Five Perspectives on Improving the U.S. Public Research, Education, and Extension System

The following five papers constitute the work of independent authors and are being made available by AGree to stimulate thinking and discussion about a significant public policy issue. They do not represent official AGree policy.

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This publication was commissioned by AGree to inform and stimulate dialogue about policy reform; it does not represent official AGree positions. The views expressed here are those of the individual authors.
AGree seeks to drive positive change in the food and agriculture system. By connecting and challenging leaders from diverse communities, AGree is working to catalyze action and elevate food and agriculture policy as a national priority. Through its work, AGree supports policy innovation that addresses critical challenges facing the global food and agriculture system in a comprehensive and integrated way. And by engaging a broad array of stakeholders, AGree is working to overcome barriers that have traditionally inhibited transformative change.

The following five concept papers were written by independent authors in response to a call for concept notes that AGree issued in September 2012. The purpose of the concept note was to elicit bold ideas on how to strengthen the U.S. public sector agricultural research system. The call for concept notes included several guiding questions to help frame submissions, including: how to address research needs and establish priorities; how best to attract and train scientists and students from the U.S. and abroad to improve the productivity and environmental performance of agriculture; what, if any, changes are needed within the current funding mechanisms for land grant universities, USDA Agricultural Research Stations, and other public sector institutions conducting food and agricultural research to drive the most efficient use of resources; and what processes could be employed to ensure that publicly funded research results in widely available information and benefits.

The five topics were selected by AGree Advisors and Co-Chairs based on the quality of the proposal, feasibility, relevance to the questions listed, and creativity. The ideas contained in these papers will contribute to AGree’s ongoing discussions and to the development of long-term, transformative recommendations.

While the concepts presented in these papers will enrich AGree’s discussions about food and agriculture research, the positions contained in the papers in no way represent official AGree positions.

We hope you find these papers a helpful resource and a source of bold ideas. And we hope you will join the effort to transform federal food and agriculture policy to meet the challenges of the future.

Deb Atwood
Executive Director
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Reforming “Formula Fund” Distribution of USDA Funding for Research, Extension, and Education

– Steve Ventura
Reforming “Formula Fund” Distribution of USDA Funding for Research, Extension, and Education

Steve Ventura

Introduction

The U.S. system of support for agricultural research, education, and extension (REE) through land grant universities and colleges can be said to feed the world. The discoveries and knowledge dissemination that this system offers have resulted in cheap food for this nation and approaches and technologies adopted throughout the world. But these approaches and technologies are not without consequences to the environment, to communities, and to people and their health.

This paper is not about the consequences of the kinds of agriculture developed by the land grant system; rather, it is about an idea for making the system more responsive to the consequences. It is based on the conjecture that the U.S. land grant system is locked into an approach to agriculture overly focused on production and slow to respond to new needs and issues because of a rigid structure and bureaucracy for funding REE. In particular, the laws that created this system specify the allocation of a substantial portion of funds from Congressional appropriations through rigid formulas. Formulas were devised more than one hundred years ago, when this nation had a very different population and agriculture.

The paper starts with a brief review of USDA formula funds – formulas, purpose, and implementation. This is followed by a more detailed assessment of positive and negative consequences of this method for funding REE in land grant institutions. This second discussion is oriented to the REE process, infrastructure, responsiveness, and personnel, not to the substance and content of REE. The third section describes an alternative funding mechanism, based on long-term grants. The last section speculates about positive and negative aspects of conversion to this alternative, including some initial reactions from colleagues at the University of Wisconsin and elsewhere around the country.

These ideas are presented as seed for further discussion. It is not intended as a position paper advocating for change, but rather as framing for a broader discussion that could result in small or large adjustments to a generally successful system. The ideas herein are my own and do not represent the positions of my university colleagues or employers. They should be considered as informed speculation and opinions from two-plus decades of experience from one perspective – faculty member and department chair in a major land grant university. The paper contains broad characterizations of the REE system. Undoubtedly specific examples can be found to contradict some of these, though I believe the main points of generalization are correct.

Interestingly, the President’s Council of Advisors on Science and Technology (PCAST) released a report on US agricultural research on December 7 of this year, which I saw a week later as I was finishing this paper. Its primary message is about the need for increased competitive funding for agricultural research. While this new report does not specifically discuss changes in formula funds, it says that the reform goals described in its recommendations

“….will require new funding to achieve the stated goals. In other cases, a restructuring of existing funds can enhance the use of competition for distribution of funding and can expand the Federal research portfolio with respect to issues of public good.”

Reforming “Formula Fund” Distribution of USDA Funding for Research, Extension, and Education
The PCAST report also includes several recommendations that parallel this paper, such as increased competitive awards for graduate students and post-doctoral researchers, funding for infrastructure, reduction in redundant efforts and facilities, and centers of excellence devoted to emerging challenges.

It should also be noted from the start that a fundamental change in the funding relation between USDA and land grant universities would require a tremendous political effort, particularly if done as sweeping rather than incremental change. The tradeoffs of such a change should be carefully evaluated before expending the tremendous amount of “political capital” that would be necessary. The evaluation will be a challenging exercise, because many of the costs will be readily apparent, particularly to the beneficiaries of the current system, while many potential benefits such as greater innovation, more rapid response to emerging issues, and greater orientation to agricultural sustainability, are less tangible, harder to measure, and accrue over long periods of time.

USDA Formula Funding for REE

USDA supports REE in colleges and universities through a combination of competitive grants (e.g., AFRI, SARE), formula funds, and Congressional line-item funding. The bulk of formula funds are distributed through the Hatch Act of 1887 for land grant university research and Smith-Lever Act of 1914 for state Cooperative Extension Services.

Smaller amounts are appropriated by formula through the Evans-Allen Act of 1977 for research at 1890 land grant institutions (traditional black colleges), the McIntire-Stennis Act of 1962 and Renewable Resources Extension Act for cooperative forestry research and extension, Animal Health and Disease Research Program, distributions from the Native American Institutions Endowment Fund for education at “1994 land grant” colleges, and grants for Cooperative Extension Services at 1890 institutions.

The land grant system dates back to the first Morrill Act (7 U.S.C. § 301) in 1862, which among other provisions, granted land to states to establish endowments for educational institutions whose objective was:

“...related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.”

Land was appropriated based on a formula – the number of Senators and Representatives of a state times 30,000 acres, a formula that substantially benefited populous eastern states. The 1890 and 1994 institutions were funded with cash grants, not land. They are still specified in law as land grant institutions but excluded from the formula funds of the 1862 institutions (Hatch, Smith-Lever, McIntire-Stennis).

The formulas used to distribute funds are still mostly based on the original laws. The formula for the two big programs (Hatch, Smith-Lever) are both based on a base grant (equal amount per state) plus a variable amount based on two proportions: rural population in a state to rural population of the nation, and farm population of a state to the farm population of the nation. Hatch allocates 20% to the base grant, 52% to the population-based variable amount (26% for each element of the formula), 25% to multi-state research (though in practice, multi-state funds appear to be allocated by the same population formula), and 3% for program administration. Smith-Lever divides as 20% base, 76% population based (40% for rural population, 36% for farm population), and 4% for administration. Evans-Allen funding for 1890 institutions uses the same general scheme as the Hatch formula; the total appropriation is pegged at one-quarter of the Hatch appropriation.
Attachment 1 is known as the **million dollar table** based on the U.S. Census of 2000 (equivalent table for 2010 table does not seem to be on-line). It shows the proportion of funds that each 1862 institution would receive based on population counts. As currently shown, it does not correspond directly to either Hatch or Smith-Lever formulas; as noted at the tops of the 2nd, 5th, and 8th columns, it is allocating 27.8% to base funding, 36.1% each for rural population and farm population, and nothing for program administration. Since it is ordinarily in spreadsheet form, these numbers are readily adjusted to the specifics of a program.

The **million dollar table** is used to calculate how much each institution will receive from the USDA appropriation for each program in a given year (once the correct allocation percentages are set). The amount each institution receives is the total appropriation times the corresponding proportion (value shown in the 9th column). For example, if Congress appropriate $100,000,000 for Smith-Lever funding, Auburn University would receive $2,340,130, based on multiplying the value in the top cell in the column labeled $1 Million Dollar Factor by 100,000,000.

The main point in providing this level of detail about formulas is that they are substantially based on population statistics of variables defined by the U.S. Bureau of Census for demographic purposes, not on variables related to agricultural production or value, resources management, Extension or research needs, or other priorities from an REE perspective. Even the “farm population” related factor does not adequately account for agricultural activity in states because of problems defining what constitutes a farm (anything capable of producing $1,000 of commodities). In contemporary agriculture, many farms produce little and a few farms produce a lot, and this varies considerably by state.

A secondary point is that the formulas consistently favor/disfavor the same institutions and only change slightly every ten years with shifts in population or definitions of rural or farm populations. Of course, institutions that benefit most tend to favor the status quo.

Some of the other formula funds could be considered more tied to purpose. The forestry funds are apportioned based on the recommendations of a 16 member panel which considers “pertinent factors including non-Federal expenditures for forestry research by State-certified eligible institutions, areas of non-Federal commercial forest land, and the volume of timber cut annually.” The total amount distributed to 1862 land grant institutions is specified as one-half of what USDA spends on forestry research. The education grants to Native American colleges are calculated as a base grant per institution (40%) plus each institution’s portion of total enrollment in 1994 institutions (60%). Animal health grants are based on the ratio of the value of livestock in a state to total value of livestock in the nation (48%) and the “proportion that the animal health research capacity of the eligible institutions in each State bears to the total animal health research capacity in all the States” as determined by USDA (48%).

Although this paper does not address issues related to REE internal to USDA, support for research by the Agricultural Research Service, Economic Research Service, and National Agricultural Statistics Service could also be thought of as formula funds. These agencies share many traits with land grant university efforts, including having top-notch scientists devoted to agriculture and food system issues, general but not explicit or detailed direction in their REE agendas from stakeholders, bureaucratic inertia, and guaranteed funding. It is easy to justify USDA having its own REE apparatus. But, to the extent that the current system shares issues with the land grant institution relation, it is appropriate to consider reforms to spark innovation and responsiveness in these agencies as well. These agencies work closely with land grant universities on many projects, including shared faculty and scientists, so they would be affected by land grant funding reform regardless of whether their funding schema is altered.
Formula Fund Administration

Formula funds are distributed by USDA NIFA upon submission of an annual request. The request requires justification in terms of department and funding program goals and detailed budget information, including information about local and state matching funds (generally 100% match of federal funds). As noted in NIFA’s online description, “The scope of the agricultural research which may be conducted under the Hatch Act is very broad.” The same is true for REE in the other formula fund programs. In addition, some of the programs require annual progress reports. Individual research activities are reported by investigators through USDA’s Current Research Information System (CRIS).

Agricultural Experiment Station directors are the administrators of research and education funds. In most cases, this is the dean of a land grant unit such as a college of agriculture at a state school. Smith-Lever funds are administered through state Cooperative Extension Services (CES). This may be through the college of agriculture, or through a separate unit (for example, in Wisconsin, CES within University of Wisconsin Extension is a separate institution from the College of Agricultural and Life Sciences of the University of Wisconsin–Madison. Both are part of the University of Wisconsin System).

Additional pieces of bureaucracy – four Regional Associations of State Agricultural Experimental Station Directors (with support from the National Information Management and Support System) – are responsible for tracking and coordinating formula-funded multistate research activities. The research conducted through the regional research committees is based “on regional priorities that are identified and developed jointly by State Agricultural Experiment Station (SAES) Directors, Departmental Chairs and participating scientists.” A similar regional structure exists for Cooperative Extension Associations. To some extent, these function as bottom-up mechanisms for identifying and addressing emerging issues.

Two advisory groups influence the formula fund process (in addition to the original and amended Acts of Congress creating the programs). The Association of Public and Land grant Universities (APLU) and particularly the associated Board on Agriculture Assembly (BAA) are strong supporters of formula funding. BAA’s Budget and Advocacy Committee retains the Washington lobbying firm Cornerstone Government Affairs to monitor and represent APLU positions in agricultural appropriations and other Congressional actions. APLU has been a consistent advocate for maintaining and increasing appropriations for formula-funded REE.

Within USDA, the National Agricultural Research, Extension, Education, and Economics Advisory Board (NAREEEAB) “provides advice to the Secretary of Agriculture and land grant colleges and universities on top priorities and policies for food and agricultural research, education, extension and economics.” NAREEEAB does not have any direct connection to formula-funded programs but does advise on REE priorities. It is safe to say that many of the constituencies represented on this board substantially benefit from formula-funded REE activities.

Consequences of Formula Funding

As noted in the introduction to this paper, the current U.S. food system is unparalleled in its ability to produce large quantities of cheap food. Funding support for REE that built this system comes from many sources, including four broad categories of federal support (internal USDA activities, formula-funded, competitive grant funded, congressional line-item funded), state and local governments, corporate sources, and the experiments and knowledge transfer of individual producers. It may not be possible to precisely quantify how much of the impressive body of knowledge and practice is due to formula-funded support for REE, but the influence is undoubtedly enormous. As noted before, the agricultural and food systems supported by this research and extension apparatus also have profound
negative as well as positive consequences for society. It is similarly unknown what contribution formula-funded activities make to mitigating or seeking alternatives to negative consequences, though in broad terms the system is set up to support high-input mechanized production and processing, and to maintain the status quo of an industrial food system.

Since it is not possible in the near term to characterize thousands of individual formula-funded activities, their contribution to U.S. agriculture and food systems and whether they address relevant social, economic, and environmental issues, this section provides a description of the structural issues associated with the formula funding mechanism. It includes positive characteristics mostly arising from a supposition that guaranteed funding allows for investments and connections that might not otherwise occur, and negative characteristics based on a premise that this funding mechanism results in certain biases and calcification of some REE activities.

Positive Aspects

On the positive side, guaranteed annual funding provides certainty that land grant institutions and CESs need in order to make long term investments in infrastructure, information technologies, and human capital. Although formula funds and land grant endowments cannot be used directly for buildings and other major infrastructure, universities would be less likely to invest in specialized research facilities such as greenhouses, growth chambers, and laboratories, as well as off-campus agricultural research stations, if a guaranteed stream of research and extension wasn’t available. Most other federal grants don’t support bricks and mortar investments. In the last decade, state support for higher education in general has declined, and agricultural programs are often hit hard.

In many states, formula funds are used to support faculty and staff salaries. Academic concepts of tenure and associated job security require long term stable sources of funding, such as that provided by formula funding. This commitment to faculty and staff engenders some of the other positive attributes discussed below, such as enduring connections to stakeholders and ability to conduct long term research.

Research conducted through formula funding tends to have an applied problem-solving orientation. Whether this is a direct result of the funding model or more attributable to the land grant system in general is debatable. What is clear is that the formula funds can support high risk research and research that might not receive funding through competitive processes. The former comprises research on ideas that did not have sufficient preliminary data to create a credible proposal and research on ideas that were too far out of the ordinary to survive the peer review process. The latter includes prosaic but necessary research, such as crop breeding or pest control, that does not make new contributions to knowledge but advances practice.

One of the greatest assets of outreach and education through formula funding is the enduring connections to certain stakeholders that it fosters. Connections to communities of practice are built on trust, and long term commitments are a very necessary component of trust-building. Similar to research, stable funding allows CES to invest in human capital and infrastructure, including teaching facilities and, increasingly, web resources. These public faces of Extension are part of the enduring legacy of support for land grant universities, particularly in rural America.

Because formula funds for research typically go to the same or closely collaborating institutions as funds for Extension and education, it helps facilitate the continuum of research and outreach. If CES is functioning as designed, it is both delivering research results to stakeholders and delivering a research agenda based on stakeholder input to researchers. This connection is bolstered by the requirement of formula funding to have a 1:1 match from state and local governments. Local and state governments have skin in the game, so there is follow through to see that identified needs are addressed. In the spirit of the original Morrill Act and subsequent legislation, formula funds represent investments in a society that cares about employment, community, and environment, not just about generating support for land grant institutions.
**Negative Aspects**

Many of the negative aspects of formula funding arise from the same characteristics as the positive. The stability of the system means that changes – new issues, new approaches, new personnel – can be slow to occur. Although agricultural and food systems in the US have always been dynamic, the pace of change (e.g., the genomics revolution), the imperatives of issues (e.g., climate change as a pervasive force), the demand for alternatives (e.g., consumer awareness), and the consequences of choices (e.g., the “obesity epidemic”), all seem to be at a peak. Heightened scrutiny of federal expenditures for discretionary purposes has emerged recently, putting additional pressure on REE systems. Processes that cannot change and adapt to new circumstances become obsolete.

This paper has briefly touched on the very large and entrenched bureaucracy embodied by the REE system. APLU published a list of acronyms in 2010. The first seven pages were listings and brief descriptions of APLU units; relevant USDA agencies and programs took another four! It is axiomatic that one of the primary functions of a bureaucracy is to perpetuate itself. An outgrowth of this is slow response to emerging issues. New ideas and suggestions for change go through numerous filters and deliberations; if they emerge at all, change is likely to be in small increments.

At the other end of the system, in land grant universities and Cooperative Extension Services, activities can be perpetuated beyond their useful life. Few researchers are able to move on to new endeavors when their problem is substantially solved or when agriculture or food systems themselves have moved on. With the stability of formula funds, there may be little imperative to work on something new. The same can be said of facilities. Since I have been affiliated with the University of Wisconsin-Madison in 1981, there have been repeated discussions suggesting that we don't need a dozen agricultural research stations scattered around the state, yet during this period only one has been closed and another added.

The legislation creating formula funds is very broad in what kinds of REE can be supported. USDA provides little additional guidance or restriction on activities. This means funds can support REE initiatives that might not otherwise be funded. As noted above, this could be for bold, new ideas, but it also means accommodating activities with minimal impact. The nature and rigor of peer review of formula funded activities is quite variable, resulting in little assurance of the scientific integrity or practical value of activities. Moreover, other than the portion of Hatch funds explicitly designated for multi-state effort, there is little state-to-state coordination, resulting in significant duplication of effort.

While “enduring connections to stakeholders” is noted as a positive attribute of formula-funded REE, it also has a negative aspect. Long term stakeholders are interested in perpetuating a status quo that is oriented to working on their issues. Through several decades, USDA supported REE has been oriented primarily to mainstream agriculture and large scale food processing; this is particularly true of formula-funded activities because of the investment in infrastructure and human capital. Without passing judgment on this type of activity, it is clear that alternatives are not well supported. Re-orientation to emerging imperatives such as agricultural sustainability, diversification, resilience, and food security occur slowly and incrementally if at all.

A more insidious aspect of stakeholder capture is the “last dollar” influence on research agendas. This is a general phenomenon in land grant institutions, perpetuated by but not limited to formula-funded research. Through a combination of state and federal funds and tuition revenues, universities pay most of the costs of conducting research by paying for salaries and infrastructure. However, faculty are encouraged to be entrepreneurial and seek outside support for their specific activities. Corporations have become quite adept at providing the last, liquid portion of funds, typically for supplies and graduate students. The university support is general, while the corporate portion is tied to very specific goals, thus the companies have a substantial influence on the research, arguably a disproportionate influence oriented to the companies’ needs.
Another consequence of stakeholder capture is the disaffection of communities that are under-served by the current system. This is apparent in the work on urban agriculture through a USDA-AFRI funded project that includes interaction with communities of color. Few urban growers seek advice from Extension sources, and many have a general and long-standing distrust of university-provided advice. Undoubtedly, colleges funded through the Evans-Allen Act are an exception to this, but their influence in most northern cities is nil.

Guaranteed long term funding can result in stagnation of personnel. For some, job security means academic freedom – freedom to pursue inquiry outside the constraints of politics and support. For others though, it means a regular paycheck without the need to continually learn and renew and evaluate the relevance of their work. The latter is quite noticeable in Cooperative Extension Services, which has been slow to adapt its outreach delivery methods to digital formats and social media. This lag is now at least recognized in Extension, and efforts are underway, but the inertia of long-time employees that may be reluctant to learn new skills and approaches means it will be a slow process.

### Types of Grants

Several types of grants are described in Table 1. The proposed grants are conceived to replace some of the key functions currently served through formula funds. They are not intended to replace the current competitive grant programs such as AFRI and SARE; these serve specific purposes. None of the new grants are directly equivalent to formula fund support used for general purposes such as salaries, supplies, travel, and publications. Such purposes will need to be fit into the new programs or funded through other sources.

Some of the proposed grants are targeted to specific segments of the REE community. Other than these specific targets, it would be appropriate to open the competitions to all land grants to eliminate the exclusive nature of formula fund programs. For some, it may even be appropriate to open the competition to any qualified university.

Like the current competitive grant programs (in USDA and most other federal programs), the proposed grants would be peer reviewed to ensure that the highest quality proposals are funded. They also would be reviewed internally by USDA for fit with program goals and compliance with proposal requirements. To find an appropriate balance between stability and responsiveness, the grants would be structured with longer durations than typical federal funding but with rigorous intermediate reviews.

Continuation of matching fund requirements for most of the categories of grants would be appropriate as a means to ensure university and state commitment to supporting REE activities and provide a stake in the process.

The research and extension “investment” grants are premised on the observation that bricks-and-mortar funding is increasingly difficult to secure. One of seven key recommendations in a recent report to President Obama was “…to find one or more mechanisms for increasing the stability and predictability of Federal research funding, including funding for research.
This may be a category for a larger matching fund requirement in recognition of the high cost and the enduring investment.

“Commitment” grants can be considered as a replacement for formula funds specifically allocated to 1890 and 1994 land grant institutions. This name was chosen because the originating legislation for these funds represents an important commitment of public resources to these institutions. Total appropriations should be maintained or enhanced. Conversion to a competitive grant program potentially result in re-distribution of funds between these institutions; this would need to be managed in a way that results in efficient and equitable use of the funds and greater accountability.

The “capacity building” grants are based on the likelihood that institutions that are currently strong are more likely to succeed in other competitive categories, leading to greater divergence and further diminution of capacity in weaker institutions. The National Science Foundation has recognized this dilemma and addressed it through its Experimental Program to Stimulate Competitive Research (EPSCoR) program. The mission of EPSCoR is to “to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education.” The basic mechanism is to set aside funding specifically for states that are historically less successful in standard competitive grant programs; currently 27 states are eligible for EPSCoR funds.

### Table 1 | Types of competitive grants to replace formula-funded research

<table>
<thead>
<tr>
<th>Name</th>
<th>Duration</th>
<th>Target</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>research infrastructure</td>
<td>10 years initial, with two 5 year renewals</td>
<td>all land grant universities</td>
<td>Grants to maintain and enhance facilities necessary for conducting research such as laboratories, research stations, and high cost equipment, and personnel necessary to run the facilities.</td>
</tr>
<tr>
<td>research investment</td>
<td>one time grants</td>
<td>all land grant universities</td>
<td>Grants for construction of buildings and other major facilities. This would be a federal contribution; it might be structured with an additional match requirement such as 1:1:1 for federal, state, and private collaborators.</td>
</tr>
<tr>
<td>long term research</td>
<td>5 year initial with one five year renewal</td>
<td>all land grant universities</td>
<td>Grants for problems requiring continued effort over long periods, particularly for “grand challenges” such as climate change adaptation and mitigation, and food system sustainability and resilience.</td>
</tr>
<tr>
<td>extension programs</td>
<td>10 years initial, with two 5 year renewals</td>
<td>Cooperative Extension Services</td>
<td>Grants to maintain and enhance outreach activities across a broad spectrum of purposes, with an emphasis on more effective stakeholder engagement, particularly for under-served and under-represented groups.</td>
</tr>
<tr>
<td>extension investment</td>
<td>one time grants</td>
<td>Cooperative Extension Services</td>
<td>Grants for facilities and information technology. This would be a federal contribution; it might be structured with an additional match requirement such as 1:1:1 for federal, state, and private collaborators.</td>
</tr>
<tr>
<td>graduate training -</td>
<td>2 years for M.S., 3 years for Ph.D.</td>
<td>all land grant universities</td>
<td>Grants for tuition and stipends to conduct research on identified high priority needs. This could be created as an expansion of USDA’s National Needs Fellowships, though the EPA STAR Fellowships provide a model with greater focus on agency needs.</td>
</tr>
<tr>
<td>Name</td>
<td>Duration</td>
<td>Target</td>
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<tr>
<td>graduate training programs</td>
<td>5 year initial with one 5 year</td>
<td>all land grant universities</td>
<td>Grants for training programs in specific fields of high need. Funds could be used to partially fund faculty coordinators and support graduate or undergrad research, leading to cohorts of students trained in an area.</td>
</tr>
<tr>
<td></td>
<td>renewal</td>
<td></td>
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<tr>
<td>new faculty/scientist</td>
<td>3 year initial with two 3 year</td>
<td>all land grant universities</td>
<td>Grants to launch the careers of new faculty and scientists in directions compatible with USDA needs. The three year increments are intended to coincide with the milestones of a typical six year tenure period.</td>
</tr>
<tr>
<td></td>
<td>renewals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>centers of excellence</td>
<td>10 years</td>
<td>all land grant universities</td>
<td>Grants to develop deep expertise on specific issues over a sustained period, with a specific orientation to reducing redundant research and duplicative facilities on common problems, and best done as regional collaborations.</td>
</tr>
<tr>
<td>innovation and high risk</td>
<td>3 years</td>
<td>all land grant universities</td>
<td>Grants to provide “venture capital” to conduct initial feasibility studies on new ideas and proof-of-concept development for new inventions. Could be paired with USDA’s SBIR activities.</td>
</tr>
<tr>
<td>commitment</td>
<td>10 years initial, with two 5 year renewals</td>
<td>1890 and 1994 land grants</td>
<td>Grants to support REE at traditional black colleges and Native American colleges.</td>
</tr>
<tr>
<td>capacity building</td>
<td>10 years initial, with two 5 year renewals</td>
<td>land grants without strong grant success records</td>
<td>Grants modeled on NSF’s EPSCoR initiative to bolster research capacity in less competitive institutions.</td>
</tr>
</tbody>
</table>

**Implementation**

Transition to a new funding model for one of the main components of USDA’s REE activities will need careful management to avoid calamitous disruptions in on-going activities and to avoid crippling institutional capacity. This transition may require several years, both to overcome the inertia of the current system and to design new programs that generate new and additional benefits. Programmatic benefits from a new system will accrue only if it can be implemented efficiently, re-forming and streamlining a large bureaucracy. Societal benefits will depend on creating processes and structure that effectively identify national and regional needs along with local and state priorities, and translate these into goals to which REE grant applicants can respond. Advisory processes will need to mitigate disproportionate influence of “deep pockets” stakeholders and encourage advocacy for broad public interests.

Some of the proposed grant categories such as *extension* and *commitment* would need initial success rates much higher than typically found in federal competitive grant pools in order to maintain activities with current commitments and provide long term support. One way to manage this transition would be to provide close to one hundred percent success rate on the initial round of grants but shorten the duration of grants that were evaluated as weaker, or applications that did not have a local/state commitment to matching funds for the entire grant period. Applicants would need to seek renewal sooner and to address deficiencies in the proposal.
Consequences of the Proposed New Funding Approach

Currently, USDA competitive grants specify F&A costs that are substantially below the federal negotiated rate for most grants to universities, and the formula funded grants do not include any indirect costs. APLU favors reform of USDA's indirect cost policies, noting in particular declining support from states. Assuming total federal appropriations remain the same, this becomes a question of how to split the pot between direct program purposes and the real costs of administering grants and maintaining infrastructure. Substantial reform of F&A cost policy may be an important enticement for APLU to consider radical change such as this proposal.

Grant renewals should not be pro forma. Renewal represents an opportunity for applicants to make a case that this investment of national resources benefited stakeholders and addressed priorities, and an opportunity to align activities with updated needs. The amount or duration of renewals could include performance-based incentives. For long term grants, it could be helpful to require renewal applications more than one year ahead of projects’ end dates so applicants have ample opportunity to address renewal proposal deficiencies.

Positive Outcomes

One of the key drivers of funding model reform is the belief that a competitive grant process would be more responsiveness to issues and needs than formula funds. This is based on the assumption of an effective advisory system that can identify needs across the entirety of food and agricultural systems within the domain of USDA and across a range of scales from local to international. The current formal system for advising USDA on REE issues through NAREEEAB has been criticized as narrowly framed, slow to respond, and conservatively oriented. Changes in this body may be a necessary adjunct to funding model reform. A more direct role in identifying REE needs and requirements

From universities’ perspective, a major consideration in transition will be how to manage indirect costs (also known as facilities and administration or F&A costs). Currently, USDA competitive grants specify F&A costs that are substantially below the federal negotiated rate for most grants to universities, and the formula funded grants do not include any indirect costs. APLU favors reform of USDA's indirect cost policies, noting in particular declining support from states. Assuming total federal appropriations remain the same, this becomes a question of how to split the pot between direct program purposes and the real costs of administering grants and maintaining infrastructure. Substantial reform of F&A cost policy may be an important enticement for APLU to consider radical change such as this proposal.

Consequences of the Proposed New Funding Approach

A significant change in funding structure for REE, and the concomitant change in relations between USDA, REE institutions, and stakeholders would undoubtedly have significant impacts. It is challenging to predict precisely what these might be, because the details of the programs, their implementation, and the pace of implementation will have significant impact on outcomes. This section speculates on what some of the possible positive and negative outcomes could be, acknowledging but not knowing any of the devils in the details.

Positive Outcomes

One of the key drivers of funding model reform is the belief that a competitive grant process would be more responsiveness to issues and needs than formula funds. This is based on the assumption of an effective advisory system that can identify needs across the entirety of food and agricultural systems within the domain of USDA and across a range of scales from local to international. The current formal system for advising USDA on REE issues through NAREEEAB has been criticized as narrowly framed, slow to respond, and conservatively oriented. Changes in this body may be a necessary adjunct to funding model reform. A more direct role in identifying REE needs and requirements
could invigorate NAREEAB and spur the creation of or linkage to additional advisory groups attuned to the wide range of sectors that should be the purview of USDA’s grant programs.

A competitive grant based system should be able to respond more quickly to new and emerging issues. The request for proposals could be more specific and tied to USDA priorities. Although many of the proposed grants are long term, they include periodic renewals that provide an opportunity to re-align activities with needs.

Several of the proposed grant programs should result in more creative research approaches. Guaranteed funding through formulas creates little incentive for new ways of conducting REE. Other than the required multi-state efforts in Hatch, the current system does not provide incentives for multi-investigator and interdisciplinary research, collaborations with other public or private organizations, or community or stakeholder driven processes. With appropriate language in requests for proposals (RFPs), any or all of these could be encouraged. Sometimes just the process of responding to RFPs for highly competitive large grants (as might be envisioned for programs such as the centers of excellence or research investment grants) fosters intra- and inter-institutional communications and new linkages that endure whether or not the proposal is funded.

Funds for graduate training programs could also be directed to specific needs. Many of the current challenges in agriculture and food systems are cross-cutting, requiring training in several disciplines. Grants to create training programs would bring together faculty across departmental boundaries; with effective use of telecommunications technology and on-line learning, this could even be across institutional boundaries. Over five to ten years, the result would be a cohort of students with deep understanding of a particular area, seeding expertise into additional universities and creating new bodies of literature. Training programs could be coupled with a USDA internship program to bolster agencies’ expertise. In totality, the proposed grants provide for continuous support for graduate, post-doctoral, and early faculty all the way through and beyond a tenure decision.

Duplicates of effort between states could be reduced with appropriate incentives for regional collaboration and a rigorous grant review process. Particularly when farming systems encompass broad multi-state regions, it is quite common to have very similar REE expertise and activities in each state. Centers of excellence and regional projects could concentrate experts, resulting in a collective synergism, though such efforts would need to be cognizant of and accommodating to within-region variability. Extension, in particular, can advantageously use Internet-based information dissemination (and stakeholder feedback) across regions. While the iconic agent standing in a field talking to farmers may still be an effective way to communicate to small groups, it is increasingly anachronistic, particularly in times of shrinking budgets. The needs assessment and requirements analysis necessary for a formula to competitive grant conversion should include evaluation of duplicative programs and redundant activities, and explicit mechanisms and incentives to eliminate obsolete programs.

Without details of implementation, it is hard to know whether about twelve competitive grant programs would be more efficient to administer than about six formula fund programs. Managing RFP processes, particularly peer review, is considerable effort. But, this would come every several years in a competitive program rather than the annual application required by the formula funding process. Since this proposal represents a fundamental transition in the way USDA does business, at the very least the transition process would be an opportunity to carefully examine bureaucratic procedures – eliminating what’s not needed and streamlining what can be.

The most speculative change that might ensue from reform of the formula funded grant system is a change in REE culture. In broad terms, this would be a change from a culture that is dependent and calcified to one that is entrepreneurial and innovative. This is also the most disparaging observation; as noted at the outset of this paper, the system contributes to incredible global food and agriculture systems. Undoubtedly some individuals within this system are
also incredibly entrepreneurial and innovative. But, it is also possible to find many examples of people doing very much the same thing their entire careers - researchers making small increments of progress on well-studied problems, outreach efforts with the similar messages to the same audiences year after year, and failure to consider or create alternatives. These shortcomings tend to reinforce the status quo, a status quo in many cases oriented to large corporations and farm enterprises that seek to externalize impacts of production as much as possible to the detriment of the public and environment.

**Negative Outcomes**

The first outcome of changing the funding mechanism for USDA-supported REE would be tremendous upheaval in well-established patterns and processes. Stakeholders accustomed to services and interactions could be disappointed and potentially alienated from land grant institutions or USDA. Scientists and agents accustomed to automatic support will need to prepare grants and seek other sources. Existing programs may be terminated or experience hiatuses in the transition process. Some may find the new system daunting or not worth the effort and drop out of the system.

Because of formula fund matching requirements, some current faculty and staff have complicated appointments. Portions of their salary come from federal, state, university, and even local sources in the case of county Extension staff. Uncertainty about one portion of salary could be problematic for personnel with complicated mixes of support, and might make other contributors less likely to pay a share.

Matching funds are frequently a challenge in grant programs. In general, federal programs do not allow use of other federal funds as match, so these will continue to be primarily from state and university sources. More sporadic need for matching funds may lead to heightened scrutiny of their use, and potentially to politicization of the decisions, particularly when the source is state appropriations. It could also lead to greater reliance on private sources.

Critics of the current system would laud making the connections between REE institutions and for-profit organizations (e.g., commodity groups) explicit, though this transparency could make these groups more hesitant to collaborate with universities. A potentially positive benefit would be engaging more foundations and non-profit organizations in supporting REE in public institutions.

New faculty that are not successful in the new faculty/scientist program may have a harder time finding support for their research. Universities will need to seek additional funds from other sources for start-up packages and early career support.

Depending on how much latitude is provided in RFPs, competitive grants could narrow the scope of the REE agenda. If applicants are only responding to the RFP and these are too narrowly cast, important issues may not receive the attention they deserve. A common perception of USDA’s current competitive grants programs is that NIFA-AFRI grants tend to favor more basic research particularly in the life sciences compared to Hatch funded research, though the much smaller SARE program provides some counter-balance.

In broad terms, this change in REE orientation can be characterized as a transfer of power for REE agenda setting from state land grants and CESs to the national level, particularly USDA and NAREEEAB. Some people worry that USDA and NAREEEAB may be susceptible to political or special interest influences, or may follow research “fads.” This problem can be mitigated both by an advisory system that is effective at issue identification, including issues brought up through the land grants and regional research committees, and by carefully crafting RFPs in ways that don’t force applicants into narrow domains, though some suppression of investigator-initiated ideas may still occur.

Many agricultural issues and some food systems issues have considerable spatial variability. Soils, climate, cropping systems, processing plants and other facilities, labor availability, and so forth vary between and even within states. While incentives in competitive programs
to regionalize REE could result in elimination of duplicative effort and synergy from collective expertise, a greater degree of centralization could also reduce the ability to understand and address issues unique to smaller areas. To some extent, research can be designed to accommodate regional variability. The issue may be more challenging for Extension if one result is fewer “boots on the ground.”

Fundamental change in the grant model will result in re-distribution of funds. As with any competitive process, this will lead to fear of that the “rich will get richer.” It is likely that a disproportionate share of competitive funding will be captured by top tier universities. Some of the proposed grants are designed specifically to address this issue, though they represent only a portion of the funding. The decision about appropriations for that portion will be consequential and fraught with politics. The advisory and RFP processes may also alleviate some of the problem if they can identify issues that second tier universities are uniquely qualified to address.

If total funding for REE through USDA remains level through a transition and it includes reformation of treatment of indirect costs more in line with other federal agencies, it will shift some funds from researchers and agents to central administration in universities. Only a very small portion of indirect costs trickle down to directly support the programs of individual investigators, if any at all, though at least some of the F&A supports the research enterprise of the university as a whole.

USDA-NIFA currently has a significant bureaucracy devoted to grant administration, including competitive grants, so the transition should not create a large administrative burden for the agency. Similarly, land grant universities may have to increase staff somewhat to manage what could be an increase in the number and type of grants, but would generally have the requisite capabilities. Some faculty and scientists accustomed to formula funding would see an increase in the amount of time devoted to grant preparation and participation in peer review processes.

Another area that could see some significant increase is in compliance monitoring. In perhaps over-generalized terms, we would go from large lump sum transfers with relatively low accountability to more and smaller transfers for specific purposes which would need to be monitored by universities and USDA.

Summary and Recommendations

Converting formula funding for agricultural REE would be a massive undertaking with deep consequences for agriculture and food systems in the US and throughout the world. It would have many and complex ramifications, both positive and negative. Many of the consequences would be influenced by details of program design and implementation, safeguards in transition processes, and reform of other aspects of REE, particularly the advisory system that defines issues and guides funding priorities.

Such a transition would be met with massive resistance from land grant universities and state Cooperative Extension Services, along with their representatives in Washington such as APLU. Suggestions for change come up periodically in federal farm bill and agricultural appropriations deliberations, and are met with editorials, position papers, and aggressive lobbying, mostly on behalf of the status quo. Although the impetus for change may be motivated by an effort to increase public benefits from the federal REE investment and to improve responsiveness of the system, any kind of change would require clear and compelling evidence that a new system would also benefit these organizations and their stakeholders that have influence in federal policy development.

The examination of potential benefits should also include other approaches to achieving similar outcomes. One possibility is modifications of formula funding. This might entail changes in the formulas to invest more where agricultural and food system activity takes place or REE needs exist, building incentives for innovation, and providing more explicit REE agendas.
based on national priorities. Although the term “earmark” has become pejorative, another way to distribute REE funds is through line-item Congressional action. If this can be done in a way that includes evaluation of need for initiatives and the science behind them, this could be a useful complement to either formula or grant-based land grant REE.

This paper is substantially speculative on the kinds of costs and benefits, and the positive and negative outcomes that a change may entail. The next steps would be to gather experts together representing key institutions, agencies, and organizations to determine what the most important issues are. From this, a study would be necessary to generate relevant data to help inform choices. The sequence would be to evaluate if the benefits potentially outweigh negative impacts in aggregate, then to develop specifications for new competitive grants such as proposed in Table 1, then to look at the distributional effects. The study would need to include evaluation of economic impacts particularly redistribution of funds, beliefs about changes in orientation and responsiveness of REE programs, potential for changes in how REE are conducted and managed by universities and CESs, and assessment of impacts on current and currently under-represented stakeholders.

### Attachment 1 | USDA’s Million Dollar Table (modified for printing)

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Endnotes

1 For example, the Association of Public and Land grant Universities identified a set of “core priorities” for REE funding in 2013 appropriations. In 2012, they called for appropriating 71% of the $927 million REE budget for these priorities through formula funds. http://www.aplu.org/document.doc?id=3817


3 This attached version is slightly modified from the USDA website version for legibility. It was pulled from http://www.csrees.usda.gov/business/awards/formula/milliondollarable.xls


5 http://www.csrees.usda.gov/about/offices/legis/mcintirestennis.html

6 http://www.csrees.usda.gov/about/offices/legis/pdfs/anileonly.pdf


8 http://www.csrees.usda.gov/qlinks/research_multistate.html

9 http://nareeab.ree.usda.gov/about-nareeab-0


11 NIFA’s Agriculture and Food Research Initiative (AFRI - the main program for competitive grants) recognizes six “priority areas” – plant production; animal production; food safety, nutrition, and health; renewable energy, natural resources, and environment; agriculture technology; and agriculture economics and rural communities. Formula funds are expected to address some aspect of these very broad categories.


13 http://www.csrees.usda.gov/fo/nationalneedsgraduatefellowships.cfm

14 http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/recipients.welcome/displayOption/grants

15 http://www.nsf.gov/od/oia/programs/epscor/about.jsp

16 http://www.nsf.gov/od/oia/programs/epscor/about.jsp

Improving Information Management at USDA to Support Research, Education, and Extension

– Marjorie Porter and Steve Ventura
Introduction

The United States Department of Agriculture (USDA) creates and manages large volumes of data and information. Its collaborators, constituents, and funding recipients also generate large volumes that are submitted to USDA. These resources are immensely valuable for researchers and educators in land grant universities and Extension services, in addition to USDA agencies and many other stakeholders. Unfortunately, several issues impair access and usefulness.

After describing the kinds of data and information that are useful for research, education and extension (REE) purposes, this paper provides an overview of issues and proposes several ideas to improve the value of these resources.

Who is using USDA information?

This paper is oriented primarily to the information needs of researchers and educators within and outside of USDA, with a focus on information that is available in digital formats. Within USDA, data and information are also used for program management and assessment, regulation and compliance, and numerous other purposes.

Several additional categories of stakeholders outside of the Department also access and use USDA information. These include policy makers, non-profit organizations such as advocacy and public service groups, commodity organizations, individual enterprises, Extension agents, farm program participants, grant applicants, and the general public. The proposed changes could also benefit these groups, though each audience needs to be considered in terms of its own needs.

What data and information are REE stakeholders using?

Because methods of creation, collection, and access may be different, it is sometimes useful to distinguish data from information (though information is also used for both at points in this paper). Data refers to raw facts and observations such as records in a geographic information system (GIS “layers”), compilations of results from surveys, censuses, and inventories, and form-based submissions to USDA such as food and nutrition program applications, farm records about income, program compliance, yields, and so forth.

Information is facts and observations in forms that are readily understood by people. It can be built from interpreted and contextualized data, among other sources. Information comes in numerous forms such as reports, briefing papers, peer-reviewed publications, educational materials, fact sheets, informational brochures, and a variety of text-based Web resources. Although we refer primarily to numeric and textual information herein, information is also conveyed as images, videos, audio recordings, and models. The latter may be of particular interest to REE stakeholders -- access to models, methods, and tools used by USDA to generate policy and program information facilitates better science, and promotes open government by providing access to the means of decision-making.

Information is the domain of the USDA National Agricultural Library (NAL) and their collaborators, including land grant universities. Their mission statement includes acquiring, preserving, and disseminating “all information concerning agriculture and rural development.” The improbably large scope of this task notwithstanding, the NAL is a key resource for supporting REE activities.
USDA agencies generate many data sets that are widely used by REE stakeholders. Prominent examples include resource inventories such as NRCS soils data (STATSGO, SSURGO) and Natural Resources Inventory, NASS Cropland Data Layer (land cover classification) and Census of Agriculture, and the USFS Forest Inventory and Analysis. Other widely used databases include NRCS PLANTS database and ARS National Nutrient Database. With some exceptions as discussed below, the agency is very good at access and dissemination of these data sets.

USDA agencies produce scores of more specialized data sets. Many of these data sets are produced initially for agency purposes and provided as a public service through internet access. For example, the Economic Research Service lists numerous data files, applications, interactive maps, and charts (http://www.ers.usda.gov/data-products.aspx). While it is more oriented to documents and services, the NAL Catalog (AGRICOLA) is at its core a database of food and agriculture publications. The NIFA Current Research Information System (CRIS) functions both as information, providing reports about USDA-supported research, and as a searchable database. USDA agencies also receive data sets submitted via research projects and grant programs. Access to and dissemination of these more specialized data sets is quite variable.

**What are the forms and formats used for USDA information?**

Our discussion generally refers to digital (computer-based) data and information, though some documents, particularly historical records, exist only in print format. Scanning and image processing technologies have obviated much of the need for handling hard copy documents. Once scanned, they are readily conveyed to multiple users without risk of damage to the original. Current records and publications almost without exception are available in electronic versions.

Although information technologies have vastly increased our ability to access and use a wide range of records, compatibility between software, hardware, and networks remains as a source of frustration and limitation to access and use. In addition to problems with data formats that vary between software packages and even versions of the same software, computer operating systems and Internet browsers can interpret the same data in different ways. Interpretation of indexes, keywords, and .xml tags for large collections and data sets can also vary between systems.

The use and management of metadata is critical to effective access and use of data and information. Metadata is data about data (or information) – its organization, format, content, quality, access procedures, and so forth. It is essential for secondary users to understand what they are getting and whether it is fit for their purposes. Library sciences have created robust metadata systems for documenting publications and other records typically managed by libraries. The most well-known metadata scheme is MARC which was developed by the Library of Congress. Since its inception there have been many changes to technology and the format of data and information products. Over time the MARC system has been restructured and new metadata systems have been developed to meet the requirements of organizing digital information. For spatial data, the Federal Geographic Data Committee has created the Content Standard for Digital Geospatial Metadata (http://www.fgdc.gov/metadata/csdgm/).

It is important to note, that the term metadata is often used to describe the structure of digital data in reference to how it interacts with a system or platform as well as to describe information for retrieval in a database or catalog. The biggest challenge with metadata is its creation. It is typically the last consideration in creating a data set, and often neglected. Metadata standards are subject to varying interpretation, and testing for conformance is not routine, leading to incompatibilities between platforms and software systems.

The two metadata systems above have been adapted to several other types of data and information, though not all types have appropriate standards. This includes non-text items such as graphs, images, and figures which may be created as part of larger documents but
end up in stand-alone contexts. In addition, items such as images, videos, PowerPoint presentations, on-line tutorials, and so forth may be in forms that require specific software unless they are reformatted. This becomes both a documentation and dissemination issue.

**Major Issues in Information**

While computers and telecommunication technologies have made enormous amounts of information available in the comfort of our offices and homes, challenges remain. These are primarily due to the way people and institutions interact with the technologies, not technological limitations *per se*. Policy, procedures, and agency norms within USDA for collecting, processing, and disseminating data affect what flows to and from REE researchers and educators. This section describes several areas where we believe significant issues remain, impeding access to high quality information for food and agriculture REE.

**Information gathering is fragmented and complex**

USDA agencies gather information from many sources for multiple reasons. Rules for information gathering and reporting vary from agency to agency and even from program to program. The result is little consistency in the forms and procedures for gathering information.

The use of Grants.gov has made grant application procedures somewhat more consistent, though to work for programs as diverse as NIFA-AFRI and NRCS-CIG (as well as the wide range of grants through other federal agency), this tool is large and convoluted. NIFA grant requests for proposals typically run 50 or more pages and the proposals themselves may be several hundred pages. This can create a barrier for organizations that don’t have grant specialists familiar with the details of the application process. Large universities are able to invest in software designed to facilitate generation of Grants.gov forms; these tools may not be accessible to smaller organizations.

Other than CRIS, grant reporting requirements are highly variable. USDA does not require grant applicants or recipients to develop data management plans. Grant recipients are not required to submit data sets as part of reporting requirements.

USDA does not have uniform policies across all agencies about how information is gathered, managed, or disseminated. Various agencies and programs within the USDA are working simultaneously to address internal information needs, but these are not coordinated. This results in duplicated efforts which cannot be joined because there is no uniformity or rules to the procedures. Because of the diverse ways and purposes that information is gathered, it is difficult to find and eliminate duplications, share data gathered across programs and agencies, or even to find and access existing data. Moreover, data gathered through agency programs is often formatted to meet the needs of USDA staff for their reporting purposes without consideration to the needs of non-USDA researchers and others information seekers.

Enrollment in federal commodity and conservation programs entails a complicated mixture of paper records and central databases. A few types of data are common to most (e.g., land owner, tract identification number), but each program has additional specific data that are collected in paper and electronic forms. Similarly, applicants for food and nutrition benefits also provide personal status and eligibility data to the department on several forms, as well as merchants accepting SNAP, WIC and other payments.

While participants in USDA programs are entitled to secure protection of privacy-related aspects of these data, it is also a vast resource of information about commodity production, land management, food availability, nutrition status, and other issues of national importance. By utilizing this data researchers are able to help improve these and other programs and services by providing analysis and evidence of successes and challenges in the program. As discussed below, with appropriate information policies, it should be possible to provide data for research, information product development, program evaluation, and so forth, without
violating personal protections. Agency policy, the lack of uniformity in gathering and data management, and the lack of a central clearinghouse that can manage and distribute redacted data all hinder this possibility.

Ironically, information gathering regulations established under the Paperwork Reduction Act may limit the timely and effective gathering of feedback from people who are using or otherwise in contact with USDA programs and services. Data that may be quite useful for program evaluation and research purposes may be omitted in the name of streamlining form filling.

**Some critical data is unavailable**

Information is kept in diverse places with diverse rules of reporting and access. Some can be accessed freely online, some is published in professional papers, some can only be accessed through a Freedom of Information Act (FOIA) request, and some is simply unavailable outside the agency. Two broad reasons make data unavailable.

The first reason is that a data set’s existence may be poorly documented and reported, and thus it is essentially invisible. A simple example of this is the substantial volumes of information collected by state Extension organizations through reporting from county staff, a necessary process for developing state work plans for Smith-Lever act funds and other federal reporting. This information is collected in widely disparate forms and not effectively documented, and effectively not available for aggregation and summarization. Solution to this issue falls in the realm of better data management practices.

The second reason is that some data are restricted from distribution by agency policy or federal law. The federal government is guided by FOIA, which states that federal data is accessible to anyone except if specifically excluded from this law. Exclusions applicable to USDA information generally fall in the realms of protecting proprietary or personal data. Proprietary data refers to all data and information that is protected under intellectual property laws or enumerated FOIA exclusions. Even research published in professional journals can have significant gaps because of trade secret protection. Neither USDA nor professional journals have rigorous procedures for determining whether such protection is necessary to protect proprietary interests. Additionally, access to professional journals may be limited by licensing fees and restrictions.

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**An example of data (un)availability**

Co-author Steve Ventura is conducting research to evaluate the economic and ecosystem service impacts generated under multiple bioenergy cropping scenarios in southwest Wisconsin (about 5,000 mi²). Ideally, the analysis is done at the level of individual farm fields, because farmers may only convert part of their land to dedicated bioenergy crops. USDA has several data sets valuable for this analysis, including:

- NRCS SSURGO (soils data) – readily available; high quality inventory with ongoing efforts to keep up to date; different Web interfaces for casual v. “power” users;

- NASS Cropland Data Layer (satellite derived land cover data) – available if you know it exists; annual updates, but limited quality (good land cover classification accuracy for cropland, poor accuracy for other land cover types; this could be improved through integration with Forest Service FIA and NRCS NRI surveys, and FSA NAIP aerial photography); distributed as .ftp download or CD from agency;

- FSA Common Land Unit (farm and farm field data) – unavailable; FSA has digitized the boundaries of farms and fields nationwide. Because these GIS polygons are linked to commodity payments and other income-related data, FSA will not provide even the spatial framework without identifying information. A FOIA request resulted in what amounted to a one-time release of these data, but the 2007 federal farm act subsequently explicitly restricted this.
A right to privacy is well established policy though a large body of case law and through several specific laws, including law dealing with on-line communications (Electronic Communications Privacy Act of 1986) and financial privacy laws (Financial Services Modernization Act). Some legal experts construe a constitutional right to privacy through the 1st, 4th, and 14th amendments.

Information privacy refers to the protection of personally identifiable information, particularly related to income, medical records, and legal proceedings. The general expectation is that any personal data gathered by public agencies will be protected and not disseminated for secondary purposes.

Information withheld due to proprietary or privacy concerns hinders the effective use of data gathered using taxpayer funds. From researchers’ perspectives, it seems plausible that the suppression of certain information may be an overreaction to concerns and not strictly necessary for the security of proprietary data or personal information. As discussed below, it may be possible to distribute data that redacts (obscures, aggregates, or otherwise de-identifies) personally identifiable information but retains most of the data fields of interest to researchers and others.

**Information access is variable**

Information users may assume that any and all information held by an agency is available through web-based services, and that it is accessible through a single portal or uniform interface. In reality, not all data sets and documents are on-line, and the access processes and tools are quite variable.

While USDA has general policies about information gathering and dissemination (for example, see http://www.usda.gov/wps/portal/usda/usdahome?navid=POLICY_LINK), the interpretation and enforcement of these policies are not uniform. In fact, the general principles of open government and the specific language of FOIA only require that data are provided upon request. A potential user has to know enough about what might exist to make a request that can be fulfilled. Courts have not generally upheld broad “fishing expeditions” as reasonable requests.

In general, agencies are making an effort to provide access to commonly requested data and documents; it is in their best interests to do so. They can fulfill the needs of many stakeholders by providing online access rather than processing many individual requests. Unfortunately, the provision of information about what agencies hold and make accessible online is incomplete. Agencies have a constant challenge to keep indexes, catalogs, and other descriptions of documents up to date, as well as keywords, .xml tags and other tools to facilitate searches through large databases.

Even if data and documents are available, a user may need to learn the interfaces of multiple agencies within USDA. Some of the search, preview, and retrieval tools are rudimentary, while others are quite sophisticated. Even a single agency may have multiple search and retrieve interfaces to accommodate casual versus frequent, knowledgeable “power” users.

**Current resources, especially human capital, are uncoordinated and underutilized**

The USDA is attached to one of only a few national libraries in the country, the National Agricultural Library. NAL appears to be underutilized in terms of collecting and managing USDA data, information, and publications and as an information reference service. Nevertheless, libraries contain most of the historical data, access to most of the current data, and have professional staff trained to find and access the data they don’t have. Land grant university libraries also access current research data and keep copies of all research and other publications produced through the CES and the Ag Experiment Stations. Public libraries sit on the pulse of their communities and are often the first entities aware of community interests and stressors. Additionally library staff are information professionals who can assist researchers and USDA personnel in organizing and storing data and information. The NAL could play a lead role in coordinating indexing and access to USDA information resources and in reaching out to land grant and public libraries to strengthen and streamline access using systems that already exist.
Solutions for Information Issues

The first step in developing improved information quality and access is to make data collection and management a priority consideration at the outset of a grant program or new agency initiative. A lack of attention to data management at the outset of a program or initiative results in substandard data collection including lost data, partial data, or lots of data with little meaning. The quality of the data impacts the ability of USDA staff and others to review and assess programs to determine the continued allocation of funds and whether programs should be revised. Unfortunately, it is usually not until after the funds are applied for, awarded, and the project underway that any problems or inadequacies in data management and collection are addressed. The solution to improving data collection both in terms of quality and access is to develop data management strategies, improve the reporting mechanisms, address concerns over data access, better coordinate information and data systems, centralize data access, and educate and support information users.

Require all federally-funded projects to create data management strategies

The ability and capacity to gather effective data should be the first considerations for any new program or initiative. Program developers should ask ‘what do we hope to accomplish or know?’ and ‘how will we know if it is accomplished or not?’ From these questions an overall data management plan should be created for each program. Important questions to consider in developing this plan include:

• What type of data will we find in the program or research outcomes?
• How will that data be collected and how often?
• How will it be formatted and stored?
• How will the data be analyzed and ultimately used?
• Who will need to access this data and why?
• How will this data be accessed?
• Who will be responsible for managing and disseminating the data?

Although overall rules and requirements can be beneficial to shaping data management plans, it is critical to create a new plan for each program or initiative since the outcomes and how they are measured will be different for each program.

It is also possible and recommended that researchers submit their own project level data management plans in addition to the overall program plan. This project level plan will show how they propose to meet the data management requirements of the program. However, it should be noted that researchers and other grant recipients are not usually trained in information management. By establishing an overall program data management plan you give them a framework on which to plan their projects with rich and effective data being a consideration at the beginning. Additionally, by explicitly noting these requirements in the original requests for applications, you provide applicants an opportunity to produce better proposals with clearer understanding of the desired outcomes. Training, tutorials, and other educational materials may be supplied to applicants to help them understand the requirements.

Based on the information needs of the USDA and the public, overall data management guidance should be developed. This guidance should not be so rigid as to exclude or limit data gathering but should describe the purpose and goal of data collection for the USDA and/or REE mission. This guidance should be easy to access, and personnel with an understanding of the data management requirements should be available to answer questions. Development and management of data management plans should be an allowable expense in budget requests.

The development of data management plans and guidance could be undertaken without a major change or challenge to existing policies. Grant recipients are already required to submit information and this would ensure that the quality of their submissions improves.
A point of leverage could be created by withholding final grant payments until all reporting requirements have been fulfilled, as is currently done with awards and CRIS reporting.

**Develop improved reporting mechanisms**

The second step to collecting effective data is providing an effective reporting mechanism. The current CRIS system has serious limitations and should be replaced. The new system should be based on the type and format of data to be received and allow for grant recipients or program participants to submit their outcome data according to their data needs. An effective reporting system cannot be a one size fits all and nor should it try to impose a rigid structure on information. Different types of data should not be manipulated to accommodate a simplistic system even if they are produced by a single project. For example, a narrative about a training program should be input into a field or form that formats and stores it differently than it would quantitative data about training attendance and retention measurements. Instead the system may provide multiple input mechanisms for different kinds of data all of which can be assigned to a unique control number for each discrete project.

Metadata markers or other reference mechanisms can ensure that the origin of the data is carefully tracked and retrieve all data associated with a control number when queried. Efforts should be made to create metadata and data structuring standards that will help ensure data can be used with available access tools or combined with other data sets. The creation of effective metadata schema and standards will allow submitters to the reporting system to add most, if not all, of the metadata themselves, allowing for improved information retrieval by end users of the system. Metadata schema should be created in conjunction with other departmental and federal agencies which produce similar types of data. It may also be preferable to adopt established metadata in some cases where there are clear national and international standards.

Finally, the system should be developed with the end user in mind. USDA staff should not assume that public users understand the intricacies of the internal USDA reporting requirements nor its vocabulary. The system should be developed based on user feedback and information requests. Any user with some understanding of database searching should be able to pull information out of the system. Users without any such understanding should be given assistance from an easy to access source. For researchers and grant recipients, training on using the USDA reporting systems should be given as soon after their award as possible.

**Address the proprietary and privacy concerns that currently limit data access**

As noted above some critical data is unavailable due to proprietary and privacy concerns. While the precedents and purpose of the rules that limit data access should not be taken lightly, current policies and practices should be reviewed with a consideration toward making as much information as possible available to researchers. Also the USDA should assist researchers and its own agencies to effectively gather data and feedback. Some possible solutions to these concerns include creating public access policies for publicly funded research, the redaction of data within data sets to obscure personal information, and improved guidance and assistance from the USDA for gathering data and feedback.

In the last few years both the National Science Foundation (NSF) and the National Institutes of Health (NIH) have altered their grant requirements to include provisions for the dissemination of research to the public. NIH in particular includes a public access requirement that addresses concerns about the loss of public funded research outcomes because of proprietary information. USDA should adopt similar policies to ensure that research paid for by taxpayers is made available to those taxpayers. By providing a public access requirement at the outset, researchers and grant recipients can prepare to meet these requirements while in the planning stages of their project. Similar policies should guide access to information generated internally within USDA.
The USDA would also benefit from supporting open access publication models. An open access publishing model does not affect the peer review process. It simply revises when and how the publication of the research is funded. This could be done by creating a public access policy similar to the National Institutes of Health backed by a research publication database similar to PubMed housed at the National Agricultural Library.

Information policies should not be based on the assumption that if part of a record has proprietary or personal information, the entire record must be restricted. Utilizing this data is critical to improving the function and effectiveness of USDA programs. The USDA should develop data processing systems that redact and/or aggregate data so that personally identifiable information is stripped out or combined in a way that ensures the privacy of individuals. Once established, this process should be standard for all such data collected.

This recommendation would impact Federal code including the Privacy Act, the Financial Privacy Act, the Freedom of Information Act, among others. Nevertheless, it is likely that other Federal departments would welcome a revision of the current laws to enable them to gather data which would improve their programs and better utilize their resources. USDA may endeavor to begin a conversation with other Departments and Agencies to development ways in which data could be redacted effectively while preserving the rights and safety of individuals.

Another hindrance to the collection of usable feedback is the rules of data collection under regulations such as the Paperwork Reduction Act which governs all data collection. Currently all data collection mechanisms including web page feedback forms must be approved by the Office of Management and Budget (OMB). This approval process can be very slow; meanwhile, the ability of agency and program personnel to collect useful data diminishes over time. USDA can help improve the ability of USDA agencies and offices to gather feedback by addressing the OMB approval requirements as an entity on behalf of its agencies and offices. The USDA can work with the OMB to create a library of OMB-approved feedback mechanisms for information gathering that can be plugged into programs and services to ensure useful and timely feedback. For example, a bank of pre-OMB-approved questions can be created where appropriate questions can be selected for a website feedback form. USDA may also develop tutorials or provide consulting services to provide clear guidance for getting OMB and other types of clearance as quickly as possible.

**Coordinate efforts inside and outside of the Department**

The need for improved inter-departmental and inter-agency communication and coordination has been noted at the USDA. There are currently many agencies and individuals working hard to improve USDA services and functions by working across agencies and offices. Nevertheless, the concept of data and information management, while recognized as important by all such groups, has not been addressed as a separate and fundamental issue. Instead, agencies, working groups, and programs make their data and information available in the best way they are able. However, most USDA staff are not information professionals or trained in information management and would therefore benefit from guidance in this area.

To address information needs and improve overall data and information offerings, a working group or task force should be established and could be coordinated through the National Agricultural Library for the express purpose of coordinating information gathering and access across agencies and programs. Such a body should consist of information and communication professionals, information technology staff, researchers, and personnel with experience working directly with the public. This group would oversee the development of clear guidelines for all agencies to move over time to consistent information management policies. This group would also oversee and coordinate special task forces. Task force projects may include the development of rules and guidance for information gathering based on the type of information to be gathered and the needs of the users who will access the data, the creation of uniform metadata schema and structured data to
allow sharing of data across platforms, the examination and analysis of current research and program data management practices, and the coordination of non-USDA programs, libraries, and information centers to enhance information offerings and to avoid duplication of efforts among other topics. This task force would require the authority to collect information about current data and information gathering practices, establish sub-committees and advisory groups, and to coordinate and work with personnel outside of the USDA.

Create an information hub

The USDA is fortunate to have possession of a national library. The National Agricultural Library (NAL) should serve as the hub of information gathering and access. Current NAL initiatives include moving the collection to a digital environment and the improvement of access tools and data management. The NAL website could serve as a portal and archive for all information products and data collected and published through the REE mission. This would utilize an existing entity without the need to create a new system although the library capacity would need to be expanded. In addition to providing a repository for data and information, NAL staff may be tasked with providing guidance on information management. By better utilizing NAL, the USDA can benefit from the centralization of data and information to improve offerings and avoid duplications.

To effectively accomplish this, NAL would need to coordinate with the USDA to find and catalog all current data and information products and set up processes for accepting and documenting all future products. USDA agencies and programs would need to work with NAL to ensure their needs and the needs of the people they serve are being met. New data and information products can be either created or a copy can be stored at the library providing an opportunity for all USDA produced information to be recorded and cataloged. Protocols may even be created to log data sets. This will create a permanent record of all research or development activities funded through the USDA.

It also ensures that information and data is never lost or mislaid. Nevertheless, programs and agencies would not be hindered in developing their own information interfaces if the need exists. NAL would provide a link to any additional interfaces or tools and serve as a backup location and archive for any programs that expire. NAL would also provide guidance on good practices, required components, USDA-wide protocols and norms, adherence to department policy and applicable laws, etc.

Educate and support information users

NAL should develop a user centered web interface to help move users closer to the wealth of information created through their tax contributions. To do this, NAL should profile their users and develop the best possible interface based on user behavior within the limits of data formatting and availability. When developing such an interface, or collection of interfaces as may be necessary due to differences in data structures and proprietary data, NAL staff should remember that the complexities of information management including integration of a variety of access tools and platforms is best left to the information professionals who understand it. Public users including casual users, researchers, and USDA personnel should be given a clear path to their information needs. Such paths can be created based on user profiling with consideration given to different types of users based on an overall content management plan.

Although we live in the Information Age, most people have limited understanding of effective information searching outside of typing keywords into a search box. No single portal or interface will ever meet the needs of all users, therefore, any such development within NAL should be supported by reference services and information literacy education. These services should be available in many formats including person to person for a variety of user profiles. Information literacy materials such as electronic tutorials and other materials will help users learn to use information and data products effectively. Additionally, NAL could collaborate and
partner with other libraries to provide training and assistance to meet the needs of information users. One way NAL may contribute is to train land grant and public librarians to use USDA information products. This provides a way for users to be served in their own institutions or communities by people who they know and who are aware of their specific needs. It also provides a way for NAL to support and enhance other library systems.

The end results of improved information management within the USDA REE mission includes better and richer information and data which results in improved policies, programs, and practices; the reduction of waste as programs become more streamlined and transparent; elimination of duplicative research and efforts; improved relationships between the USDA and partners; and the development of effective standards that can be used by researchers throughout the world.

**Summary**

Several problems with current policies and procedures for managing data and information at USDA are presented. These include the complex and fragmented way that information is collected and complex systems and obsolete policies for managing it. This leads to inappropriate access restrictions and inefficient information systems.

Six broad ideas are presented to mitigate these issues. Some of these could be implemented immediately through internal changes in USDA policies and procedures:

- Require USDA funded project proposal to include data management plans; and
- Develop improved reporting procedures and requirements.

Two of the ideas would require changes in federal policy, though these are policy changes that could be applied broadly to federal agencies and result in substantial improvement to information access in general:

- Clarify how and where federal agencies can provide access to partially redacted version of data containing proprietary or private information; and
- Coordinate data collection within and beyond the USDA.

Finally, two ideas involve specific investment in USDA information resources and procedures, with a focus on what the National Agricultural Library could and should be doing:

- Create an information hub and first-stop portal for access to USDA information; and
- Education and support information users.

This paper provides some initial ideas that will need to be further developed through the work of professionals and task forces directly involved with each recommended change. While these are common sense ideas, transitions and changes in procedures will need to be carefully implemented and managed to achieve the desired changes and avoid undesirable consequences.

**Relevant Resources and Policies**

**Information Policies**


USDA Data Policies
Other USDA web policies http://usda.gov/wps/portal/usda/usdahome?navtype=FT&navid=POLICY_LINK

Grant Reporting Systems
Ag Risk Education Library http://www.agrisk.umn.edu/
Federal Funding Accountability and Transparency Act (FFATA) Subaward Reporting System (FSRS) https://www.fsrs.gov/
National Institutes of Health Research Portfolio Online Reporting Tools (RePORT) http://report.nih.gov/
SARE Project Reports Database http://www.sare.org/Project-Reports
USDA Current Research Information System (CRIS) http://cris.nifa.usda.gov/Welcome.html

USDA Data and Information Products
AGRICOLA database National Agricultural Library http://agricola.nal.usda.gov/
NASS Cropland Data Layer http://nassgeodata.gmu.edu/CropScape/
NRCS PLANTS database http://plants.usda.gov/java/
Soil Survey Geographic Database (SSURGO) http://soils.usda.gov/survey/geography/ssurgo/
State Soils Geographic Database (STATSGO) http://soils.usda.gov/survey/geography/statsgo/
USFS Forest Inventory and Analysis National Program http://www.fia.fs.fed.us/
Stakeholder Engagement to Provide Advice on USDA Supported Research, Extension, and Education

– Steve Ventura
Stakeholder Engagement to Provide Advice on USDA Supported Research, Extension, and Education

Steve Ventura

Introduction

This paper is premised on the notion that engaging stakeholders and providing advice to USDA and its academic partners in research, extension, and education (REE) is a desirable path to decision-making. While participants within the system are smart and capable, a democracy functions best when channels are open to guide the policies and activities of public agencies and institutions – to provide information, expertise, and new ideas relevant to the execution of the agencies and institutions responsibilities. This is particularly true for massive bureaucracies such as USDA and the land grant institutions that comprise much of the capacity for agriculture and food system REE.

Numerous official and unofficial bodies and paths provide advice to and interact with USDA. Herein, the focus is primarily on an official structure -- the National Agricultural Research, Extension, Education and Economics Advisory Board (NAREEEAB), along with the interaction of USDA with the land grant institutions that engage in the food and agriculture REE though. As such, it does not directly address other aspects of food and agriculture related REE stakeholder engagement, such as the REE carried out in collaboration with other federal and private partners. In particular, the nature of USDA interactions with private enterprise (except as mediated through the NAREEEAB) is not addressed. USDA uses several mechanisms for this engagement, including funding through Small Business Innovation Research awards and Cooperative Research and Development Agreements. The nature and extent of informal interactions with food and agriculture industry and with advocacy organizations is not easily ascertained from the outside through secondary sources. It is difficult to separate their direct influence on REE priorities at USDA versus what is mediated through lobbying Congress.

The current structures and processes for engagement and advice are complex, arcane, and primarily oriented to preserving a status quo. This status quo consists of a steady stream of federal funding for university and USDA agency REE to support mainstream agriculture and its private and corporate interests. While this contributes to a robust agricultural economy, the system is slow to recognize needs and provide support for public interests such as REE related to environmental protection, climate change adaptation and mitigation, sustainable agriculture, nutrition and public health, rural and community development, and food security.

It is also important to note from the outset that USDA, in particular the National Institute of Food and Agriculture (NIFA), is aware of this issue and has made significant efforts to address it. Shortly after its inception in 2008, this agency began a concerted effort to seek stakeholder input to guide research priorities and refine grant procedures. Listening sessions, webinars, and other input have resulted in making the Agriculture and Food Research Initiative (AFRI) competitive grants programs substantially stakeholder driven. Under Secretary of Agriculture for Research, Education, and Economics and USDA Chief Scientist Catherine Woteki also describes a vision for Department-wide REE that includes stakeholder engagement and cross-agency coordination in her Research, Education, and Economics Action Plan.1

Unfortunately, this kind of effort does not extend throughout the REE system – not in some other NIFA programs or other USDA agencies with REE responsibilities, nor in land grant universities (LGU) which carry out the bulk of REE activities outside of the department. At the risk of over-simplifying a large and multi-faceted system, USDA and LGU REE has
many channels of advice. It is not apparent to many stakeholders who develops priorities and how, which channels of influence are open to them, and whether the channels are likely to have an influence on REE activities. The mass of the system and its many pieces with not-always-transparent relations means changes occur very slowly, often with significant resistance. The domain and authority of advisory bodies is not always clear; expertise may be inappropriate or insufficient when ideas and suggestions about science, policy, assessment, and funding are conflated.

This paper starts with an overview of the various influences on USDA/LGU REE priorities, policies, and procedures. The issues that arise from the current system are presented, including some ideas about what aspects could or should be reformed. This is followed by a description of the tenets of an ideal system for advising and stakeholder engagement might be and discussion of what might be feasible through changes in the current system. The gist of the proposal is a simpler structure that engages a broader range of stakeholders, uses existing information gathering mechanisms, and uses a wide range of tools including social media to understand issues and set priorities.

The observations in this paper are based substantially on what can be garnered from review of internet resources. As such, they provide a useful but incomplete picture of advising and stakeholder engagement. Thus, the ideas in this paper are presented as seed for further discussion, both with individuals within the system and with those that recognize that they are in some way excluded. The ideas herein are my own and do not represent the positions of my university colleagues or employers.

A Multitude of Advice for USDA

USDA research, education, and extension are guided by both bottom up and top down processes. Top down influences start with the President and Congress. About every five years, Congress adopts a federal farm bill, with input through briefings from the President and USDA and massive amounts of lobbying. The bill directly creates and authorizes numerous REE programs and associated titles, and specifies provisions for many REE activities and programs. The annual appropriations process specifies the level of federal funding for REE programs including “formula funds” and competitive grant programs such as AFRI, specialty crops (SCRI), sustainable agriculture (SARE), integrated REE (Section 406 grants) and others.

Congress created mechanisms for advising USDA REE, including the National Agricultural Research, Extension, Education and Economics Advisory Board (NAREEEAB) and specific advisory committees such as the Dairy Industry Advisory Committee and the Advisory Committee on Beginning Farmers and Ranchers. NAREEEAB as it is currently configured is the result of a merger of three advisory committees in the late 1990s - the Joint Council on Food and Agriculture, the National Agricultural Research and Extension Users Advisory Board (UAB), and the Agricultural Science and Technology Review Board (ASTRB). The expertise and impact of the ASTRB has been substantially lost, and the contributions of the end users and stakeholders who comprised the UAB have been greatly reduced, as a result of this merger.

NAREEEAB provides guidance to USDA on REE priorities and funding, and reviews activities of four agencies – National Institute of Food and Agriculture (NIFA), Economic Research Service (ERS), Agricultural Research Service (ARS), and National Agricultural Statistics Service (NASS). The NAREEE Advisory Board comprises 25 specific slots intended to represent the range of issues and activities of agriculture and food systems. This structure leads to criticism that it is a rigid structure oriented to preserving the status quo. Because members represent specific sectors, they are oriented to special interests rather than national and public interests, and interests not represented need to gain the attention of the Secretary of Agriculture to gain a seat. In Public Law 105-185, Congress asked USDA to balance public and private representation on the board; it currently has 9 of 25 seats held by identifiably private sector individuals.
Congress itself has noted shortcomings in NAREEEAB’s ability to carry out its mandate. House Report 112-699 on the Federal Agriculture Reform and Risk Management Act of 2012 noted that USDA-imposed term limits on Board members impaired the Board’s ability to develop the expertise necessary to carry out its increasing workload “…that inhibits the individual members and the overall Board’s effectiveness.” The report goes on to admonish NAREEEAB oversight of USDA grant application reviews to include merit and relevancy “to the community [a research or extension project] is meant to serve.” It specifically calls for USDA to consult with NAREEEAB about “less traditional production areas” including urban agriculture, which has no organized constituency or representation on the Board.

It is interesting to note in the fall of 2012, when Congress failed to renew the federal farm bill, NAREEEAB cancelled their meeting. While this was premised on the notion that their charter had expired because there was no re-authorization, this seems to be a critical juncture when USDA could have benefited from external guidance – for example, what programs are affected by lack of authorization and what can be done to maintain critical activities. Even an informal meeting of the Board could have been used to determine how the constituencies it represents could coordinate advocacy for reauthorization of this necessary piece of legislation.

As previously noted, USDA’s main agency for distribution of REE competitive grant funds (NIFA) has created a process for stakeholder involvement in priority setting. The process is explained in detail in many of its Requests for Applications, including descriptions of the shortcomings stakeholders observed in the AFRI programs. One result of the initial stakeholder input effort was refining the AFRI “Foundational Research” topics -- identifying five “Challenge Areas” (climate change, sustainable bioenergy, food safety, childhood obesity prevention, and food security) and providing substantial funding. On an on-going basis, NIFA solicits input on its requests for requests for applications (RFAs) and conducts stakeholder input in all of its eleven “National Emphasis Areas:”

“Stakeholder input is obtained in several ways. Input is solicited in all NIFA RFAs. NIFA also conducts stakeholder listening sessions or workshops, some as standalone events, some in conjunction with national scientific meetings. NIFA staff also gathers stakeholder information from other government and private sector events and publications.”

The Sustainable Agriculture Research and Education (SARE) program administered by NIFA builds stakeholder involvement directly into the RFAs. Successful grant applicants are expected to have end users (e.g., farmers, ranchers, food processors) involved in the creation and implementation of projects.

NIFA also distributes formula fund grants to land grant universities. The expectation of stakeholder involvement in AFRI, SARE and other competitive grant programs does not explicitly extend to this arena, though individual universities have a wide range of mechanisms for feedback and evaluation of the REE activities. As previously noted, Cooperative Extension Services supported by Smith-Lever funds function in a two way mode, providing feedback from stakeholders back through the REE system, at least informally.

The Association of Public and Land grant Universities (APLU) has numerous councils and commissions for evaluating and guiding REE in USDA and the land grant system, as well as influencing federal appropriations and policies. APLU is fundamentally an advocacy organization for higher education in public institutions, particularly in interactions with the federal government. Members on the councils and commissions are mostly senior administrators from member universities. APLU has a Washington based staff, and they retain the lobbying firm Cornerstone Government Affairs to assist with advocacy and lobbying.
APLU’s Board on Agriculture Assembly (BAA), under the Food, Environment, & Resources Commission is the APLU committee most directly aligned with USDA’s REE activities, particularly how these intersect with and affect land grant universities. BAA includes the Council for Agricultural Research, Extension, and Teaching (CARET), “a national grassroots organization” with state based representatives appointed by the deans and directors of land grant universities. It is created to “advocate for greater national support and understanding of the land grant university system’s food and agricultural research, extension, and teaching programs.” Attachment 1, from the APLU website, shows the organizational placement of CARET. It also demonstrates the complicated structure of just the components of APLU concerned with food and agriculture REE. This structure has emerged from organizational mergers and evolving imperatives, and is criticized as arcane and overly complicated.

Some organizations have activities spanning from the grassroots to the top of the REE system. Cooperative Extension Services (CES), in its many forms, is intended for two-way communication – disseminating research results and training and discovering needs for subsequent research and communicating this back through the land grant system. USDA itself has agencies with ears throughout the country. Farm Service Agency (FSA) elects farmers and ranchers to County and State Committees throughout the country, and generally shares county offices with local staff of Rural Development. Natural Resources Conservation Service (NRCS) has State Technical Advisory Committees comprising local experts in natural resources management; it has offices in most counties. Other USDA agencies have state offices, and the ERS and ARS have staff affiliated with land grant universities. USDA has no official mechanisms for incorporating input from such “one-foot-in-the-furrow” local staff into national REE goals, and only informal communications exist between them and NAREEEAB and the various APLU bodies.

From time to time, Congress has mandated or USDA has chosen to create special committees. These range from short term task forces to permanent committees. USDA also uses consultants and external committees. For example, the National Academy of Sciences has been commissioned for several studies that have had substantial impact on USDA policy, including the recent “Advancing Agriculture” forum and National Academy reports on food security and sustainable agriculture.

Many for- and non-profit organizations and networks exist that tacitly or explicitly seek to influence USDA policies and REE activities. These include other state and federal agencies, commodity groups and other special interests, academic networks and professional organizations, regional associations of agricultural experiment stations and CESs, USDA networks such as regional offices of SARE. Some non-profit organizations promote the public interest, such as the National Sustainable Agriculture Coalition, Center for Science in the Public Interest, Union of Concerned Scientists, Environmental Working Group, American Farmland Trust, and several other environmental groups. Other non-profit organizations represent the specific interests of commodity areas. The Agricultural Marketing Resource Center lists more than 150 national commodity and agricultural organization sites, essentially the list of commodity groups with a Washington presence. Many professional organizations arising from academic disciplines are also represented in Washington.

Some of this vast array of organizations can identify with “slots” on the NAREEEAB; others note that it is challenging to have their interests considered. As a result, organizations seek other means to influence REE efforts. Suggestions for stakeholder input herein are not intended to change or restrict how these groups attempt to influence REE policy and funding through Congress. But, for the sake of transparency and for understanding the means and modes of government decision-making, the nature of interactions with USDA should be clear, consistent, and documented.

The overall process for developing a national REE agenda is not always nimble at identifying emerging needs and needs that don’t have a strong or organized voice (e.g., various aspects of sustainability). The process of translating guidance from Congress,
What’s Needed for USDA Advising and Stakeholder Engagement

Under ideal circumstances, all REE activities affecting food and agriculture would emanate from a single source within the Department. The lines of authority and decision-making would be clear, as would the structures and processes for stakeholder engagement and influencing decisions. Of course, the current reality is far more complex. While NIFA is the lead agency for REE-related grants, other USDA agencies such as ERS and ARS also conduct research, and NRCS, FS, and RD have a wide range of education and outreach activities. Land grant institutions receive more than a billion dollars of USDA funding annually for REE activities, with varying amounts of control on how these funds are used. Other federal agencies such as the Food and Drug Administration, Departments of Energy, Interior, and Commence, Centers for Disease Control, National Institutes of Health, U.S. Environmental Protection Agency, and National Science Foundation also have programs involving food and agriculture REE.

Many hundreds of constituencies are affected by USDA and LGU REE activities. Several broad processes are possible for conveying their interests and needs to USDA. The current situation ranges from permanent broad-spectrum advisory bodies (e.g., NAREEEAB) to open solicitations (e.g., NIFA’s stakeholder engagement calls), along with intermediate processes such as permanent issue-oriented committees (e.g., USDA Advisory Committee on New Farmers and Ranchers) and temporary issue-specific committees. USDA lists over 50 such committees. The proliferation and overlap of these committees can be a problem in and of itself; clear mandates for purpose and duration and periodic review of committees can mitigate this problem.

The sheer magnitude of organizations and activities involved in agriculture and food system REE advice and stakeholder engagement means it is unlikely that a singular structure and process can ever be devised that serves the needs of all organizations. This may explain, in part, why NAREEEAB has many external critics, and why NIFA created a separate process for stakeholder feedback on its competitive grant programs.

It is possible though, to identify general principles that a system and culture of stakeholder engagement would entail, along with some ideas which USDA and LGUs might consider.

Given that it is desirable to have a clear and manageable process for stakeholders to provide input into decision-making, different structures may be needed depending on the nature of decisions. It may be useful to distinguish advice and feedback on REE agendas and priorities, program policies and administration, funding levels, and program monitoring and evaluation while retaining ability to communicate findings and recommendations between groups working separately on these issues.

The scope of advisory processes also includes definition of the kind of advice that is useful. In many circumstances, it is useful to distinguish science, policy, and support such as funding advocacy. While these domains are part of a continuum of Department activity, each demands a high degree of focus and expertise to provide useful advice. The NAREEE Advisory Board includes several scientists, but is predominantly senior academic administrators and corporate managers. It does not have critical mass of food and agriculture expertise to function as a science advisory body. Because the administrators and managers generally come from
organizations benefitting from the REE system, there may be bias in the kinds of advice they are able and/or willing to provide. The same is true of APLU bodies working with REE such as the Board on Agriculture Assembly and its components. This is not to suggest that these groups are not providing useful advice on the nature and scope of programs, and on levels of support. But, this input is not unbiased information and it is not balanced by advocates for other options.

Clear and consistent process for input into USDA’s REE agenda would include better defining the scope of advisory processes, in essence, what decisions and actions within the authority of USDA agencies and LGUs can and should be influenced by stakeholder input. Stakeholder input should be limited to these issues, using processes that are documented by the agencies, including making the stakeholder input part of public record. Under the current situation, in addition to the formal and documented paths such as the NAREEEAB and NIFA’s stakeholder solicitations, many informal connections exist between USDA agencies and stakeholders. These include personal connections, “revolving door” personnel decisions, and political influences. The result is less than fully transparent input; in some cases, this is perceived as backroom deals that favor particular constituencies.

In ideal circumstances, all stakeholders would feel they had channels and roles in advisory processes. In reality, it has been considered necessary to use a representative structure, at least for any permanent bodies such as the NAREEEAB (as opposed to ad hoc and open solicitations of stakeholder opinions or ideas). As described in the next section on a proposed strategy, a representative structure is not the only way to engage stakeholders, or may be used in conjunction with other structures. On the assumption that some form of stakeholder representation in committees or boards is inherent in advisory structures, some principles can be identified for improving the quality and accountability of advice:

- **representative** – If an advisory body is constituted for broad purposes such as NAREEEAB, it should have members with expertise across the entire range of food and agriculture. Bodies constituted around specific issues should include members across the entire spectrum of beliefs and conditions within that issue.

- **independent** – Advisory bodies should be free of overt political and agency influence, and able to provide recommendations that push agencies in new directions.

- **multi-directional** – Advisory bodies must be able to gather and disseminate information and advice in both top-down and bottom-up processes. For example, they may need to gather ideas or potential solutions from the best experts in the country on a particular topic, but they need to ground evaluation of options by understanding how they will impact stakeholders on the receiving end of changes in programs or policies.

- **oriented to public interests** – A basic tenet for bodies advising public agencies and universities is that they are working to use public investment to generate the greatest net benefit for the nation (or state) as a whole. This does not preclude representing private interests and perspectives. But, the committee needs to be charged with evaluating who will benefit and who may be disadvantaged by any given choice, and provide this information as part of its recommendations.

- **transparent** – Activities and recommendations should be made in open sessions and documented. Members of an advisory body should declare when they have a conflict of interest.

- **open** – Advisory processes should include channels such as blogs to allow open exchange of ideas with stakeholders not directly involved in committees or other advisory bodies. As appropriate, processes should include active engagement of stakeholders through surveys, focus groups, interviews and so forth to solicit ideas and beliefs.
Ideas for Reforming REE Advisory Processes and Stakeholder Input

Several ideas can be considered to improve REE advisory processes and structures. These ideas are mostly incremental changes to bring more ideas and viewpoints into consideration. They may need to be complemented with ideas for how this advisory input could best be managed within and beyond USDA – in other agencies and in the organizations with deep interaction such as APLU. The focus herein is primarily on USDA agencies and their REE related decisions, including decisions influencing REE activities in land grant institutions. Some observations are provided specifically on NAREEEAB and APLU, followed by generic discussion of new forms of stakeholder engagement.

Incremental changes would primarily affect how USDA and LGUs connect with stakeholders that are already connected with the system. They are not likely to engage communities and organizations currently disenfranchised, communities that are disconnected because of lack of awareness, not interested in influencing REE decisions, distrust the system, and so forth. For these, active campaigns of engagement using some of the tools discussed in the New Forms subsection will be needed.

Change is also needed in the way LGUs solicit and use stakeholder feedback, but this requires changes in many institutions, not one department. LGUs may be influenced to some extent through a top-down push from USDA, particularly in USDA’s specifications related to stakeholder input in development and implementation of USDA funded grants (as has already happened to some extent in AFRI and SARE). Over the long haul, it could also be influenced by change in the culture and orientation of USDA staff. To affect currently disenfranchised communities and organizations, this culture change will need to include reform of the dynamics between LGUs and stakeholders. This is now substantially a one-way

• supported – A body should have adequate staff and logistic support. This should include assistance in managing internet presence. For controversial issues generating large volumes of input, support should include assistance with response filtering to distill out good ideas and critical observations such as program impacts to date or unique circumstances that should be considered.

• accessible – The deliberations and recommendations of a committee should be available on the Web and by paper upon request. This includes information provided to the committee for its consideration (redacted for proprietary and personal data).

• responsive – Advisory structure and process should be nimble and dynamic so they can be adapted to changes in laws, agency and LGU circumstances, issues, and priorities. It is particularly important for representative bodies to have internal processes for reviewing and modifying “slots” in their structure.

• authority – An advisory body should have clear channels for delivering advice, and an understanding of how an agency will incorporate the advice in their decisions. Bodies that have specific legal authority, beyond advising, should have means to ensure that their decisions are implemented.

• assessment – An advisory body should undergo periodic review of its purpose and activities, including determination as to whether there are discernable impacts of advice delivered by the body.

• accountable – Individuals who provide input to advisory processes should be willing to put their views in the public record.

Overall, effective and open communication seems critical to advisory processes. Ideas, information, and recommendations should be provided in internet-accessible forms to increase transparency and accountability. Of course, the Web can also be an important medium for stakeholder input. To the extent feasible, communication to agencies from stakeholders should include acknowledgement from agencies, with explanation of how they intend to use it.
Ideas for Reforming REE Advisory Processes and Stakeholder Input

relation. LGUs operate on an assumption that ‘we are the experts, you are the recipients of our knowledge,’ when in fact communities of practice can have both valuable practical experience and deep understanding of issues that academia should recognize and use.

Broad scale reform such as re-constituting NAREEEAB would require a Congressional mandate. This should be built from a comprehensive review of the current systems, including a needs assessment. The needs assessment would include:

• What decisions do agencies make that should include stakeholder input;
• What are the gaps and overlaps in current structures and processes;
• What are the best structures and processes for soliciting stakeholder input;
• How can current structures and processes be modified; and
• How well do new (proposed) structures and processes adhere to the principles described in the previous section.

National Agricultural Research, Extension, Education, and Economics Advisory Board

The current configuration of NAREEEAB promotes some special interests and excludes others. The designation of 25 named positions on the Board orients members to representing their constituency and aligning with other members with similar interests. While input and feedback from special interests is useful in the advisory process, it makes it less likely that recommendations are first based on public interests and needs. It is conceivable that NAREEEAB members may even oppose REE efforts focused on externalities of agricultural production and food processing such as non-target impacts of agricultural chemicals or agriculture’s contribution to climate change if these cast a negative light on their constituencies.

The two main criticisms of NAREEEAB are that it is not truly representative of all the stakeholders and the domain of its advisory role is not clearly defined. The first might be addressed by revising the slots on the board. Simply increasing the number is likely to be less than satisfactory, as the number of members is already at or exceeding a level where discourse can meaningfully include everyone. As an alternative, the Board could include a periodic review and revision of slots. This would require current members to justify their positions and provide an opportunity to identify new constituencies. It could also include more effective public dialog procedures, including hosting open meetings at which other views can be expressed and taken into account (or not) by NAREEEAB.

As previously noted, the purview of NAREEEAB includes advisory science, program assessment, REE policy within and beyond USDA, and REE funding and support. The need for specific science advice is recognized through creation of standing committees, but this is currently limited to four very specific examples. A brief review of the recent meeting minutes of these committees suggests that they are primarily deliberating on program assessment and funding. For these specialized areas, it could be more productive and responsive to create temporary task forces with specific charges and durations.

In a sense, NAREEEAB has begun to address the second question of how to separate their advising roles. In response to a congressional request, they have established an Adequacy and Relevancy Committee (now divided into two sub-committees) to provide a comprehensive evaluation of USDA REE. The Adequacy sub-committee is grappling with questions of funding for REE activities. As noted in their March 2012 meeting minutes, “the charge to the Relevancy sub-committee is to ‘consider the priorities of the REE agencies and how relevant they are to the needs of the nation and world.’” This is a laudable goal and seemingly takes NAREEEAB down the path of guiding REE priorities toward public interests. It also seems like a monumental task for a volunteer committee that meets for a few hours twice a year.
A more productive approach might be to use this team of experts to guide a task force of USDA staff or external consultants into a comprehensive examination of this question, including active engagement of a wide range of stakeholders. This kind of approach is suggested and authorized by Congress.

NAREEEAB’s efforts seem to be primarily focused on the one clear channel of reporting that they have – providing information to Congress on adequacy and relevancy. For this committee to provide useful guidance on the science, programs, information dissemination, and other activities of USDA and the land grant system would require establishment of clearer channels of communication and authority. Recommendations to the Secretary of Agriculture and senior officials within USDA should be acknowledged. If the Department chooses not to follow recommendations, they should be obliged to provide explanation to the Board. This level and type of communication could be established through executive order or instilled as agency policy.

A more radical approach to making NAREEEAB adequate and relevant would be to restructure how the Board is constituted. For example, instead of representing USDA stakeholders, board members could be selected based on their expertise in the main functional areas of REE. Here is one approximation based on the previously cited Research, Education, and Economics Action Plan. One or more slots each could represent these areas:

- USDA research - ARS, ERS, NASS plus research in other USDA agencies
- External research in land-grant institutions
- External research in other universities, organizations, and agencies
- Training and technology transfer, Cooperative Extension Services
- Education and university partnerships
- Information creation and dissemination, NAL, national databases
- Monitoring and assessment of USDA policies and programs in agriculture
- Monitoring and assessment of USDA policies and programs in food and nutrition

Given the Department-wide imperative to move toward greater sustainability in all functions, it might be appropriate to also provide a slot for someone with this as a primary focus. Another addition could be a futuring slot. An important role for both the current and a re-formed Board is to continually anticipate critical issues and organize REE resources around these.

A potential advantage of a function-oriented Board accrues if it is a forum for cross-functional exchange of ideas and information. Applied research, extension and education is a continuum of effort around problem-solving that will benefit from coordinated and complementary activities, and these can be informed by monitoring, assessment, and information resources.

A function-based structure for REE advising could lend itself well to effective collaboration between USDA staff and external advisors. All of the eight or more slots could have a senior staff liaison/counterpart that could draw on the resources of the agency to provide the committee information and could help organize broader stakeholder input within the functional domain, using existing and new methods.

**Association of Public and Land grant Universities**

APLU serves important coordination and advocacy roles well beyond agriculture and food system REE. However, based primarily on what can be determined from Web resources, its organization and activities relative to agriculture and food REE are arcane and self-serving. The purview of its various bodies is not always clearly defined, nor are its points of articulation with USDA agencies. While periodic meetings of what is essentially a professional association for senior university administrators has inherent value for communication
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of ideas and for cross-institution collaboration, it is questionable whether this is the most focused or efficient way to accomplish this, particularly in an era of shrinking public support for public universities.

APLU as a whole, or the focus area in food and agriculture (generally within the Commission on Food, Environment, and Renewable Resources), could benefit from a comprehensive evaluation of structures and activities. Given its vested interest in status quo, this is probably best done by an independent management consultant rather than internally. Major components of such a study would include how APLU works with USDA and how APLU interacts with stakeholders. Its immediate stakeholders are the universities that comprise its membership, but an evaluation should also include how APLU can understand and communicate about the needs and beliefs of students, staff, and faculty within universities. These are not always the same as those of senior administrators, and the organization could benefit from stakeholder engagement mechanisms to understand when its positions or activities are not in concordance with rank and file.

New Forms of Stakeholder Engagement

Public and private organizations involved in agriculture and food systems have structures that span from local to national; these are essentially networks that could gather ideas and information at the grassroots and funnel this to top-level decision-making. Examples on the public side include FSA’s farmer committees and Cooperative Extension Services (which already has some issue identification and stakeholder engagement mechanisms). Private organizations such as commodity groups, farmers’ organizations, and public interest groups also have local to national structures. These organizations focus on their own interests, but at the same time could contribute information and ideas to public interest REE deliberations. Tapping these existing structures would require a deliberate effort from USDA and/or LGUs to create linkages to these organizations and form advisory networks. To get value from advisory networks, USDA would have to specify what kinds of information they need, how it would be used, and how it could be provided. Assuming that organizations are interested in influencing REE decisions, they would allocate some resources to create networks that feed into this model of stakeholder input.

Representative structures have been the default assumption for advisory bodies. These are typically representative of domains or organizations of stakeholders. Another model is regional representation. For example, APLU-BAA Council for Agricultural Research, Extension, and Teaching has state-based representation. As noted above, bodies could also be based on functional representation. Advisory structure in some organizations is more hierarchical. FSA and NRCS in USDA have local to national offices, and Cooperative Extension Services bubble up to at least a regional level, with occasional coordination between regions. A hierarchical structure is not suited for an advisory body that crosses into many realms such as NAREEEAB, but the existing hierarchies are networks that could be organized to provide stakeholder input.

“Extended peer communities” are another opportunity for building networks. These are formal or informal groups with expertise in a particular topic or issue that can be consulted as needed. Academic and professional associations are a good starting point for building these networks. A dynamic and responsive advisory body should have the ability to gather information and feedback from hierarchies and networks as needed; this depends on pro-active establishment of relationships with appropriate organizations.

Stakeholder engagement can take many forms. Some of them involve active prompting for information, ideas, or feedback. For example, NIFA uses open and targeted solicitations, webinars, and surveys. Other in-person techniques include facilitated discussions and panels at meetings and conferences, key stakeholder interviews (including use of “snowball” methods to identify additional key stakeholders), focus groups, and consensus conferences. For any of these to engage disenfranchised stakeholders, it will be necessary to actively solicit participation and even provide explicit incentives.
In addition to its common role in communication (e.g., email and surveys), the internet provides new opportunities for stakeholder engagement. Several recent studies have demonstrated how social media, particularly wikis, blogs and twitter, can be tapped for useful information. These could be particularly valuable if used in collaboration with organizations interested in soliciting ideas and opinions from members. Effective use of social media will require development of tools for data mining and filtering, presumably by staff supporting advisory bodies.

**Summary of Observations and Recommendations**

The current structures and processes for stakeholder engagement and advice to USDA and LGUs are complex, arcane, and primarily oriented to preserving a status quo. This paper calls for simplification along with explicit definition of scope and authority of advisory bodies, and clear paths for soliciting ideas, opinions, and information from all stakeholders.

A set of operating principles is provided to create clear, consistent, and documented advice to USDA that is oriented to public interests.

Suggestions are provided to reform NAREEEAB. Incremental change would entail making the “seats” on the Board more dynamic; fundamental change would be accomplished by aligning the positions on the Board with USDA functions or other radical change in the structure and function of the Board. The incremental changes could be accomplished by changes in USDA policies, within its existing authority. Fundamental changes would require statutory change.

Structural changes alone will not align stakeholder engagement process with direction (or re-direction) of USDA and land grant REE. This alignment will require a commitment to the principles outlined herein, particularly open and transparent process and an orientation to working in the public interest. Given the massive bureaucracies and infrastructure associated with the current configuration of the REE system, this will require a substantial culture change, a concerted effort with appropriate incentives for change, and perseverance over a lengthy transition period.
Endnotes


5. A Sustainability Challenge: Food Security for All: Report of Two Workshops

6. Toward Sustainable Agricultural Systems in the 21st Century


10. See http://www.sciencenews.org/view/feature/id/347011/description/Scientists_take_on_Twitter for a summary of recent articles
Strengthening the U.S. Agricultural Research, Education, and Extension System: A Reorientation Model to Address 21st Century Challenges

–Meredith Niles, Ferd Hoefner, Ariane Lotti, Juli Obudzinski
Strengthening the U.S. Agricultural Research, Education, and Extension System: A Reorientation Model to Address 21st Century Challenges

Meredith Niles, Department of Environmental Science and Policy, University of California, Davis.

Ferd Hoefner, Ariane Lotti, Juli Obudzinski, National Sustainable Agriculture Coalition

Overview and Proposed Strategy

Agriculture is at the nexus of complex environmental, socioeconomic, and health challenges that the U.S. and the world face in the 21st century. Climate change and extreme weather further stress the natural resource base upon which all agricultural systems rely. Global economic recession has complicated the challenges faced by rural communities, many of which are having essential human capital resources eroded through depopulation and high poverty rates (Doering, 2013; USDA, 2012). At the same time that populations around the world are suffering due to food insecurity, diet-related diseases, such as obesity, have reached epidemic proportions. Especially since many countries look to U.S. agriculture as the model for a modern production system, the way that the U.S. structures its agriculture system – and its complementary research, education, and extension (REE)1 policies and programs that help shape tomorrow’s food and agricultural system – will be a determining factor in whether these challenges are exacerbated or overcome nationally and globally.

Investments in REE have underpinned transformations in agriculture and, likewise, future investments can provide solutions to societal challenges. Faced with 21st century challenges, the REE system must now be configured to provide solutions to complex environmental, socioeconomic, and health issues. All agricultural systems – conventional, sustainable, organic, and biodynamic – can become more environmentally, economically, and socially sustainable. Below we present four key components of a framework for reorienting agricultural REE to address these challenges through a focus on methods and criteria that align with the principles and definition of sustainable agriculture. We recognize that there are many other changes needed to fundamentally reorient the REE system and implement a transformative approach to improve the sustainability of U.S. agriculture (National Research Council, 2010). The following four components are, we believe, necessary first steps:

• Development and application of sustainability criteria;

• Priority for systems-based, participatory, and interdisciplinary research to advance sustainable agriculture;

• Application of technology assessments to better understand potential impacts of new, existing, and emerging technologies; and

• Improved evaluation, outreach, and communication strategies.
While we recognize that there are opportunities to improve REE efforts within the private sector and at other public agencies, our proposal is focused heavily on strategies that reorient the United States Department of Agriculture (USDA) and its Research, Education, and Economics mission area towards more sustainable agricultural systems, because USDA is the primary agency responsible for setting and implementing the U.S. agricultural REE agenda, and USDA programs and policies are our areas of expertise. Within the USDA REE mission area, we are mostly focused on the National Institute of Food and Agriculture (NIFA) and the Agricultural Research Service (ARS), though we note at the outset that the Economic Research Service and the National Agricultural Statistics Service have very important roles to play in the reorientation we are proposing.

Additionally, though we advocate larger public investment in agricultural REE, our recommendations do not come with a price tag attached. Recognizing the nation’s current fiscal challenges and the pressure to cut public funding generally, we focus our proposal on improvements and additions to processes that set the REE agenda and determine its outcomes. We do in a few areas suggest modest funding for certain new activities, but many of our recommendations can be implemented without additional funding and working through existing funding streams. While a significant challenge, the tight fiscal environment also creates an opportunity to refocus REE on addressing pressing challenges and investing in solutions that achieve multiple goals – which is what our four components of a larger reorientation model aim to do.

Our paper begins with a short background on the theory and definition of sustainable agriculture. We then discuss our four key recommendations for reorienting REE for 21st century challenges. For each of our four recommendations, we discuss the existing challenges, strategies currently in place related to these recommendations, and our vision for tangible practices that can be implemented to reorient REE at the USDA. We conclude by briefly discussing the barriers to implementation.

The Theory of Sustainable Agriculture

The theory behind sustainable agriculture is that when properly managed, agricultural systems provide society with multiple benefits, and can continue to evolve over the long term without harm to farmers, farm workers, and their families; rural communities; natural resources; the environment; and public health. A sustainable agricultural system increases productivity and also maintains and improves the natural resource base; expands genuine farming and economic opportunities and improves the quality of life for farmers, workers, and rural communities; and provides access to healthy food for all people. Widely adopted, but adapted to local and regional conditions, sustainable agricultural systems can provide solutions to complex, intertwined issues because by definition they must address multiple objectives simultaneously. Investments in agroecologically based systems can help make “conventional” more sustainable and help sustainable and organic producers be more successful.

In this paper, we use as a touchstone the statutory definition of sustainable agriculture. Sustainable agriculture, by current statutory definition, “means an integrated system of plant and animal production practices having a site-specific application that will, over the long term-

- Satisfy human food and fiber needs;
- Enhance environmental quality and the natural resource base upon which the agriculture economy depends;
- Make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls;
- Sustain the economic viability of farm operations; and
- Enhance the quality of life for farmers and society as a whole.”

The Theory of Sustainable Agriculture
Importantly, we believe that all systems can become more sustainable across not only environmental measures but also measures for economic viability and social vitality. If we hope to inspire future generations of farmers to remain in or enter into agricultural professions, farming must be profitable, attractive and feasible as a career, and support vibrant communities in the immediate and long-term.

Four Key Components of a Larger Fundamental REE Reorientation Model

Development and Application of Sustainability Criteria

Challenges

Though agricultural research in the U.S. has made significant advancements in production efficiency in the past several decades that has led to positive impacts for food, feed, and fiber production, advancements in production have also simultaneously contributed to major negative environmental, socioeconomic, and health impacts (e.g., Matson et al., 1997; National Research Council, 2010). Today’s agricultural production must aim to satisfy a growing number of priorities, including the provision of food, fiber, and feed as well as an expanding number of structure of agriculture, socioeconomic, and environmental benchmarks and benefits. USDA lacks a broader and consistent framework for evaluating its REE portfolio and strategies, and for how the research that it funds contributes to or detracts from the goal of agricultural sustainability. To address the complex farm, rural, environmental, and societal problems of today and tomorrow, USDA should first evaluate its entire REE portfolio and programs for their potential to contribute to a more sustainable food and agriculture system.

Knowledge Gaps and Current Strategies

Federal statute requires that all special and competitive grant programs administered by USDA emphasize sustainable agriculture. However, despite the statutory definition of and emphasis on sustainable agriculture, USDA does not currently evaluate or prioritize REE proposals and grants systematically based on how they contribute to this emphasis and definition.

The most systematic treatment ever given to the issue of sustainability evaluation by REE was a 1992-1997 study, “Relevancy of Agricultural Research to a Sustainable Agriculture” (Bird, 1997). The study was the result of a Task Force convened by the Cooperative State Research Service (one of the predecessor agencies to NIFA) and the Agricultural Research Service. The project used a USDA Sustainable Agriculture Research Relevancy Protocol based on the 1990 Farm Bill definition cited above. The Task Force included farmers and ranchers as well as representatives from government, academia, agribusiness, and farm-related NGOs. Through a rigorous review and audit panel process, research projects from ARS and from State Agricultural Experiment Stations (SAES) were designated as:

- Sustainable agriculture systems,
- Contributing to sustainability,
- No direct impact on sustainability, or
- Detracting from sustainability.

In total, over a five-year period, the Task Force made six different analyses. The results revealed significant failure of the REE agencies to fulfill the statutory sustainable agriculture requirement. In the ARS review, sustainable agriculture systems projects were determined to constitute less than 2 percent of the projects reviewed, but nearly 30 percent of projects contributed to sustainability, while over 5 percent detracted from sustainability. In a review of 403 research projects from 22 SAES, the results were the same except that nearly 5 percent were classified as sustainable agriculture systems research. Economic and social indicators were found
lacking as much or more than environmental indicators in the reviews, contributing to the low level of sustainable systems projects overall.

At least one SAES regional directors association did a similar internal review in response to the Task Force report. However, a system-wide review of federal research projects in relation to sustainability criteria has not been repeated since this Task Force undertook the effort in the mid-1990s.

Additionally, USDA does not provide adequate guidance to grant applicants and reviewers to implement a robust sustainability agenda. Researchers submitting proposals for consideration to the USDA usually do not need to specifically identify how their work will contribute to the mandate to address sustainable agriculture. For example, an RFA from USDA's National Institute of Food and Agriculture (NIFA) for FY 2012 for the National Integrated Water Quality Program aims to “contribute to the improvement of the quality of our Nation's surface water and groundwater resources through research, education, and extension activities,” a goal that has clear potential sustainability components. Despite this, the RFA notes that applications will be reviewed based on their potential to address technical merit and relevancy, which include a suite of requirements, none of which specifically addresses sustainability (USDA NIFA, 2012).

In the review process, according to the USDA Agriculture and Food Research Initiative (AFRI) Review Criteria for Research Project Applications, USDA gives priority to proposals that have strong scientific merit, personnel and facility qualifications, and relevancy. Relevancy priority is given to proposals directed towards specific priority areas identified in the request for applications (RFA), which “are designed to yield improvements in and sustainability of U.S. agriculture, the environment, human health and well-being, and rural communities” (USDA CSREES, 2009). Despite this passing mention of sustainability, there is no additional guidance provided for applicants or peer-reviewers to understand how to build sustainability into proposals, identify these sustainability components, and rank proposals based on their potential to achieve sustainability.

Proposed Strategies and Examples
In order to address the knowledge gap on how USDA is meeting its mandate to address sustainable agriculture, we propose several strategies, none of which requires new legislation. We also highlight several existing examples of proposed strategies.

Implement a review and evaluation of the USDA REE portfolio to assess the degree to which previously funded research has met sustainable agriculture goals.

We recommend that USDA commission an external review of its REE portfolio to assess whether or not, and the degree to which, USDA REE has contributed to sustainability goals. Modeled on the review conducted in the mid-1990s mentioned above, this comprehensive review could evaluate previously funded proposals for contribution to sustainable agriculture based on the five components of agricultural sustainability identified in statute. Conducting this assessment could provide USDA with a snapshot to understand how grants in the recent past have or have not contributed to the overall sustainability of U.S. agriculture and also provide baseline data for future evaluations. These results could assist USDA in developing its sustainability criteria and in developing future RFAs targeted to addressing areas of sustainability that may be lacking in current REE activities as determined by the review.

In addition to the first comprehensive review, we recommend that similar reviews be conducted at least every five years to ensure that USDA is monitoring whether or not its REE activities are promoting sustainable agricultural systems and addressing economic, environmental, and social sustainability goals.

Apply a set of sustainability criteria to proposals during the grant development and review process to assess economic, social, and environmental sustainability.

We recommend that USDA develop a set of criteria and indicators in order to rank proposals based on their overall potential to address and contribute to solutions for social, economic and environmental sustainability.
These criteria should encompass at a minimum the five components of sustainable agriculture previously described.

In addition, the criteria might also draw upon other departmental resources, such as the various ranking systems used by the Farm Service Agency and Natural Resource Conservation Service to assess the conservation benefits of proposals; environmental market tools from the Office of Environmental Markets; organic criteria within the National Organic Program; and economic, environmental, and social indicators reviewed in Economic Research Service reports. USDA should also look to international bodies that have proposed indicators for social and economic agricultural sustainability, including the European Union (European Commission, 2001) and the United Nations (United Nations, 2007) to assist them in the development of sustainability metrics.

For purposes of grant review, these initial steps should be adequate. Longer term, more research in general on sustainability indicators (including social indicators, which are particularly scarce) and in particular to relate indicators to the outcomes they are intended to represent is itself an important research priority (National Research Council, 2010).

**Develop internal education initiatives within USDA to educate staff, peer-reviewers, and applicants about sustainable agriculture.**

USDA should develop a series of workshops, discussions, and internal education initiatives to inform its staff, peer-reviewers, and potential applicants across all USDA REE agencies (and other relevant agencies outside of the USDA REE mission area) about sustainability and sustainable agriculture. These initiatives should provide information about the existing policy mandates for sustainable agriculture, appropriate definitions and best practices for sustainability, and case studies and examples of sustainable agriculture.

In developing these programs and resources, USDA should consider work done by the Science for Sustainability (S4S) Working Group that formed within NIFA's predecessor agency, the Cooperative State Research, Education and Extension Service (CSREES). The S4S Working Group (no longer in existence) was formed in 2002 to advance the knowledge and application of sustainability principles within CSREES programs and procedures. As part of their numerous initiatives, the S4S Working Group sponsored seminars, discussions, and other internal education at CSREES to expand the understanding and expertise of staff and administrators related to sustainable agriculture, forestry, and community development (USDA NIFA, 2005).

USDA could also gain important insight into ways to line up proposals with sustainable agriculture criteria from the Sustainable Agriculture Research and Education (SARE) program requirement for researchers to include sustainability relevancy statements in their proposals, and from the ARS requirement that projects be coded for contributions to sustainability. These examples should be expanded and then applied to all REE project proposals.

These efforts should be expanded to serve peer-reviewers. In order for peer reviewers to adequately assess proposals based on sustainability criteria and to gauge the potential of proposals to contribute to sustainable agriculture goals, they should have a solid basic understanding of sustainable agriculture systems and appropriate assessment tools to use in the review process.

**Systems-based, Participatory, and Interdisciplinary Research to Advance Sustainable Agriculture**

**Challenges**

The many challenges our world faces exist across multiple scales, timeframes, and disciplines. Addressing these challenges requires an investment in REE that considers the inter-connectedness of our world, the multiple scales at which problems manifest and impacts occur, and the diversity of stakeholders that can contribute to real solutions. Furthermore, we recognize
that long-term research is necessary to understand these challenges across multiple scales. Most grants are considered for only several years, while in agricultural systems it can take significantly longer time periods for changes to occur. Capturing and understanding these temporal shifts requires research that is integrated across regions and aims to study systems for the longer term. Such work is increasingly difficult, particularly in light of budget constraints.

We advocate for REE activities that are more systems-based, participatory, and interdisciplinary to achieve sustainable agriculture outcomes, including “component” research that is closely coordinated with and integral to systems work, and including a substantial emphasis on agro-ecological approaches.

Knowledge Gaps and Current Strategies

Currently, USDA REE has several efforts to help achieve systems-based, participatory, and interdisciplinary research. NIFA “integrated” projects must include, by statute, at least two out of the three REE components. USDA guidelines for proposals also highlight that “stakeholder involvement in project development, implementation, and evaluation [should be] demonstrated where appropriate” (USDA CSREES, 2009). Increasingly, RFAs also acknowledge the benefit of interdisciplinary work and welcome interdisciplinary proposals. The newly emerging ARS Long-Term Agro-Ecosystem Research Network for Agriculture is also a promising step forward, both in its focus on comparative systems-based field-scale experimentation and on its long-term duration (Walbridge and Shafer, 2011).

However, despite these positive developments, there are still practices within the USDA that discourage active, comprehensive participation from farmers, the agricultural community, and public interest representatives, as discussed below. Additionally, many REE programs have focused on improving production of specific commodities (i.e., dairy), which has narrowed the focus of REE efforts and limited the opportunity for interdisciplinary research to consider a systems-based approach rather than a single commodity perspective.

Proposed Strategies and Examples

Despite some positive efforts from USDA, we believe that USDA can implement a number of other strategies to make REE more systems oriented, participatory, and interdisciplinary. We propose several strategies and demonstrate existing programs already implementing similar efforts.

Prioritize and Encourage Systems-Based Research That is Multi-disciplinary and Considers Long-Term Time Scales

Addressing agricultural challenges requires a consideration for how management, practices, and technologies affect an entire agricultural and ecological system over an extended period of time. Yet, as noted by the National Research Council (National Research Council, 2010), the percentage of long-term integrated systems research at USDA remains small, with little progress since the NRC’s earlier sustainable agriculture report (National Research Council, 1989).

We encourage USDA to consider within its sustainability criteria (see above) measures for assessing systems-level impacts of proposals. Full cost accounting that considers the cumulative impacts across all systems and scales is necessary to fully evaluate the potential impacts of a proposal. USDA should include within its RFAs and national program plans explicit language prioritizing systems-based approaches. Systems-based research also inherently requires a multi-disciplinary team and perspective to understand the integrated impacts of management decisions across space and time. We also encourage an increase in the number of RFAs and programs that are specifically geared towards long-term agricultural research. Understanding systems effectively is often only achieved through long term monitoring to assess cumulative impacts across scales and systems.

In order to facilitate increased research proposals that include systems-based perspectives, we encourage USDA and other REE agencies and departments to use webinars and educational outreach to applicants to better inform both program leaders and applicants about
systems-based research and relevant methodologies. Such practices have already been implemented in several programs, including the Organic Agriculture Research and Extension Initiative (OREI) and SARE.

In addition to increasing emphasis on systems-based research projects, NIFA RFAs and ARS national plans should include innovative, often smaller-budget proposals that address one or a few “components” of sustainable farming systems. It is important to engage producers, producer organizations, and smaller institutions in this innovative research, as well as the larger universities that have the financial and technical resources to undertake the large systems projects. Reviewers must be sufficiently informed of sustainability criteria to assess whether these smaller component proposals are adequately set within a sustainable farming systems context to make important contributions to the success and sustainability of these systems.

**Improve Stakeholder Involvement for More Participatory Research**

USDA should develop improved strategies to integrate and engage stakeholders throughout the REE process. To this end, we suggest that USDA establish opportunities for farmers and other stakeholders to assist in developing research priorities and participating in REE activities in three key ways:

- Encourage the participation of farmer and stakeholder advisory boards in setting research priorities at USDA and for research proposals;
- Include farmers and other stakeholders in the peer-review process; and
- Ensure that producers, non-profits, and other non-academic stakeholders can apply for grants.

**Encourage Participation of Farmer and Stakeholder Advisory Boards or Administrative Councils**

Farmers and other stakeholders who have a significant stake in federally funded REE activities can and should contribute greatly to the development of research priorities. USDA should encourage the formation of advisory groups for individual national programs and, where feasible, individual research projects. Participation should include historically under-represented farmers and farm labor as well as public interest representatives. We believe this is a minimum requirement for both NIFA and ARS programs. For NIFA competitive grant programs, we recommend that more of them adopt the Administrative Council approach used in the SARE program. In the SARE approach, farmers and other stakeholders have a seat on the governing body along with scientists, educators, extension agents, and agency representatives.

When implementing project farmer and stakeholder advisory boards, USDA should consider the efforts of the OREI. OREI has been explicit in insisting that a high level of stakeholder involvement is crucial for successful proposals. The 2011 OREI RFA noted, “Projects must involve work that is viewed by stakeholders as both necessary and important. There is an expectation that a local and/or regional advisory panel will inform the program throughout its life, including ongoing identification and prioritization of research and extension objectives” (USDA OREI, 2011).

The SARE program has a similar requirement to establish a “Sustainable Agricultural Project Team” for research projects that at minimum include producers, researchers, and extension/outreach professionals. SARE proposals also require explicit documentation from stakeholders that proposals will meet their needs (USDA Western SARE, 2012). Successful implementation of this kind of program should consider the timing and length of proposals to be sensitive to the time constraints that farmers face during particular times of the year (e.g., planting time and harvest).

**Include Producers and Other Stakeholders in the Peer-Review Process**

The current peer-review system largely excludes farmers and other food system practitioners, including non-academics and non-profit professionals. Panelists are not explicitly required to be scientists but are assumed
to be from “institutions” (NIFA, 2009). Many USDA NIFA programs require that review panel managers be scientists. We encourage USDA to consider a more inclusive peer-review process that includes farmers and other stakeholders in addition to scientists and academics.

USDA can look to SARE and the Beginning Farmer and Rancher Development Program (BFRDP) for viable examples. In the Western SARE research and education grants program, pre-proposals are evaluated for relevancy and technical merit by a panel of scientists, agency personnel, and producers. In the North Central SARE region, technical and review committees made up of a diversity of scientists, educators, and agricultural stakeholders make proposal recommendations to the Regional Administrative Council, which also represents various agricultural sectors, states, and organizations. The Regional Administrative Council sets program priorities and makes final grant decisions (USDA North Central SARE, 2012). This process allows farmers and stakeholders the opportunity to consider whether research is relevant and useful for stakeholders.

BFRDP includes similar measures for farmers to participate in peer-review panels and actively recruits producers. BFRDP considers practical timing constraints that farmers have to allow for their participation, such as scheduling review panels during the winter or early spring when farmers will likely find it easier to travel away from their farms. This is an incredibly important component of the program; successful inclusion of farmers in REE must consider the timing of such requests for participation. Poorly timed meetings and reviews will prohibit most farmers from meaningful participation.

By allowing farmers a seat at the decision-making table and to contribute to the discussion of which projects should be funded, SARE and BFRDP have funded incredibly important research that is directly relevant to the issues farmers face in their fields everyday.

Ensure that Producers and Non-Profits can Apply for Grants

We recommend that USDA provide greater opportunity for non-academic individuals and organizations to apply for funding. While some programs allow producers and non-profits to apply for funding, many explicitly prohibit a diversity of applicants. Even in cases where producers or non-profits are not prohibited, there may be an inherent bias in the peer-review process since it is heavily weighted towards scientists and academics.

For example, despite clear statutory language to support a “diversity of applicants,” unfortunately, USDA has implemented AFRI in such a way that prohibits non-profit organizations and private labs from applying for integrated projects. The statute is clear with respect to both the list of who is eligible for all grants under AFRI and is also clear in its specific directive that the agency seek the widest possible participation in the program.

USDA should encourage greater diversity of applicants for grants by developing partnerships between academic institutions and ARS, non-profit organizations, private labs, producer groups, or individual farmers, and by allowing these other participants to be principal investigators where appropriate. In other words, competitive grants should actually be fully competitive, not limited to competition only between academic institutions, and partnerships and collaborations should be given priority.

In addition to administrative limitations on eligibility, the grant application procedures for most USDA competitive grants are clearly targeted to large-scale, multi-institutional grants, with hundreds of pages needed to complete a grant proposal. This process discourages smaller eligible institutions and organizations from submitting grant proposals for smaller projects that request less funding but could pay
off with big results. We recommend that USDA take steps to streamline the application process and reduce the administrative requirements for applicants with limited institutional capacity and without access to the same high indirect cost subsidies from the agency enjoyed by many academic institutions.

Encourage Interdisciplinary Research
Advancing systems-based research requires interdisciplinary projects that can consider multiple impacts and outcomes. We propose several actions to increase the interdisciplinary nature of REE:

• Redefine research priorities to encompass interdisciplinary, user-driven research while increasing the number of RFAs and national program plans with explicit interdisciplinary projects;

• Establish standards for interdisciplinary peer-review panels; and

• Coordinate internally across agencies.

Redefine Research Priorities to Encompass Interdisciplinary, User-driven Research while Increasing the Number of RFAs with Explicit Interdisciplinary Projects
While many USDA REE programs encourage applications that are interdisciplinary, there are many more opportunities for USDA to expand in this area. We recommend that the USDA redefine its research priorities across program areas to ensure that interdisciplinary projects with diverse stakeholders are a key goal. Once so redefined, we encourage USDA to then create additional RFAs exclusively for interdisciplinary research.

We would like to note that continued investment in basic research is necessary and that interdisciplinary research is not meant to replace such investments. In fact, interdisciplinary research is not possible without scientists engaging in basic research questions. Instead, creating opportunities for basic researchers to collaborate to apply their findings to solve society’s problems from multiple perspectives should be an important complement to our nation's existing commitment to basic research. To this end, interdisciplinary research does not need to only consist of large grants; smaller and more frequent interdisciplinary grants can help drive applied research.

We also think it is important to note that, while not within the capacity of the USDA to rectify, interdisciplinary research remains outside the ability of many researchers because of university-based restrictions or lack of incentives. Interdisciplinary work is often not considered in tenure reviews or is not valued in the same ways as disciplinary efforts. Until university systems develop incentive strategies that reward collaborations outside of academic and traditional disciplinary boundaries, many researchers will justifiably not want to consider interdisciplinary work.

The National Science Foundation's Integrative Graduate Education and Research Traineeship (IGERT) is an outstanding example of interdisciplinary research based on different priorities. The IGERT program brings together individuals from multiple disciplines to engage in coursework and research projects around themes at different institutions. By focusing on themes (e.g., rapid environmental change), IGERT is able to identify individuals from a variety of disciplines who are qualified to address issues from many perspectives. USDA should consider developing similar programs or application calls that explicitly include a diversity of researchers and participants. These RFAs could be designed to answer calls around specific agriculture and food system themes that require an inherent interdisciplinary focus (e.g., reducing childhood obesity, increasing agricultural diversity, etc.).

Establish Standards for Interdisciplinary Peer-Review Panels
Assessing whether proposals can address a diversity of stakeholder needs and potential impacts requires an interdisciplinary peer-review process. Even if proposals
are not inherently interdisciplinary, there is a benefit to including multiple disciplinary perspectives within the peer-review process. To assess the overall potential for a proposal to contribute to sustainable agriculture goals, it is vital to include natural and biological scientists, economists, social scientists, and stakeholders who will benefit from the research. We urge USDA to establish requirements within their peer-review process that at least 20% of a panel include individuals from the social and economic sciences with relevant agricultural expertise.

Coordinate Internally Across Agencies
Improving the interdisciplinary nature of REE also requires the agencies to continue to find opportunities to tap into expertise at other non-USDA government agencies that fund food and agriculture research. Funding for agriculture and food systems REE is occurring to varying degrees at the Environmental Protection Agency, National Science Foundation, National Institutes of Health, Food and Drug Administration, Department of Energy, and the Centers for Disease Control, among others. We suggest that USDA REE continue to explore opportunities for joint funding of integrated sustainable food and agriculture systems research.

Technology Assessment
Challenges
Technological advancements have the potential to assist in agricultural development and contribute to solving 21st century challenges. Yet, the pace with which technologies are emerging creates challenges for understanding how they affect the long-term sustainability of our environmental, social, and economic systems. Current strategies for assessing technologies are largely reactionary; society takes actions after significant consequences emerge rather than implementing anticipatory measures ahead of time. As a society we currently lack the framework to assess technologies before they are implemented and introduced (Robertson et al., 2004).

Knowledge Gaps and Current Strategies
Many of the technologies we use in agricultural systems – much less those that will grow out of new research being undertaken today and in the future – are wholly untested for their social, environmental, or economic impacts. There are no standards or strategies for USDA or other agencies to assess technologies before they emerge, which means that there is a knowledge gap about how agricultural innovations affect our society, environment, and economy before they are deployed. Evaluating technologies before their use in agricultural systems requires understanding those systems and how the technology will affect the ecological processes in those systems (Robertson et al., 2004). It also requires an understanding of their impact on economic opportunity, the structure of agriculture, and the health and vitality of rural communities (U.S. Congress, Office of Technology Assessment, 1986). This research is mostly absent from current public research agendas.

Proposed Strategies
Given the rate at which new technologies emerge, USDA should take a more active role in supporting technology assessment as a vital component of research. Science and technology assessments should be made on a continual, iterative basis. Assessments should include both applied and developmental (mission-linked) research, and also broad categories of fundamental research. The latter is a more difficult and less direct relationship, but is an important part of the total portfolio and thus an important part of a comprehensive assessment.

The assessment should examine the relative merits and disadvantages of different public science and technology investments scenarios, including an analysis of both the impact on productivity and the allocation and distribution of the benefits of productivity growth. In determining the costs and benefits of different scenarios, the assessment should look at impacts on economic and social indicators such as returns to labor and management versus capital, the structure of
agriculture, rates of farm exit and entry and barriers to entry, the health and vitality of rural communities, quality of life for farm families and farmworker families, and employment effects. The assessment should also consider impacts on natural resource management, environmental quality, public health, and trade and sustainable development globally.

To comprehensively evaluate new technologies, we propose a two-pronged approach. First, USDA should fund technology assessments from a multi-disciplinary perspective and require greater impact assessments from projects developing and working with emerging technologies. Second, USDA should reinstate a board to oversee technology introduction and assessment.

**Incorporate Technology Assessment into RFAs and National Program Plans**

We encourage USDA to fund assessments of emerging technologies from a multi-disciplinary perspective. This recommendation echoes that of the National Research Council’s Sustainable Agriculture Report to “increase support for research that clarifies the economic and social aspects of the many current and potential technologies and management practices and that address issues of resilience and vulnerability in biophysical and socioeconomic terms” (National Research Council, 2010). RFAs and national program plans should call for assessments of emerging and current technologies used in a variety of agricultural systems, including animal and cropping systems. These RFAs and plans should include principal investigators or program leaders that can adequately assess baseline data and determine the impact of these technologies on environmental, social, and economic systems.

Furthermore, for projects that involve the use of emerging technologies, we suggest that USDA require explicit statements of how the project will address sustainability concerns and the safeguards that will be put in place to minimize adverse impacts to society and sustainability. Proposals that use emerging technologies should include a mechanism for reporting and evaluating the use of emerging technologies within their given system – including the impacts of these technologies on the environment, the structure of agriculture, farm economics, farm workers, public health, and social and cultural acceptance. USDA should prioritize proposals that give significant attention to addressing issues associated with emerging technologies.

**Reinstate the Agricultural Science and Technology Review Board**

We propose a reinstitution of the Agricultural Science and Technology Review Board (ASTRB) to advise USDA and other relevant REE institutions on technology-related agricultural REE and economics policy and priorities. Assessment of publically funded technology development should become a part of competitive grants programs, as well as a part of intramural national research programs within ARS. Along with the Users Advisory Council, the ASTRB was consolidated into the National Agricultural Research, Extension, Education, and Economic Advisory Board. The consolidation of these three separate boards has meant that technology assessment activities have become far less visible and received low or no priority in recent years.

The newly reinstated ASTRB could be explicitly tied to setting priorities for the AFRI program and other NIFA competitive grant programs. ASTRB could also help inform priorities for ARS national programs so that they address societal concerns and ensure accountability for technologies developed with taxpayer dollars. We suggest that the Board produce a report that examines the costs and benefits of technology-related agricultural research and expected impacts on the structure of agriculture, environment, nutrition, and the broad social, economic, and health consequences on urban and rural communities. The report should be periodically updated and measure change over time, from baseline conditions, as innovations are introduced and adopted.

We suggest that ASTRB be composed of at least 11 individuals, to be appointed by the Secretary, who have expertise in: 1) principles and practices of sustainable
agriculture; 2) technology assessment; 3) systems science; 4) environmental sciences; 5) international agricultural issues; 6) social sciences; 7) agricultural sciences (both basic and applied); 8) technology transfer; and 9) education. The board should include farmers and representatives of ARS, NIFA, Extension, land grant universities, private foundations, non-profit organizations, and the private sector. Each member should serve for a staggered term of 3 years, and the board should select a chairperson. The board should report to USDA’s Chief Scientist and consult regularly with USDA’s National Agricultural Research, Extension, Education, and Economics Advisory Board.

Improved Evaluation, Outreach, and Communications Strategies

Challenges

Robust education and extension strategies are critical to broadening the impact and dissemination of agricultural research results. The loss of funding in recent years to Cooperative Extension makes this aspect of research projects even more important. Furthermore, a dearth of indicators for current projects means that USDA lacks the data to adequately understand whether and how funded projects are reaching farmers and stakeholders; whether and how results assist farmers in making their operations more economically, ecologically, and socially sustainable; and how research is being communicated. At the same time, agricultural research continues to primarily be published in peer-reviewed journals that are costly and inaccessible to farmers and stakeholders outside of the university setting.

Knowledge Gaps and Current Strategies

Many USDA RFAs currently include language to require or encourage the dissemination of research results to farmers and stakeholders. For example, a number of RFAs now include specific language requiring that researchers include in their applications how they will distribute their results through the eXtension website. Despite this emphasis, little is known about how researchers actually implement their grants, the number of people they reach through REE activities, and how USDA funds lead to the adoption of new practices.

Though USDA runs its Current Research Information System (CRIS), this system only displays grant abstracts, objectives, approaches, and progress for existing or finished grants. Progress reports generally do not include indicators for extension, education, or communication, and almost all of the language in these grants is highly technical. The SARE reporting system is a notable exception to this general rule.

The following recommendations outline a variety of existing and emerging examples of innovative ways to conduct and design outreach, education, and extension.

Proposed Strategies and Examples

We provide a number of suggestions for how to improve the outreach and extension activities of USDA grants, better monitor their success, and make their data more publicly available and accessible.

Require a Broader Impacts Section for Grant Proposals

We recommend that USDA adopt a strategy that the National Science Foundation (NSF) currently employs in its grant applications. In addition to the intellectual merit component of proposals, NSF requires that all applicants include a section on the “broader impacts” of proposals. NSF provides guidelines on what merits broader impacts and how those should be described, including:

- How well does the activity advance discovery and understanding while promoting teaching, training, and learning?
• How well does the proposed activity broaden the participation of under-represented groups (e.g., gender, ethnicity, disability, geographic, etc.)?

• To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships?

• Will the results be disseminated broadly to enhance scientific and technological understanding?

• What may be the benefits of the proposed activity to society?

NSF provides additional guidelines and recommendations for the types of activities that could be included within each of these five separate components of a broader impacts section (National Science Foundation, 2007). We believe that including at minimum this type of section within an application will assist USDA in better understanding the potential of grant applications to contribute to outreach, communication, and research intended to benefit society and assist underrepresented groups. A stronger set of criteria and questions than those used by NSF could also be included that would allow for grants to more explicitly consider how the research will assist agricultural and food system stakeholders in establishing more sustainable systems.

Broader adoption within USDA REE programs of the SARE requirements for research and education grants would also be beneficial. SARE requires that:

• Research and education projects address the full range of sustainability criteria (with clear and precise relevancy statements in proposal submissions);

• Farmers be involved in all areas (planning, design, implementation, and educational outreach) of grant activities;

• All applied projects have strong, integrated education and outreach components;

• Proposals include measurable outcomes or performance targets and milestones;

• Results and outcomes be communicated with end users, agricultural professionals, and the public at large.

Develop Clear Monitoring and Evaluation Mechanisms of Results Measured with Indicators

In order to understand how USDA grants and funding are contributing to the overall mission of USDA and the mandate to promote sustainable agriculture, it is necessary to have more clearly measured outcomes through evaluation mechanisms and indicators. Though there is language in many RFAs requiring or prioritizing grants that have measurable outcomes, USDA lacks a broader framework for measuring outcomes and impacts, and quantifying them to understand and benchmark their achievements.

We encourage USDA to develop a set of indicators to use in all grants and proposals that measure how grants contribute to the structure of agriculture and sustainability goals, which can be cumulatively assessed over time. In developing these criteria, we encourage USDA to consider the indicators used in the President’s Emergency Plan for AIDS Relief (PEPFAR). Though PEPFAR is a much larger initiative focused on a different issue, it uses indicators that closely track program goals (The President’s Emergency Plan for AIDS Relief, 2007). Indicators that USDA develops could then be included in CRIS, USDA’s online database, that highlights existing and previous USDA grants to enable monitoring and evaluation over time in conjunction with data collection.

Fund and Prioritize Web and Print-Based Outreach Materials

An increasing number of farmers use the internet; currently 62% of farms nationwide have internet access, up from 59% in 2009. At the same time, data suggest that a growing number of farmers use the internet to find information that informs their agricultural
decisions, and to purchase supplies and resources for their farms (National Agricultural Statistics Service, 2011). Younger farmers are more likely to use web-based applications and social media, with 76% of young farmers reportedly using Facebook (American Farm Bureau Federation, 2011). Providing research results and resources for farmers requires using both web and print-based applications.

We suggest that USDA better incorporate and encourage the development of print and web-based outreach materials into their national program plans and RFAs. In conjunction with this effort, we suggest that USDA design national program plans and RFAs with funding specifically for the development of web-based tools and print materials.

**Offer RFAs to Fund the Development of Smartphone Apps**

With the growing use of the internet, smart phones, and tablets comes an opportunity to provide new and innovative tools to assist farmers and agricultural communities in using and applying research results. New applications for smart phones and tablets have significant potential to help farmers make informed management decisions in real time. Many of these “apps” also have the potential to directly assist in implementing sustainability initiatives at the farm, landscape, and regional level. One recent project funded through NRCS provides an excellent example of a phone app developed to provide farmers and others with GPS linked data on soil types (California Soil Resource Lab, 2010).

In recognition of this opportunity, we believe that USDA should offer RFAs to encourage the development of tools and web-based applications that can be applied directly to farm-level landscapes and decisions.

**Implement an Open Access Policy**

Though USDA funds millions of dollars of research annually, research results may not reach end-users because many results are published in peer-reviewed publications that offer limited access. Currently, there are several ways in which USDA-funded projects generate education or extension publications, including through the eXtension website and the SARE website and database. These are excellent examples of how peer-reviewed research can be translated into useable information for farmers and stakeholders. However, there are thousands of relevant papers published every year for agriculture and food systems, and USDA does not currently have the capacity to implement strategies to translate and communicate this research. We believe that access to peer-reviewed journal publications is an additional tool for farmers that is not currently broadly available, and would provide farmers the opportunity to view research directly. Given that such federal projects are funded through taxpayer dollars and intended to directly benefit society and the public at large, we support USDA beginning an open access to federally funded research initiative.

Currently, the National Institutes of Health (NIH) has a public open access policy that has been in place since 2008. Under this policy, any NIH-funded research that results in the publication of a peer-reviewed paper is required to be submitted to NIH for inclusion in their publicly available database. In order to allow publishing companies continued profit margins, a one-year embargo period exists for the publications so that these companies can maintain an economic advantage. PubMed Central, the NIH Database, has been an excellent test case for open access policies and currently receives between 420,000 and 450,000 web inquiries a day. Evidence suggests that 40 percent of these inquiries come from the general public rather than from universities (which make up only 25 percent of visitors daily) (University of Arkansas Medical Sciences Library, 2011). The NIH policy has made important steps to make publicly funded research accessible to American people. USDA should implement a similar policy to give farmers and stakeholders access to a wealth of federally funded research results.
Challenges to Implementation and Conclusions

The recommendations presented above form a starting point for reorienting REE towards agricultural sustainability in the face of environmental, economic, and health challenges felt throughout the world. Implementing these recommendations will require a significant shift away from USDA’s current REE structure and orientation – which is still focused primarily on increasing the productivity of certain commodities with comparatively little attention paid to the social, environmental, and economic aspects of agricultural systems.

There are knowledge, political, and ideological barriers to implementing these recommendations. As addressed above, there is a critical knowledge gap at USDA and throughout the REE system about sustainable agricultural systems and how to support the systems-based research that advances sustainability goals. Political barriers stem from the strong support for the status quo REE agenda within agricultural research institutions, Congress, and USDA. The ideological barriers, which underpin the other barriers, manifest themselves as lack of support for examination of and innovation in alternative sustainable systems.

Overcoming these barriers requires longer-term research, education, and advocacy strategies to build the knowledge base and the leadership on sustainability issues within the REE system and research institutions. Cultivating Congressional champions that can advance policy proposals and supporters within the Administration that can implement the proposals are also important aspects to changing the agricultural REE policy agenda and structure.

In addition to overcoming barriers, a key component of implementing these recommendations will be setting concrete benchmarks to measure progress on reorienting REE around an agricultural sustainability framework. Above we included recommendations on developing monitoring and evaluation mechanisms supported by data collected through indicators, and we stress the importance of setting measurable objectives and monitoring progress towards achieving those objectives. Setting benchmarks and measuring progress in meeting them is particularly necessary in a time of limited funding for REE, when we cannot afford to be wasteful with public funds.

Now is a critical time for reorienting the public investment in agricultural REE. The relatively small amount of research into sustainable agricultural systems over the past few decades has started to yield impressive results around, for example, adaption and mitigation to climate change, agricultural diversification, and new economic renewal strategies for farmers and rural communities. With relatively little attention and support paid to date on encouraging and improving sustainable practices and systems, it is notable that results thus far have been so promising. Fully implementing our recommendations will build on these successes and, we believe, deliver outcomes to address pressing 21st century challenges.
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Endnotes

1. As used in this paper, the abbreviation REE refers broadly to the agricultural research, education, and extension system, except when the USDA REE mission area is specifically indicated.


3. Subsection (b) of section 2 of Public Law 89-106 as amended by Section 1615 (b)(j) of the Food, Agriculture, Conservation, and Trade Act of 1990.

4. In the early 1990s, a series of oversight hearings in the U.S. Senate Committee on Agriculture, Nutrition, and Forestry took a critical look at this deficiency. In recent years, some progress has been made, such as sustainability coding being required for ARS research projects and greater attention to sustainable agriculture in a few subprograms of NIFA’s Agriculture and Food Research Initiative.

5. In this section, we use the shorthand “systems-based” to refer to the utilization of the knowledge and methodologies of systems science, and “interdisciplinary” to refer to a multiple-discipline team approach in which the team works together on a mutually accepted set of system objectives.

6. Section 2(b) of the Competitive, Special, and Facilities Research Grant Act as amended by Section 7406 of the Food, Conservation, and Energy Act of 2008 (Public Law 110-246).

7. USDA-NIFA FY 2013 Requests For Applications, Agriculture and Food Research Initiative Competitive Grants Program, Foundational Program. Part II – Eligibility Information, pg 30.

8. www.igert.org

9. The ongoing and pressing need to re-invent and revitalize Extension is beyond the scope of this paper, though the authors wish to note their belief in the continuing critical significance of the extension function.


11. For example, PEPFAR uses a number of measures across programs to assess the total number of individuals trained on a particular topic, or the total number of individuals reached by certain programs.

12. The Consolidated Appropriations Act of 2008 (Division G, Title II, Section 218 of PL 110-161) states, “The Director of the National Institutes of Health shall require that all investigators funded by the NIH submit or have submitted for them to the National Library of Medicine’s PubMed Central an electronic version of their final, peer-reviewed manuscripts upon acceptance for publication, to be made publicly available no later than 12 months after the official date of publication; Provided, That the NIH shall implement the public access policy in a manner consistent with copyright law.”
Strengthening the U.S. Agricultural Research System

– Liz Carlisle and Albie Miles
Strengthening the U.S. Agricultural Research System

Liz Carlisle and Albie Miles
University of California, Berkeley

Abstract: Biologically Diversified Farming Systems for Ecological & Social Sustainability

We propose a new strategic vision and multi-level policy agenda for shifting the focus of USDA Research, Education, and Extension (REE) programming toward agroecology and biologically diversified farming systems, to address the challenges of food and farming in the twenty-first century and beyond. The specific program changes we recommend focus on strategically strengthening USDA’s stable, core programs (such as NIFA, ARS and LGU research), while partnering with farmers to develop regionally adapted solutions.

With global food needs projected to double by 2050 - and given the pressing environmental, social, and economic issues facing the food and agriculture system today - a fundamentally new model for agricultural research, education and extension is needed. This model must aim to meet growing demand for food, fiber and fuel in a manner that is ecologically sustainable, socially equitable and economically viable over the long term (Gliessman 2004, Pretty et al. 2010, NRC 2010, Koohafkan et al. 2011).

Current Research on the Environmental Performance of Biologically Diversified Farming Systems

Biologically diversified farming systems are agricultural systems that integrate a suite of agronomic practices and/or landscape management strategies that intentionally incorporate functional biodiversity at multiple spatial or temporal scales in order to enhance the ecosystem services that provide key inputs to agriculture (Kremen et al. 2012). From the diversified farming systems perspective, economic and ecological sustainability go hand in hand.

Biologically diversified farming systems support significantly greater biodiversity, soil quality, carbon sequestration, soil water-holding capacity, energy use efficiency, and resistance and resilience to climate change. Biologically diversified farming systems also tend to enhance the biological control of weeds, diseases, and arthropod pests, while increasing pollination services from native insects. Importantly, the available evidence also indicates that the degree to which these later ecosystem services are provided by farming system diversification alone may be insufficient to consistently control pests or provide pollination services at the levels required by growers.

However, a series of recent review studies illustrate the significant potential of biologically diversified farming systems to reduce or ameliorate many pressing global environmental impacts caused by modern agriculture while enhancing key ecosystem services.
services and producing similar yields (Kremen and Miles 2012, Gomiero et al. 2011, Bacon et al. 2012). Given the very high rates return on investment for government expenditures on agricultural research and extension (Alston 2009), we recommend significant increases in USDA REE support for agroecological research and development, so as to realize the full ecological and economic potential of biologically diversified farming systems.

**Current Research on USDA Funding for Agroecology and Biologically Diversified Farming Systems**

Despite the well-documented performance of biologically diversified farming systems, funding to advance such farming systems remains only a small fraction of agricultural research and development budgets, both nationally and globally (Lipson 1998, Sooby 2001, IAASTD 2008, Vanloqueren and Baret 2009). Current USDA data, for example, demonstrate that certified organic farming systems research accounts for only 1.68% of total REE funding (OFRF unpublished data). Moreover, while organic farming systems frequently utilize biological diversification as a key soil fertility and pest management strategy, both the lack of research and extension support and the selective pressure of organic markets has pushed much of US organic agriculture toward monoculture systems supported by a process of input substitution (Guthman 2004). We have undertaken an analysis of the USDA Current Research Information Systems (CRIS) database to identify and quantify the total REE support for agroecological research that specifically facilitates the development of biologically diversified farming systems that provide multiple ecosystem services and meet specific targets of ecological and social sustainability. Our findings indicate that, to date, such support makes up an even smaller fraction of total REE funding than that allocated to organic farming systems research (Miles and Carlisle, in preparation).

The environmental performance research analyzed in the review cited above suggests that the provisioning of ecosystem services from biologically diversified farming systems could be significantly enhanced through further study. We therefore believe that substantially greater public investment in agroecological research and development is warranted to tap the full potential of such farming systems and to evaluate tradeoffs among total costs and benefits. Conducting this much needed research will provide the empirical basis for the design and management of biologically diversified farming systems that sponsor a wide range of ecosystem services, reduce or eliminate yield gaps where they exist, and sustain agricultural productivity and environmental quality over the long term (Vandermeer 2011, Kremen and Miles 2012, Tscharntke et al. 2012).

The most prominent criticism of the biologically diversified farming systems approach is that conventional-level productivity of staple commodities has not yet been fully realized on a commercial scale, thus raising the question of the ability of biologically diversified farming systems to support global food security. Given the substantial evidence that such systems can achieve significant energy use and production efficiencies by exploiting biological complementarities (Zhu et al 2000, Li et al. 2007, Vandermeer 2011, Davis et al. 2012, Kremen and Miles 2012), we see this as yet another argument for increased funding for agroecological research and development. We have much to gain by closing the “knowledge gap” that has left biologically diversified farming systems woefully underdeveloped compared to their conventional counterparts.

**Suggested Innovations in Policy and Practice**

In order to tap the full potential of biologically diversified agriculture, we suggest that the USDA redirect and strengthen REE programming at three major levels. First, we outline our recommendation for a new agency-wide strategic vision. Second, we propose the development of new metrics and targets to guide
USDA work toward realizing this vision. Finally, we propose five REE-wide strategic emphases that we consider particularly promising strategies for achieving these broader objectives. Below we present a short summary of our approach, followed by a more thorough exposition in the remainder of the paper.

Beginning at the highest level, we propose shifting the strategic vision of REE toward the objective of ecological and social sustainability in food and agriculture. We imagine an REE in which all programming would be directed and evaluated according to this overarching goal.

Accordingly, new targets and metrics for assessing the ecological, social and economic performance of farming systems would guide the allocation of funds among program areas and competitive grants, as well as evaluations of program success.

Significant progress in meeting such targets can be achieved through a new set of strategic research emphases. Multi-disciplinary teams, conducting long-term agroecological studies, would provide key data for directing food and agriculture toward greater ecological and social sustainability. Such research would assess whole systems, across social, economic, and ecological dimensions. Full life cycle analysis would provide a comprehensive accounting of the constraints, costs, and benefits of biologically diversified farming systems. Research would focus on regionally adapted varieties and farming systems, would frequently be conducted on-farm, and would be integrated with innovative education and training at Land Grant Universities. A discussion of targets and metrics and detailed review of the five recommended REE-wide strategic emphases follows.

Targets and Metrics: Toward Ecological and Social Sustainability in Agriculture

“Sustainable” agriculture is frequently described as integrating three main goals: environmental health, economic profitability, and social and economic equity (SAREP 2012, NRC 2010). More specifically, sustainable farming systems have been variously defined as those that maintain or enhance the natural resource base upon which they depend, rely on a minimum of off-farm and artificial inputs, manage pests and pollination services through internal biological mechanisms, are resistant and resilient to environmental and human-induced disturbances, and contribute minimally to environmental externalities while sustaining high levels of productivity over the long term (Gliessman 2001, Zink 2004, NIFA 2009). Principles of social sustainability in the agri-food system have been advanced as food and agriculture systems that are socially equitable, non-exploitative and serve as a foundation for future generations (Allen et al. 1991, CASFS 2012). Key criteria for realizing economic and social sustainability in agriculture include long-term farm profitability, universal food security, living wages and safe working conditions for agricultural workers, and enhanced quality of life for farmers and society as a whole (Gliessman 2007, NIFA 2009, Allen 2010).

Directing U.S. and international agriculture toward greater ecological, economic, and social sustainability will require the development and adoption of a clear set of internal definitions, goals, criteria and indicators to meaningfully evaluate food and farming systems in meeting such normative goals (Gómez-Limón 2010). To this end, we recommend that USDA REE develop and implement a new set ecological and social sustainability standards for evaluating all relevant program areas as well as specific selection criteria for grant making programs such as the National Institute of Food and Agriculture (NIFA). These standards and criteria should serve to direct farming system research, education and extension resources toward advancing ecological and social sustainability in agriculture.
Five Strategic Priorities

1. Agroecology and Biologically Diversified Farming Systems: Enhancing Ecosystem Services to and from Agriculture

As indicated above, one of the most promising strategies for achieving better social, ecological, and economic sustainability in U.S. agriculture is a new focus for REE on biologically diversified farming systems. For USDA research, education, and extension, this will mean a heightened focus on the discipline concerned with designing and evaluating such systems: agroecology. Derived from the disciplines of agronomy and ecology, the scientific field of agroecology is defined as the ecology of agroecosystems - the application of scientific research methods to understanding and describing the relationships among organisms and their biotic and abiotic environments, and the application of this knowledge to the design and management of sustainable agroecosystems (Jackson 1997, Gliessman 2001, Altieri 2002, Vandermeer et al. 2010, Vandermeer 2011). A new strategic emphasis on agroecology and biologically diversified farming systems would prioritize projects that further develop scientific knowledge of the role of biological diversity in enhancing ecosystem services to and from agroecosystems (Altieri 1999, Collins and Qualset 1999, Zhang et al. 2007).

Important focal areas would include the biological processes involved in biodiversity–ecosystem service relationships, and the role of biodiversity in supporting multifunctional agriculture (Gliessman 2004, Tschannke et al. 2005, Jackson et al. 2009). In addition, further agroecological research and development is needed across the spectrum of ecological services: soil quality and nutrient management, natural pest regulation, pollination services, yield/productivity, climate change adaptation and mitigation, and water, soil and biodiversity conservation (Kremen and Miles 2012). Robust and decentralized selective breeding programs for crop and livestock development would be key in conserving and regenerating crop genetic diversity and achieving high levels of productivity and multifunctionality from biologically diversified farming systems (Francis and Smith 1985, Hijjar et al. 2008, Lammerts van Bueren et al. 2011, Dawson et al. 2008).

The ultimate goal of such research and extension would be the ecological intensification of agriculture and the development of regionally adapted farming systems that meet rigorous standards of environmental performance while enhancing social and economic welfare (Boody et al. 2005, Naeem et al. 2009, National Research Council 2010, Bommarco et al. 2012).

A new REE-wide strategic emphasis on agroecology and biologically diversified farming systems would direct key resources toward actively addressing the most pressing ecological and social issues facing U.S. and international agriculture (Pretty et al. 2010). For example, agroecological soil fertility and nutrient management research would further develop cropping systems that reduce reliance on fossil energy, maximize nutrient use efficiency, minimize nutrient losses and restore soil quality - while reducing greenhouse gas emissions and sequestering carbon (Mäder et al. 2002, Crews and Peoples 2004, Gomiero et al. 2011, Lynch et al. 2011). Agroecological pest management research would reduce reliance on toxic pesticides by furthering scientific knowledge of preventative and biological control strategies for managing pathogens, weeds, and arthropod pests through farming system diversification (Liebman and Dyck 1993, Zhu et al. 2000, New 2005, Gurr et al. 2012). Agroecological research on the relationship between farming system biodiversity and pollination services would reduce US agriculture’s dependence on the European honeybee as the sole pollinator of temperate region crops, while conserving biodiversity and enhancing pollination services from native bees and other fauna (Nabhan and Buchman 1997, Kremen et al. 2002, Garibaldi et al. 2011).

Ecological research on total productivity and multifunctionality will be key in realizing the potential of diversified farming systems to sustain long-term crop yields, enhance multiple ecosystem services and reduce environmental and social externalities (Pretty et al. 2006, Li et al. 2007, Davis et al. 2012, Kremen and Miles 2012). Much needed research and development work in the field of agricultural engineering will prove
essential in developing the agricultural machinery needed for the scaling-up of complementary polycultures known to achieve equivalent levels of productivity and even over-yield conventional monoculture in some cropping systems (Vandermeer et al. 1987, Zhu et al. 2000, Li et al. 2007, Vandermeer 2011). Working in collaboration with the global change research community, the development of a robust climate change adaptation and mitigation research agenda for agriculture will be critical to ensuring global food security and sustaining the planet’s life-support systems under predicted climate change scenarios (Lal 2004). Agroecological research directed toward climate change adaptation and mitigation would further develop biologically diversified cropping systems that are more resistant and resilient to extreme weather conditions, have an overall lower global warming potential, and maximize water use efficiency (Kremen and Miles 2012). Lastly, with agriculture increasingly dominating the world’s terrestrial ecosystems, multi-scale agroecological research would enable the reconciliation of the long-standing conflict among livelihoods, agricultural productivity, and conservation by designing biologically diversified farming systems and landscapes that are highly productive, enhance a wide range of ecosystem services, and conserve wild biodiversity (Vandermeer et al. 2010, Batary et al. 2011, Tscharntke et al. 2012). Each of these agroecological research areas dovetails well with sustainability-focused extension.

2. Multi-disciplinary ‘Whole Systems’ Research: Understanding Agriculture as Complex Socio-ecological Systems

The second strategic emphasis follows necessarily from the first: understanding and exploiting the full potential of biologically diversified agriculture will require multi-disciplinary and multi-scale scientific analyses that relate farming system and landscape-scale biodiversity to the full range of ecological and social services (Robertson et al. 2004, Tscharntke et al. 2005, Naem et al. 2009, Bacon et al. 2012, in press). In addition to quantifying and describing the impact of farming system biodiversity on ecological and social conditions, this research would also serve to identify important economic and policy obstacles to achieving environmental and social sustainability in agriculture (Allen et al. 1991, Gliesman 2001, Allen 2008, Iles and Marsh 2012, in press).

In our research to date, we have identified several pilot research and development projects in the USDA/CRIS database that could serve as models for such an approach:

- Grossman et al.’s “Evaluating the Potential of Winter Cover Crops for Carbon Sequestration in Degraded Soils Transitioning to Organic Production,”
- Hatfield et al.’s “Reducing Tillage Intensity in Organic Crop Systems: Ecological and Economic Impacts of Targeted Sheep Grazing on Cover Crops, Weeds, and Soil” and
- Barbercheck et al.’s “Improving Weed and Insect Management in Organic Reduced-Tillage Cropping Systems.”

Model international case studies of socio-ecological research include:

- Farshad et al.’s (2000) “Assessing agriculture sustainability using the six pillar model: Iran as a case study,” and

Finally, we recommend the National Science Foundation’s Coupled Human-Natural Systems program as a promising model for such interdisciplinary research.

Comparing the findings of socio-ecological research projects with quantitative benchmarks of ecological health and social well-being will prove essential to evaluating the ability of farming systems to achieve the goals of multi-functionality and sustainability (Gliesmann 2001, Davis et al. 2012, Koohafkan et al. 2012, see also Metrics and Targets above). Such
research would also be key in informing agricultural policies that encourage the internalization of social and ecological costs of production while maintaining the economic viability of farm enterprises (Pretty et al. 2001, Tegtmeier and Duffy 2004, Pimentel 2009, Reganold et al. 2011).

3. Complete Life Cycle Analysis: A Net Gain Perspective

While assessing whole systems, USDA research and extension should evaluate current farming practices or proposed innovations on a “net gain” basis across the full life cycle of the system in question (PCAST 2012). We recommend complete life cycle analysis, in which social, economic and ecological dimensions would be considered in a comprehensive accounting of constraints, costs, and benefits.

Historically, public agricultural research has frequently focused on benefits realized in one part of the life cycle (e.g. yield increase over first ten growing seasons) without accounting for social, environmental or economic costs incurred in another part of that life cycle (e.g. eutrophication downstream, reduction of soil organic matter). As a result, many industry-standard agricultural practices rely on externalizing ecological and social costs of production, exacting a significant toll on human welfare and the environment (Tegtmeier and Duffy 2004, Pimentel 2009). For example, in areas of California where irrigation is available at low cost to growers, crop development and variety selection seldom focuses on dry-land systems, even though high levels of irrigation draw down limited water resources at a rate that will exhaust them within a couple decades. A full life cycle analysis in this system would better account for water as an input cost and potential constraint, and would also factor in the impact of agricultural water use on the surrounding social and ecological community.

Clearly, a major hurdle in achieving a life cycle perspective is a policy and market context that has externalized the social, ecological, and economic costs of agricultural practices. However, a related and important problem is the significant knowledge gap that exists for this area of research. Full life cycle analysis is not available for many key agricultural practices and technologies because it simply has not been done, and few land grant personnel have the training and expertise to conduct this research.

Consequently, we recommend life cycle analysis as a key strategic focus for the Agricultural Research Service, as well as research and extension work conducted throughout the Land Grant University system. We further urge NIFA to make life cycle analysis a priority area for grant making. Criteria considered in such analyses will vary by system, but should focus on the key metrics of social and ecological sustainability described above.

Because those who study the costs of agriculture have traditionally been housed in separate departments or agencies from those who evaluate benefits, assembling teams capable of conducting life cycle analysis will involve crossing or dissolving traditional institutional boundaries. For the short-term, we recommend grant making and research initiatives that encourage cross-agency or cross-disciplinary life cycle analysis projects. For the medium-term, we recommend organizational structures and hiring practices that integrate life cycle analysts trained in a wide range of disciplines including, soil chemistry, riparian ecology, rural sociology, agronomy, and so forth. For the long term, we recommend that public agricultural institutions make life cycle analysis a key feature of the curriculum, a priority skill set to be emphasized in faculty recruitment, extension, and graduate and undergraduate student training.

These three strategic priorities for USDA research and extension - ecologically based agriculture, socio-ecological systems, and life cycle analysis - provoke three questions: who is going to do it, in what time frame, and where? Our fourth strategic priority responds to these three questions.
4. Redesigning Key Elements of Agricultural Research and Extension Work: Who, What Time Frame, and Where?

WHO will conduct this research and extension? Multi-disciplinary Teams

As the above discussion of life cycle analysis makes clear, the type of research and extension we are recommending will require collaboration. Although we call for graduate training and hiring to focus on developing multi-dimensional agricultural professionals, no single individual or lab will be able to do such research on their own. Studying whole systems in ways that account for costs and benefits, both ecological and social, will require multi-disciplinary teams.

Such multi-disciplinary teams should include scholars with different fields of expertise relevant to the system and research question at hand. For a research project exploring the restoration of an indigenous agricultural system, for example, a team of eight might include an agronomist, a microbiologist, a sociologist, a biogeographer, a land use planner, a public health specialist, an entomologist, and a soil ecologist. Multi-disciplinary teams should also include extension and other technical assistance personnel and should substantively involve farmers as co-researchers if not research leaders.

Unfortunately, multi-disciplinary team research is not adequately incentivized by the current structure of Land Grant Universities or USDA agencies, so it remains rare. Yet we found examples in the CRIS database of NIFA-funded projects that pursue such an approach. For example, Shennan et al.’s “Collaborative Research and Extension Network for Sustainable Organic Production Systems in Coastal California” engages a team of social and natural scientists with extension, a local nonprofit, and participating farmers to evaluate strawberry and vegetable cropping systems across their full life cycle.

Projects such as this not only contribute a one-time research product, but also develop an ongoing, adaptive research process to continually evaluate socio-ecological indicators of interest. As part of this process, social learning among farmers, extension personnel, and faculty researchers integrates the work of research and extension, such that knowledge is not “lost in translation,” but is continually developed in the context of practice (Warner 2007).

We urge NIFA-grant making to prioritize multi-disciplinary team projects, and we also encourage the USDA to develop such teams “in-house.” University departments and faculty clusters should be structured to facilitate such collaborative research, and tenure evaluations should be changed to reward this form of scholarship and service. Guidelines for graduate student training should be revised to encourage graduate students to work as part of such teams. Farmer participation should be encouraged by both outreach and compensation, and a portion of applied research grants should require farmer initiation. For example, a Montana-based nonprofit, the Alternative Energy Resources Organization, developed a model of providing seed grant funding to Farm Improvement Clubs, which it supported throughout the 1990s. The grant-makers mandated that projects be farmer initiated, but also required farmer/researchers to involve a technical assistance advisor from their university or a state or federal agency. This requirement not only provided farmers with an additional resource, but also ensured that extension, researchers, and experiment station personnel were part of the learning process.

Other research and extension models that should be considered include the Farming Systems Research approach (Chambers and Thrupp 1989) and the National Socio-Environmental Synthesis Center (http://www.sesync.org). Farming Systems Research, a methodology that dates back to the 1970s, encourages systems thinking, integration of biophysical and social science, and participation to build co-learning processes. SESYNC is a relatively new effort that brings together teams of natural and social scientists to conduct actionable research that addresses environmental problems.

In addition, we encourage Land Grant Universities to incorporate multi-disciplinary teamwork into their curriculum. Courses focused on such projects train
students to work in teams and think across disciplines, while engaging them as stakeholders in their food system (see #5 below for more on education and training within the LGU system).

**What is the TIME FRAME for such research and extension? Long-term Studies**

As is clear from the above discussion, such work will not happen overnight. In order to capture trends in both social and ecological phenomena, both research and extension need to take into account variability over time. Unfortunately, the time scale at which most agricultural research has been funded and conducted is poorly matched to the time scale of the ecological and social indicators we recommend as guiding metrics. This dearth of long-term studies produces a portion of our current knowledge gap. Farmers, extensionists and researchers, for example, frequently work without good information about the residence time of persistent chemicals, the soil fertility effects of proposed multi-year crop rotations, or the degree to which a particular cover crop or rotation strategy might help control a specific pest or multi-pest complex over the life of a cropping system.

To address these issues we recommend adopting multi-disciplinary, Long-Term Ecological Research (LTER) methodologies and research site development as a pragmatic investment for the USDA REE system (Redman et al. 2004). Sound models for medium-term studies of diversified farming systems have already been developed within the REE system and should be expanded upon. A recent study conducted at Iowa State University’s Marsden Farm (Davis et al. 2012) is one such model, as is the research conducted by John Teasdale at the USDA experiment station in Beltsville, MD. We would also encourage both in-house USDA facilities and Land Grant Universities to engage with long-term research models developed outside the public agricultural research system, by organizations such as the Land Institute and the Rodale Institute. Long-term projects must be developed with a steady source of institutional and financial support, such that they can track systems over many years and record basic ecological and economic performance data.

Incentivizing long-term research will require just as much change in current institutional practice as will incentivizing multi-disciplinary teams. Since long-term projects will often exceed the scope of students’ degree programs and even full research careers, they will be shared not only among current team members but with past and future team members as well. Thus, they will not be carried out fully if later team members are professionally penalized for failing to initiate an original project of their own.

To support the development of institutional capacity for long-term research, we urge NIFA grant-making to prioritize long-term studies and continued monitoring. We also recommend integrating long-term studies into post-secondary agriculture and food system curriculum, such that students learn monitoring skills while thinking at the timescale of important social and ecological processes.

**Where should such research and extension be conducted? In and for Specific Regions**

Evaluating social and ecological sustainability not only requires taking into account variability over time. The form of analysis we call for also requires taking into account variability over space, and the multiple nested spatial scales at which ecological and social phenomena interact.

One of the most chronicled blind spots in the history of public agricultural research and extension has been over-extrapolation of experiment station data to diverse production contexts (White 1983, Altieri 2002, Buruchara 2008, Sayre 2008, Weiseger 2009). We think the best way to close this knowledge gap is to engage producers and their systems from the beginning of the research process. When feasible, studies should combine the use of both agricultural research stations and commercial farms and ranches. The combination of the two will allow researchers to capture “real world” conditions by utilizing commercial farms, while allowing for highly replicated and controlled experiments at research stations to illuminate specific ecological mechanisms under consideration. In general, research should be conducted within the system of interest, without assuming the availability of significant external...
inputs. Constraints - a key focus of analysis that takes full life cycles into account - are particularly variable, so studies need to be targeted and fine-grained enough to capture this variability. These considerations should become key criteria for grant-making, and the location of research infrastructure should be evaluated to ensure both that it is proximate enough to the people it is intended to serve, and that it sufficiently captures spatial and temporal variability. Where this is not the case, research infrastructure should be better aligned, but researchers should put even more emphasis on partnering with farmers to ensure that their results will be representative.

Furthermore, a critical focus of such research-in-context should be the development of regionally-adapted varieties and cropping systems that perform well with few to no external inputs. We urge renewed emphasis on conventional public breeding, with participatory plant breeding highlighted as a key strategic practice for the preservation and enhancement of crop genetic resources and agro-biodiversity (Chiffoleau and Desclaux 2006, Østergård et al. 2009). Building the capacity for the ongoing development of regionally adapted varieties will require emphasizing these skills in graduate and undergraduate education, as well as creating and replacing positions for conventional plant breeders at land grant universities.

An example of this type of research, taken from the CRIS database, is the “Northern Organic Vegetable Improvement Collaborative” (Myers et al.), which “[brings] farmers and researchers together for four consecutive years to breed, trial and improve varieties for optimum production in organic systems. Trial results are gathered and shared locally, regionally and nationally through published breeding materials, workshops and a collaborative database.” The goal of this project is “to improve organic farmers’ access to vegetable varieties that grow optimally on their farms,” and institutional partners include Oregon State University, the University of Wisconsin, Washington State University, Cornell, the Geneva Plant Genetic Resource Center (USDA), and a nonprofit organization, the Organic Seed Alliance. The Collaborative “[teaches] farmers how to breed on-farm for performance under organic conditions” and has “[created] an online forum for farmers and researchers to pool resources about organic variety needs.” Finally, “all the partnering farms have strong similarities in scale, type of farm and variety needs, representing a sector of organic agriculture that has traditionally had difficulty accessing organic seed for expanding markets.” (http://blog.seedalliance.org/2010/07/16/welcome-to-novic-the-northern-organic-vegetable-improvement-collaborative/).

5. Innovative Education and Training: Next Generation Land Grant Universities

As suggested above, addressing the many pressing ecological and social issues in agriculture and directing food and farming systems toward greater sustainability will not only require changes to U.S. agricultural research and extension but must involve considerable transformations in how Land Grant Universities educate the next generation of agriculture and food system professionals (Lieblein et al. 2000, Frances et al. 2011). In order to train undergraduate and graduate students to better understand and manage complexity and change in food and farming systems, key elements of a new “integrative agricultural university” would include an emphasis on multi-disciplinary and applied scholarship, problem-based learning opportunities, and the integration of theory with practice (Röling and Wagemakers 2000, Lieblein and Francis 2005, Østergaard et al. 2010). These components are essential not only to the acquisition of knowledge, but to the formulation of meaningful and sophisticated responses to challenges, a necessary skill for environmental professionals tasked with solving real world problems (Lieblein et al. 2012).

Promising national and international models of post-secondary sustainable agriculture and agroecology education include the Sustainable Agriculture and Food Systems Major at the University of California, Davis (http://asi.ucdavis.edu/students/about-major), the Graduate Program in Sustainable Agriculture at Iowa State University (http://www.sust.ag.iastate.edu/
gpsa/), the Major in Organic Agriculture Systems at Washington State University (http://afs.wsu.edu/majors/organic.htm) and the Master of Science in Agroecology at the Norwegian University of Life Sciences (http://www.umb.no/study-options/article/master-of-science-in-agroecology). To support the transformation of LGU research and education, we advise that USDA formula funds - the federal dollars allocated to the land grant colleges of agriculture - be directed toward the development of multi-disciplinary and applied agroecology research and education programming as outlined above. Similarly, we recommend that USDA NIFA significantly increase financial support, via the Higher Education Challenge Grants Program (http://www.csrees.usda.gov/fo/highereducationchallenge.cfm), for developing new post-secondary programs in agroecology and sustainable agriculture in U.S. colleges and universities.

Training the next generation of young and aspiring farmers in the practice of sustainable agriculture will also involve substantial changes to U.S. post-secondary institutions. To achieve the goal of preparing competent and knowledgeable stewards of agricultural production systems, we suggest providing additional support for new and existing practical training, including extension programming and associate degrees, as well as graduate and undergraduate curriculum focused on the skills and agronomics of ecologically-based agriculture and sustainable farming enterprises.

Promising models of university extension and 2-year college programs include the Apprenticeship in Ecological Horticulture at the University of California, Santa Cruz (http://casfs.ucsc.edu/apprentice-training/apprenticeship-information), the Farmer Training Program at the University of Vermont (http://learn.uvm.edu/sustainability/farmer-training/), the Sustainable Agriculture Associate and Certificate Programs at Central Carolina Community College (http://www.cccc.edu/sustainableag/) and Santa Rosa Community College (http://www.santarosa.edu/instruction/instructional_departments/agriculture/sustainable-ag.php), the Sustainable Urban Horticulture and Agriculture Program at the City College of Chicago (http://www.chicagobotanic.org/windycityharvest/), and the Associate of Science degree in Agroecology at Northwest College in Wyoming (http://www.northwestcollege.edu/academics/programs/detail.dot?id=81000). To support such opportunities for educating and training the next generation of farmers, we urge the USDA to significantly expand funding for NIFA’s Beginning Farmers and Ranchers Development Program (http://www.nifa.usda.gov/fo/beginningfarmerandrancher.cfm) for those institutions emphasizing practical training in sustainable agriculture.

**Summary and Conclusions**

While such long-term, multi-disciplinary, whole systems research and development projects focused on biologically diversified farming systems have comprised a very small percentage of total NIFA and ARS grants to date, much greater social, ecological, and economic benefits could be realized if a stable base of financial and infrastructural support was provided to expand the scope of this critically important work. Thus, the specific program changes we recommend focus on strategically strengthening USDA’s stable, core programs (such as NIFA, ARS and LGU research), while partnering with farmers to develop regionally adapted solutions.

As one of the most successful public agricultural research systems in the world, USDA REE is arguably the only entity capable of providing the financial and programmatic support necessary to generate and disseminate agroecological knowledge at the national scale. By shifting its strategic focus and supporting cutting-edge research on biologically diversified farming systems, the REE will position the United States to take a leadership role in addressing the many critical ecological and social issues that currently threaten national agricultural and environmental security. With such a commitment, the USDA REE will ensure not only the protection of important natural resources essential to sustaining vibrant agricultural economies, but also the long-term health and well-being of the population.
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**Endnotes**

1 For a complete listing of agroecology and sustainable agriculture programs offered in US colleges and universities, please see the following URL: http://sustainableaged.org/Resources/AcademicPrograms/tabid/86/Default.aspx.

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Endnotes
AGree is designed to tackle long-term food and agriculture issues. The initiative seeks to drive positive change in the food and agriculture system by connecting and challenging leaders from diverse communities to catalyze action and elevate food and agriculture policy as a national priority. AGree also recognizes the interconnected nature of agriculture policy globally and seeks to break down barriers and work across issue areas.

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Contact us:

1920 L Street, NW • Washington, DC 20036 • 202-354-6440