National Program 215 Pastures, Forage and Rangeland Systems
National Program Annual Report: FY2014

Introduction

The USDA-ARS National Program for Pasture, Forage and Rangeland Systems (NP215) had another productive year in 2014 in terms of scientific output, technology transfer activities and breadth of collaborations with partners and stakeholders across the US and around the world. For example, 12 of the top 25 cited articles during FY2014 published in the journal *Rangeland Ecology and Management* since 2010 were authored or co-authored by ARS scientists from Units within NP215. Scientists in NP215 continue to make extraordinary impact in numerous diverse areas of research relating to the management of the Nation's natural resources, including the over 1B acres of rangelands and pasture lands.

In FY2014, NP215 continued implementing project plans that were developed from comprehensive stakeholder input gleaned from the NP215 national stakeholder workshop in 2012. The workshop brought stakeholders and the NP215 research community together to prioritize the scope and direction of research in NP215 and to discuss current and future areas of impact for stakeholders. These efforts are documented online at: http://www.ars.usda.gov/research/programs/programs.htm?NP_CODE=215 and include: the ***Retrospective Review Panel Executive Summary*** and the ***FY2013-FY2018 Action Plan*** for NP215 which went into effect on October 1, 2012.

The overarching goal of NP 215 is:

> *To improve food and energy security while enhancing the natural resources base by developing and transferring economically viable and environmentally protective technologies for sustainable range, pasture, forage and turf production systems that are based on fundamental applications of ecological and agronomic processes, and that are flexible to mitigate and adapt to the uncertainties of changing climate and market conditions.*

Our Nation's range, pasture, and herbage-based forage and turf landscapes serve many critical functions. Farms and ranches produce high quality, nutritious, abundant, and safe food products, as well as fiber and wood products that are the basis of income for producers and their rural communities. Rural areas provide significant ecosystems services such as clean air, water, and wildlife habitat, and are a long-term repository for biodiversity. These systems comprise about half of the land surface of the United States and represent a large and diverse mix of ecological sites, including annual grasslands of California, tundra rangelands of Alaska, hot arid deserts of the Southwest, temperate deserts of the Pacific Northwest, semiarid cold deserts of the Great Basin, prairies of the Great Plains, humid native grasslands of the South and East, and pastures and hay fields within all 50 states from Hawaii to Maine and Alaska to Florida.

The United Nations estimates that two-thirds of the world's agricultural land is pasture, forage and rangelands that can sustainably produce high quality animal products, but are unsuitable for more sustained, intensive production of grains or vegetables for human consumption. Knowledge gained about the development of sustainable land management in the United States will aid people across the globe, and ARS research will be critical to meeting the food security demands of a projected 9+ billion people by 2050. In FY2014, the importance of these global applications was demonstrated by NP215 scientist collaborations with researchers from 27 other countries in North America, South America,

Asia, Europe, India, Australia, New Zealand, and Africa. Many of these international interactions continue long term and productive scientific relationships.

The Nation's 30-40 million acres of turf lands are found around our homes, schools, municipal and commercial buildings, in our parks, greenbelts and recreational areas, and along our roadsides, airports and right-of-ways. These lands contribute to our well-being in many ways, including beautifying our towns and cities; enhancing property values; and providing vital environmental services such as erosion prevention, nutrient cycling, carbon sequestration and aquifer replenishment. These industries contribute an estimated $40 billion a year to the U.S. economy.

Pastures, forages and rangelands are the primary forage base for U.S. livestock grazing industries and are used by more than 60 million cattle and more than 8 million sheep and goats. Forage livestock systems contribute more than $100 billion in farm sales annually to the U.S. economy. The estimated value of alfalfa and other hay production is $13 billion, and is the third most valuable crop to U.S. agriculture, behind only corn and soybeans. In addition, hay exports from all US ports has increased 34% during the 2002-2011 period to nearly 4M metric tons per year. The publicly owned rangelands in the western U.S. are also critically important, providing forage on 260 million acres for three million beef cattle and sheep raised on over 30,000 primarily family owned and operated ranches. Nearly 70% of dietary protein and 40% of dietary calories for the U.S. population are of animal origin, and forage resources are crucial for sustained efficient production of food animal products.

The ecosystem services provided by these lands are of increasing importance. Watersheds in upland range and pasture regions are essential sources of clean water for urban areas, irrigated agriculture, and recreation. These lands provide forage and habitat for numerous wildlife species, including 20 million deer, one-half-million pronghorn antelope, 400,000 elk, 55,000 feral horses and burros, and hundreds of additional animal and bird species. An array of additional demands are also placed on these natural resources, including mining, oil and natural gas production, camping, hiking, fishing, hunting, and other recreational activities. For example, Bureau of Land Management rangelands, primarily in the western U.S., supported over 1.5M hunters and over 40M visitors in 2011. Meeting these many demands requires an improved understanding of how basic ecological processes are affected by grazing livestock production, drought, climate change, forage management and harvest, and other conservation practices.

Of particular significance is the continued close working relationship between NP215 Scientists and technical staff with the Natural Resource Conservation Service. The NRCS provides technical support to the management of ~1B acres of private grazing lands. ARS scientific support in the development of conservation practices deployed by the NRCS, and the quantitative techniques employed in evaluation their effects, is critically important to the management of these natural resources.

Harvested and conserved forages provide a dietary resource for continuity of livestock production that is especially important during periods of cold or drought when nutrient rich plants are not available. Harvested and conserved forages also provide an important source of roughage and nutrients for dairy cattle in confined animal feeding operations. To meet this demand, nearly 200 million tons of forage crops are harvested each year from 73 million acres in the U.S., which is 24% of the cropland - providing about half the forage requirements of dairy cattle. The remainder, along with rangeland and pasture, supplies the forage needs of beef cattle, sheep, goats, horses, and other livestock. Increased

forage and food animal production efficiencies are needed to ensure the competitiveness and sustainability of food animal producers and to improve domestic and international food security.

During FY 2014, 96 full-time scientists working at 23 locations across the U.S. actively engaged in more than 232 ARS-led and cooperative research projects in NP215. ARS-lead projects were approved through the ARS Office of Scientific Quality Review in 2012, making FY14 the second year of implementation of these five-year projects. The gross fiscal year 2014 funding for NP215 was $47 million.

New additions to the NP215 team in 2014 were:

- **Serge J. Edmé** has joined the Grain, Forage & Bioenergy Research Unit in Lincoln, NE. Dr. Edmo has expertise in Plant Breeding (particularly that of polyploids) with particular emphasis in resistance breeding (drought, freeze, flood, disease). Serge will lead GFBRU's efforts in germplasm development and genetics of perennial forage grasses.
- **Beth Newingham** joined the Great Basin Rangelands Research Station in Reno, NV. Beth is a rangeland ecologist; her research focus is on effects of post-fire rehabilitation and revegetation efforts on soil, native plant recovery, and cheatgrass invasion in the Great Basin. In addition, she is evaluating the role of livestock grazing and climate change in post-fire rangeland recovery. Her scientific background includes community ecology, ecosystem ecology, plant ecology, rangeland management, restoration ecology, and climate change research. She received her PhD from the University of Montana in 2002.

The following scientists retired from the ranks in NP215:

- **Gary Banowetz** and **Bill Pfender,** of the Forage Seed and Cereal Research Laboratory, Corvallis, Oregon
- **Srinivas Rao,** from the Forage and Livestock Production Research Unit, El Reno, OK

The distinguished record of service of these scientists is recognized world-wide, and they will be missed in NP215.

The following scientists in NP 215 received prominent awards in 2014:

- **Chad Boyd** of the Eastern Oregon Agricultural Research Center in Burns, OR received the William Renwick Conservation Leadership Award
- **Kris Havstad** of the Rangeland Management Research Unit in Las Cruces, NM, received the WR Chapline Research Award from the Society for Range Management, and was the inaugural recipient of the ARS Research Leader of the Year Award.
- **Jeff Herrick** of the Rangeland Management Research Unit in Las Cruces, NM, was named a Fellow of the Society for Range Management.
- **JoAnn Lamb**, of the Plant Science Research Laboratory, St. Paul, MN, received the Honorary Membership award from the North American Alfalfa Improvement Conference recognizing her career-long contributions to alfalfa improvement.
- **Deb Peters** of the Rangeland Management Research Unit in Las Cruces, NM, was among the first cohort to be named Fellow of the Ecological Society of America.

The quality and impact of NP 215 research was further evidenced in 2014 by following:

- Over 200 refereed journal articles published
- $5.69M received through incoming agreements (Cooperative Research and Development, Interagency Reimbursable, Reimbursable Cooperative and Trust Fund Agreements), a 34% increase over the $4.23M in incoming agreements received in FY13
- Application for one new patent and two new invention disclosures submitted
- Nine new material transfer agreements with stakeholders
- Three new germplasm releases
- 34 new scientific technologies developed, and
- Administration or development of 18 collaborative web sites for partners in academia, other research organizations or non-government organizations, and stakeholders.

In 2014 NP 215 scientists participated in research collaborations with scientists in: Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Czech Republic, Egypt, Ethiopia, France, Germany, Greece, India, Ireland, Italy, Kazakhstan, Kenya, Mauritius, Mongolia, Namibia, New Zealand, Russia, Spain, Switzerland, United Kingdom and Uruguay.

NP 215 Accomplishments for FY2014

This section summarizes 19 significant and high impact research results that address one of the 4 specific components of the FY 2013 – 2018 action plan for the NP 215. Each section summarizes accomplishments of individual research projects in NP 215. Of particular note are the many high impact accomplishments that address key problems facing management of the Nation's grazing lands. Units in the NP215 program have been nimble in directing research to develop conservation practices and pasture/forage management systems that solve critical problems, including controlling wildfire and erosion, enhancing habitat values for critical species including sage grouse, controlling invasive species such as cheatgrass, and development of ecologically based techniques for quantitatively assessing and monitoring land. Many of the programs summarized for FY 2014 include significant domestic and international collaborations with both industry and academia. These collaborations provide extraordinary opportunities to leverage funding and scientific expertise for USDA - ARS research by rapidly disseminating technology, which enhances the impact of ARS research programs.

Component 1. Improved Rangeland Management for Enhanced Livestock Production, Conservation, and Ecological Services

Winter grazing of rangelands reduces wildfire risk and severity of wildfires. Wildfire protection and suppression costs taxpayers more than $3.0 billion annually. During 2012, a record was set for total acres of rangeland burned by wildfire in eastern Oregon. In the last 15 years, 7 of the 11 western states have experienced their largest wildfires since European settlement. Much of the area being burned is prime habitat for sage-grouse and these fires have created severe hardship for ranchers in the region because of the loss of palatable forage. Research by ARS scientists in Burns, OR, demonstrated that winter grazing by livestock could be used to reduce the period of wildfire risk from three months to less than one month by altering the abundance and moisture content of fuel for wildfires. This information will help both private and public land managers develop strategies to reduce wildfire risk on rangelands.

Rangeland Hydrology and Erosion Model (RHEM) enhancements for applications on disturbed rangelands. RHEM is a process-based model developed by ARS scientists in Boise, Idaho, and Tucson, Arizona, for use on undisturbed rangelands where concentrated flow erosion is minimal and most soil loss occurs by rain splash and sheet erosion processes. RHEM has now been enhanced for use on disturbed rangelands by incorporating a new modeling approach that addresses the increase in concentrated flow erosion caused by exposed bare soil conditions found after disturbances such as fire or tree encroachment. The enhanced RHEM model is easily parameterized using readily available vegetation, soils, and ground cover data. The enhancements to RHEM expand its applicability as a practical land management tool for conservation planning and quantifying environmental benefits of alternative conservation practices.

Patch burning improves production and conservation benefits in semiarid rangelands. The integrated management of grazing and fire can be an important means to modify livestock grazing distribution, enhance forage quality, and enhance biodiversity conservation in the moderate water-supply regions of the eastern Great Plains. ARS researchers at Fort Collins, CO and Cheyenne, WY conducted October burns on pastures grazed season-long with yearling steers at traditional moderate stocking rates. Cattle spent more time grazing in recently burned areas during periods of rapid plant growth, and forage quality was enhanced in the early part of the growing season following the burning. Forage production was not affected by burning but remaining standing dead biomass and litter were substantially reduced. Livestock gains were similar between patch burning and traditionally managed pastures (season-long grazing only, no fire), and patch burning significantly enhanced habitat conditions for the Mountain Plover, a grassland bird species of concern. Combined management of fire and grazing for conservation objectives can be consistent with, and even complementary to, livestock production goals in semiarid rangelands of the western Great Plains.

Resilience of semiarid rangelands to summer fire and post-fire grazing utilization. Understanding plant response to grazing following summer fire can help reduce ecological and financial risks associated with wildfire. Most wildfires occur during summer and fire effects during this season are least understood. ARS researchers at Miles City, MT determined that summer fire had no first-year effect on productivity for any biomass component and that grazing after fire had no effect on total aboveground productivity the year after grazing compared to non-burned, non-grazed sites. Fire and grazing increased grass productivity 16% and reduced forbs (51%), annual grasses (49%), and litter (46%). Results indicate that grazing with up to 50% biomass removal the first growing season after summer fire was not detrimental to productivity of semiarid rangeland plant communities. Livestock exclusion the year after summer fire furthermore did not increase productivity or shift species composition compared to grazed sites. Consistent responses among dry, wet, and near-average years suggest plant response is species-specific rather than climatically controlled. These results are changing post-fire grazing management decisions, particularly for federally managed lands that required one to three years of livestock removal following fire.

Tools and techniques for multi-scale inventory, monitoring, and assessment of Western rangelands. Standardized approaches are needed to monitor rangelands that allow agencies to share data and address policy needs. ARS scientists in Las Cruces, NM led the implementation of ARS-developed core land monitoring indicators, field methods, and sample design techniques within the Bureau of Land Management (including BLM's national guidance for monitoring solar and oil/gas development impacts and sage grouse habitat). ARS also led integration of BLM's monitoring efforts

with the existing Natural Resources Conservation Service (NRCS)–National Resources Inventory private-land monitoring program. ARS scientists based at the Jornada Experimental Range also created web-based tools for monitoring data analysis and reporting, mobile and tablet-based data collection applications, and extensive training modules that are deployed with U.S. agencies and international partners. The inventory, monitoring, and assessment techniques and tools developed at the Jornada are providing managers and policy makers with information needed to manage resources at local to national scales.

New sand bluestem variety released for the arid Southern Plains Region. Under field conditions, soil moisture is often inadequate for the satisfactory establishment of native grass seedlings. These dry soil conditions limit a rangeland manager's ability to reestablish native grasses after a disturbance such as drought or energy exploration. ARS scientists in Woodward, OK, in cooperation with the NRCS Plant Materials Centers in Knox City, TX, and Manhattan, KS, have developed a variety of sand bluestem that has superior field emergence and plant density when planted in dry soil conditions. The new variety, named 'Centennial,' was developed by traditional breeding techniques over three generations of selection, and increases establishment success through improved seed germination under dry soil conditions. Selection for increased seed germination in sand bluestem has resulted in increased emergence and 17% higher plant density compared to older, unselected varieties. The development of this grass variety will prove beneficial to all users attempting to establish native grasses on disturbed lands because of the greater establishment rate it will provide.

Drought helps in revegetating sites dominated by cheatgrass. Recent drought conditions have impacted most of the Great Basin. The very favorable precipitation of 2010/2011 produced much carry-over fuel on Great Basin rangelands. These fuel loads, which contained the highly invasive and flammable cheat grass, contributed to the devastating 2012 wildfire season whereas more than 1 million acres burned within the Great Basin. Drought conditions have occurred following the 2012 wildfire season and have contributed to extreme failures of post-fire rehabilitation/restoration activities. ARS scientists at the Great Basin Rangelands Research Unit (GBRRU) in Reno, Nevada, have evaluated soil-active herbicide/fallow treatments and with excellent cheatgrass control (97.8%) during this same time period, the GBRRU has recorded a more than 800% increase in emergence and initial establishment of seeded species in the treated plots versus the control plots. The control of cheatgrass and the fallow of these treated sites have 40-45% more available moisture than untreated sites, which is critical to germination, emergence and establishment of seeded species.

Reduction in annual grass and poisonous plant invasion. Annual grasses have extensively invaded the rangelands of the channeled scablands of central Washington State which are already infested with lupines. When the grasses dry out in early summer, lupines become the preferred forage, exacerbating lupine-induced “crooked calf syndrome”. ARS scientists from Logan, Utah established research sites in the channeled scablands of central Washington State to determine which grass species is best adapted for this harsh environment and if forage Kochia would grow in this area. Vavilov II, Hycrest and Sherman Big Blue were the grasses most likely to germinate and establish, and demonstration and range scale plots were planted. Immigrant Kochia germinated and established over a three year period on the demonstration and range scale plots. Improved perennial grasses and forage Kochia germinated, persisted in the short term (three years to date) and reduced re-invasion of the annual grasses and poisonous plants, providing an improved forage base for livestock and wildlife.

Component 2: Develop Improved Pasture Technologies and Management Systems

Improved breeding strategies to aid organic small ruminant production. The greatest barrier to organic small ruminant (such as sheep and goats) production in the U.S. is reduced weight gains and death due to gastrointestinal parasites. Genetic selection for parasite resistance in sheep with heritability as high as 0.5 can eliminate the need for most deworming and reduce mortality and morbidity, especially with good nutrition and pasture management. As lead for a multi-institutional, multi-disciplinary team funded by NIFA's Organic Agriculture Research and Extension Initiative and the Small Business Innovation Research program, ARS scientists from Booneville, AR, along with colleagues from Louisiana State University, Virginia Tech, Fort Valley State University, and the University of Arkansas, and cooperation from several farmers, have developed selection tools to aid in the control of gastrointestinal nematodes for organic production of small ruminants After selecting replacement stock from parasite-resistant parents (determined by fecal egg counts around and after the time of lambing), fewer animals within the flocks required deworming. The research has resulted in farmer-friendly publications available through the National Center for Appropriate Technology and the website of the American Consortium for Small Ruminant Parasite Control.

Small farm programs for military veterans and beginning farmers. Scientists from the Fayetteville and Booneville, Arkansas, locations were part of a multi-institutional team that directly supported approximately 300 veterans through workshops, internships, research, and training, and an additional 650 veterans nationally through the Farmer Veteran Coalition (FVC) and helped many of them establish or expand their farming operations. Funded through the NIFA Beginning Farmers and Rancher Development Program, the team developed a program that incorporated ARS research into teaching materials, hands-on activities, mentoring, and networking opportunities for military veterans focused on farming. This program provides specific tools to help veterans during their transition into a rewarding employment option and a fruitful and satisfying civilian life. Through the New Farmer Online Training Program, over 28,000 participants have accessed the training program to date (https://attra.ncat.org/uofa/). This online training course (in English and Spanish) is open to all individuals; however, it is targeted towards the training of veterans, Spanish speaking individuals, women in agriculture, African Americans and economically and educationally disadvantaged groups.

Seed suppression of tall fescue enhances forage nutritive value to enhance steer performance. Previous work has demonstrated that chemical seed head suppression of endophyte-infected tall fescue can increase the nutritive value of endophyte-infected tall fescue and alleviate seed heads that are a toxic source of toxic ergot alkaloids; however, it has not been determined how much of a contributing factor that the enhanced nutritive value is in increasing in weight gain performance. A grazing study using pastures of endophyte-free tall fescue in mixture with Kentucky bluegrass and orchard grass demonstrated that steers grazing pastures with chemically suppressed tall fescue had 20% greater average daily gain than those grazing pastures with unsuppressed tall fescue. These results indicated that chemical suppression of tall fescue seed heads can enhance the daily weight gain of growing beef calves.

Component 3: Improved Harvested Forage Systems for Livestock, Bioenergy and Bioproducts

Rapid method for characterizing tannins improves nitrogen use efficiency on dairy farms. Condensed tannins, a component in many plants (including some forages), have been shown to improve

nitrogen use efficiency at different steps in milk production including silage production, rumen efficiency, and manure chemistry. Due to the complex chemical structure of condensed tannins, they are often difficult to characterize; chemical methods currently available are cumbersome and time-consuming. ARS scientists in Madison, WI have developed a rapid characterization method based on nuclear magnetic resonance spectroscopic analysis. This method can determine the chemical components that make up individual tannins, the ratio of the components in the tannins, and the size of the individual purified tannins. This information is critical in the accurate characterization of tannins as they are used in protein precipitation, protein degradation, and enzyme inhibition studies. The method can be used not only in dairy-related research and production, but in any discipline or industry where tannins have an important function. A more comprehensive understanding of how condensed tannins work will enable farmers to develop farm/feed management processes, leading to both economic and environmental benefits.

New switchgrass hybrid expands opportunities in northern climates and marginal environments. Switchgrass is one of the leading candidates for bioenergy feedstock production, especially in marginal environments where field crops are either not profitable or not sustainable. However, many of those marginal lands are in the more northern USDA Hardiness Zones 3 and 4 where switchgrass is not as productive as it is in Hardiness Zones 5 and 6. Recent field experiments by ARS scientists in Madison, WI provide the first demonstration that biomass yields in Zones 3 and 4 can be increased, and competitive to those grown in Zones 5 and 6, through directed selection and breeding for high biomass yield and winter survival following harsh winters. The greatest gains in biomass yield, up to a 50% increase, were achieved with hybrid switchgrass that combined the high yield of a southern strain with the winter hardiness of a northern strain. This research provides the first documentation of range expansion for high-yielding switchgrass strains into Hardiness Zones 3 and 4.

A mineral seed treatment suitable for organic alfalfa production systems. The most common fungicide used on alfalfa seed does not protect against all soil-borne diseases and cannot be used in organic production systems. ARS researchers at St. Paul, MN found that a novel mineral seed treatment using aluminosilicate (natural zeolite) -- which is allowed under the National Organic Plan (NOP) Rule 205.203(d) (2) -- gave significantly greater control of major seedling diseases of alfalfa than the existing Apron XL seed treatment. The mineral treatment resulted in excellent control of multiple strains of the pathogen causing Aphanomyces root rot for which Apron XL is ineffective, and resulted in a similar or greater percentage of protected plants than the Apron XL treatment in field soils with a range of disease pressure. No deleterious effects were seen on symbiotic bacteria needed for nitrogen fixation. These experiments indicate that the zeolite mineral seed treatment is a promising new means of controlling seedling diseases in conventional and organic alfalfa production systems.

More flexible and resilient alfalfa harvest system reduces costs with no negative impact on milk production of cows. Alfalfa, the most widely cultivated forage legume worldwide and the fourth most produced crop in the U.S., is typically harvested at early-bud stage to keep total fiber as low as possible. This practice helps insure high-quality forage with high protein and low fiber; however, it requires multiple harvests on the farm, increasing costs for alfalfa producers. Additionally, these harvests must also occur in a relatively narrow window of time (2-3 days) to maintain high-quality alfalfa, which is easily compromised by unfavorable weather conditions. ARS scientists in Madison, WI, are testing an alternative harvesting method that removes the leaves from the stems so they can be stored separately. Alfalfa leaves contain high protein (25-30% dry matter) and low fiber while stems contain high fiber and

low protein (7-9% dry matter). When the two alfalfa components are stored separately, they can be recombined in the appropriate ratios to optimize diets for dairy cows. ARS scientists in Madison, WI, conducted a feeding trial comparing silage from: 1) a typical early-bud alfalfa harvest with leaves and stems together; and 2) leaves harvested 4 weeks later at late full-bloom stage. Leaves were then recombined with stems to meet fiber needs of the cow. Subsequent results showed that milk production, milk protein, and milk fat from dairy cows were the same using the two diets. This system will potentially reduce the number of alfalfa harvests and enable producers to better time harvest and alfalfa storage needs, resulting in improved yields, diet quality and forage consistency while significantly decreasing costs associated with alfalfa harvest.

Understanding gene expression profiles of mineral transporters and mineral content in switch grass. Mineral nutrition is an important aspect of plant growth, and plant mineral composition can affect ethanol conversion efficiencies. Using a combination of biochemical and bioinformatics tools, ARS scientists in Lincoln, NE in collaboration with University of Nebraska scientists, discovered the expression patterns and profiles of a large array of mineral transporters in different switch grass tissues. Mineral analysis suggested that some minerals were more likely to be transported from the shoots to the rhizomes at the end of the growing season. This research will be used to develop breeding strategies to improve switch grass and other warm-season grasses for use in the bioenergy sector.

Component 4: Turf Improvement

Bermuda grasses with improved winter tolerance. Many central and northern U.S. locations have experienced warmer-than-average winters over the last 15 years. Bermuda grass is a warm-season species that uses less water than most other species, while providing superior traffic tolerance on golf courses and athletic fields. However, Bermuda grass lacks the winter tolerance found in many of the cool-season grass species used in much of the northern U.S. states. Over the last two decades, ARS scientists with the National Turfgrass Evaluation Program in Washington, D.C., have evaluated many new bermudagrass cultivars for their use across the U.S., and in particular in locations where winter temperatures can damage bermudagrass, limiting their use. However, after the winter of 2013/2014 with its extremely cold conditions across much of the U.S., the National Turfgrass Evaluation Program was able to gather cold tolerance data that will allow breeders to further their selections for adaptability in northern locations.

Molecular characterization of root-knot nematodes new to the United States. Root-knot nematodes (RKN) are parasitic on a wide range of host plants, including alfalfa, turfgrasses, and numerous other crops. ARS scientists and colleagues from Arizona and Utah used anatomical features and molecular markers to identify and describe two populations of RKN from golf course turfgrass; one was a species not previously found in North America. This research is significant because new molecular information obtained for these populations will facilitate future identification of RKN and prevent possible economic harm due to spread of these nematodes to potato-growing areas. This study will aid researchers and diagnosticians in accurately identifying economically important root-knot nematodes that are difficult to tell apart by comparing anatomical features alone.

Seashore paspalum is a very useful turfgrass for coastal areas due to the presence of salt tolerance. There are varying levels of salt tolerance within the species. For this reason genetic markers are needed for further varietal improvement by plant breeding. To reach this end, ARS scientists in Tifton, GE,

obtained 487,331 sequence reads and 35,460 unique sequences containing simple sequence repeats (SSRs-repetitive repeats) were identified. From these sequences that contained SSRs, 84 were developed as markers and used to genotype 17 seashore paspalum lines with different responses to salt. Two markers that were present only in the resistant lines from our study will be tested in a collection of 88 diverse seashore paspalum genotypes that were exposed to high levels of salt in two experiments. Furthermore, these markers were used to determine genetic relationships of potential parents for two-way crosses to be performed for development of new high quality turf cultivars with greater salt tolerance.