

**Review of the
Long Term Research in Agricultural Sustainability
Research Facility**

The University of California – Davis

13-15 May 2002

Submitted to

Dean Neal Van Alfen

College of Agriculture and Environment

by

Review Committee

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27 May 2002

Summary Recommendations

The Review Committee presented the following recommendations to Associate Deans Parella (Agricultural Sciences), Jarvis (Human Sciences) and Southard (Environmental Sciences) of the College of Agriculture and Environment (CAES) on the last day of the review, 15 May 2002. The rationale for these recommendations was discussed with the Associate Deans at that meeting and is developed in more detail in this accompanying report.

The Review Committee feels that the LTRAS research facility, and specifically the long-term annual rotation studies that have been established there, is a valuable, but under-exploited resource that should be a cornerstone of a sustainable agriculture program (research, education and outreach) at the University of California-Davis (UCD). We therefore recommend that the CAES demonstrate continuing support for the LTRAS program and adopt the following recommendations:

KEEP IT

1) LTRAS is a valuable and unique facility because it is the only long-term trial devoted to dry-land agriculture in a Mediterranean climate. The large physical scale of the plots allows use of field-scale equipment and provides comparative treatments that will support the development of emerging technologies (e.g., aerial imagery, use of remotely sensed data). Having this facility at UCD provides a unique opportunity to develop a lead role in sustainable agriculture.

2) Only a long-term experiment can determine how the inputs of water, nutrients and new technologies can be used to sustain production and influence the condition of the soil resource. The comparison of low, intermediate and high input production systems at LTRAS has already produced significant results that are likely to be reported in textbooks.

3) The experimental management and lay-out achieved during the establishment phase of the study has been excellent. Appropriate attention has been paid to the collection, storage, and archiving of data, samples and materials. It is unlikely that the University would ever recreate this opportunity. LTRAS needs to be preserved and extended to realize the full benefit of this investment.

ENHANCE IT

4) There is an immediate need to revamp the existing management structure of LTRAS to make it more responsive to the scientific community, while not compromising the integrity of the project. We recommend that an Interim Director or committee be appointed as soon as possible to develop a strategic plan to address issues that have limited the involvement of other scientists in this project. Specific issues that should be considered are:

- Modifications of the treatments
- Partnerships with existing groups to increase the utility and use of LTRAS in sustainable agricultural research, education and outreach
- Development of an aggressive plan to secure long-term financial support.

PROMOTE IT

5) The relevance and importance of LTRAS has not been adequately communicated to the public or researchers at large. The summary of the first 10 years of the study will present an opportunity to publicize the trial and generate interest, but this alone will not be sufficient.

We therefore recommend that:

- LTRAS be promoted as a cornerstone of the sustainable agriculture program at UCD
- The research activities at LTRAS should be better integrated with other, more outreach-oriented research and educational programs in sustainable agriculture at UCD (e.g., SAFS, the Student Farm, SAREP).

This will bring greater visibility and increase the impact of sustainable agriculture research, teaching, and outreach at UCD.

Report of the LTRAS Review Committee

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Charge to Committee/Focus of this Report

This Review Committee was called by Associate Dean Michael Parrella to review the Long-Term Research on Agricultural Systems (LTRAS) program at the University California-Davis (UCD) and to provide guidance as to how LTRAS could better fulfill its envisaged role as a core facility in sustainable agricultural research, teaching and extension. In the letter of invitation to participate in the review of the LTRAS program, the Committee was asked to evaluate:

1. The appropriateness of the design (including treatment rotations)
2. Opportunities for expansion
3. Procedures for protection and preservation of data and samples
4. Appropriateness of the budget
5. Adequacy of outreach and extension activities.

Currently, the support for the LTRAS project, approximately \$250,000 per year, comes entirely from the College of Agricultural and Environmental Sciences (CAES). During our visit it became clear that the impending short-term budget shortfalls at UCD will put extraordinary pressure on the financial resources of the CAES and continuation of financial support for LTRAS would be contingent upon demonstrating its value (current and future) as a core research facility in sustainable agriculture at UCD.

The Committee met with researchers and administrators involved in many aspects of sustainable agriculture on campus as well as organizations that fund sustainable agricultural activities throughout the state (e.g., SAREP). In addition, we made follow-up calls to individuals from the community (university researchers, farmers, UCD Agricultural Services). We also were given a copy of the original proposal to establish the experimental plots (funded partially by SAREP) that outlined the initial goals and vision for LTRAS. From our meetings it became clear that while there was strong support for the continuation of LTRAS and overall broad recognition of the unique features of the design and nature of the experiment, there were consistent comments on specific issues related to management and the structure of the project. In this report we have summarized the information we gathered over the 1.5 days of meetings (May 13-14) on the strengths and potentials of LTRAS to be a functional core research facility in sustainable agriculture at UCD and issues that need to be addressed for it to achieve this potential. We have also included recommendations on how these issues might be addressed to assure that LTRAS fulfills its intended role and becomes a fully integrated and utilized component of the sustainable agriculture program at UCD.

Overview of Sustainable Agriculture Activities at UC Davis

Applied and basic research into sustainable agriculture has a long history at UCD, starting with the establishment of the Student Farm in 1973, followed in 1988 by the start of the Sustainable Agriculture Farming Systems (SAFS) project, and in 1990 by the initiation of LTRAS. In addition, since 1987, the University of California system-wide Sustainable Agriculture Research and Education Program (SAREP) has been located on the UCD campus. These developments have mirrored the growing concerns about the future of California agriculture, which has been under increasing pressure to reduce the use of pesticides and other chemicals, and to moderate the impact of agricultural practices on the environment. The recent establishment of a committee to report to the Dean on how to coordinate and focus the sustainable agriculture activities on the UCD campus is evidence of a heightened interest in raising the profile of research and outreach on sustainable agricultural systems on this campus. The Review Committee fully endorses this approach.

Motivation for LTRAS

LTRAS was initiated in 1990 with funding from a competitive grant from SAREP (approximately \$150,000) and an initial commitment of matching funds from the CAES (\$500,000 over 4 years). The initial proposal was developed by a team of 19 UCD faculty with broad interdisciplinary interests and was focused on evaluating the long-term impacts of crop rotation and variation in inputs on productivity, economic return and environmental components (particularly soil biology and structure) in a Mediterranean climate. The experimental design focused on two key variables: the diversity of crops in the rotation and the level and source of inputs (water and nitrogen). The proposed initial experiment (funded by SAREP and the CAES) focused on annual cropping systems, but the proposal included reference to a broader vision for LTRAS to include experiments on annual, perennial and rangeland systems. The current long-term experimental plots occupy approximately 60 acres of the 300+ acres identified as being dedicated to LTRAS on the Russell Ranch property (approximately 1,500 acres in total). Thus there is sufficient land area available at this site for the originally envisioned potential of the expansion of this project to include a broader range of cropping and agricultural systems. The proximity of LTRAS to the Putah Creek Natural Area also affords the potential to explore the very important, but frequently unexplored linkages between natural and agricultural lands.

The Experimental Design and Management

The design of the LTRAS experiment was constrained by the need to have large plots to allow for the use of commercial-size farm machinery, the complexity of the proposed irrigation treatments, and the need to minimize run-off of irrigation water. Given these constraints, the design and layout of the plots is excellent. It is a replicated (n=3) experiment with both phases of ten two-year rotations representing a gradient of inputs (low, medium and high) of water and nitrogen. The specific treatment rotations were specified in the SAREP proposal and developed by the consensus of the investigators on the proposal.

The original treatments and rotations were designed to test a range of inputs in water and nitrogen that would allow experimental assessment of their sustainability both agronomically and environmentally. Although the present treatment rotations may not now be considered optimally 'relevant to 21st Century agriculture in California,' the importance of understanding the role of water and nitrogen in sustainable agriculture is a critical issue. The current irrigation treatments are not creating the range of inputs that were initially intended and it would seem appropriate to change some of these treatments after the first decade of the experiment. In particular, it seems important to consider the incorporation of a sprinkler or drip irrigation treatment in the experimental design to overcome water input limitations in the organic-based treatment (high infiltration rate) that have been documented in the first decade of these experiments (see Recommendations, below). This would also provide a way to evaluate this input mode and provide a linkage to the movement on farms in California to delivery methods emphasizing water conservation.

The current experimental facility is managed extremely well. The level of record keeping is excellent; samples of plant and soil materials are taken for archiving at appropriate intervals and have been since the inception of the project. Although there are concerns about access to and availability of equipment with high seasonal demand from Agricultural Services, the plots are meticulously managed and maintained. This results in an extraordinary level of treatment integrity that is critical for a long-term experimental study of this nature. The Committee was impressed by the dedication of those who manage and run the experiments in the field. Their work is to a very high standard, especially in view of the small number of people involved and the physical and logistical challenges involved with managing and maintaining a project of this nature and size. We hope that the College will ensure that this continues by recognizing the value of those responsible.

The Value of Long-term Field Experiments

"Insights from foresight: The role of long-term experiments and databases in agricultural and ecological sciences" was the title of the conference held to celebrate Rothamsted's 150th anniversary in 1993. This title reflects the scientific insight that has been gained because of the foresight shown by the station's founders, Lawes and Gilbert, in retaining the field experiments started between 1843 and 1856 at Rothamsted after the initial aims of the experiments had been fulfilled. They recognized that the crop and soil samples could be of benefit to future generations of scientists. Their foresight has been amply rewarded, not only by producing results relevant to agriculture, but also by contributing to a better understanding of many aspects of ecology, particularly the interaction between agriculture and the broader environment.

The Rothamsted Experiments have demonstrated the important role that a well-designed and executed long-term field experiment can play both in testing current scientific hypotheses and in providing new hypotheses to be tested. Some of these hypotheses can be tested within the long-term experimental plots; others on satellite experiments have been conducted outside it.

Long-term agricultural experiments must be capable of measuring and evaluating the effects of both farming practices and non-agricultural anthropogenic activities on soil fertility, water and air quality, and the sustainability of crop production. Although the principles of crop growth and inorganic soil processes have wide applicability, crops, soils, and their biological components invariably interact and respond to other external factors, like weather, in very different ways in different parts of the world. Thus there is a need for long-term experiments focused on the interactions between crop diversity, inputs and the environment in a range of different climatic conditions.

The value of well-designed and executed experiments increases with time and their cost-effectiveness can be increased if they serve a number of different objectives on well-characterized sites so that the conclusions can be extrapolated more widely. However, there are unique features of a long-term experiment that typically slow the rate of 'initial productivity' derived from such projects.

Among the more easily identified objectives of such long-term experiments are:

1. To test the sustainability of a particular agro-ecosystem/management practice over a long time span because changes in some soil processes respond slowly to changes in management practices.

2. To ascertain what changes, if any, are needed to maintain an environmentally benign, sustainable, husbandry system.
3. To provide the data on which to develop and to improve best husbandry (management) practices involving expertise from farmers, ecologists and environmentalists.
4. To provide a resource of soil and plant material to further scientific research into soil and plant processes that control soil fertility, plant productivity, water, soil, and air quality.
5. To allow a realistic assessment of non-agricultural anthropogenic activities on soil fertility and crop quality.
6. To provide comprehensive long-term data sets that can be used to develop mathematical models to predict the likely effects of management practices and climate change on soil properties, on the productive capacity of soils and on the environment.

To achieve these objectives requires well-designed experiments, the facility to archive and manage samples and data, the willing support of stakeholders, and an appropriate management structure that both protects the integrity of the plots and allows access by scientists so that the full potential of the experiments can be achieved. It must be realized that long-term studies do not have the quick 'pay-off' in terms of publications in peer-reviewed journals that would be typical for a more standard scientific study. By their nature, long-term studies address questions that require multiple years (decades and longer) to answer and/or to detect differences among treatments. For example, changes in soil properties that are likely to affect sustainability of crop production in the long-term will develop over decades and follow-up studies to determine the causes of these differences will involve evaluation of processes that operate over similar time scales.

We perceive that LTRAS will provide insights to agriculture in a Mediterranean climate due to the foresight of those who started and have maintained this facility at UCD.

Strengths of LTRAS

The current long-term experimental studies of annual cropping systems at LTRAS are a unique and valuable resource. It is the only long-term experiment devoted to dry-land production. The majority of long-term studies are in temperate climates, only a few exist in the tropics. The large physical scale of the plots is a unique attribute that is important because it supports use of field-

scale equipment and provides comparative treatments that will support the development of emerging technologies (e.g., aerial imagery, use of remotely sensed data). Only a long-term experiment of this sort can determine how the inputs of water, nutrients and new technologies can be used to sustain production and will influence the condition of the soil resource. The comparison of low, intermediate and high input production systems represents production strategies that have been and are likely to continue to be used in dryland regions of California and around the globe. How production and soil properties vary in response to water and nutrients in the original series of two-year rotations has already produced results likely to be reported in textbooks.

The experimental management and lay-out achieved during the establishment phase of the study has been excellent. Appropriate attention has been paid to the collection and storage of archival materials and policies worked out for data access, sharing and attribution (reference the LTRAS Charter). The high quality of the management and careful documentation of procedures and protocols assure the integrity and reliability of the data from this project. The large plot sizes allow use of commercial equipment and closely match the practices of full-scale farming systems. While concerns have been raised since the inception of the project about the relevance of the specific treatments, they represent a broad spectrum of management inputs and a diversity of crop types that allow comparisons of a wide range of cropping systems appropriate to California (dry land, conventional, organic, etc). The availability of unassigned plots has allowed exploration of specific hypotheses that relate to the management and rotations on these plots (e.g., the 'organic transition' plots were initiated in 1998). The project is coming up to its 10th year (1994 was the first cropping year after the uniformity cropping with Sudan grass in 1993) and the Committee suggests that changes should not be introduced until the 10 years are complete. Changes should in part, be based on the results from the first ten years.

From our discussions with faculty involved in sustainable agricultural research at UCD it is clear that the long-term experiments at LTRAS are recognized as a valuable and unique resource for research, education and outreach in sustainable agriculture. They are also clearly an under-exploited resource – only a few of the researchers we met with conduct research on the site and these activities have been sporadic. Several issues emerged as potentially responsible for this, and while the reasons are partially historical, it is clear that many of these concerns would be readily addressed by implementing changes in management and the treatments applied.

Recommendations

Developing production systems that ensure both food security and quality in environmentally benign ways must be an essential feature of all research activities in agriculture.

The Committee commends the Dean for his initiative in establishing a committee to consider the diverse programs on the campus that are addressing questions in agricultural sustainability. We emphasize the importance of including LTRAS as a cornerstone of the College's Agricultural Sustainability programs, but note the critical importance of including programs such as the Student Farm, the SAFS project, and linking with statewide programs such as SAREP. One model would be to establish a continuum of interlinked programs, partnering the Student Farm, where innovative strategies in teaching and demonstration of sustainable and organic farming practices conducted on a small scale, have long been successful, with SAFS, where farming systems research informed by an adaptive management strategy has hosted pilot evaluation of farmer-appropriate strategies and supported effective outreach, and LTRAS, which is the only experimental system that can record the long-term influences of management strategies of production and environmental function. The linkage could be made if the crop production systems in LTRAS were modified in response to the needs and findings of the Student Farm and SAFS. The Committee felt that it would be beneficial for the LTRAS site (i.e. 300+ acres) to expand to and emulate the SAFS project. Ideally, the facility will support new SAFS 'playground' plots where innovative production strategies could be tested. The expanded facility would be an ideal location for graduate training in agroecology

Specific Recommendations

Recommendation 1. Alter the LTRAS management structure.

While the current Director of LTRAS (Ford Denison) and Associate Director (Dennis Bryant) have been extremely successful in establishing the plots and developing protocols for management of the plots, data and samples, and assuring the quality and content of core measures, they have been less successful in promoting use of the LTRAS by other scientists. To some extent this has been due to past difficulties in obtaining permission to work on the site. New policies and procedures were implemented early in 2002, including a web-based site access request process. However, real and perceived difficulties in working with the Executive and Operating Committees and current management structure of LTRAS clearly have reduced the involvement of a number of UCD faculty in using LTRAS as a research site/ facility. The individuals involved in management of the project (Director(s), Executive and Operating

Committee) also do not seem to have been proactive in promoting the value of the site for other research projects.

It is time to consider modification to the LTRAS Charter in relation to the management of the facility over the next decades to ensure its smooth running and to maximize the use of this increasingly valuable scientific resource. We suggest setting up two committees.

1. An Interim Director and management committee should be appointed as soon as possible. The committee should include representatives from a broad range of scientific disciplines and should include individuals who are actively engaged in research at the LTRAS site.

2. An external advisory committee should be appointed composed of selected representatives from organizations with an interest in LTRAS. This could include, for example, representatives from SAFS, SAREP, and the Davis Student Farm, members of Cooperative Extension, researchers involved in similar research outside Davis and local farmers. In particular, we believe that it is essential to reengage farmers in an advisory role, extension and fund-raising activities.

The Interim Director and management committee should develop both a short-term strategic plan for LTRAS for wide ranging discussion among all interested parties and begin the process of developing a longer-term, broad vision for LTRAS that would incorporate the full range of issues in sustainable agriculture, including the interactions between managed/ agricultural lands and natural areas. The issues that need to be addressed include:

(i) Involving greater numbers of principal investigators, graduate students and others in research and outreach to more fully utilize the LTRAS site

(ii) Careful discussion of possible changes in experimental treatments

(iii) Exploring opportunities for new core funding or additional funding to expand observations and measurements, for example of trace gas emissions and leaching of inorganic and organic pollutants

(iv) Ensuring that the research is hypothesis driven

(v) Maintaining the long-term integrity of the site

(vi) Generating and maintaining quality data sets to which numerous questions can be addressed.

It may be worthwhile considering co-directors charged with overseeing different aspects of the project, e.g., day-to-day operation, research projects, outreach, fund-raising and coordination and cooperation with other sustainable agricultural projects.

Recommendation 2. Carefully consider modifications to LTRAS treatments.

The yields currently being obtained are similar to or a little better than those obtained by better local farmers who follow similar husbandry practices on similar soil types. This suggests that there is nothing fundamentally wrong with the management of the experiment from a practical agronomic perspective. However, modifications to the existing LTRAS treatments/ cropping rotations appear to be justified. But any changes must be based on consideration of:

(i) A comprehensive evaluation of existing results

(ii) Realistic concepts about the medium-term future of agriculture in California

(iii) Environmental issues to ensure that the system(s) to be tested offers the prospect of being environmentally benign

(iv) Not compromising the scientific, long-term integrity of the LTRAS experiment.

While members of this Committee are not necessarily the appropriate people to suggest changes, we feel it appropriate to make some observations. It is essential to remember that treatments fall into one of two categories:

1. Those, which if applied for short periods, are unlikely to leave substantial residues, e.g., water and nitrogen

2. Those which can change important soil properties like the inclusion of cover crops or those which appreciably change soil organic matter, such as long periods in grass or legumes.

Within these two categories, the Committee considers that some modification to the existing treatments can be incorporated into the experiment without damaging the long-term objectives. For example, (i) the rain-fed and irrigated wheat treatments could be tested on one plot as sub-plot treatments.

These treatments can be alternated to minimize possible unexpected results. (ii) In view of the likely limitations to water use in the region, the irrigated plots could be divided, to test furrow irrigation versus sprinkler/drip irrigation. This treatment may have long-term effects so treatments should be cumulative.

The Committee also recognizes that the current organic farming system is not one that would be practiced commercially. We, therefore, recommend that serious consideration be given to modifying the organic farming system. If sufficient plots could be made available, it would be interesting to test two alternative systems of introducing nitrogen into the system, i.e. long-term (3 year) grass or legume crops versus compost applied to all arable crop rotations.

The Committee was given to understand that, in reality, there are only two water treatments, rain-fed and irrigated, and that the amount of irrigation required depends on the farming system and crop grown. This may determine whether and how the supplemental irrigation plots are available for reallocation and in determining whether to incorporate additional treatments on subplots or full plots.

Recommendation 3. Partner with other programs, in particular the Sustainable Agriculture Farming Systems (SAFS) project to increase the utility and use of LTRAS in sustainable agriculture, education and outreach.

The primary objectives of the SAFS and LTRAS projects are parallel, but in many ways their approaches are complimentary. Their individual efforts need to be better integrated, and this might most easily be achieved by having appropriate SAFS activities relocated to Russell Ranch. Modifications to the LTRAS treatments should be made so that they serve as a

foundation for the more manipulative short-term experimental trials of SAFS that support more immediate technology transfer.

To further enhance the value of the research of the long-term experiments at LTRAS in the family of worldwide, long-term experiments, the influence of these production systems on the environment must also be monitored. Measures of impacts on air and water quality (e.g., trace gases and leaching losses) are missing from the list of measures that are currently taken at LTRAS. These data are critical to assessing the environmental impacts of different cropping systems as well as developing linkages between managed (agricultural) and unmanaged/natural areas. The expansion of LTRAS to include consideration of the linkage between production systems and landscape-scale issues including watershed and wildlife sciences will add greatly to the value of the work. Creative partnering with SAREP, for example their sponsorship of a competitive grants program supporting work at the LTRAS facility, could jump-start this process.

Develop the facility for graduate training in agroecology. Partner with the Student Farm and the UCD faculty in ecology, environmental sciences and agriculture who have an interest in graduate education in this area. The facility could support educational programming in many areas (e.g. field research based courses, studies of fundamental ecology, technology applications, experimental design, landscape ecology, data base management). Davis' tradition of graduate groups makes this an easy and inexpensive option.

Recommendation 4. Develop an aggressive plan for long-term financial support of LTRAS.

There is a need to pursue sustainable funding to support the infrastructure of LTRAS and promote growth and greater use of the site. While funds for long-term, hypothesis driven research can be obtained from a variety of federal and state agencies (e.g., NSF, USDA, EPA, CalFed), sources need to be identified that will support the growth of LTRAS infrastructure in partnership with the CAES.

A strategic effort of development and fund-raising for LTRAS should be pursued to support and enhance the educational, outreach and scientific missions of the project. To be successful, these missions must be well articulated. Thus far, the LTRAS mission and scientific vision have

not been adequately communicated. Communication/ outreach strategies should be tailored to accomplish specific goals and serve sectors of interest. The LTRAS committee/ director should capitalize on the tremendous opportunity that will result from the completion and publication of 10 years of results.

Recommendation 5. Promote LTRAS as a centerpiece of the sustainable agriculture program at UC Davis.

The relevance and importance of LTRAS also has not been adequately communicated to the public, particularly farmers and educators in the area. The summary of the first 10 years of the study will present an opportunity to publicize the trial and generate interest in the project, but this alone will not be sufficient. The contributions of LTRAS will be made if it's utility is perceived by and then broadcast through other programs. In addition to strengthening outreach ties by partnering with or preparing material for use by SAREP and SAFS, the LTRAS facility should be developed as a teaching resource. Integration into teaching programs (e.g., Student Farms, Agronomy, LAWR, and any emerging ecology programming) should be encouraged.

Optimally positioning UC Davis in sustainable agriculture/ agroecology. The Review Committee believes it is critical that UCD better position itself in sustainable agriculture, agroecology and related fields, taking advantage of the many faculty on campus working in this area and programs such as the Student Farm, SAFS, LTRAS, and the DANR Sustainable Agriculture Research and Education (SAREP), which is housed on the Davis campus. It appears efforts are already underway in this direction with the recent establishment of a review committee evaluating sustainable agriculture efforts on the campus. Two efforts we might suggest are to (i) make the graduate program in agroecology on campus more visible to potential applicant students through mailings, the world-wide web, and linking Putah Creek and LTRAS and (ii) re-establishing an undergraduate program in this area with a name that better reflects the focus of the major, such as agroecology or sustainable agriculture. Both of these programs could make use of, and further promote linkages between, the small scale demonstration activities of the Student Farm) and the observations and real-time data from LTRAS and SAFS.

Just as management practices piloted in SAFS and the Student Farm might ultimately end up as treatments in LTRAS, results from LTRAS systems could inspire new research initiatives and demonstration activities appropriate for short-term trials at SAFS and the Student Farm. For example, recent findings from LTRAS suggest that yield loss during the transition to organic

farming are a result of management skills and not soil condition. By articulating the conceptual ties between approaches and projects, these groups would build a united and valuable outreach portfolio. By building on existing strengths, and reducing overlap, the various groups will be able to achieve more with outreach.

To thrive, ultimately LTRAS must compete effectively for the attention of researchers. The same is true for extension specialists and producers seeking engagement with the university. To be useful to these constituencies, LTRAS data and resources must be accessible, communicated and used. LTRAS must make its synergies with other efforts in sustainable agriculture (particularly education and outreach) more visible and more effective. Other projects ongoing at Davis, like the SAFS projects, should be viewed as partner projects. The trend, seen this year at LTRAS, to develop satellite trials adjacent to the main plots, should be expanded. A conscious effort to emulate SAFS strategies and/or an effort to enlist their participation in such efforts might be warranted. The satellite trials are a natural future home for researchers that will be displaced when the Agronomy farms are displaced.

Integration of LTRAS with other efforts will bring the required visibility and efficiency to all efforts. We suggest building on the strengths of respective programs, not attempting to rebuild the wheel and ask LTRAS to do everything programmatically that could be better done in collaboration with existing programs. This would unduly burden LTRAS staff and undercut other established programs. The challenge will be to make LTRAS a resource in its own right to UC extension (building on overlaps with SAREP, aspects of the Student Farm, efforts linked to SAFS), and education (undergraduate and graduate programs on campus).

Conclusions

The Review Committee concludes that it is essential to instigate a KEEP INITIATIVE for LTRAS at UC Davis by adopting the following recommendations:

- KEEP IT - LTRAS is an extremely valuable resource unique to North America.

Much time and effort has already been expended to develop the facility.

- EVALUATE IT - Review the existing results, list the strengths and weaknesses of the current experiment and make modifications (cautiously) to enhance its scientific and educational utility.

- **ENHANCE IT** - Revamp the existing management structure, modify treatments as appropriate, ensure the participation of other researchers on the existing long-term experiments and appropriate related projects.
- **PROMOTE IT** - Widely publicize and communicate the importance and value of LTRAS in its own right and its potential to integrate with other programs on sustainable agriculture.