Preparing an Effective SAES-422 Report

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Revised By
Nicole Nelson, January 2007

INTRODUCTION

Agricultural research has become one of the many successes of federally-funded research. In particular, multistate research that takes place among the State Agriculture Experiment Stations continues to produce sound scientific results on which future research will be based. In recent years, these research projects have documented much of their success using the SAES-422 annual report form. Since the late 1990s, these forms have continually evolved to become more specific and uniform in layout and content. Additionally, each SAES regional association now requires that every project type submit these forms before an Administrative Advisor can authorize a meeting for the following year. The SAES-422 form has improved over time, and the regional associations expect research projects to document even stronger accomplishments and impacts in the future.

HISTORY

Until the early 1990s, the federal government made few demands on scientific research to demonstrate impact and effective use of federal resources. Scientists were left alone to pursue discoveries regarding the nation's economy, society, health and the environment. The 1945 publication entitled "Science, The Endless Frontier" by Vannevar Bush (http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm) a policy document in force for nearly 50 years, called for major federal investments in post-WWII science with the general pledge that such investments would yield huge payoffs. Indeed such payoffs did occur, but the documentation on the extent of the payoffs is scanty. The Bush doctrine has guided federal research investments since its publication.

For most of the late 20th Century the federal government invested heavily in scientific research, resulting in legendary health improvements for the general public, improvements in agricultural productivity and harmony with the environment, protection of natural resources and enhanced success for youth, families and communities. For example, research funded by the federal government has vastly increased food supplies, and food costs have dropped to less than 9% of the average American's disposable income. It also greatly improved the environment. These results and many more are a direct consequence of public and private scientific research investments.

In 1993, the Federal Government Performance and Results Act (GPRA – refer to http://www.whitehouse.gov/omb/mgmt-gpra/gplaw2m.html) significantly changed Executive Branch agency expectations. Hence fourth it required that all agencies, including those funding scientific research activities, develop performance-based plans to report against annually. They anticipated that future budget decisions would relate to demonstrated performance by agencies based on their reported results. However, the Act omitted organized plans for gathering performance and result information generated outside the agency. This was notably true for scientific research activities for which accomplishments and impacts were notoriously difficult to predict as in research trials "yet-to-be conducted."

The government imposed the GPRA requirements across all agencies from the Social Security System, the Internal Revenue Service and the Department of Defense to the science-based agencies such as the National Science Foundation and the Department of Agriculture.

The 1998 Farm Bill required all public institutions to organize federal formula fund activities using state-based Plans of Work. Congress expected to provide the funding agency (i.e., the USDA Cooperative State Research, Education and Extension Service (CSREES)) with reliable information they could assemble into performance reports for GPRA compliance.

The State Agricultural Experiment Stations use formula funds to maintain facilities, pay faculty salaries, hire technicians, feed research animals, buy fertilizers for crop trials, and for other essential resources. The government requires matching non-federal funding in equal amounts, and the federal investment is often overmatched by a ratio between five- and ten-to-one.

Additionally, formula funding requires that public institutions use “not less than 25%” for multistate research projects. Also, twice the 1997 base amount (or not less than 25% of the formula funds, which ever is less) must be used for integrated activities with extension. The justification for these requirements rests with the perspective that researchers should not use federal tax dollars to study local- or state-specific problems or issues. Researchers should use federal funds to invest more towards regional and national needs and opportunities.

The ramp up period to full GPRA reporting is over, and those units receiving USDA CSREES formula-distributed funds must provide information showing the use of those funds to meet national or regional goals. The consequence of poor or inadequate reporting could result in loss of formula funding, a prospect that would be devastating to agricultural research as we know it.

Federal formula funding, viewed as an essential component of the Federal-State Partnership in agricultural research and Extension, is under attack for not being sufficiently accountable. Some critics of formula funds also assume it to be an entitlement and propose converting the funds to competitive grants. SAES directors remain committed to assuring proper use of formula funds and, given the importance of these funds to their funding portfolio, have sought increases in federal formula allocations.

Agricultural research programs funded by the federal government must provide information that justifies continuation of the funds. This means that each project or activity must report results in a way that the committee can results into comprehensive reports for decision makers. To facilitate this responsibility and better support the preservation of this important research funding source, the regional associations of State Agricultural Experiment Station directors adopted a set of guidelines designed to implement the intent of the changes in the 1998 Farm Bill and turn reporting instruments into an impact-oriented system. Among those changes was the requirement for the annual SAES-422 accomplishment report (see Appendix 1) for each multistate research fund (MRF) project or activity.

The SAES-422 annual report evolved from a series of federal forms that must be prepared and submitted in connection with Hatch money and CRIS (ie. AD-416, AD-417, AD-418, AD-419, and AD-421). Early SAES-422 reports focused mostly on activities rather than accomplishments or impacts, for example, a meeting attended, a common set of plants grown or an animal fed for so many days. Unfortunately, none of these measures informs the reader about research accomplishments or the application benefits of research knowledge as impacts.

In 2001, the Northeast Regional Association of SAES directors introduced their online multistate database, the Information Management and Support System (IMSS). Soon after, the other regional associations adopted this system creating the National Information Management and Support System (NIMSS). With the creation of NIMSS came a way to submit uniform proposals and reports, including the SAES-422. NIMSS is now the official multistate proposal and report submission mechanism for not only the regional associations, but also for CSREES.

While NIMSS has been a great resource by which to obtain uniform SAES-422 reports, the report format still challenges some committees. In 2005, the regional associations agreed that ALL project types (MRF, Advisory Committees, Extension/Education and Research Activities, Coordinating Committees and Development Committees) must submit SAES-422s to report their project activities. Prior to this time, the regional associations and CSREES only required MRF projects to submit these forms. The reason for now requiring all committees to submit the forms is to provide information on outputs, outcomes and impacts of all activity supported by multistate research funds. The form provides a quick, easy and convenient way of summarizing the project or activity thereby justifying the continued existence of the project or activity. Also in 2005, the regional association began allowing the regional association offices to cancel meeting authorizations if a committee did not submit its annual report from the previous year. SAES-422 Annual Reports are due within 60 days of an annual meeting. If a project does not submit an annual report for the previous year, a committee may not authorize its next year's annual meeting until the committee submits that report.

In addition to the SAES-422 reports, the regional associations require termination report submission when an NC-, NE-, S- or W- project number (aka MRF project) terminates. Termination reports do not apply to CC, ERA, AC or DC projects (see http://www.wisc.edu/ncra/identifiers.htm for project-type descriptions). Termination reports use the same format as SAES-422 annual reports and provide comprehensive accomplishment, impact and publication sections from the five-year period, rather than from only a one-year period. Basically, they sum up the project before the regional association and CSREES archive it. Termination Reports are due within six months of an MRF project's termination.

The regional associations and CSREES developed this publication to provide guidance to those charged with preparing the SAES-422. To address the need for clear communication, the authors adapted the terminology of the Consultative Group on International Agricultural Research (CGIAR). It aligns the terms with current American English to accommodate terminology used by USDA. Appendix 2 displays an example of an exemplary SAES-422.

TERMINOLOGY

Performance Targets:

Goals: Overall benefits intended for the targeted beneficiaries. The agricultural research Federal-State Partnership has adopted these six USDA goals:

1. Increase economic opportunities in agriculture and natural resources
2. Improve human nutrition and health
3. Support rural and urban community development
4. Protect America's natural resource base and environment
5. Enhance safety and security of U.S. agriculture and food supply
6. Ensure family, youth, and community success.

Intermediate Goals: Benefits directly resulting from innovation uptake including Federal-State Partnership research outputs (see Appendix 3 for "A Science Roadmap for Agriculture Revised Challenge Areas and Objectives").

> **Themes:** Information topics organized to describe progress addressing one or more goals (or intermediate goals). Theme utility (versus a programmatic organization) is theme versatility; stakeholders can flex it to respond to shifting priorities as administrations change in Washington, D.C. Thematic organization application is commonly done through text key words searches (e.g., food safety).

Accomplishments:

This section focuses on intended activities, outputs, and short-term outcomes. Committees should build information built around the activity's milestones, as identified in the original proposal. Please indicate significant evidence of linkages both internal to the project/committee and to external peer groups, stakeholders, clientele, and other multistate activities. The report should also reflect on the items that stakeholders want to know, or want to see. The committee should describe plans for the coming year in no more than one or two short paragraphs. If the committee is filing an annual report, the accomplishments will cover only the current year of the project; for termination reports, list accomplishments from the entire span of the project.

To aid in understanding the description of accomplishments, these definitions are offered for key words.

> **Short-term Outcomes:** Quantitative, measurable benefits of the research outputs as experienced by those who receive them. Examples include the adoption of a technology, the creation of jobs, reduced cost to the consumer, less pesticide exposure to farmers, or access to more nutritious food.
>
> **Outputs:** Defined products (tangible or intangible) that are delivered by a research project. Examples of outputs are reports, data, information, observations, publications, and patents.

Activities: Organized and specific functions or duties carried out by individuals or teams using scientific methods to reveal new knowledge and develop new understanding.

Milestones: Key intermediate targets necessary for achieving and/or delivering the outputs of a project, within an agreed timeframe. Milestones are useful for managing complex projects. For example, a milestone for a biotechnology project might be "To reduce our genetic transformation procedures to practice by December 2004."

Impacts:

This section focuses on actual or intended potential long-term outcomes and impacts. Committees should build information around the activity's milestones, as identified in the original proposal. The report should also reflect on the items that stakeholders want to know, or want to see. List any grants, contracts, and/or other resources obtained by one or more project members as a result of the project's activities. Include the recipients, funding source, amount awarded and term if applicable. If the committee is filing an annual report, the impacts will cover only the current year of the project; for termination reports, list impacts from the entire span of the project.

To aid in understanding the description of accomplishments, these definitions are offered for key words.

Additional Definitions of "Impact":

"The economic, social, health or environmental consequences derived as benefits for the intended users. These are usually quantitatively measured either directly or indirectly as indicators of benefits. (An example of an impact would be improved human nutrition for so many individuals through genetically engineering rice to contain the precursors to vitamin A.)"

Source: National Multistate Guidelines - Glossary

"'The quantifiable difference a land-grant program makes in the quality of life for its clients and general citizenry.' Supplementing that brief statement is also the definition of an impact statement: 'A brief document that describes the social, environmental, and/or economic difference that your research, teaching, or extension efforts have made on the public. Specifically, it states your accomplishments and the payoff to society.'"

Source: National Impact Statement Writing Team

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Indicators: Qualitative surrogate observations or indirect measures of quantitative performance measures which permit monitoring the achievement of outcomes when direct measurement of performance is difficult, too costly, or not possible. An indicator of cultivar adoption might be seed certification records, rather than actual land area planted to that cultivar.

REALITY CHECK

If only the world were as neat as this typology, but it is not. Many research results find utility in some far off applications. Some research discoveries must combine with other findings to make a difference. Many times a research discovery must await other "market" factors before being applicable. Frequently, scientists do not gather the associated research impact measures or they are not available. So who gets credit? Who does the study?

Researchers need a system that provides suitable information to Federal Partners in the form of summary statements for policy and budget decision-makers. Committees should consider the following items as they craft their SAES-422 annual report forms:

- ***Organize research project proposals to facilitate evaluation:*** This includes reporting accomplishments and impacts. If a project has as an objective that they will reduce pesticide use, how might they measure that? If another project is intending to improve child nutrition, what statistics are available as benchmarks, and how might the intended change be documented?

- ***Rate of return on the investment:*** Selection of research objectives needs to become more closely tied to meaningful future measures. Some measures are relatively simple, such as calculating internal rates of return on a research investment. If a project cost $500,000 to accomplish and provides the target audience with $10 million in benefits the following year, researchers can easily calculate the annual rate of return on the investment.

- ***Cost: benefit ratio; Proportion of an area affected; Percentage of individuals adopting a research aspect or plan:*** Researchers can express project cost versus the benefits in terms of gains for the intended users as a ratio. Another measure might be the proportion of an area affected or the percentage of individuals adopting a specific technology.

- ***Indicators:*** In many cases, scientists cannot directly measure an impact or it would be dubious. In these instances, researchers may use indicators to express research investment outcomes.

- ***Testimonials from beneficiaries:*** These may be an adequate substitute (e.g., a quote from a please farmer) for indicators. In fact, many newspaper reporters use anecdotal information to prove a point. Politicians particularly use case examples to make their points.

- ***Case studies:*** Long eschewed by science, case studies may be necessary to defend some types of research accomplishments, especially for project outcomes scientists cannot easily measure, such as environmental quality improvements.

- ***Plausible associations:*** Useful in establishing research accomplishments. For example, it is plausible to claim that higher yields and other factors reduced food costs. In particular, high-yielding cultivars and better cultivation technologies result in cheap potatoes. Proving that claim might be difficult, but claiming it to be true seems plausible.

- ***Sharing credit for research impacts:*** This can be problematic in many cases, especially when the work of many contributes to a success story. A common example happens when several institutions work with the private sector to complete an activity. Who gets the credit? In all fairness, everyone should be able to claim the success.

- ***Ex ante and ex post impact studies:*** These can help document research impacts, but in many cases the expense of doing such an analysis may not be worthwhile. In these instances, scientists should seek substitutes.

- ***Milestones:*** Particularly helpful in reporting accomplishments and impacts, if researchers cleverly design a project with well-thought-out milestones, it can greatly facilitate reporting progress and achievements. Thus, time invested in project design pays off in the reporting requirements. This thought motivated the multistate project outline changes, which now list outcomes oriented with a milestones structure.

- ***Other things to think about:***
    - Has the project become more of the same? How is it innovative compared to previous projects (if the project has been renewed/revised)?
    - Does the project overlap with other MRF projects? If so, could/should the committees combine to form one larger project? What makes this project unique?
    - Is the research "cutting edge"?
    - Does the project have a wide variety of expertise participating in relation to the research?
    - Is the report written so that non-scientists can understand it? Some stakeholders reading the reports may not come from a scientific research background.
    - Is the group following regional association review committee (MRC/MAC/RCIC) advice provided when the project was renewed/revised or underwent midterm review?
    - How has the meeting attendance been?

CONCLUSION

Due to the introduction of NIMSS and the regional associations continually expecting nothing but the best from their research projects, today's SAES-422s have become more uniform, complete and direct than ever before. The SAES directors maintain high standards and set the bar increasingly higher for future multistate research committees. We need to persistently sustain (and indeed increase) agricultural research funding. Our staunch advocates want to double agricultural research funding, as has been done for the National Institutes of Health and the National Science Foundation in recent years. We need to give our advocates within and outside the Federal government ammunition to make a case for increased funding. To do this, research scientists need to provide clear, concise and up-to-date information on research accomplishments and impacts. Equally important are clear statements about what it all means for the intended beneficiaries. The SAES-422 is the way to fill that need.

APPENDIX 1

National Multistate Research Guidelines

APPENDIX D

SAES-422
Format for Multistate Research Activity
Final version must be submitted in the National Information Management
And Support System (NIMSS)

Note: *This report is submitted each year of an activity's duration and is due 60 calendar days following the annual meeting. The SAES-422 is submitted electronically by AAs into NIMSS. Annual Reports for MRF projects are available to CRIS and CSREES through NIMSS.*

Project/Activity Number:

Project/Activity Title:

Period Covered:

Date of This Report:

Annual Meeting Date(s):

Participants: Provide information with a focus on the decisions made. As an alternative, list the URL for the meeting minutes, if that report contains the list of those who were present. And, if available, add the address for the list server as well. (Max characters = 4,000. Suggested Format: "Last name, First name (email) - Institution;" The semicolon is used to separate participant information.)

Brief summary of minutes of annual meeting: Provide information with a focus on the decisions made (Max characters = 12,000. Single line breaks are not preserved, use double line breaks instead or use a <p> tag to separate paragraphs.). As an alternative, list the URL for your meeting minutes.

Accomplishments: This section focuses on intended activities, outputs, and short-term outcomes. Committees should build information built around the activity's milestones, as identified in the original proposal. Please indicate significant evidence of linkages both internal to the project/committee and to external peer groups, stakeholders, clientele, and other multistate activities. The report should also reflect on the items that stakeholders want to know, or want to see. The committee should describe plans for the coming year in no more than one or two short paragraphs. If the committee is filing an annual report, the accomplishments will cover only the current year of the project; for termination reports, list accomplishments from the entire span of the project.

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Impacts: This section focuses on actual or intended potential long-term outcomes and impacts. Committees should build information around the activity's milestones, as identified in the original proposal. The report should also reflect on the items that stakeholders want to know, or want to see. List any grants, contracts, and/or other resources obtained by one or more project members as a result of the project's activities. Include the recipients, funding source, amount awarded and term if applicable. If the committee is filing an annual report, the impacts will cover only the current year of the project; for termination reports, list impacts from the entire span of the project.

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"The economic, social, health or environmental consequences derived as benefits for the intended users. These are usually quantitatively measured either directly or indirectly as indicators of benefits. (An example of an impact would be improved human nutrition for so many individuals through genetically engineering rice to contain the precursors to vitamin A.)"
Source: National Multistate Guidelines - Glossary

"'The quantifiable difference a land-grant program makes in the quality of life for its clients and general citizenry.' Supplementing that brief statement is also the definition of an impact statement: 'A brief document that describes the social, environmental, and/or economic difference that your research, teaching, or extension efforts have made on the public. Specifically, it states your accomplishments and the payoff to society.'"
Source: National Impact Statement Writing Team

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Indicators: Qualitative surrogate observations or indirect measures of quantitative performance measures which permit monitoring the achievement of outcomes when direct measurement of performance is difficult, too costly, or not possible. An indicator of cultivar adoption might be seed certification records, rather than actual land area planted to that cultivar.

Publications: For SAES-422 reports list the publications for **current** year only (with the authors, title, journal series, etc.). If the list exceeds the maximum character limit below, an attachment file may be used. (Max characters = 50,000. Single line breaks are not preserved; use double line breaks instead or use a <p> tag to separate paragraphs.)

Authorization: Submission by an AES or CES director or administrative advisor through NIMSS constitutes signature authority for this information.

APPENDIX 2

Example of a Completed SAES-422

Multistate Research Project NC213

Taken from the National Information Management and Support System

Project No. and Title:	NC213 Management of Grain Quality and Security for World Markets
Period Covered:	02-2005 to 02-2006
Date of Report:	14-Mar-2006
Annual Meeting Dates:	28-Feb-2006 to 01-Mar-2006

Participants: Terry Arbogost - USDA-ARS-CMAVE Paul Armstrong - USDA-ARS-GMPRC Lloyd Bullerman - University of Nebraska Mark Casada - USDA-ARS-GMPRC Florence Dunkel - Montana State University David Funk - USDA-GIPSA-TSD Arvid Hawk - Cargill, Inc. Ken Hellevang - North Dakota State University Tim Herrman - Texas A&M University Charles Hurburgh - Iowa State University David Jackson - University of Nebraska Stephen Kells - University of Minnesota Bill Koshar - Ohio State University Dirk Maier - Purdue University Frank Manthey - North Dakota State University Lina Mason - Purdue University Leland McKinney - Kansas State University Sam McNeill - University of Kentucky Michael Montrose - University of Kentucky Marvin Paulsen - University of Illinois Bill Ravlin - Ohio State University James Stitzlein - Consolidated Grain & Barge Co. Dennis Strayer - Dennis Strayer & Associates Charlene Wolf-Hall - North Dakota State University

Brief Summary of Minutes of Annual Meeting:
The General Business Meeting began at 3:00 PM on Tuesday, February 28, 2006

Motion passed to approve minutes of the 2005 general business meeting

Old Business

1. Revision to responsibilities of officers (Dirk Maier Committee Chair).

The previous revisions, which began in 2004, were discussed. Comments that had previously been submitted by Tim Herrman, Charles Hurburgh and Charlene Wolf-Hall were mentioned as well as feedback from the summer meeting. Areas that needed clarification included:

- Project Advisor versus Project Coordinator responsibilities - how to separate these (Bill Ravlin would come up with wording).
- Vice Chair - use consistent terminology - would chair nomination committee.
- Andersons grant proposal review committee - coordinator will determine if there is a conflict of interest as consistently as possible - committee will include two objective chairs, two industry advisors, and two USDA representatives - all will review all proposals - may use adhoc reviewers.
- Industry advisory committee - attendance at annual meeting expected - executive committee can decide on continuing membership (Dirk Maier would come up with wording)
- Membership - can members who are not official university representatives vote (the answer was no), but can be officers in which case they would be able to vote (Dirk Maier would come up with wording)
- Discussion on the heading for the document - use of the legal name versus a consortium name - tentative agreement on using the official title with consortium tag-line (Executive Committee will finalize)

2. Education proposal development update (Charlene Wolf-Hall, Academic Group).

The survey information was mentioned for the partner survey and the development of the industry survey. Input was asked for and given by:

- Dirk Maier - the GEAPS group would be open to the industry survey.

- Bill Ravlin - good way to leverage history of NC-213 and new ideas.
- Florence Dunkel - volunteered to help as much as possible and has contact with the HEC program director through 3 other HEC grants.
- Charles Hurburgh – don't make it too big.
- Dirk Maier - wouldn□t necessarily be one degree granting institution.
- Stephen Kells - how would subcontracts fit in? How would this affect a tenure track person? Charlene will initiate the formation of a small group of individuals (David Jackson, Dirk Maier, Leland McKinney, and Charlene Wolf-Hall) who had expressed strong interest through the partner survey to continue with the process. This group will consult with the industry advisors for the industry survey and will keep others updated.

3. Industry Advisory Committee - deferred to Executive Committee meeting.

New Business

1. Midterm review was discussed - led by Bill Ravlin.

There is an apparent disconnect between what is asked for in the review versus the annual reports. Impact statements and connections are important. Handouts including a powerpoint presentation by Mike Harrington describing impact statements was distributed. It was emphasized that these will be very important with the President□s budget proposal. It was emphasized that it is important to indicate the funding is a good investment and results in impacts and is leveraged by state and private sector funds. Things that can be included were quality of life, dollars, things that can be quantified. Charlie Hurburgh cautioned against getting "too far a field" as can raise questions, to which Bill Ravlin said there is some acceptable overlap.

2. Financial status of NC-213 was discussed - led by Bill Ravlin.

The Anderson's endowment is in "fine fiscal shape".

3. Discussion of the Anderson's award process - led by Bill Ravlin.

Bill Ravlin emphasized the importance of following the directions in the RFA. Handouts of the review criteria for the regular and team awards program was distributed. The RFA can only be changed at the beginning of the year. There had been some dissatisfaction with the reviewer feedback to applicants, so this revision is an attempt to make the process more transparent and give applicants better feedback. Some of the comments on the criteria for the regular and team award review forms included:

- Yes/no questions should not need numbers.
- Some yes/no questions could be answered at administrative level and don't need to be on the review form.
- Be more specific on what can be included in the ten page minimum.
- Bill Ravlin will reword methodological questions.
- The outcomes will move up in order - use outputs instead of outcomes?
- Timetable question is OK.
- Impact - should indicate if project is part of long term or short term study.
- Take out the question about if the problem will be solved by the project.
- Budget appropriate - yes/no, if no explain why.
- Additional comments can be sent to Bill Ravlin, referred to executive committee.

4. Summer workshop ideas

Discussion on what "summer" means ensued. Some workshop possibilities were suggested by:

- Tim Herrman - Feed Industry HACCP Training May 9-11.
- Lloyd Bullerman - tentative mycotoxins in grains conference in Omaha.
- Charlie Hurburgh - do we have to have one?
- David Jackson - will discuss with executive committee.

5. New officers.

The floor opened for nominations for secretary. Linda Mason nominated Stephen Kells, seconded by Florence Dunkel. Kells agreed and was unanimously approved, pending Minnesota Station Rep approval. David Jackson will move up from chair to past-chair, Mike Montrose will move up from vice chair to chair, Charlene Wolf-Hall will move up from secretary to vice chair.

6. 2007 Annual Technical Meeting.

Was suggested to overlap with the Wheat Quality meeting in Kansas City. There was consensus that it was good to hold it every other year or so with GEAPS. Dirk Maier proposed NC-213 sponsorship if the 2008 International Grain Quality Conference. Charlie suggested it be the NC-213 annual meeting place for 2008. Bill Ravlin will check if meeting can occur in another country. Dirk indicated that a decision would need to made soon.

Meeting was adjourned at 5:15 PM.

Accomplishments:

A. Develop practices and technologies to support quality management systems for production, distribution, processing, utilization of quality grains and oilseeds.

- Near infrared calibration models for determination of subunit (amino acid, fatty acid, etc)factors of corn and soybeans were extended.
- Survey of corn and soybean quality on an annual basis, targeted at end-use related factors for corn/soybean quality and yield information will be reorganized and expanded.
- Measurement of ethanol production from corn hybrids are optimal for use in dry grind ethanol plants.
- Examine milling properties, dough characteristics, protein functionality, and baking properties of soft white wheat varieties. Biochemical studies on flour proteins were conducted and the use of transglutaminase (TG) to improve dough strength of weak gluten protein flour samples was investigated.
- Evaluate postharvest insect resistance of most popular varieties of wheat for organic producers in Montana organic producers most popular varieties of wheat. Determine location within the kernel causing insect resistence in Montana-grown hard spring and hard winter wheat varieties.
- Development of methods that allow for the characterization of grain and its end-use processing properties. Efforts were focused on tests associated with predicting the alkaline cooking (nixtamalization) processing performance of sorghum and maize.
- Effect of preharvest production practices on end-use quality of wheat, specifically changes in vitreousness kernel content.
- Characterization of maize and sorghum samples representative of genetic and environmental diversity for establishing a sample set for the end-use quality on the basis of physical quality-associated properties. This enables development of classification rules to predict the suitability of samples for the particular end-use processing performance.

- Define the attributes of wheat flours with excellent quality for flour tortillas. Evaluate the baking quality of Texas wheat breeders' samples.

- Evaluate physical, chemical and processing properties of sorghum and corn and develop improved food quality cultivars. Improve aflatoxin tolerance and improve nutritional and processing quality of corn through breeding.

- Development of a system simulation model to evaluate and quantify the practically achievable purity levels for the segregated handling and delivery of differentiated (GM vs. non-GM; identity preserved vs. commodity) grains and oilseeds from producer to end user.

B. Develop basic knowledge, science-based standards, and technologies that promote crop quality, food security and food safety in grain markets.

- Measurement of fermentation process used for dry-grind ethanol production.

- High value (pharmaceutical, industrial) grains will require extremely stringent isolation from staple commodities if they are to be grown in commodity-producing areas. Operations from planting to end-use will be quantitatively assessed for their potential to contribute either accidental or malicious mixing. Estimates will be pooled in 3 case study traceability models, which will then be used to create a standard evaluation template. These models will also be used to collaborate with scientists in the EU, for the purpose of developing international standards/data exchange protocols.

- Iowa State has assisted a large country elevator in the creation of a certified quality management and product tracking system, based on the American Institute of Baking Quality Systems Evaluation System (QSE). The QSE system was converted to the more management-based ISO 9000 format and applied to other grain and feed locations. At one location historic performance data sufficient to document the economic efficiency benefit of the quality management system will be compiled. A procedure and template for converting alternative or industry specific quality management system formats to ISO 9000-2000 certifiable formats will be created.

- A computer model was used to evaluate low-temperature management strategies to control Indianmeal moth.

- Assess the reduction of the toxicity of FB1 during extrusion cooking of contaminated corn grits using in vivo bioassay methods.

- Survey of the microbiological quality of the wheat crop from the northern plains and evaluation of ozone for reducing microbial loads and mycotoxin content in wheat.

- Development and modeling of a continuous-flow dryeration process.

- Utilization of carbon dioxide detectors to monitor for the spoilage of stored corn prior to the time that spoilage would be detected by traditional methods. In-lab and pilot bin experiments as well as tests in large commercial storage structures have been conducted and indicate the effectiveness of CO_2 detection.

- Develop markers and tools to identify and trace lots of grain

- Development of a mycotoxin surveillance network involving major grain states and Texas is being developed including a database consisting of mycotoxin incidence, field of origin (GIS coordinates), cropping data including rotation, hybrid, planting date, fertility, weather data.

- Develop trapping and contour analysis of trap catch as a method for monitoring stored product insect pests in warehouses, processing plants, and retail stores, and for locating foci of infestation or points of entry.

C. Create and disseminate scientific knowledge that will enhance public confidence in market driven quality management systems for grain.

- Identify methods of measuring shelled corn storability using CO_2 Test Kit (Woods End Research, Mt. Vernon, Maine), for measuring CO_2 production (storability) of shelled corn; evaluated several rapid (< 15 min) tests that can be used together to provide a less precise but more rapid storability indication; and (3) to examine the correlations among the various tests used as storability indicators.

- Developed high speed detection and sorting technology to remove toxins from grain, and to sort breeder samples for significant attributes. Systems can process kernels from 1 to 1000 kernels/s. We developed methods to detect insect damaged wheat using an acoustic method and using computed tomography. Both of these methods have promise to inspect large samples very accurately. We also developed an NIR system capable of capturing NIR spectra from 900 to 1700nm on single grain kernels at rates up to 10 kernels/second.

- Conduct basic and applied research in the biochemistry and technology of grain sorghum to identify and evaluate the biochemical components that govern processing, functionality, and susceptibility to mold. The information is used to improve sorghum quality and utilization for increasing domestic and export markets.

- Investigated the effect of enzymes on whole wheat tortilla quality. Evaluated the shelf-life extension of 100% whole wheat (WW) tortillas by adding enzymes. Various enzymes have been incorporated into the tortilla formulation. These included bacterial ±-amylase, glucose oxidase (GOX), transglutaminase, phytase, pentasonase, and a blend of cellulose and amylase

- Evaluate kernel characteristics, milling properties, and dough and bread-, tortilla- and Asian alkaline noodle-making properties of hard winter wheat progenies. Determine protein and lipid contents, and composition and interaction among these components of cereal grains as they relate to storage, handling, and end-use properties.

- Develop fast reliable methods for the identification of quality traits of wheat starches using digital image analysis and laser diffraction sizing.

Impacts:

1. NC-213 scientists have developed systems that provide critical information to grain processors that allows then to institute component pricing systems resulting in increase sales of U.S. grains.

2. NC-213 scientists conducted research that shows that adding transglutaminase (TG) increases flour quality and reduces the need for costly testing.

3. NC-213 scientists discovered that by reducing humidity and moisture wheat kernel quality is increased and a greater economic return realized.

4. NC-213 scientists have developed systems that track the origin and shipping history of bulk grains and these systems allow producers and handlers to realize higher prices.

5. By using techniques developed by NC-213 scientists corn starch levels can rapidly be determined and producers/handlers can realize increased profits of 4-6 cents/bu.

6. NC-213 scientists developed grain quality management systems that led to the formation of international quality standards affecting global grain markets.

7. NC-213 scientists developed a CO2 test kit that rapidly identifies the risk of fungal contamination in shelled corn. This allows grain elevator managers to lower storage losses and costs.

8. NC-213 scientists discovered that ethanol yields are significantly increased by processing sorghum grain prior to fermentation thereby increasing the value of sorghum.

9. Over 95% of all hard winter wheat cultivars were evaluated by NC-213 scientists for end-use quality. This information allows the U.S. wheat industry to focus on high value cultivars and capture increased value.

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APPENDIX 3
A SCIENCE ROADMAP FOR AGRICULTURE
Revised Challenge Areas and Objectives

Revised based on 2005 survey results.
Challenges, and their respective objectives, have been reordered to reflect their current relative priority.

Challenge 7. *We can ensure food safety and health through agricultural and food systems.*
- Eliminating food borne illnesses.
- Developing technologies to improve the nutritional value of food and create health-promoting foods.
- Conduct research on the behavioral dimensions (personal, consumption, and policy) that influence personal and family dietary and health decision-making to reduce public health issues, such as obesity.
- Developing policy and strategies to address agro-security, bioterrorism, and invasive species to protect producers and consumers.

Challenge 4. *We can provide the information and knowledge needed to further improve environmental stewardship.*
- Developing better methods to protect the environment both on and beyond the farm from any negative impacts of agriculture through optimum use of cropping systems including agroforestry, phytoremediation, and site-specific management.
- Finding alternative uses for the wastes generated by agriculture.
- Developing more environmentally friendly crop and livestock production systems that utilize sustainable weed, insect, and pathogen management strategies, along with feeding strategies that promote environmental stewardship.
- Developing better strategies, ecological and socioeconomic systems models and policy analysis to address soil, water, air and energy conservation, biodiversity, ecological services, recycling, and land use policies.

Challenge 5. *We can improve the economic return to agricultural producers.*
- Developing sustainable production systems that are profitable and protective of the environment, including finding ways to optimize the integration of crop and livestock production systems.
- Developing strategies for integration of local, regional, national, and global food systems to maximize the benefits to both U.S. agriculture producers and consumers throughout the world.
- Designing improved decision support systems for risk-based management of farms, ranches, and forests/woodlots.
- Finding ways to improve on strategies for community-supported food and fiber production systems.

Challenge 6. *We can strengthen our communities and families.*

- Stimulating entrepreneurship and business development in rural communities and new forms of economic activity built around regional trade associations, rural cooperatives, and local production networks.
- Building coalitions among environmental, labor, and community development groups to facilitate democratic social change to ensure that families have access to food, health care, education, and welfare services
- Enhancing the problem solving capacities of rural communities through leadership development
- Determining strategies to enhance the well-being of families and individuals.

Challenge 1. *We can develop new and more competitive crop production practices and products and new uses for diverse crops and novel plant species.*

- Conceiving new markets for new plant products, and new uses for those crops.
- Developing technologies to improve processing efficiency of crop bioproducts.
- Supporting the development of marketing infrastructure for crop bioproducts.
- Improving crop biomass quantities, qualities and agricultural production efficiencies.

Challenge 3. *We can lessen the risks of local and global climatic change on food, fiber, and fuel production.*

- Diminishing the rate of long-term global climatic change by increasing the storage of carbon and nitrogen in soil, plants, and plant products.
- Creating broad-based, comprehensive models to assess the socioeconomic impacts, risks, and opportunities associated with global climate change and extreme climate events on agriculture and natural resources.
- Integrate long-term weather forecasting, market infrastructures, and cropping and livestock management systems to rapidly optimize domestic food, fiber, and fuel production in response to global climatic changes.
- Minimizing the effects of long-term global climatic changes on production of crops, livestock, forests, and other natural resource systems.

Challenge 2. *We can develop new and more competitive animal production practices and products and new uses for animals.*

- Developing innovative technologies for reducing the impact of animal agriculture on the environment.
- Enhancing the value of food and other animal products for both the producer and consumer by using conventional and newly developed technologies that are socially and ethically acceptable.
- Developing new and enhanced technologies for the improved efficiency and welfare of animals that are processed for food.
- Improving conventional technologies as well as developing new technologies to improve the efficiency of animal production.