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Washington, DC 20548

September 13, 2007

The Honorable Tom Harkin
Chairman
Committee on Agriculture, Nutrition, and Forestry
United States Senate

The Honorable Herb Kohl
Chairman
Subcommittee on Agriculture, Rural Development, Food and Drug Administration, and Related Agencies
Committee on Appropriations
United States Senate

Subject: *USDA: Information on Classical Plant and Animal Breeding Activities*

This report responds to your request for information on activities related to classical plant and animal breeding—creating an organism with desirable traits through controlled mating and selection without the insertion of genes from another species—that occurs at the U.S. Department of Agriculture (USDA). Within USDA, the Agricultural Research Service (ARS) and the Cooperative State Research, Education, and Extension Service (CSREES) are the primary scientific research agencies involved in classical plant and animal breeding activities. ARS has more than 100 research facilities in the United States and abroad and received about $1.3 billion in funding for fiscal year 2006. ARS conducts research to develop and transfer solutions to agricultural problems, and its research partners include universities; crop, horticultural, and livestock producer and industry organizations; state, federal, and other research agencies or institutions; private companies; and international agricultural research centers. CSREES, which received about $1.2 billion in funding for fiscal year 2006, has the primary responsibility for providing linkages between the federal and state components of a broad-based, national agricultural research, extension, and higher education system. CSREES provides funding for projects conducted in partnership with the state agricultural experiment stations, state cooperative extension system, land grant universities, colleges, and other research and education institutions.

As you have noted, classical breeding is important to agricultural producers as they seek to meet changing environmental conditions and shifting consumer demands. You raised concerns about the difficulty of quantifying public resources being dedicated to classical plant and animal breeding and asked us questions about these resources. We found that generally, USDA data show a gradual increase in ARS classical plant breeding funding over the past 10 years, while funding for its classical

animal breeding activities has remained level, with the exception of an upward trend from 2002 to 2004. USDA data also show that funding for CSREES classical plant breeding was higher in 1985 than in 1990, 1995, 2000, and 2005—the other 4 years for which USDA provided data. CSREES classical animal breeding funding data, however, show an upward trend since 1998.

To answer your questions about classical breeding, we reviewed USDA data on funding and scientist-years[1] devoted to classical breeding, genomics, and genetic engineering activities for plants and animals.[2] We included genomics because some genomic techniques can be applied to both classical breeding and genetic engineering, according to USDA officials. In addition, we reviewed USDA extramural classical plant and animal breeding project information and statistics on the percentage of acres of U.S. farmland with genetically engineered corn, soybeans, and cotton.[3] We also reviewed USDA data and spoke with USDA officials and university researchers, as well as with officials from agricultural nonprofit groups who also were farmers, on public access to germplasm and potential barriers to this access.[4] We did not speak to a probability sample of these stakeholders; consequently, our results may not be representative of these groups. We conducted analyses to determine the reliability of USDA funding and scientist-years data and determined they were reliable for our purposes. For more information on our scope and methodology, see enclosure I. We conducted our work from April to September 2007 in accordance with generally accepted government auditing standards.

[1]For the purposes of this report, USDA defines a scientist-year as a full-time, permanent scientist assigned to the program.

[2]Genomics refers to the study of genes and their function. Genetic engineering refers to methods by which biologists splice genes from one species into the DNA of another species in an attempt to transfer chosen genetic traits.

[3]Extramural research refers to research that is funded by federal sources but conducted by nonfederal entities.

[4]For the purposes of this report, USDA defines plant germplasm as the genetic variation of a species and animal germplasm as any unique breed, line, or strain of a species.

Question 1: What USDA resources and personnel are devoted to classical plant and animal breeding activities, and what is USDA's budget for research and development of genetically engineered plant and animal varieties?

In fiscal year 2005, the most recent year for which data are available, ARS and CSREES spent a total of about $145 million and 557 scientist-years on classical plant and animal breeding activities, according to USDA (see table 1).

Table 1: USDA Funding and Scientist-Years Devoted to Classical Plant and Animal Breeding Activities, Fiscal Year 2005

Dollars in thousands

	ARS	CSREES	Total
Plant activities			
Funding	$71,555[a]	$31,688[b]	$103,244
Scientist-years	155[a]	292[b]	447
Animal activities			
Funding	15,111[c]	26,172[c]	$41,284
Scientist-years	33[c]	77[c]	110
Total			
Funding	$86,667	$57,861	$144,527
Scientist-years	188	369	557

Source: USDA.

Note: Dollar figures have been adjusted for inflation to 2007 dollars and have been rounded to the nearest thousand dollars.

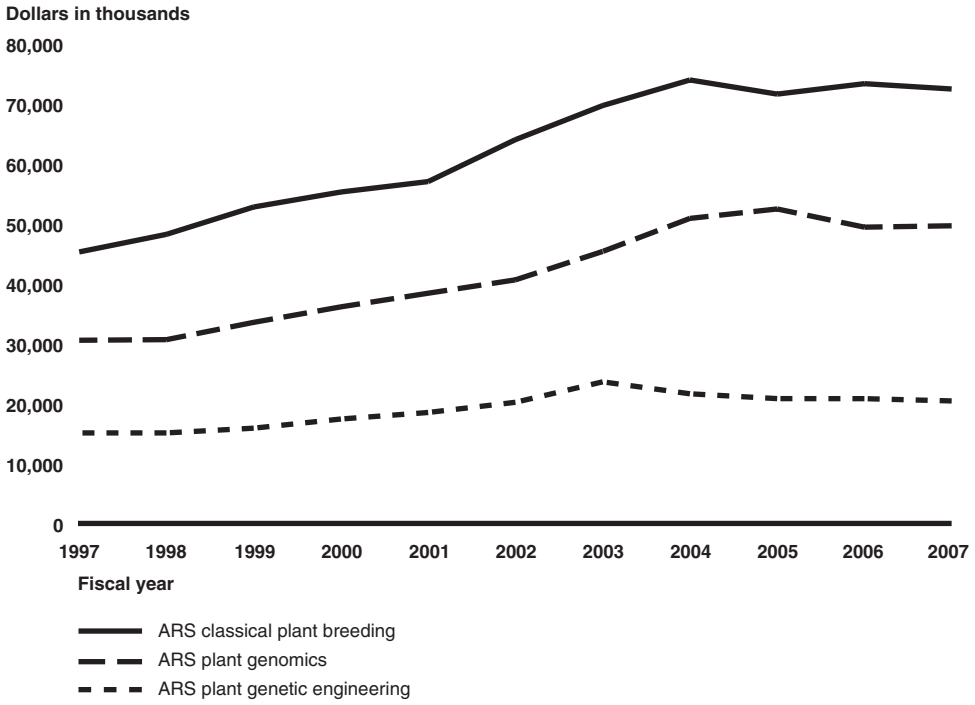
[a]ARS classical plant breeding figures include funding used for germplasm evaluation—evaluation of plant materials for characteristics that can be utilized in plant genetic improvement and breeding heredity—and germplasm enhancement and plant breeding.

[b]CSREES classical plant activities figures include funding for plant breeding activities and molecular-assisted plant breeding. While ARS separated molecular-assisted plant breeding into a genomics category, CSREES was unable to separate out this funding because it codes projects by strategic goal area, knowledge area, and field of science rather than by specific method used. Depending on the project, CSREES figures include either the total amount of the grant awarded or the amount that the recipient reported to CSREES as expended for the fiscal year.

[c]ARS and CSREES classical animal breeding figures encompass all research at the whole-animal level, studying variation within and between lines and breeds of a species in poultry, beef and dairy cattle, sheep, swine, and aquaculture species. Depending on the project, CSREES figures include either the total amount of the grant awarded or the amount that the recipient reported to CSREES as expended for the fiscal year.

Shown below is the first of eight figures with information on USDA resources for classical breeding, genomics, and genetic engineering, broken out by agency (ARS or CSREES), type of resource (funding or scientist-years), and subject of research (plant or animal). ARS plant research funding for classical breeding, genomics, and genetic engineering generally trended upward from fiscal year 1997 to the mid-2000s, when the amount of funding leveled off for all three types of research, as shown in figure 1. In particular, ARS funding devoted to classical plant breeding activities has consistently exceeded that devoted to genomics and genetic engineering over the past decade.

Figure 1: ARS Plant Research Funding in 2007 Dollars, Fiscal Years 1997-2007

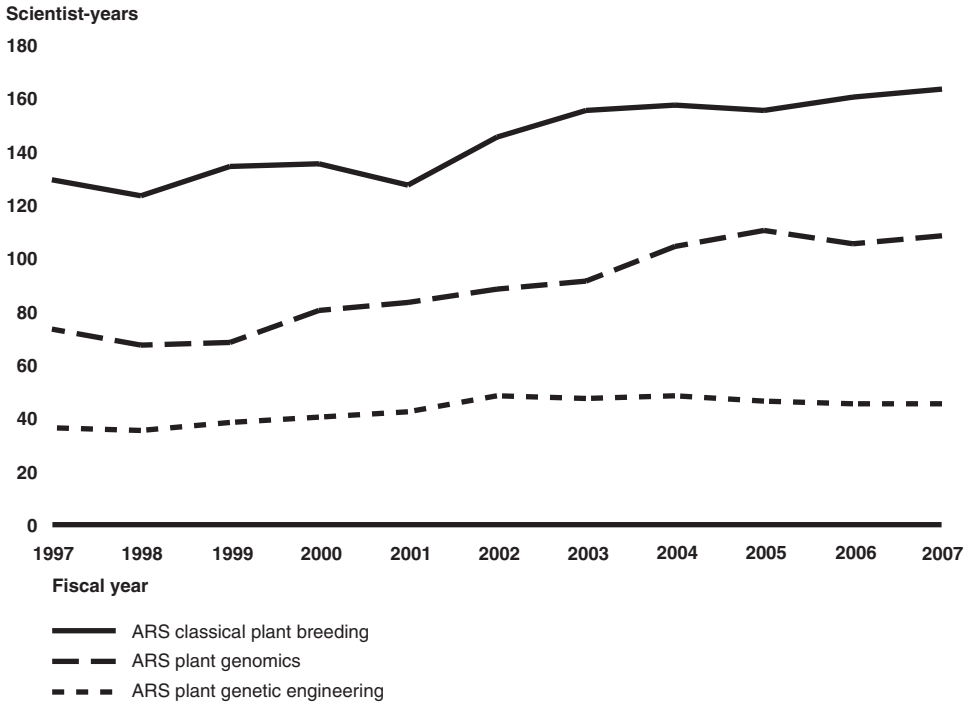


Source: USDA.

Notes: Classical plant breeding figures include funding used for germplasm evaluation, germplasm enhancement, and plant breeding. Plant genomics figures include funding for research in molecular and cellular genetics, gene growth and development, genome mapping, and gene expression. Plant genetic engineering figures include funding for gene transformation and biotechnology risk assessment research.

Figure 2, in general, also shows a gradual upward trend in ARS scientist-years for classical breeding and genomics. The scientist-years for genetic engineering, however, have remained level since 2002.

Figure 2: ARS Scientist-Years Dedicated to Plant Research, Fiscal Years 1997-2007

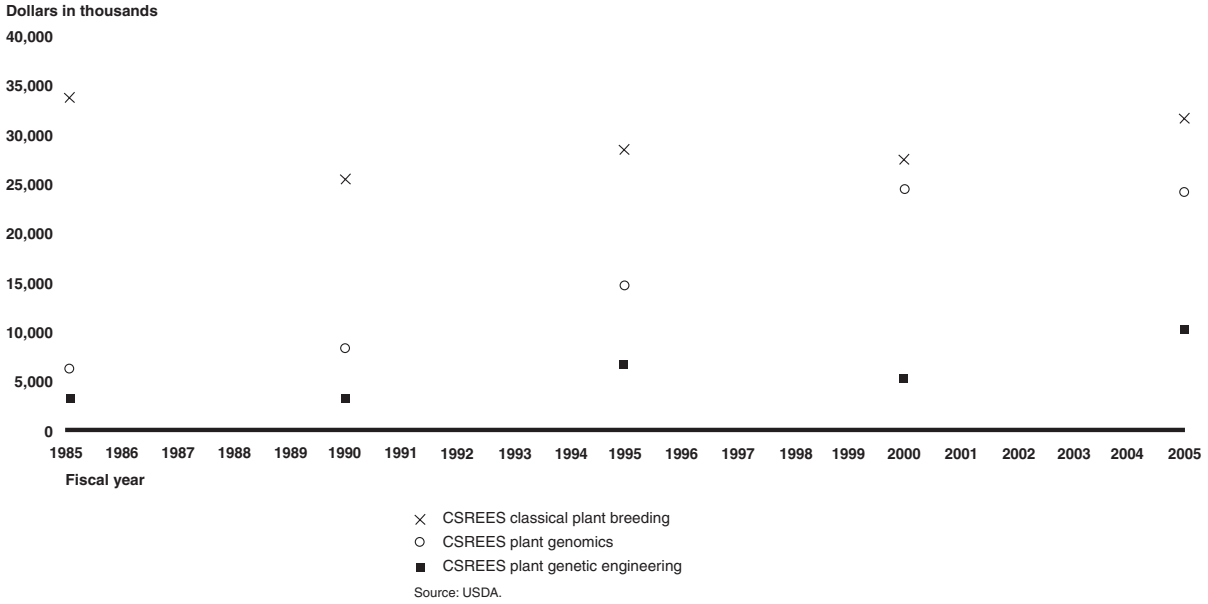


Source: USDA.

Notes: Classical plant breeding figures include germplasm evaluation, germplasm enhancement, and plant breeding. Plant genomics figures include funding for research in molecular and cellular genetics, gene growth and development, genome mapping, and gene expression. Plant genetic engineering figures include gene transformation and biotechnology risk assessment research.

Figure 3 shows CSREES plant research funding at five points in time from fiscal years 1985 to 2005. Because collecting the data was labor intensive and required manual review of thousands of project titles, we agreed with CSREES that data for 5 fiscal years would be sufficient for the purposes of this report. Specifically, the figure shows that funding for (1) classical breeding was higher in fiscal year 1985—almost $35 million—than at the other four points; (2) genomic research was significantly higher in fiscal years 2000 and 2005 than in fiscal years 1985, 1990, and 1995; and (3) genetic engineering research was higher in fiscal year 2005 than in the previous selected fiscal years. CSREES officials commented that the increase for genetic engineering research was, in part, caused by the doubling of biotechnology risk assessment research funds between fiscal years 2000 and 2005.

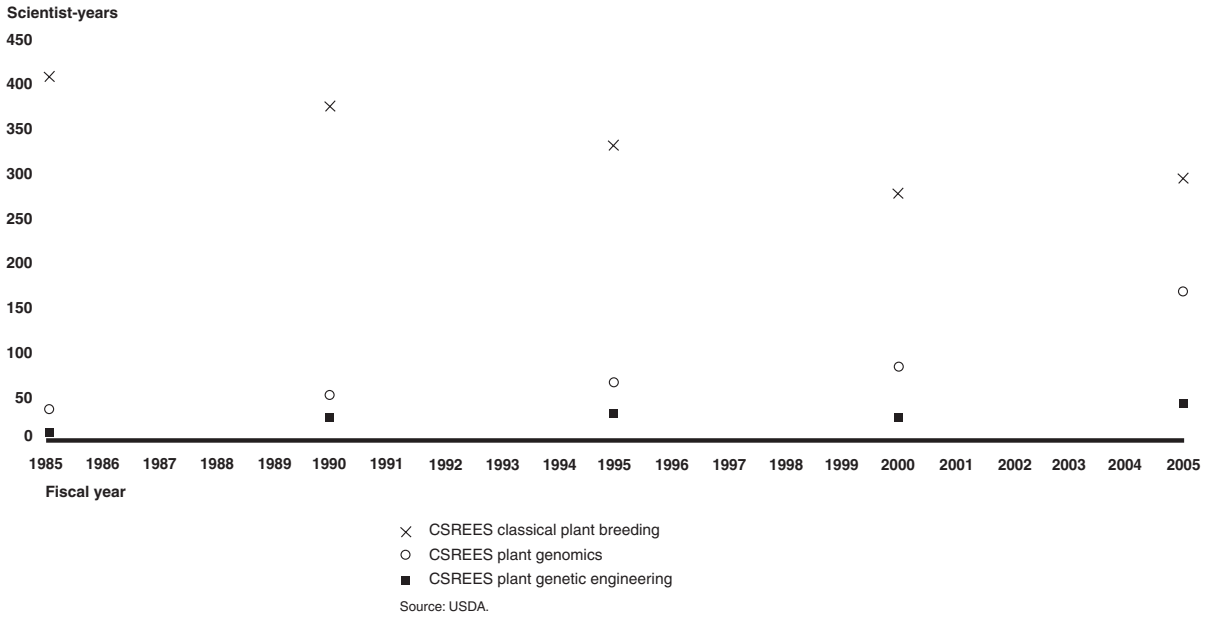
Figure 3: CSREES Plant Research Funding in 2007 Dollars, Fiscal Years 1985, 1990, 1995, 2000, and 2005



Notes: Data collected manually by CSREES. After sorting projects coded by knowledge area and field of science, CSREES staff manually reviewed titles of over 10,000 projects to provide 5 years of funding and scientist-year data. Classical plant breeding activities figures include funding for plant breeding activities and molecular-assisted plant breeding. Plant genomic figures include some of the research coded as plant genomic, genetics, and genetic mechanisms. Plant genetic engineering figures include funding for genetic transformation research. Depending on the project, CSREES's figures include either the total amount of the grant awarded or the amount that the recipient reported to CSREES as expended for the fiscal year.

Figure 4 shows CSREES plant research scientist-years at five points in time from fiscal years 1985 to 2005. The greatest number of scientist-years expended for classical plant breeding research was 411 in fiscal year 1985. However, the greatest number of scientist-years expended for both plant genomics and plant genetic engineering research was 167 and 41, respectively, in fiscal year 2005.

Figure 4: CSREES Scientist-Years Dedicated to Plant Research, Fiscal Years 1985, 1990, 1995, 2000, and 2005

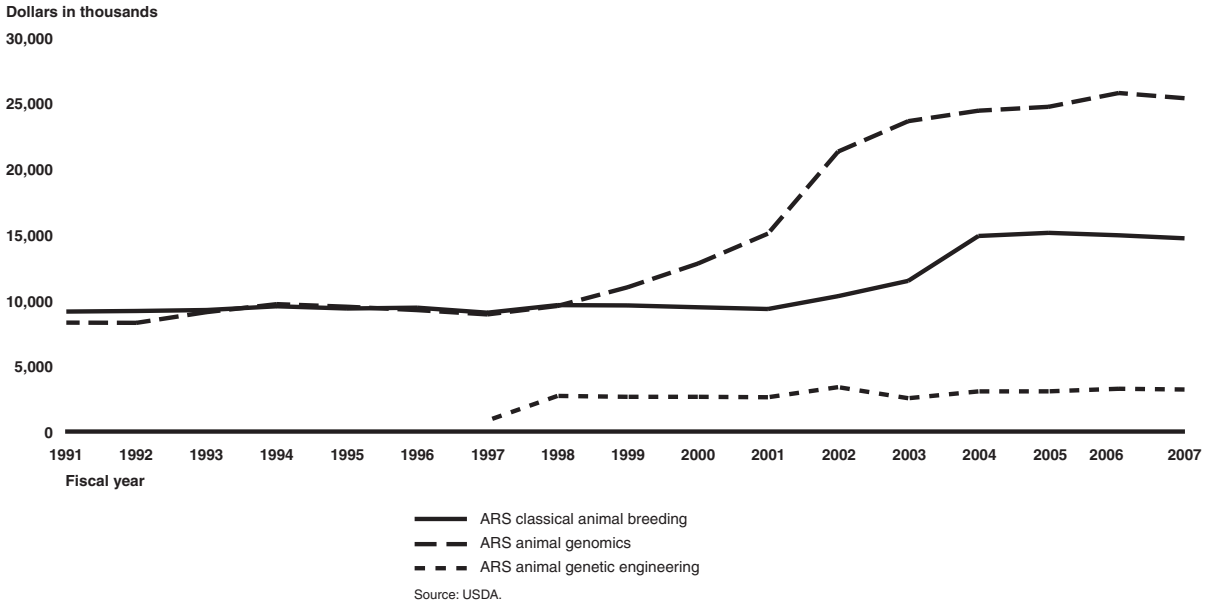


Source: USDA.

Notes: Data collected manually by CSREES. After sorting projects coded by knowledge area and field of science, CSREES staff manually reviewed titles of thousands of projects to provide 5 years of funding and scientist-year data. Classical plant breeding activities figures include funding for plant breeding activities and molecular-assisted selection research. Plant genomic figures include some of the research coded as plant genomic, genetics, and genetic mechanisms. Plant genetic engineering figures include funding for genetic transformation research.

Figure 5 shows similar funding levels for ARS classical animal breeding and animal genomics research from 1991 to 1998. This funding, however, increased more substantially for animal genomics than for classical animal breeding research since 1998. Figure 5 also shows that ARS animal genetic engineering research has remained relatively constant since 1998.

Figure 5: ARS Animal Research Funding in 2007 Dollars, Fiscal Years 1991-2007

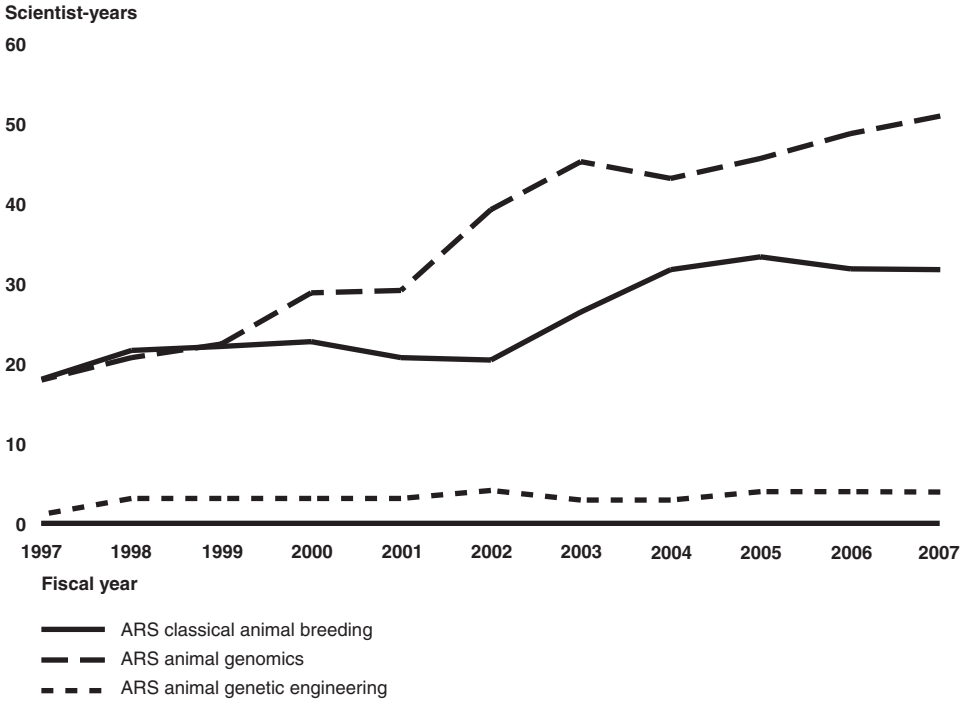


Source: USDA.

Notes: Classical animal breeding figures encompass all research at the whole-animal level, studying variations within and between lines and breeds of a species in poultry, beef and dairy cattle, sheep, swine, and aquaculture species. Animal genomics figures include research at the molecular level of the genome. Animal genetic engineering figures include research that involves transferring genes between animal species.

Figure 6 shows an upward trend in ARS scientist-years dedicated to genomic animal research since 1997 and an upward trend in ARS scientist-years dedicated to classical animal breeding research from 2002 to 2004, when it leveled off. Figure 6 also shows that ARS scientist-years dedicated to animal genetic engineering research have remained relatively constant since 1998.

Figure 6: ARS Scientist-Years Dedicated to Animal Research, Fiscal Years 1997-2007

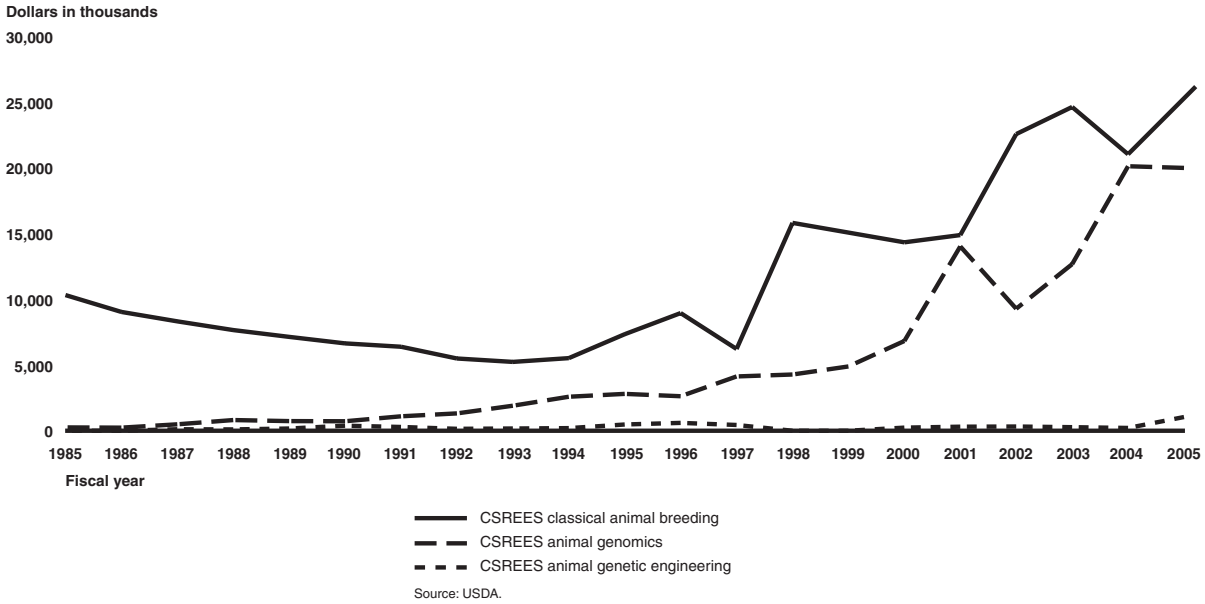


Source: USDA.

Notes: Classical animal breeding figures encompass all research at the whole-animal level, studying variations within and between lines and breeds of a species in poultry, beef and dairy cattle, sheep, swine, and aquaculture species. Animal genomics figures include research at the molecular level of the genome. Animal genetic engineering figures include research that involves transferring genes between animal species.

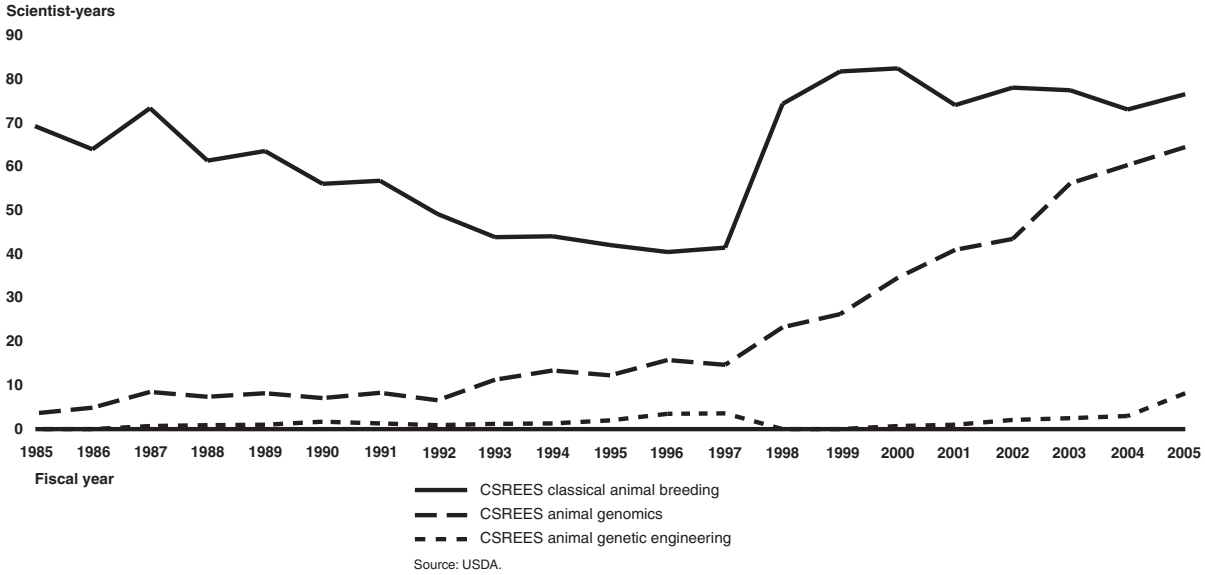
Figures 7 and 8 show an increase in funding and scientist-years in fiscal year 1998 for CSREES classical animal breeding. In addition, for animal genomics, funding and scientist-years also increased around the same time. However, in their explanation of this increase, agency officials commented that prior to 1998, under USDA's budget coding system, funding for classical breeding and genomics was not fully captured. They also stated that a change in the CSREES classification coding system in fiscal year 1998 resulted in more accurate figures. Funding and scientist-years for CSREES animal genetic engineering research have remained relatively flat since 1987, although CSREES did not have animal genetic engineering projects in fiscal years 1985, 1986, 1998, and 1999.

Figure 7: CSREES Animal Research Funding in 2007 Dollars, Fiscal Years 1985-2005



Notes: Classical animal breeding figures encompass all research at the whole-animal level, studying variation within and between lines and breeds of a species in poultry, beef and dairy cattle, sheep, swine, and aquaculture species. Animal genomics figures include research at the molecular level of the genome. Animal genetic engineering figures include research that involves transferring genes between animal species. Classical animal breeding and animal genomics data are from budget codes for fiscal years 1998-2005 and from a combination of USDA codes and manual reviews for fiscal years 1985-1997. All genetic engineering data are from a combination of USDA codes and manual reviews. Depending on the project, CSREES's figures include either the total amount of the grant awarded or the amount that the recipient reported to CSREES as expended for the fiscal year.

Figure 8: CSREES Scientist-Years Dedicated to Animal Research, Fiscal Years 1985-2005



Notes: Classical animal breeding figures encompass all research at the whole-animal level, studying variation within and between lines and breeds of a species in poultry, beef and dairy cattle, sheep, swine, and aquaculture species. Animal genomics figures include research at the molecular level of the genome. Animal genetic engineering figures include research that involves transferring genes between animal species. Classical breeding and genomics data are from budget codes for fiscal years 1998-2005 and from a combination of USDA codes and manual reviews for fiscal years 1985-1997. All genetic engineering data are from a combination of USDA codes and manual reviews.

Question 2: What is the total level of funding dedicated to USDA-funded extramural classical plant and animal breeding initiatives and research projects, and what are the specific initiatives and research projects?

According to CSREES officials, in fiscal year 2005, the most recent year for which data are available, CSREES provided $31.7 million to fund classical plant breeding research projects and $26.2 million to fund classical animal breeding research projects.[5] (See encl. II for a list of USDA-funded extramural classical plant and animal breeding projects.) According to USDA officials, CSREES funds all USDA-funded extramural classical plant and animal breeding initiatives and research projects.

Question 3: What percentage of the overall USDA research budget goes to develop and release new, publicly held plant and animal varieties? What is the budget trend?

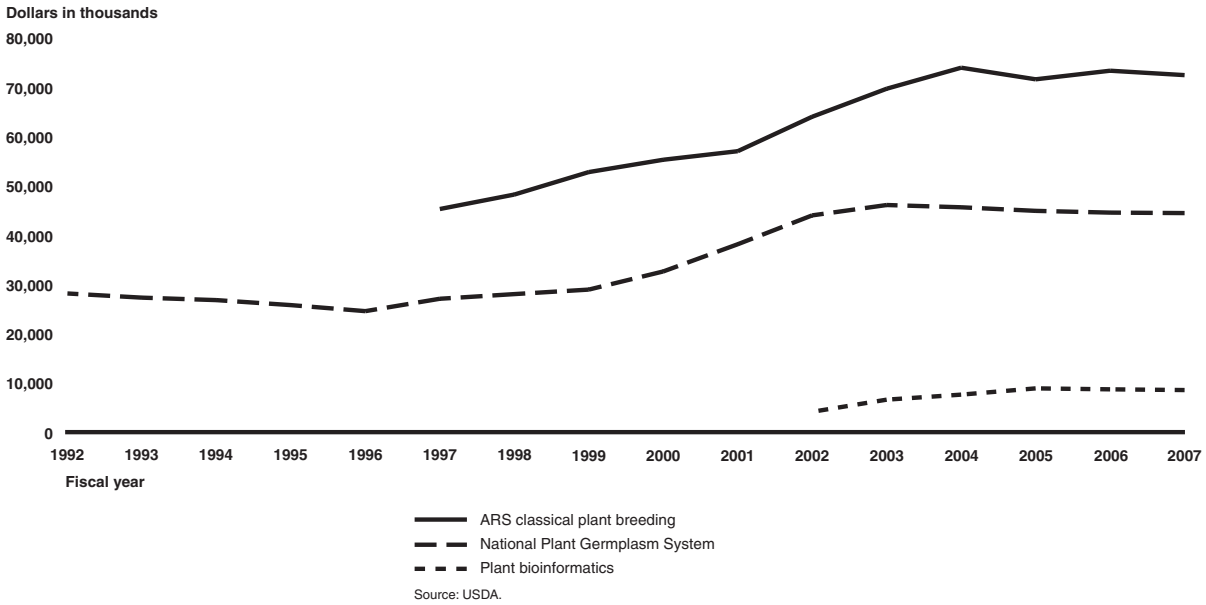
We were unable to determine the percentage of USDA's overall research budget devoted to these activities because CSREES does not track new, publicly held plant and animal varieties developed with its funding. CSREES explained that while it does track the percentage of its research budget devoted to projects that develop and release new plant varieties, it does not track whether these varieties become publicly or privately held. According to CSREES, one reason for this is that the variety

[5]Dollar figures have been adjusted for inflation to 2007 dollars.

development process is longer than the federal grant authorization cycle. Although we could not determine the percentage of the overall USDA research budget that goes to develop and release new, publicly held plant and animal varieties, according to ARS data, 10.7 percent of ARS's fiscal year 2007 $1.2 billion budget is to be directed toward these activities.

ARS officials said that in addition to its funding of classical plant breeding research, ARS contributes to the infrastructure for classical plant breeding in the United States by managing and making available to the public most of the seed stocks held by the U.S. government through the National Plant Germplasm System (NPGS)—primarily a federally and state-supported effort aimed at maintaining supplies of plant germplasm with diverse genetic traits for use in breeding and scientific research. Funding for NPGS, shown in figure 9, increased from $24.5 million in fiscal year 1996 to $46.1 million in fiscal year 2003.[6] ARS also supports crop genome databases that enable researchers to access and leverage emerging information for breeding and development of gene markers. ARS officials call these databases plant bioinformatics. Funding information for plant bioinformatics goes back only to fiscal year 2002.

Figure 9: ARS Funding for Classical Plant Breeding, National Plant Germplasm System, and Plant Bioinformatics in 2007 Dollars, Fiscal Years 1992-2007

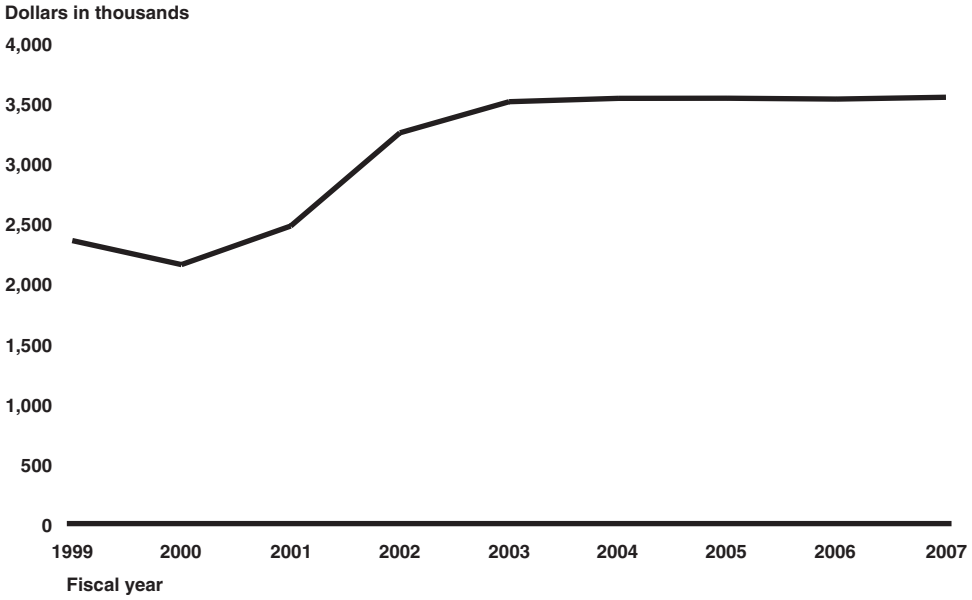


Source: USDA.

[6]CSREES noted that it also contributes to the infrastructure for classical plant breeding in the United States through funding for plant breeding research at state agricultural experiment stations and land-grant universities, including funding for collaborative work with NPGS.

ARS generally is not involved with the development of publicly held animal varieties. However, in recent years, it has conducted some classical animal breeding research to create genetically improved lines of fish germplasm in aquaculture, specifically for catfish. The funding trend for this research, which has been mostly flat since 2003, is shown in figure 10.

Figure 10: ARS Funding for Fish Germplasm Research in the Aquaculture Area in 2007 Dollars, Fiscal Years 1999-2007



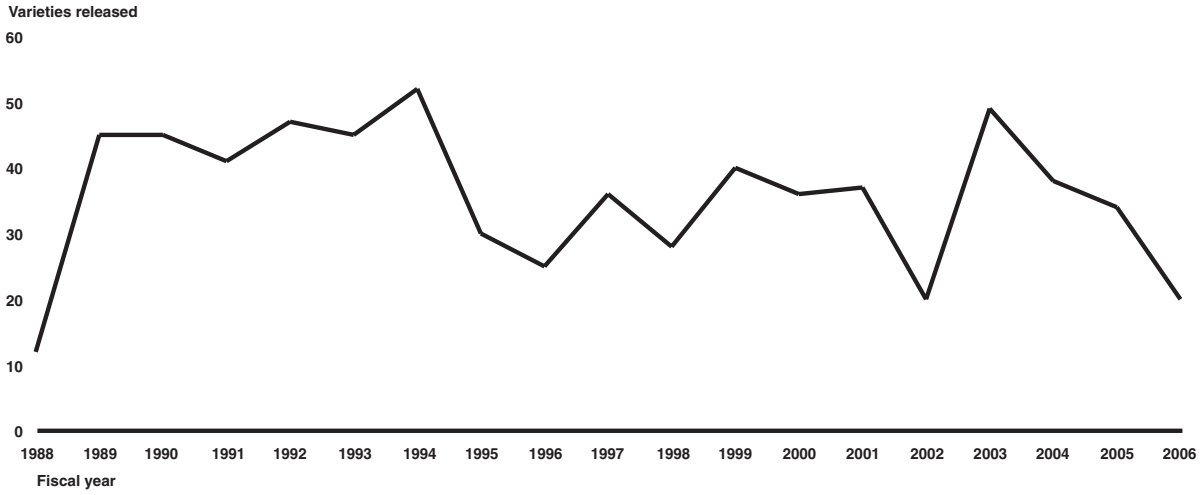
Source: USDA.

Question 4: How many USDA-funded plant and animal breeders (scientist-years) using classical methods are there, and how many new varieties have they released in the last 2 years?

ARS and CSREES expended a total of 557 scientist-years for classical plant and animal breeding research in fiscal year 2005, the last year for which data for both ARS and CSREES are available, as shown in table 1.

CSREES officials told us that CSREES does not track the number of new varieties its grant recipients have released. ARS does, however, track the number of new varieties released. As figure 11 shows, ARS released 12 to 52 new plant varieties a year between fiscal years 1988 and 2006. In the last 2 years (fiscal years 2005 and 2006), ARS released a total of 54 new plant varieties. In addition, ARS commented that since fiscal year 1998, it has released 37 to 311 plant germplasm lines per year, which allowed other U.S. classical plant breeders to incorporate improved traits into their locally adapted varieties. ARS also released two new animal varieties, both catfish, through its aquaculture research in the past 2 years. Eight scientist-years were involved in this aquaculture research.

Figure 11: Number of Plant Varieties ARS Has Released, Fiscal Years 1988-2006

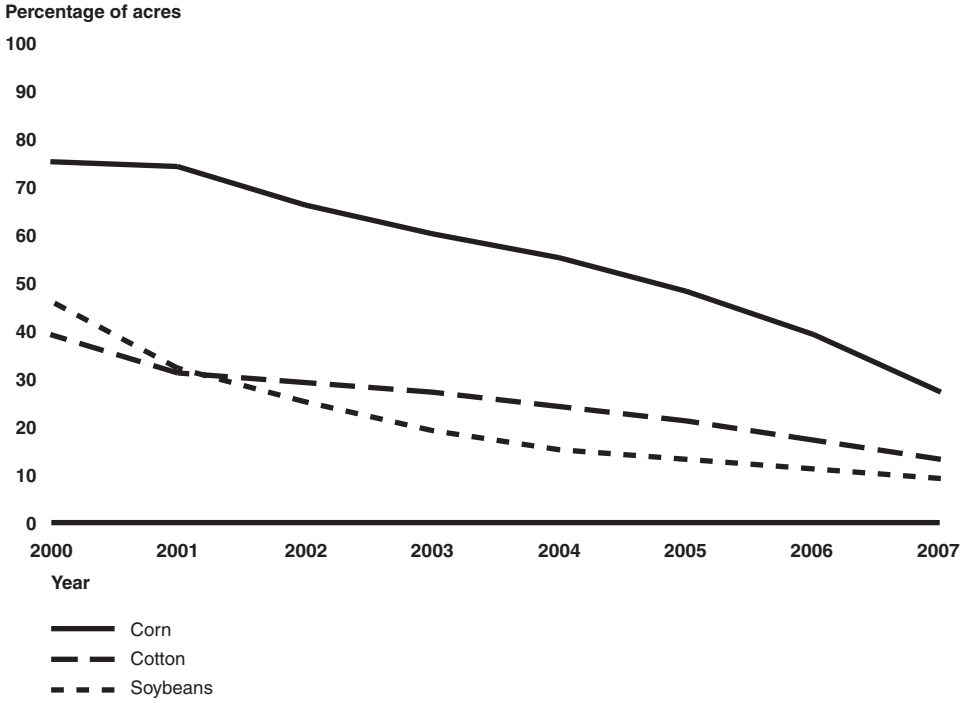


Source: USDA.

Question 5: How many different varieties of nongenetically engineered or nonpatented corn, canola, soy, and cotton have been released and grown in the United States?

We were unable to determine the number of different varieties because USDA does not collect this information. While the amount of nongenetically engineered crops grown may not reflect on the number of different varieties of nongenetically engineered crops grown, USDA does maintain information on the percentage of acres of nongenetically engineered corn, cotton, and soybeans grown in the United States since 2000. USDA's National Agricultural Statistics Service conducts an annual national survey of 125,000 U.S. farmers on crops planted, including the number of acres planted with genetically engineered and nongenetically engineered corn, cotton, and soybeans. Figure 12 shows the downward trend in nongenetically engineered crops since 2000.

Figure 12: Percentage of Acres on Which Nongenetically Engineered Corn, Cotton, and Soybeans Were Grown in the United States, Years 2000-2007



Source: USDA.

Note: According to the National Agricultural Statistics Service, data from farmers surveyed in 48 states represent 81 percent to 86 percent of all corn-planted acres, 89 percent to 90 percent of all soybean-planted acres, and 81 percent to 92 percent of all upland cotton-planted acres.

Question 6: To what extent are breeding lines being imported from other countries?

USDA does not collect information on breeding lines—genetic lines that provide the basis for modern varieties—imported from other countries.

Question 7: How much public access is there to plant and animal germplasm? What barriers, if any, limit public access to germplasm?

Although classical plant breeding researchers and USDA officials told us that the public generally has access to plant germplasm through ARS's NPGS, the researchers also said that most of NPGS's germplasm is not considered "elite" germplasm—germplasm that is ready for a farmer to use. The available NPGS germplasm can require years of classical breeding research before it is ready for farmers to use, according to the researchers with whom we spoke.

One USDA official told us that ARS plant varieties and improved germplasm lines are publicly released and can be obtained from ARS researchers. According to ARS, in 2006, NPGS received 6,662 requests for one or more genetic material samples (accessions) and responded by distributing 159,266 of these samples. When the supply of a requested seed becomes limited, according to a USDA official, NPGS either provides a small amount or delays filling the request until sufficient seeds are regenerated.

Regarding barriers to accessing plant germplasm, plant breeding researchers with whom we spoke said that intellectual property laws can limit access to elite germplasm. For example, the University and Small Business Patent Procedures Act, also known as the Bayh-Dole Act, allowed nonprofit organizations, such as universities, to retain title to and market the inventions they created using federal research funds.[7] As a result, universities now restrict their sharing of germplasm, according to these plant breeding researchers.

According to USDA officials, the public does not have access to animal germplasm because the purpose of the USDA's animal germplasm collection is conservation of the animal species for replacement of a breed, line, or strain if it is lost, or for research purposes of unique germplasm that would help characterize the breeds. Access to germplasm is determined on a case-by-case basis by species committees that consist of university and federal scientists and industry representatives. Some of the animal germplasm samples were donated by private industry under terms that prevent access to the samples for a limited amount of time.

[7]Pub. L. No. 96-517, § 6, 94 Stat. 3019 (1980).

Agency Comments

We provided a draft of this report to USDA for review and comment, and USDA provided us with oral comments. USDA generally agreed with the contents of the draft report. The department provided us with technical comments, which we incorporated into the report as appropriate.

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As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the date of this report. At that time, we will send copies to the Secretary of Agriculture, interested congressional committees, and other interested parties. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staffs have any questions about this report, please contact me at (202) 512-3841 or shamesl@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report were José Alfredo Gómez, Assistant Director; Allen Chan; Nancy Crothers; Kevin Bray; and Greg Wilmoth.

Lisa Shames
Director, Natural Resources
and Environment

Enclosures

Enclosure I: Scope and Methodology

To determine what U.S. Department of Agriculture (USDA) resources and scientist-years are devoted to classical breeding, genomics, and genetic engineering activities for plants and animals, we asked USDA to provide us with funding and scientist-years data since 1985. The Agricultural Research Service (ARS) gave us these data from its budget codes. We reported ARS animal research funding data from fiscal years 1991 to 2007 because ARS did not have animal research funding data for the years before fiscal year 1991 that it felt were sufficiently accurate to report. We reported ARS plant research funding data from fiscal years 1997 to 2007 because ARS did not have a separate budget code for genomics before fiscal year 1997. Data for classical breeding and genomic research before fiscal year 1997 were combined into one budget code.

The Cooperative State Research, Education, and Extension Service (CSREES) provided plant research data from its current research information system. Using this database, CSREES sorted projects coded by knowledge area and field of science. CSREES staff then manually reviewed titles of over 10,000 projects to provide 5 years (fiscal years 1985, 1990, 1995, 2000, and 2005) of funding and scientist-year data. CSREES animal research data for classical breeding and genomics for fiscal years 1985 to 1997 are from a combination of USDA codes and manual CSREES reviews. Similar data for fiscal years 1998 to 2005 are from budget codes. CSREES animal research data for genetic engineering are from a combination of USDA codes and manual CSREES reviews.

To determine the total overall level of funding dedicated to USDA-funded extramural classical plant and animal breeding initiatives and research projects and the specific names of the initiatives and research projects, we obtained project funding information and a list of project names from CSREES. (See encl. II.) We did not review individual USDA projects to ensure the accuracy of the list. To determine the amount of USDA funding that goes to develop and release new, publicly held plant and animal varieties, we obtained funding figures for ARS's National Plant Germplasm System, plant bioinformatics program, and fish germplasm research in the aquaculture area.

We obtained the number of scientist-years involved in developing and releasing new plant and animal varieties and the number of new varieties released from ARS. CSREES does not track this information.

To determine the reliability of ARS and CSREES funding and scientist-years data and of ARS data on the number of new varieties it has released, we examined existing information about the data and systems that produced them, questioned knowledgeable agency officials about the data, and discussed the manual coding process with CSREES. While we determined that these data were reliable for our purposes, we did not review whether USDA had accurately categorized the funding and scientist-years data.

We were unable to determine how many different varieties of nongenetically engineered or nonpatented corn, canola, soy, and cotton have been released and

grown in the United States because USDA did not have this information. However, USDA provided us with survey statistics on the percentage of acres of U.S. farmland with genetically engineered corn, soybeans, and cotton. USDA did not have this information for canola or information on the percentage of nonpatented crops grown in the United States. The survey statistics were taken from USDA's annual June Agricultural Survey, which surveyed more than 125,000 farmers about their crops. We were unable to answer the extent to which breeding lines were imported into the United States because USDA did not have this information.

To determine how much public access there is to germplasm and what barriers, if any, limit public access, we spoke with USDA officials, university breeding researchers, and officials from agricultural nonprofit groups who were also farmers. We did not speak to a probability sample of these stakeholders; consequently, our results may not be representative of these groups.

We conducted our work from April to September 2007 in accordance with generally accepted government auditing standards.

Enclosure II: CSREES Classical Plant and Animal Breeding Projects

CSREES provided the following list of extramural classical plant breeding projects for fiscal year 2005. Projects with funding to multiple states may be repeated on this list.

1. Development and Management of Canola in the Great Plains Region
2. Evaluation of Native and Exotic Herbs and Vegetables for Their Production Potentials, Stress Physiology, and Nutritional Qualities
3. Development of Winter Type Canola Lines for the Mid-South United States
4. Development of New Commercial Fruit Crops for Kentucky and the Southeastern United States
5. Improving Sweet Potato Production in Alabama through Breeding, Selection, and Biotechnology Techniques
6. Characterizing Soybean and Corn Genotypes for Phosphorus Hyperaccumulation
7. Development of White Lupin as an Alternative Crop in Virginia
8. Improving Sicklepod for Industrial and Medicinal Uses by Means of Conventional and Molecular Breeding Approaches
9. Improving Sweet Potato Production in Limited Resource Farming Systems through Cultivar Development and Integrated Pest Management
10. Breeding Aroids for Quality, Productivity, and Disease/Pest Resistance with Emphasis on Anthurium
11. Conservation, Management, Enhancement, and Utilization of Plant Genetic Resources
12. Breeding, Evaluation, and Selection of Hardy Landscape Plants
13. Wheat and Oat Genetics and Breeding
14. Oat Breeding and Genetics
15. Barley Breeding and Genetics
16. Plant Genetic Resource Conservation and Utilization
17. Conservation and Utilization of Plant Genetic Resources
18. Improvement of Winter Wheat through Breeding
19. Genetics, Breeding, and Physiology of Yield in Cucurbits
20. Breeding and Testing Improved Varieties of Spring Barley, Wheat, and Oats
21. Plant Genetic Resource Conservation and Utilization—Colorado State University
22. Genetics, Breeding, and Evaluation of Winter Small Grains Crops for Nebraska
23. Breeding and Testing Oats, Barley, and Canola for Michigan
24. Plant Genetic Resource Conservation and Utilization—Texas A&M University
25. Plant Genetic Resource Conservation and Utilization—Oregon State University
26. Genetics and Breeding of Alfalfa for New Uses and Forage Quality
27. Genetic Manipulation of Sweet Corn Quality and Stress Resistance
28. Tree Fruit and Grape Investigations
29. Breeding and Genetics of Hazelnut
30. Development of Germplasm and Breeding Methods for the Improvement of Tomato
31. Breeding and Genetics of Floricultural Crops: Germplasm Enhancement, Risk Assessment of Invasiveness Potential
32. Conservation, Management, Enhancement, and Utilization of Plant Genetic Resources
33. Development of New Potato Cultivars for Colorado via Germplasm Enhancement and Evaluation
34. Wild Perennial Glycine Information Management and Untilization
35. Conservation and Utilization of Plant Genetic Resources
36. Development of Cotton Germplasm/Cultivars with Resistance to Biotic and Abiotic Stresses
37. Evaluation and Genetic Improvement of Forage Legumes
38. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Pest Resistance, and Food Value
39. Genetic Manipulation of Sweet Corn Quality and Stress Resistance
40. Rootstock and Interstem Effects of Pome and Stone Fruit Trees
41. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Pest Resistance, and Food Value—Oregon State University
42. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Pest Resistance, and Food Value—Cornell University
43. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Pest Resistance, and Food Value—Colorado State University
44. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Pest Resistance, and Food Value—University of California
45. Improvement of Forage Quality in Alfalfa by Breeding
46. Genetic and Breeding of Cool Season Vegetable Crops

47. Improvement of Cotton Cultivars Adapted to Stripper Harvesting and Short Growing Season
48. Vaccinium Breeding and Genetics
49. Development of Improved Vegetable Legume Varieties for the Southwest
50. Quantitative Genetics and Cultivar Development
51. The Impact of Hybridization on Plant Population Genetics and Ecology
52. Alfalfa Breeding
53. Genetic Conversion of Exotic Sorghums for Temperate Zone Use
54. Development of Improved Potato Varieties for Texas and the Southwest
55. Development of Disease-Resistant Wheat Germplasm and Studies of Selected Wheat Diseases
56. Breeding Superior Raspberry Cultivars for the Pacific Northwest
57. Prunus Genetics, Germplasm, and Cultivar Development for Mild Winter Zones
58. Fresh-Market Tomato Breeding and Genetics
59. Use of Genetic Resistance to Control Leaf Blight and Ear Rot Diseases of Corn
60. Barley Breeding and Genetics
61. Utilization of Species of Arachis to Improve Cultivated Peanuts
62. Breeding and Genetics of Barley
63. Breeding Superior Strawberry Cultivars for the Pacific Northwest
64. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Disease Resistance, and Food Value
65. Sorghum Breeding and Genetics
66. Insect Resistance and Stress Adaptation through Genetic Manipulation of Sorghum
67. Cucumber, Luffa, and Watermelon Breeding and Genetics
68. Enhancement of Arachis Germplasm to Improve Peanut (A. Hypogaea L.) Cultivars
69. Stone Fruit Breeding for New York Tree Fruit Industry Diversification
70. Genetics and Varietal Improvement of Strawberries
71. Genetics, Breeding, and Evaluation of Citrus Fruits
72. Disease Resistance in Peanut to Sclerotinia Blight
73. Rootstock and Interstem Effects on Pome and Stone Fruit Trees
74. Spring Wheat Breeding and Genetics
75. Improvement and Testing of Winter Small Grains
76. Breeding and Genetics of Peach
77. Abiotic Stress Tolerance in Plants
78. Small Grains Breeding Investigations
79. Rootstock and Interstem Effects on Pome and Stone Fruit Trees
80. Develop Management Practices for Recently Introduced Rice Diseases in California
81. Improvement of Quality and Performance of Colorado Wheat
82. Novel Methods for Soybean Genetic Improvement and Genomic Analysis
83. Vegetable Breeding Material Evaluation and Alternative Crop Development
84. Molecular Population Genetics of Natural Populations
85. Genetic Improvement of Bean (Phaseolus Vulgaris L.) for Yield, Pest Resistance, and Food Value
86. Peanut Breeding and Genetics
87. Development of Multiple-Use Barley Varieties
88. Winter Wheat Breeding Program
89. Breeding Annual Ryegrass for Forage and for Turf
90. Identification, Propagation, and Development of Ornamentals and Floriculture Plants for Texas
91. Utilization of Forest Genetic Resources to Enhance Productivity of Forested Lands
92. Forage and Turf Grass Breeding and Genetics
93. How Populations Cope with Heterogeneous Environments: Plasticity, Adaptation, and Population Coexistence
94. Winter Wheat Breeding and Genetics
95. Genetic Improvement of Apple
96. Breeding Cotton Varieties for North Carolina
97. Vegetable Improvement for Appearance, Flavor, Texture, Nutrition, and Health Benefits
98. Improvement of Plant Defenses Against Botrytis Cinerea
99. Vegetable Breeding and Genetics
100. Genetic Improvement of Peach and Almond

101. Genetic Manipulation of Sweet Corn and Quality and Stress Resistance
102. Genetic Diversity and the Propagation of Native Hawaiian Plants for the Ornamentals Industry
103. Testing and Evaluation of Berry Crops for Commercial Production in the Pacific Northwest
104. Genetic Improvement of Walnut
105. Multidisciplinary Evaluation of New Apple Cultivars
106. Evaluation of Soybean Cultivars and Advanced New Strains and Corn and Grain Sorghum Hybrids in Arkansas
107. Nursery and Greenhouse Production of Ornamentals with Emphasis on Roses and Bedding Plants
108. Ecology And Management of European Corn Borer and Other Stalk-Boring Lepidoptera
109. Use of Wild Lycopersicon Species in Breeding for Improvement of Cultivated Tomato
110. Soybean Breeding and Genetic Studies
111. Breeding and Genetics of the Small Grains Cereals
112. Breeding, Genetic, and Agronomic Studies of Barley in California
113. Breeding and Genetics for the Improvement of Potato (Solanum Tuberosum L.) for Yield, Quality, and Pest Resistance
114. Genetic Improvement of Strawberries and Blueberries
115. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Disease Resistance, and Food Value
116. Genetic Manipulation of Sweet Corn Quality and Stress Resistance
117. Breeding and Genetics of Winter Wheat
118. Wheat Breeding and Genetics
119. Genetic Improvement of Sorghum Bicolor (L) Moench for Improved Productivity, Adaptability, and Quality
120. Development of New Potato Clones for Environmental and Economical Sustainability
121. Introduction and Evaluation of Ornamental Plants
122. Wheat Breeding and Molecular Genetics
123. Conservation and Utilization of Germplasm at the C.M. Rick Tomato Genetics Resource Center
124. Mitigation of Diseases of Dry Edible Bean and Stem Rot of Soybean by Managed Plant Resistance
125. Developing New Apple Cultivars for Washington State
126. Turfgrass Breeding, Genetics, and Cultivar Development
127. Breeding and Development of Buffalograss for the Central Great Plains
128. Breeding and Genetics of Corn
129. Breeding Tree Fruits Adapted to the Soils and Climate of Arkansas
130. Breeding and Genetics of Small Fruits and Grapes in Arkansas
131. Evaluation, Development, and Management of Native and Adapted Grass Species for Turfgrass Applications in the Intermountain West
132. Breeding Multiple Stress Tolerant Corn for Texas Conditions
133. Potato Breeding and Genetics
134. Evaluation and Identification of Potential Turfgrass Species for Lower Latitude Turf
135. Feed Barley for Rangeland Cattle
136. Hawaii Floriculture Research Grant—2005
137. Grass Seed Cropping Systems for a Sustainable Agriculture: ID, OR, and WA
138. Development of Phytophthora Root Rot-Resistant Avocado Rootstocks for the Caribbean
139. Russian Wheat Aphid Resistance, Stress Tolerance, and Quality Enhancement of Wheat
140. Life and Death in Plants: Studies on Perennial Wheat as a Sustainable Alternative Cropping System
141. Selecting and Breeding Sweet Potato Genotypes Under Minimum Cultural Conditions
142. Developing Alternative Vegetable Soybean Crops to Farmers
143. Breeding Vegetables for Pest and Stress Tolerance
144. Breeding and Genetics of Herbaceous and Woody Landscape Plants
145. Enhancing Impatiens Resistance to Feeding by Western Flower Thrips
146. Intermediate Stage Evaluation of Apple Rootstocks for the Eastern U.S.
147. Forage Germplasm Evaluation in Louisiana
148. Selection, Development, and Propagation of Native Herbaceous Landscape Plants
149. Breeding, Genetics, and Productivity of Small Grains
150. Small Grain Genetic Improvement, Variety Testing, and Cultural Practices
151. Turfgrass Breeding and Evaluation
152. Strawberry Cultivar Development
153. Genetic Improvement of Wheat
154. Improvement of Hard Winter Wheats and Other Small Cereal Grains for Kansas

155. Increased Genetic Diversity for the Winter Wheat Breeding Program in Oklahoma
156. Selection and Evaluation of Superior Woody Ornamental Plants Suitable for Arkansas Landscapes
157. Soybean Breeding and Genetics
158. Breeding and Evaluation of Improved Soybean Cultivars and Germplasm
159. Breeding and Genetics of Temperate Forage Grasses and Legumes
160. Genetic Diversity in Cotton through Germplasm Enhancement and Molecular Genetics
161. Breeding Tropical Vegetable Crops
162. Analysis of Disease Resistance in Rice
163. Improving Spring Wheat Varieties for the Pacific Northwest
164. Breeding and Genetics of Cabbage, Broccoli, Cauliflowers, and Common Beans
165. Development of Adapted Potato Varieties for the Mid-Atlantic and Southeastern United States
166. Sweet Potato Breeding and Genetic Enhancement
167. Screening Genotypes for Traits Associated with Tolerance to Abiotic Stress for Crops Grown in the Southern Plains
168. Genetic Variability, Selection, and Inbreeding in Flower Crops
169. Improvement of Fruit Size and Yield of Mandarins in California and Genetic Analyses of Date Palms and Ornamental Foliage Plants
170. Variety Evaluation of Corn, Corn Silage, Cotton, Small Grain, and Soybean
171. Multidisciplinary Evaluation of New Apple Cultivars
172. Soybean Genetic Improvement and Cultivar Evaluation in Louisiana
173. Vegetable Crop Studies
174. Multidisciplinary Evaluation of New Apple Cultivars
175. Improving Landscape and Horticultural Production Systems
176. Quantitative Genetics with Focus on Corn Breeding and Corn Germplasm Improvement
177. Improvement of Strawberry and Raspberry Cultivars
178. Development of Disease Management Strategies for Soybean Pathogens in Ohio
179. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Disease Resistance, and Food Value
180. Development of Snap Bean Varieties and Genetic Investigations in Common Bean
181. Breeding Sorghum for Improved Yield Potential and Stress Tolerance
182. Genetic Manipulation of Sweet Corn Quality and Stress Resistance
183. Sugercane Improvement for Arid, Alkaline Environments
184. Molecular Mapping and Marker-Assisted Selection and Breeding for Disease Resistance and Improved Fruit Quality in Tomato
185. Development of High-yielding, Multiple Pest-Resistant Soybean Breeding Cultivars with Improved Nutritional Value for Missouri
186. Breeding and Evaluation for Improved Rice Varieties
187. Breeding and Testing of Winter Grain Crops
188. Genetic Improvement of Floricultural Crops
189. Enhancing Soybean Production-Efficiency and Stability through Breeding and Genetics
190. Genetic Improvement of Melons, Peppers, and Tomatoes to Enhance Production and Quality in Texas
191. Production Strategies for Improved Vegetable Production and Alternative Crops for Diversification
192. Evaluation of Hard Red Spring and Hard White Spring Wheat Quality in Relation to End-Use Functionality
193. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Pest Resistance, and Food Value
194. Genetic Improvement of Beans (Phaseolus Vulgaris L.) for Yield, Pest Resistance, and Food Value
195. Genetic and Turfgrass Breeding
196. Wheat Breeding and Small Grain Management for the High Rainfall Area of East Texas
197. Evaluation of Selected Fruit Species for Adaptation to Southern Louisiana
198. Breeding for Disease Resistance and Processing Qualities of Potato: Determination of Genetic Variability of Pathogens and Disease Management
199. Genetic Improvement of Underutilized Perennial Crop Plants
200. Cereal Breeding
201. Developing Land Races Adapted to Ohio Landscapes
202. Regional Moderate-Chilling Peach and Nectarine Breeding and Evaluation Project
203. Winter Wheat Breeding and Genetics
204. Selection and Adaptation of Grass and Legume Species for Forage Production in the Southern Coastal Plain and Penisular Florida
205. Selection and Adaptation of Grass and Legume Species for Forage Production in the Southern Coastal Plain and Penisular Florida

206. Development of Genetic Resources for Cotton
207. Genetic Manipulation of Sweet Corn Quality and Stress Resistance
208. Improving Wheat Quality in the State of Washington
209. Development of Genetic Resources for Cotton
210. Strawberry Breeding and Genetics
211. Development of Genetic Resources for Cotton
212. Development of Blueberry Cultivars Adapted to the Deep South
213. Development of Genetic Resources for Cotton
214. Potato Variety Improvement, Evaluation, Management, and Seed Increases in Idaho
215. Genetic Studies and Germplasm Enhancement in Cool-Season Legumes
216. Maize Breeding and Germplasm Base-Broadening
217. Development of Improved Wheat Cultivars for Idaho
218. Molecular Genetic Accelerated Development of Red-Skinned, Golden Nematode-Resistant Potato Varieties
219. Studies of Host-Parasite Interactions between Small Grains and Their Fungal Pathogens
220. Development of Cornus Florida Cultivars Resistant to Dogwood Anthracnose and Powdery Mildew
221. Integrated Tree Fruit Physiology, Genetics, and Management
222. Breeding Cotton Germplasm with Higher Lint Yield, Improved Fiber Quality, and Resistance to Biotic and Abiotic Stresses
223. Breeding Southern Peas
224. Breeding, Disease Epidemiology, Pathogen Characterization, and Genetic and Molecular Determination of Disease Resistance in Spinach
225. Breeding Improved Wheat Cultivars and Germplasm for Ohio
226. Exotic Germplasm Conversion and Breeding Common Bean (Paswoulus Vulgaris L.) for Resistance to Abiotic and Biotic Stresses
227. Rice Breeding and Cultivar Development in Mississippi
228. Development of Genetic Resources for Cotton
229. Cultivar Testing, Breeding, and Culture of Vegetables
230. Breeding and Genetics of Barley and Wheat for Increased Productivity, Value, and Durability
231. Variety and Quality Evaluation of Virginia-Type Peanuts
232. Preservation, Characterization, and Genetic Improvement of Hawaiian Taro
233. Variety and Quality Evaluation of Virginia-Type Peanuts
234. Developing Biotic and Abiotic Stress Tolerance in Corn
235. Maize Genetics and Improvement
236. Breeding High-yielding, High-value Soybean for South Carolina
237. Genetic Improvement of Soybean for Food Value, Yield, and Pest Resistance
238. Integrated Disease Management of Dry Edible Beans in North Dakota
239. Disease Resistance in Small Grain Cereal Crops and Their Wild Relatives
240. Salinity and Environmental Stress Resistance in Turfgrass and Landscape Plants for Recycled Water Irrigation and Phytoremediation
241. Peanut Breeding and Genetics
242. Development of Superior All-Male Asparagus Hybrids for All Major Cultivation Regions
243. Development of Cotton Cultivars and Breeding Lines Adapted in Mississippi
244. Utilization of Monoploid Derivatives of Potato in Genetic Studies
245. Specialty Crop Evaluation and Product Development
246. Biology and Control of Leaf Rust and Spring Dead Spot in Wheat and Bermudagrass Respectively Intergrated Activity
247. Cotton Germplasm Breeding for Improved Lint Yield, Fiber Quality, and Resistance to Biotic and Abiotic Stresses
248. Peanut Breeding and Management
249. Breeding and Germplasm Enhancement for New Jersey Cranberry and Blueberry Industries
250. Evaluating Salt Tolerance and Seed Germination in New Guayule Breeding Lines
251. Development of Multiple Disease-Resistant Commercial Tomatoes
252. Development of Wheat Varieties Adapted to Oregon with Improved Disease Resistance, Stress Tolerance, and Superior End-Use Properties
253. Improved Sugarcane Cultivars for Louisiana through the Identification of Superior Parents, Crosses, and Seedlings
254. New Crop Development for Oregon Agriculture, with Current Emphasis on Meadowfoam (Limnanthes)
255. Breeding and Genetics of Forage Crops to Improve Productivity, Quality, and Industrial Uses
256. Development and Utilization of DNA Markers for Soybean Breeding and Cultivar Development for North Carolina Environments
257. Market-Targeted Breeding with Molecular Wheat Protein Quality Assessment

258. Developing and Managing New Potato Varieties
259. Onion Breeding: Research and Development for Onion Improvement
260. Characterizing Genetic and Biochemical Differences among American Ginseng Populations
261. Woody Landscape Plant Breeding, Evaluation, and Introduction Program
262. Oat (Avena Sativa) Cultivar Improvement
263. Development of New Gene Combinations for Cotton Improvement
264. Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East
265. Developing a New Hybrid Breeding System for Alfalfa
266. Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East
267. Breeding and Genetics of Forage Crops to Improve Productivity, Quality, and Industrial Uses
268. Potato Breeding and Cultivar Development
269. Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East
270. Breeding Pierce's Disease-Resistant Table and Raisin Grapes
271. Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East
272. Breeding and Genetics of Forage Crops to Improve Productivity, Quality, and Industrial Uses
273. Cotton Germplasm Improvement and Genetics Research
274. Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East
275. Corn (Zea Mays L.) Breeding in the Northern Corn Belt
276. Applied Sweet Potato Genomics
277. Genetic Improvement of Alfalfa (Medicago Sativa L.) Germplasm for New Mexico
278. Genetic Improvement of Forage Grass and Legume Species
279. Cultivar Development and Genetic Improvement of Oilseed Rape
280. Improvement of Proso Millet and Other Crops for Adaptation to Western Nebraska
281. Breeding and Genetics of Forage Crops to Improve Productivity, Quality, and Industrial Uses
282. Genomic Tools for Peach and the Rosaceae
283. Breeding and Genetics of Forage Crops to Improve Productivity, Quality, and Industrial Uses
284. Breeding and Testing Vegetable Crops for Processing, Fresh Market, and Home Garden
285. Development of Rice Germplasm Using Molecular and Conventional Genetic Approaches
286. Developing Hard White Spring Wheat, Specialty Wheat, and Sawfly Resistant Wheat
287. Biological Improvement, Habitat Restoration, and Horticultural Development of Chestnut by Management of Populations, Pathogens, and Pests
288. Breeding and Genetics of Flax
289. Breeding and Genetics of Forage Crops to Improve Productivity, Quality, and Industrial Uses
290. Genetic Manipulation of Sweet Corn Quality and Stress Resistance
291. Improving Corn Silage Wheat and Barley Production in Pennsylvania
292. Use of Genetic Resistance to Control Aflatoxin and Fumonisin in Corn Grain
293. Soybean Breeding and Production
294. Domestication of Western Vaccinium Species (Bilberries, Blueberries, Cranberries, Huckleberries, and Whortleberries)
295. Development of Stress-Resistant/High-yield Sorghum Germplasm for Release and Use in Investigation of Contributing Physiological Mechanisms
296. Breeding Cotton for Adaptation to Arkansas Conditions
297. Quantitative Genetics and Crop Breeding Investigations
298. Onion Genetic Improvement
299. Breeding and Genetics of Legumes for Use as Forage and in Sustainable Agriculture
300. Genetic Improvement of Forage and Cover Crop Species
301. Genetic Improvement of Chile (Capsicum) Germplasm for New Mexico
302. Spring Wheat Breeding and Genetics
303. Evaluation of Native and Naturalized Germplasm for Reduced-Input Turfgrass in the Northern Plains
304. Breeding Perennial Grasses and Legumes for Forage, Biomass, Wildlife Habitat, Conservation, and Tolerance to Stresses
305. Development of Oat Varieties for South Dakota
306. Wheat Germplasm Enhancement
307. Golden Nematode Resistant Chipping and Tablestock Varieties to Meet the Evolving Needs of the NYS Potato Industry
308. Faster Breeding of Vegetable Crops through Doubled-Haploid Techniques
309. Corn Breeding and Sustainability
310. Development of a Breeding Program to Improve the Non-Transgenic Resistance of Maize Against the Western Corn Rootworm

311. Pigeonpea Breeding, Improvement, and Production
312. Plant Genetic Resource Cultivation and Utilization
313. Host Resistance as the Cornerstone for Managing Plant-Parasitic Nematodes in Sustainable Agroecosystems
314. Evaluation and Improvement of Rice Germplasm for Texas
315. Development of Epichloe Festucae as a Model System for Analysis of Fitness Enhancing Components of Grass-Endophyte Mutualisms
316. Breeding and Plant Development of Unique Geophytes
317. Hard Red Spring Wheat Improvement
318. Soybean Improvement via Classical and Molecular Breeding
319. Breeding and Genetic Studies of Sweet Potato
320. Development of Potato Cultivars for North Dakota Utilizing Germplasm Enhancement and Selection
321. Development of New Potato Clones for Improved Pest Resistance, Marketability, and Sustainability in the East
322. Environmental and Genetic Determinants of Seed Quality and Performance
323. Potato Variety Selection, Evaluation, and Development
324. Evaluation of Maize Germplasm, Hybrids, and Inbreds for Resistance to Gray Leaf Spot Disease under No-Tillage Production
325. Pecan Breeding and Cultivar Evaluation
326. Soybean Crop Improvement: Enhancing Nutrient Utilization
327. Breeding Landscape Plants for Adaptation to Urban Environments
328. Georgia Peanut Breeding and Genetics
329. Genetic Improvement of Sour Cherry and Sweet Cherry Rootstocks
330. Developing New Crops, Nutraceuticals, and other Value-Added Products
331. Novel Breeding Methods, Genetic Enhancement, and Evaluation of Agronomic Crop Plants Focusing on Alfalfa (Medicago sp)
332. Floricultural Crop Breeding and Genetics for Plant Performance, Disease and Pest Resistance, and Stress Tolerance
333. Wheat Genetic Improvement
334. Breeding and Genetics of Spring Six-Rowed Barley for North Dakota
335. Characterization and Commercialization of Wyoming-Bred Brown-Root-Rot-Resistant Alfalfa
336. Breeding and Genetics of Hop
337. Managing Karnal Bunt of Wheat
338. Rice Breeding and Genetics
339. Integration of Molecular and Classical Breeding for Turfgrass Improvement
340. Sunflower Breeding and Testing Alternative Oilseed Crops for South Dakota
341. Soybean Breeding, Genetics, and Production
342. Developing Taro as an Alternative Food and Ornamental Crop
343. Improvement of Edible Dry Bean
344. Introduction and Evaluation of Ornamental Plants
345. Introduction and Evaluation of Ornamental Plants
346. Genetic Improvement of Native Plant Species for Coastal Restoration in Lousiana
347. Developing Corn Silage Varieties with Improved Starch Utilization
348. Development of Large-Fruited Early-Bearing Papaya in the Virgin Islands
349. Identification of the Colonial Bentgrass Contribution to Dollar Spot Resistance in Colonial X Creeping Interspecific Hybrids
350. Broadening the Genetic Base and Introgression of Resistance to Multiple Diseases in Pinto Bean
351. Multistate Evaluation of Winegrape Cultivars and Clones
352. Genetic Improvement of Cotton (Gossypium Hirsutum L.) Germplasm for New Mexico
353. Genetic and Molecular Marker Strategies to Enhance Breeding for Multiple Disease Resistance in Maize
354. Durum Wheat Improvement
355. Development of Genetic Resources for Cotton
356. Cotton Management Practices, Variety Choices for Quality, and Production Efficiency Improvements
357. Genetic Improvement of Woody Plants (Trees and Shrubs) for Ornamental Uses
358. Developing Black Raspberry for Diversified and Sustainable Agriculture Systems in the Northeast
359. Small Grains Breeding and Genetics
360. Breeding and Genetics of Spring Barley
361. Developing Superior Oilseed and Mustard Cultivars for Brassicaceae
362. Multistate Evaluation of Winegrape Cultivars and Clones
363. Breeding Sorghum for Improved Yield Potential and Stress Tolerance
364. Soybean Breeding

365. Enhancement of Small Grains Productivity and Value by Breeding and Genetics
366. Hard Winter Wheat Improvement
367. Germplasm Enhancement, Breeding, and Genetics of Turf and Native Grasses
368. Molecular Mapping and Marker-Assisted Selection and Breeding for Disease Resistance and Improved Fruit Quality in Tomato
369. Improving Efficiency of Corn Breeding and Developing Alternative Breeding Methods
370. DNA Marker-Assisted Small Grains Breeding
371. Managing the Genetic Diversity of Michigan Pines
372. Accelerating Domestication of Forest Trees for Intensive Plantation Forestry
373. Genetics and Regeneration of Pennsylvania Hardwood Forests
374. Evaluating Tree Varieties
375. Development, Wilt Evaluation, and Marketing of Improved Seeds of Acacia Koa
376. Genetic Structure within and among Four Grasses Native to Ponderosa Pine Ecosystems
377. Genetic Improvement, Seed Orchard Construction, and Restoration of Tennessee Forest Species
378. Biological Improvement, Habitat Restoration, and Horticultural Development of Chestnut by Management of Populations, Pathogens, and Pests
379. Forest Genetics Research for Sustainable Forest Improvement in Mississippi
380. Quantitative Genetics and Tree Improvement of Southern Pines
381. Genetics of Wheat Grain Hardness Genes
382. QTL Mapping and Population Structure of Insecticide Resistance in Corn Rootworm
383. Genetic Dissection of Quantitative Resistance Using the Barley: Barley Stripe Rust Model
384. Genetic Control of High Oleic Acid Seed Content in Soybean
385. QTL Dissection of Variance Sources for Long-Term Selection
386. Simulation Modeling of Heading Time in Rice: A Genetic Control Network Approach
387. Raspberry as a Model System for Studying Phytophthora Root Rot Resistance and for Testing Marker-Assisted Selection in Cultivar Development
388. Genetic Correlates of Weediness in Cereal Rye (Secale Cereale)
389. Development of Corn Germplasm to Reduce Aflatoxin Contamination and Genetic Characterization of Aflatoxin Resistance
390. New Genetic Approach to Wide-Species Hybridization, Detection of Alien Chromatin, and Transfer of Agronomically Important Genes into Sorghum
391. Comparative Analysis of Phenotypic and Marker-Assisted Selection in Cucumber for Multiple Traits
392. Conference Planning Proposal for a 2005 Coordinated Agricultural Project (CAP) in Wheat Translational Genomics
393. A Coordinated Research, Education, and Extension Project for the Application of Genomic Discoveries to Improve Rice in the United States
394. CAP Conference Proposal: Translational Genomics for Cotton
395. Coordinated Agricultural Project Conference on Barley Translational Genomics
396. APGI-CAP Conference: Soybean Translational Genomics
397. Genecology, Genetic Diversity, and Adaptive Trait Variation in Bitterbrush (Purshia Tridentata) from the Pacific Northwest
398. Feed and Forage Analyzer 6500 Equipment Grant
399. Genetic Diversity of Wild Apple Accessions in the National Plant Germplasm System
400. Gene Pair Haplotypes and Sequence Samples from Strawberry (Rosaceae): Multipurpose, Transferable Resources for Genomics and Variety Improvement
401. Development of Segregating Populations for Molecular and Genetic Analyses of X-Disease in Chokecherry (Prunus Virginiana L.)
402. Application of Genetic Approaches to Enhance Cold-Hardiness of Guava
403. Characterizing Cowpea Genotypes for Drought Tolerance in the Delmarva Ecosystem
404. Bringing Genomics to the Wheat Fields
405. Assessment of Weediness and Fertility of Hybrids between Creeping Bentgrass and Related Species
406. Interdisciplinary Training Program in Agricultural Biology: Linking Emerging and Existing Technologies
407. Educating Young Researchers for Sustainable Agriculturally-Based Bio-Industries
408. Harnessing Investments in Genomics of Model Species for Vegetable Improvement
409. Establishment of a Grape (Vitis L.) Germplasm Center with Emphasis on Evaluation and Genetic Analysis of Pierce's Disease
410. Identification and Characterization of Potato Clones for Organic Production Systems
411. Southern Regional Canola Research Program
412. Development of Seedless Pawpaw Fruit by Germplasm Enhancement
413. Development and Management of Canola in the Great Plains Region
414. Utilization of Genomics for Molecular Breeding of High-quality and Disease-Resistant Peppers

415. Biological Nitrogen-Fixation and Seed-Composition Traits of White Lupin
416. Southern Regional Canola Research Program
417. Stakeholder Workshop Implementation of Molecular Marker Technologies in Public Wheat Breeding Programs
418. Natural Systems Agriculture
419. Gene Flow in Transgenic Tall Fescue and Ryegrasses: Pollen Dispersal and Hybridization Potential with Related Grass Species
420. Use of Resident Biological Resources for the Management of Replant Disease in Organic Tree Fruit Production Systems
421. The Organic Seed Partnership
422. International Cotton Research Center
423. North Central Region Canola Research Program
424. Southern Regional Canola Research Program
425. International Cotton Research Center—Part 3 (Breeding and Genetics Projects)
426. Developing Medicinally Used Echinacea Cultivars by Intra- and Inter-Species Hybridization
427. Improved Agricultural Sustainability through Microbial Enhanced Disease Resistance and Yield in Corn
428. Developing Medicinally Used Echinacea Cultivars by Intra- and Inter-Specific Hybridization—Phase II
429. Biology, Epidemiology, and Development of Methods for Detection and Suppression of Citrus Canker
430. Using A Patho-System Approach to Develop Disease-Resistant Ornamental Foliage Plants
431. Squash Breeding for Disease Resistance to Phytophthora Blight, Caused by P. Capsici
432. Environmental Constraints and Genetic Improvement of Tropical Forage Production
433. Improving the Sustainable Production of Specialty Crops
434. Alternative Crops for Arid Lands
435. Technology and Market Development for the Gulf Coast Satsuma Mandarin Industry
436. Crop Diversification, North Dakota and Missouri
437. Hawaii Floriculture Research Grant—2002
438. Tropical and Subtropical Agricultural Research (T-STAR) for Hawaii 2002: Umbrella A
439. Hawaii Agricultural Diversification 2002—New Crop/Product Development for Market Niches
440. Caribbean Basin Tropical and Subtropical Agriculture Research—Virgin Islands
441. T-STAR Agricultural Research at the University of Guam for FY2002
442. Identification and Introgression of Silverleaf Whitefly (Bemissa Argentifolii) Resistance Genes from Lycopersicon Hirsutum to Tomato
443. Integrated Biotechnological and Genetic Systems for Enhanced Forest Productivity and Health
444. Improving the Sustainable Production of Specialty Crops
445. Northwest Center for Small Fruits Research Program
446. Peach Tree Short Life in South Carolina
447. Genetically Enhancing the Industrial Oilseed Crop Meadowfoam
448. Blueberry and Cranberry Breeding, Disease, and Insect Management
449. Management of Russian Wheat Aphids in Dryland Cropping Systems of the Great Plains
450. International Cooperation for Agricultural Research in Central Asia and the Caucasus
451. Technology and Market Development for the Gulf Coast Satsuma Mandarin Industry
452. Tropical and Subtropical Agricultural Research (T-STAR) Umbrella B: Tropical Agriculture
453. Tropical and Subtropical Agricultural Research (T-STAR) Umbrella D: Agriculture Research in the Tropics
454. Hawaii Floriculture Research Grant—2003
455. Caribbean Basin Tropical and Subtropical Agriculture Research—Virgin Islands
456. Life and Death in Plants: Studies on Perennial Wheat as a Sustainable Alternative Cropping System
457. Developing Multi-Species Insect Resistance in Romaine Lettuce
458. Galia Melon: A New High-quality Shipping Melon for Florida Producers
459. Genetic Diversity and Domestication of Forage Legumes for the Subtropics and Tropics
460. Development of Phytophthora Root Rot-Resistant Avocado Rootstocks for the Caribbean
461. Peach Tree Short Life in South Carolina
462. Controlling Fire Blight of Apple Trees
463. Potato Breeding and Variety Development to Enhance Pest Resistance and Marketing Opportunities in the Eastern United States
464. Potato Variety Development and Improvement in the Northwest
465. Development of Multipurpose Potato Cultivars with Enhanced Quality, Disease, and Pest Resistance—North Central Program
466. Northwest Center for Small Fruits Research Program
467. International Cooperation for Agricultural Research in Central Asia and the Caucasus

468. Improving the Sustainable Production of Specialty Crops
469. Potato Breeding and Cultivar Development in the Southwest
470. Identification, Inheritance, and Utilization of Host Plant Resistance in Caladiums to Fusarium and Pythium
471. Genetic Control of Ripening of West Indian and West Indian-Guatemalan Avocado Fruit
472. Squash Breeding for Disease Resistance to Phytohthora Blight Caused by P. Capsici Part II
473. Identification and Introgression of Silverleaf Whitefly (Bemisia Argentifolii) Resistance Genes from Lycopersicon Hirsutum to Tomato
474. Grass Seed Cropping Systems for a Sustainable Agriculture: ID, OR, and WA
475. Development of Citrus Germplasm that Will Eliminate Loss of Trees and Production Due to CTV
476. Increasing Sustainability of Tropical Pastures through Selection of Legumes Tolerant to Drought and Aluminum
477. Hawaii Floriculture Research Grant—2004
478. Feed Barley for Rangeland Cattle
479. Varietal Variation in Papaya Fruit Softening and Its Inheritance
480. Tropical and Subtropical Agriculture Reseach (T-STAR) Umbrella B—2004
481. Improving the Sustainable Production of Specialty Crops
482. Center for Sorghum Improvement
483. Designing Foods for Health
484. Potato Breeding and Variety Development to Enhance Pest Resistance and Marketing Opportunities in the Eastern United States
485. Novel Approaches to Integrated Management of Armillaria Root Rot of Peach
486. Blueberry and Cranberry Breeding, Disease, and Insect Management
487. International Cooperation for Agricultural Research in Central Asia and the Caucasus
488. Field Testing of Resistant Tomato Lines to Control Late Blight and Early Blight in Conventional and Organic Growing Systems
489. Northwest Center for Small Fruits Research Program
490. Peach Tree Short Life in South Carolina
491. Organic Cropping Research for the Northwest
492. Developing Multi-Species Insect Resistance in Romaine Lettuce
493. Screening Tropical Pumpkin and Related Species for Melonworm Resistance
494. Enhancing the Genetics and Productivity of the Oilseed Crop Meadowfoam
495. Genetic Diversity and Domestication of Forage Legumes for the Subtropics and Tropics
496. Molecular Improvement of Physiological Traits Defining the Environmental Adaptation of Tropical Forage Grass Production
497. Improving the Quality of Kava Beverage
498. Integrated Management of Phytophthora Root Rot of Avocado in Puerto Rico

CSREES provided a list of current extramural classical animal breeding projects. Projects with funding to multiple states may be repeated on this list.

1. Advanced Technologies For the Genetic Improvement of Poultry
2. Alabama Beef Connection
3. Analysis of the Hairless-Wrinkled Mouse: A Spontaneous Mutant with Severe Skin Abnormalities
4. Application of Genomic and Proteomic Approaches to the Improvement of Disease Resistance and Performance in Farm Animals
5. Assessment of Live Animal, Quantitative Genetic, and Molecular Biological Approaches to Enhance Genetic Improvement in Pork Quality
6. Association of Imprinted Genes with Reproductive Efficiency in Swine
7. Beef Cattle Breeding and Management
8. Beef Cattle Breeding at the V Bar V Ranch
9. Beef Cattle Production Systems in the Southern Great Plains
10. Biological Basis for Variation in Net Feed Efficiency in Beef Cattle
11. Cell Cycle Control of Mouse Embryonic Stem Cells
12. Cell-Mediated Gene Transfer in Fish
13. Cellular and Molecular Characterization of the Spider Lamb Syndrome, a Heritable Chondrodysplasia
14. Characterization and Genetic Evaluation of Conformation and Gait in the American Warmblood and Tennessee Walking Horse
15. Characterization of a Unique Ap4A Receptor

16. Comparative Mapping of the Bovine Genome

17. Controlled Breeding, Larviculture, and Intensive Growout of High-value Marine Fish Species for U.S. Agriculture

18. Delineation of Interactive Molecular and Genetic Mechanisms Involved in Pathogenesis Disease Using Unique Modalities as Investigative Probes

19. Developing New Technology for Aquaculture in Louisiana

20. Development of Selection and Mating Strategies to Improve Dairy Cattle Health and Performance Using Field Data

21. Discovery and Evaluation of Genetic Factors that Influence Growth, Carcass Merit, and Meat Quality of the Pig

22. Discovery and Use of Quantitative Trait Loci Associated With Growth, Carcass Traits, and Feed Efficiency in Beef Cattle

23. Effect of Culture Conditions on the Protein Expression Patterns and Viability of Bovine Embryos

24. Effect on Carcass Traits Due to Sire Selection Based on EPD Predicted From Live Animal Carcass Measures On Young Seedstock

25. Effects of Genotype and Plane of Nutrition Performance, Carcass Composition, and Meat Quality Traits of Guinea Fowl (Numida Meleagris)

26. Engineering Mammalian Glutamine Metabolism

27. Enhancement of Dietary Energy Use For Maintenance, Growth, and Lactation by Beef Cattle

28. Evaluating and Modeling Extended Lactations in Dairy Goats

29. Evaluation and Further Development of Sheep Genetic Resources

30. Evaluation of Crossbred Calf and Cow Types for the Coastal Plan of North Carolina

31. Evaluation of Market Potential and Production Characters Related to Two Specialty Markets for Maine Livestock Producers

32. Expression and Function of Chicken MHC Class I Molecules

33. Factors Mediating Nuclear Reprogramming in Porcine Embryos Produced by Using Nuclear Transfer

34. Feed Efficiency in Cattle

35. Finfish Aquaculture: Improved Production Technologies, Cultivars, and Farming Practices

36. Genetic (Co) Variance of Parasite Resistance, Temperament, and Production Traits of Traditional and Non-Bos Indicus Tropically Adapted Breed

37. Genetic (Co) Variance of Parasite Resistance, Temperament, and Production Traits of Traditional and Non-Bos Indicus Tropically Adapted Breeds

38. Genetic (Co)Variance of Parasite Resistance, Temperament, and Production Traits of Traditional and Non-Bos Indicus Tropically Adapted Breed

39. Genetic Analysis of Fatty Acid Composition of Beef and Milk-Developing Tools for Use in Selection

40. Genetic Analysis of Production Traits in Beef Cattle and Sheep

41. Genetic Analysis of Selected Traits in Swine

42. Genetic and Environmental Aspects of Dairy Cattle Health and Milk Quality

43. Genetic and Functional Genomic Approaches to Improve Production and Quality of Pork

44. Genetic and Functional Genomic Approaches to Improve Production and Quality of Pork

45. Genetic Approaches to Enhance Efficiency and Profitability of Pork Production

46. Genetic Bases for Resistance and Immunity to Avian Diseases

47. Genetic Effects on Reproduction in Beef Cattle

48. Genetic Engineering of Dairy Animals to Improve Milk Composition

49. Genetic Enhancement of Agriculturally Important Animals

50. Genetic Improvement of Aquaculture Stocks

51. Genetic Selection and Crossbreeding to Enhance Reproduction and Survival of Dairy Cattle

52. Genetic Selection and Crossbreeding to Enhance Reproduction and Survival of Dairy Cattle

53. Genetic Selection and Crossbreeding to Enhance Reproduction and Survival of Dairy Cattle

54. Genetic Variation in Feed Energy Utilization

55. Genetic, Nutritional, and Environmental Methods to Improve Hatchability in Long-Stored Avian Eggs

56. Genetics and Functional Genomic Approaches to Improve Production and Quality of Pork

57. Genetics of Growth and Reproduction in Rainbow Trout (Oncorhynchus Mykiss) Fed a Plant-Based Diet

58. Genetics of Growth and Reproduction in the Turkey

59. Genetics of Phytate Phosphorus Utilization in Chickens

60. Genetics Selection for Increased Hatchability of Japanese Quail Embryos when Incubated at 102°F

61. Germ Cell and Embryo Development and Manipulation for the Improvement of Livestock

62. Growth-Hormone Receptor DNA Polymorphisms and Their Associations with Growth Traits in Grass-Fed Cattle Populations

63. Haplotype Structure of the Bovine Prion Gene Region and Association with Bovine Spongiform Encephalopathy

64. Hawaii Agricultural Diversification 2005—New Crop/Product Development and Marketing
65. Homologous Gene Targeting of Primary Embryonic Bovine Fibroblast Cells
66. Identification of Genes Controlling Animal Growth and Development
67. Identification of Genes Underlying Production Traits in Poultry
68. Identification of the Cellular Components Involved in the Recognition and Pairing of Homologous Chromosomes during Meiosis
69. Improved Ewe Productivity
70. Improving Nuclear Transfer Efficiency Using Donor Cells of Known XCI Patterns
71. Improving Responses of Range Beef Cattle to Estrus Synchronization
72. Improving the Design Of Breeding Schemes in Ruminant Livestock Using a Sheep Paradigm
73. Improving Yields of Pacific Oysters through Selection
74. Increasing Sheep Productive Efficiency
75. Inflammatory Responses to Diseases
76. Integrated Resource Management Beef Production Systems for the South Carolina Coastal Plains
77. Interpreting Cattle Genomic Data: Biology, Application, and Outreach
78. Interpreting Cattle Genomic Data: Biology, Applications, and Outreach
79. Interpreting Cattle Genomic Data: Biology, Applications, and Outreach
80. Livestock Management Systems
81. Maintenance of Immune Gene Variation
82. Material Genotype and Fescue Endophyte Effects on Meat Goats' Performance Traits
83. Metabolic Profiling of Butterball, a Morbidly Obese Mouse Mode
84. Minimizing Neonatal Lamb Losses
85. Molecular and Cellular Mechanisms in Agriculture
86. Molecular and Cellular Mechanisms in Agriculture: Gene Expression Mechanisms
87. Molecular Cloning and Characterization of the Androgenic Hormone(s) in Aquacultured Prawns and Shrimp
88. Molecular Mechanisms Regulating Skeletal Muscle Growth and Differentiation
89. Multi-Cropping Strategies for Aquaculture: A Collaborative Approach to Aquaculture Research and Extension—2004
90. Multi-Cropping Strategies for Aquaculture: A Collaborative Approach to Aquaculture Research and Extension—2005
91. Muscularity Genes and Their Functional Regulations for Efficient Animal Production
92. National Animal Genome Research Program
93. National Animal Genome Research Program (From NSRP-8)
94. National Animal Genome Research Program Species Coordinator for the Horse
95. National Animal Genome Research Project (NRSP-8): Aquaculture Genomics (Oysters)
96. National Beef Cattle Genetic Evaluation
97. NC1010: Interpreting Cattle Genomic Data: Biology, Applications, and Outreach (NC-209)
98. Nutritional and Genetic Factors Affecting Growth, Adipocyte Development, and Muscle Characteristics in Cattle
99. Ohio Aquaculture Research and Development Initiatives
100. Paternal, Maternal, and Environmental Influence on Hatchability and Post-Hatching Survival of Turkeys
101. Performance of Crossbred Hair Sheep Ewes under Extensive Management in the Tropics
102. Physiological Genomics of Growth and Reproduction in Chickens
103. Poultry Production Systems: Optimization of Production and Welfare Using Physiological, Behavioral, and Physical Assessments
104. Predicting Genetic Merit by Gene-Expression Profiling
105. Regional Aquaculture Center
106. Reproductive Physiology in Male Japanese Quail Selected for Divergent Adrenocortical Responsiveness to Restraint
107. Risk Assessment of a-Lactalbumin Transgenic Pigs
108. Role of Antioxidants in Health and Disease in Poultry
109. Roles of a GTPase-Activating Protein, PRGAP, in Mediating Pitx2 Function
110. Selection Strategies for Improving the Pulmonary Vascular Capacity in Broilers
111. Selective Breeding Programs for Commercially Important Bivalves in Maine
112. Shellfish Genetics and Breeding for Aquaculture
113. Statistical Procedures for Genetic Evaluation of Susceptibility to Mastitis in Dairy Cattle

114. Strategies to Enhance Meat Goat Production in North Carolina
115. Systems Evaluation of Animal Production
116. The Genomic and Proteomic Basis of Marek's Disease Virus-Induced Cellular Transformation
117. The Interface of Molecular and Quantitative Genetics in Plant and Animal Breeding
118. The Mechanism of PDHE1/Fdi Regulation in Response to Oxidative Stress in Azotobacter Vinelandii
119. The Molluscan Broodstock Program
120. The Relationship between Function and Mutations within the Mitochondrial NADH Dehydrogenase Complex 1 Gene
121. Tn5 Transposase—Host-Protein Interaction
122. Understanding Ecological Aspects of Shellfish Pathogens to Improve Management
123. Uracil-DNA Repair in Vitro and in Vivo
124. Use of Halothane Gas to Identify Novel SR Calcium Release Channel Protein Defects in Pigs
125. Utilization, Characterization, and Preservation of Goat Genetic Resources II
126. Validation and Characterization of a High-density Chicken SNP Map
127. Western Regional Aquaculture Center—17th Annual Work Plan (FY03)
128. Western Regional Aquaculture Center—18th Annual Work Plan (FY04)
129. Western Regional Aquaculture Center—19th Annual Work Plan (FY05)

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