows:

CONTENTS

1.0 PURPOSE
2.0 DEFINITIONS
3.0 POTENTIAL HAZARDS
4.0 PERSONAL PROTECTIVE EQUIPMENT
5.0 ENGINEERING AND VENTILATION CONTROLS
6.0 SPECIAL HANDLING PROCEDURES
7.0 FIRST AID
8.0 SPILL AND ACCIDENT PROCEDURES
9.0 SEQUENCE OF OPERATIONS

Appendix 1 provides an example of a complete laboratory SOP that meets federal safety requirements in the United States. This format may be similar to the ISO requirements for laboratory SOPs.

Laboratory training of faculty/staff/students

It is essential to provide training for employees, concerning general safe work practices, as well as instruction pertaining to hazards specific to each laboratory procedure. The essential components of this training should be part of the SOP for each unique laboratory activity. Understanding the information presented in Safety Data Sheets (SDS) and where to find them is part of this training process. Training should be documented and repeated on a periodic basis.

Chemical inventory, compatibility, security and labeling

A physical inventory of chemicals on hand should be conducted periodically to

- identify containers which are leaking
- identify containers which are damaged and may begin leaking
- identify materials which are unknown (labels missing or illegible)
- identify chemicals which are no longer needed

Chemicals should be stored according to their chemical compatibility (their ability to react with each other) rather than strictly by another organizational pattern (such as alphabetical). Chemicals which can react with each other and create a hazardous condition (such as fire or the generation of toxic or flammable gases) should be stored apart from each other. Chemicals should be stored securely on a shelf or cabinet and under controlled conditions (secured in a locked room with access restricted to trained staff). Appropriate spill response materials should be kept on hand, and staff training on proper spill response should be provided. An internet search can provide many good examples of a university chemical hygiene plan which provides greater detail on safe handling of chemicals.

Labeling of containers in the laboratory should follow the specifications in the Globally Harmonized System (GHS) and ISO laboratory standards.

Hazardous waste management

Chemical wastes (hazardous waste) must be kept in closed, appropriately labeled containers which are in good condition, and placed secondary containment. Proper handling of hazardous waste is a component of laboratory safety training, and is described in detail in a chemical hygiene plan.

Safety Equipment

Personal protective equipment (PPE) includes task-appropriate gloves and eye-wear, and lab coats and aprons; and possibly other items as well. These should be made available to laboratory workers and be maintained in good condition. The selection and proper use of PPE is a component of laboratory safety training and SOPs.

Fume and biosafety hoods, eyewashes, and showers are engineered fixtures that are necessary in many laboratory situations. These should be maintained in proper working order and used in a manner consistent with manufacturers' specifications. They must also be periodically checked to document their condition, and to provide an opportunity to correct any deficiencies in operation. The purpose and proper use of these fixtures is a component of laboratory safety training and SOPs.

First aid kits should be present in the laboratory and routinely checked and restocked.

Posting of laboratory safety information

Posting of safety information within the laboratory should include rules of safe conduct in the lab and procedures for dealing with emergencies.

Laboratory safety inspections

Comprehensive **l**aboratory safety inspections should be completed on a regular schedule, and records of the findings of these inspections should be maintained. Safety inspection forms and questions should be tailored to the type of work being performed in the laboratory.

Developing collaborations

Developing innovative approaches for the Soil Science Department to share the expertise of its faculty and staff with other UoE programs through collaborative resource use will work to meet many of the space and equipment needs of the soil science program, as well as other university programs. This strategy maximizes material resource use, and works to promote collegiality within the university. Additionally, such efforts in multi-program collaboration provide an enhanced university appeal for grant funding entities.

Appendix 1. Sample Standard Operating Procedure

Standard Operating Procedure:
Removing carbonates from soil for measurement of organic carbon

Cal Poly State University Department of Natural Resources Management and Environmental Sciences

CONTENTS

1.0 PURPOSE

The purpose of this standard is to provide a procedure for the removal of carbonates from soil for measurement of organic carbon content.

2.0 DEFINITIONS

A corrosive liquid is one that will destroy and damage other substances with which it comes in contact with. Of most concern is living tissue such as eyes, skin and respiratory tract.

The centrifuge is a commonly used tool in laboratory research. It uses centrifugal force to separate substances in liquid or solid media according to particle size and density differences.

3.0 POTENTIAL HAZARDS

Hydrochloric acid is corrosive and causes eye and skin burns, if contacted. May cause severe respiratory tract irritation with possible burns. May cause severe digestive tract irritation with possible burns.

Grinding of soil may release sediment dust.

Rotors on high-speed centrifuge and ultracentrifuge units are subject to mechanical stress that can result in rotor failure. Improper loading and balancing of rotors can also cause failure. Aerosolization of biological, chemical, or radioactive materials can cause unintended exposure.

4.0 PERSONAL PROTECTIVE EQUIPMENT

Use chemical splash goggles for eye protection for operations that present splash hazards. Hand protection requires gloves or other gloves developed that withstand corrosive liquids for at least the amount of time given to perform the procedure, if available. Check glove manufacturer for recommendations on a suitable glove. Wear a lab coat and closed-toe shoes with non-slip soles.

5.0 ENGINEERING AND VENTILATION CONTROLS

Adequate ventilation is essential when working with corrosive liquids because of the irritating effects of corrosives on the respiratory system. Prepare and process samples in a fume hood.

6.0 SPECIAL HANDLING PROCEDURES

1. Never allow any unprotected part of the body to touch corrosive liquids;
2. Do not breathe corrosive fumes
3. If sediment dust is generated while grinding soil, perform grinding in the fume hood.

7.0 FIRST AID

Hydrochloric acid first aid:
Eyes: Get medical aid immediately. Do NOT allow victim to rub eyes or keep eyes closed. Extensive irrigation with water is required (at least 30 minutes).
Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Destroy contaminated shoes.
Ingestion: Do not induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.
Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If breathing is difficult, give oxygen. Do NOT use mouth-to-mouth resuscitation. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.

If sediment dust is contacted in eyes, flush eyes with plenty of water for 15 minutes. Seek medical aid, if eye irritation continues.

8.0 SPILL AND ACCIDENT PROCEDURES

In the event of a small spill of a corrosive liquid (< 1 liter) such as 0.1- 6 M hydrochloric acid;

1. Cover the liquid entirely with sodium bicarbonate.

2. Sweep up bicarbonate/acid paste and prepare for hazardous waste disposal.

In the event of a large chemical spill, follow these guidelines:
1. Notify everyone in the immediate area and the supervisor.
2. Evacuate personnel from the spill area.
3. Deny entry.
4. Notify lab supervisor and/or Risk Management for further clean-up.

9.0 SEQUENCE OF OPERATION for removing carbonates from soil measurement of organic carbon.

1. Grind soil.
2. Put a small amount (2000 ug) of soil into a small test or microfuge tube. Use smaller amounts if soils are rich in carbonates. Include checks to confirm a successful procedure if desired. These can be for example, soils of known organic carbon and/or 13C content, artificially enriched with different amounts of carbonate.
3. Add 0.1 M HCl, leaving enough space in the tubes for bubbles to form. More concentrated acid may used if carbonate is expected to be high, up to approx. 1 M HCl.
4. Make sure acid and soil are well mixed, and wait for bubbles to stop.
5. Test the pH of at least some of the samples with pH paper or indicator.
6. If the pH is close to 7, all the acid has been consumed and there is still carbonates in the sample. Add a small aliquot of concentrated, i.e. 6 M HCl to the tube to renew the acid to o.1M or whatever was used before. Mix and test pH again.
7. Once the pH remains low, less than approx. 2, all carbonate has been consumed.
8. Centrifuge the samples, pour off the liquid into _____ and dry the samples. Alternatively, simply dry the samples, this will take longer but no dissolved carbon will be lost. Make sure samples are completely dry so that no HCl remains.
9. Weigh an appropriate amount into tin capsules for analysis.

10.0 WASTE DISPOSAL

Anything less than a pH of 4 cannot go down the sink. Pour all waste into a properly labeled hazardous waste jar.