National Program 215 – Rangeland, Pasture & Forage

Assessment Report
Executive Summary

Key Conclusions and Panel Recommendations

National Program (NP) 215 involves very productive scientists, support scientists, and staff that are pushing the envelope to provide a scientific basis for rangeland, pasture, and forage management, and producing very good work. If this is going to be a true nationally coordinated program rather than a collection of independent projects, then programmatic leadership is required that provides a clear framework and a focus on directly linking the outputs and outcomes to the NP215 Action Plan. What is needed is a cohesive vision and economic analysis that shows how everything relates and builds to form the program.

Each component and problem statement contains some form of improvement or maintenance of economic viability. USDA-ARS does few economic assessments or analysis of any of their activities. There are very few programs that even attempt to conduct such analyses through cooperators. It is misleading to claim improvement in economic viability or sustainability unless USDA-ARS changes focus and philosophy by hiring or working with economists or sociologists. The basic premise seems to be that if we find a lower cost way of doing something it must lead to economic viability.

In order to analyze whether a change in management will lead to economic viability or environmental sustainability, a systems approach is needed. For example, in Problem Statement A, if there is a need for economically viable rangeland management practices, germplasm, technologies, and strategies, then each sub-objective would need to be analyzed for economic viability (however defined). The common meaning of the term sustainability concentrates on balancing environmental (ecological), social, and economic components of a system. Just focusing on the environment does not necessarily mean the system is more sustainable until all parts of the system can be balanced.

Currently, parts of the Accomplishment Report (AR) appear disconnected from the goals of the Action Plan (AP). Accomplishment descriptions should be more standardized, e.g., provide the problem or importance statement, the basic results and accomplishments, how these activities relate to the current *and previous* action plans, and their impacts/outcomes. Impact can be defined as whether the work is being applied by the scientific community or management. A project leader should summarize whether in their view the program meets the goals of the action plan, followed by a brief synthesis either in figure or table format. Going forward, perhaps the accomplishment reports should be reviewed by research leaders to provide a more structured and understandable synthesis of the program accomplishments. It would be valuable to summarize how each project contributes to each statement or goal. Background for research that has been ongoing for many years should be provided including a

justification for continuing incremental research (long-term projects that do not seem to progress quickly or may seem redundant without proper information and justification).

Panel recommendations by Problem Statement:

A. Panel members felt that ARS scientists need an overall plan for moving remote sensing technologies into the hands of public or private land managers. There appears to be a variety of platforms being tested, thus making it difficult to determine the general usefulness of any one platform. There is a need to evaluate the costs versus benefits of each of these technologies, and determine where they can be economically used and the criteria that allow or prevent their use. Research involving the effects of livestock grazing on rangeland ecosystems is a key direction for future work and should be given high priority. It represents the use of livestock as a tool to manage rangelands not only for meat production but also for all other ecosystem goods and services they provide, which may be more important than the former. Post-fire management and grazing on fire impacts and risk research were found to advance management, and next steps should include extending work to other locations and to develop a general set of guidelines. ARS scientists should be encouraged to answer questions concerning how soon livestock can be reintroduced after a wildfire rehabilitation/revegetation project.

B. The research on larkspur poisoning appears to be exhaustive. However, it is unclear what the specific impact of the work is on food safety or what the exact economic impact might be. These are areas that require additional ARS research. Next steps include analysis of livestock producer implementation of the management strategies resulting from this research. In terms of the effects of poisonous plants on rangelands, additional efforts need to focus on whether cattle losses actually were reduced, and if so, will the economic well-being of producers and rural communities be enhanced? Identify cattle genetic differences in susceptibility to larkspur alkaloids that will enable selection of cattle breeds, or lines of cattle within breeds that could be used to graze on larkspur without being poisoned. Develop field tests for detecting alkaloid content of larkspur plants so as to be able to manage livestock and keep them out of larkspur rangeland when the plants are most toxic. Conduct a survey of producers to assess the economic benefits from the management changes to reduce or prevent larkspur losses. Compare the current larkspur losses to the last survey in which losses were determined to approach $10 million. Panel members felt that the objective to ‘treat affected livestock and improve the harvesting of forage in areas where pine needles may be consumed’ needs further investigation. Development of a simple ‘field test’ to determine the toxicity of pine needles that would enable a livestock producer to manage his cows accordingly to prevent abortion would be a practical management tool. Also, future research could be directed at establishing when broom snakeweed is most toxic to livestock, and by answering the question, should strategies for adapting cattle to grazing this plant safely be developed? The Panel suggested ARS researchers investigate what geographical, soil, and climatic factors determine the alkaloid profiles in lupines thereby identifying when the plants may be safe to graze. Since locoweeds are widely distributed in the western States and internationally, and they cause more losses to the livestock industry than any other plant genera, are there

viable biological controls that could be developed to control locoweeds in problem areas? Further investigation into the role of the endophyte in locoweeds is needed. Can novel vaccines against swainsonine poisoning be developed to protect livestock? As this line of research matures, future work on some species may be limited to refining existing knowledge or transferring processes to other species, i.e., poisonous plants of grasslands in other parts of the world. ARS's work to elucidate grazing strategies and forage/animal production in semi-arid rangelands advances management, and the next steps are to move from this synthesis work to designing research approaches that promote understanding the principles of real-world application of grazing management. While the literature reflects the studies related to grazing systems and the response of the vegetation, it does not incorporate the entire ranch enterprise or the social/human factors of grazing management systems. Partly because of both of those factors, it does not address economic feasibility or ranch sustainability. ARS has investigated using livestock as 'ecosystem engineers' in rangelands with published manuscripts on work related to prairie dogs, grassland birds, and carbon sequestration. It is not clear that different types of grazing animals, different stocking rates, or other factors related to grazing, are being tested to understand the response function necessary to determine 'what is best.' ARS's studies to determine rangeland biodiversity management practices to enhance rangeland wildlife habitat while sustaining livestock production advances management, and next steps should include extending work to other locations to develop a general set of guidelines. Focusing on prairie dogs and grassland birds are important as many of these species are declining. There should be much more work on species of broad concern such as sage grouse and other sagebrush obligate species. Work should be occurring on the effects of grazing on these and other broad ranging species, understanding habitat use and timing, dietary overlap, how and if livestock can be used to improve habitat, and other such considerations.

C. Mechanistic studies involving invasive species and insect biocontrols in this problem statement are important and appear to be meeting objectives. These studies should be encouraged to evaluate population responses of the invasive plants, not merely the immediate reductions in cover or density alone. Many of these studies evaluated population responses of desirable plants relative to invasive plants. This work needs to be expanded beyond the small area in Oregon to have greater inference to the Intermountain West. Only in one case was there an apparent treatment (herbicide)-response (weed control) type study that could have been improved by a greater emphasis on the population dynamics cause by the treatments. The study of reducing restoration costs lacked strong scientific support and should be discouraged. No economic analyses of alternatives, despite being listed as important goal. Release and evaluation of newly developed plant materials efforts by ARS are necessary for improved plant materials that are competitive to replace existing undesirable vegetation.

D. The continued likelihood of greater seasonal and annual environmental variation in climate will require greater need to identify and characterize useful genetic traits through genomic, physiological and biochemical techniques. It is important to remember that the use of genomics should be linked or integrated with evaluating beneficial

physiological and biochemical (i.e., forage quality) characteristics to provide the most robust pasture or forage for stable long term performance. It is important also to recognize the end user of the new crop being developed, which may be livestock, biomass/biofuel industries etc. One of the most extensively studied species for biomass energy production has been switchgrass in North America. Therefore more research in this area would seem justified and needed with the potential that environmental conditions could be quite variable in the future. The use of medicinal plants to improve animal health in the USA has received little attention in the livestock industry with the exception of plants to treat intestinal helminth problems. Plant preparations are more commonly used in companion animals although much research needs to be done to prove efficacy and safety. For the future, the panel suggests that ARS scientists should identify and evaluate medicinal plant compounds and properties in plants of North America, utilizing information from other countries where medicinal plants are commonly used to treat intestinal disorders, parasite problems, and others. This research line needs research using sheep/goats to assess efficacy and economics of medicinal plants. Objective evidence-based research into herbal treatments is needed. Anthelmintic use of plant compounds (e.g., tannins in oak, *Chenopodium ambrosioides*, *Artemisia* species*, Fumaria parviflora)* could assume extreme importance because of the rapidly evolving resistance to conventional anthelmintics.

E. Much more research should be committed to using currently available forages species and their varieties effectively. Forage-based production systems are more sustainable (economically and environmentally) than intensive feeding operations and should be encouraged. A key question related to endophytic tall fescue research includes: Can a vaccine be developed to protect against the toxic effects of the ergot alkaloids produced by the endophyte in fescue? USDA-ARS should develop further non-toxic endophytes that maintain the vigor and productivity of the tall fescue as compared to the endophyte-free fescue that is less drought tolerant and less productive. Does the endophyte only affect tall fescue, and if so can ARS develop alternate Comparable non-toxic forages to reduce livestock losses? Additionally, several achievements raise some important questions that require further investigation. This is particularly true for the proposal that endophyte-infected tall fescue has a role for C sequestration. This observation raises many interesting questions on the process that explains the activity and on the ramifications of adopting the practice of using this fescue as a tool for C sequestration. The work evaluating alternative methods for controlling parasites in small ruminants (copper needles + *Sericea lespedeza, o*range oils, chicory) is appropriate for proving efficacy of these plant compounds. Controlled studies to evaluate plants and plant compounds as a means of reducing/controlling intestinal parasitism of ruminants should be continued. Combining rotational grazing with selected plants such as *Sericea lespedeza* that has anti-parasitic properties would provide valuable management information. Recommendations by the Panel include evaluating the effects of other livestock intensive system's effluent on the environment, especially as it may relate to antibiotic residues in water.

F. Identifying when it will be best to graze cool season species (either planted grasses or wheat) will be important. This research needs to move beyond just the species

approach to begin looking at different grazing systems and the effects on beef carcass quality under the alternative management systems. The research done to date appears to only scratch the surface of the Action Plan as most work is looking at persistence and toxicity of specific species. For the future, continue to develop a better understanding of livestock grazing and GHG emissions. Accomplishments were focused on improving profitability by extending the grazing season, reducing the cost of forage establishment, and the use of supplements. Cost effective management practices to improve pasture is medium impact research, some of it is a refinement or application of previously established principles (forage height-grazing efficiency) and the use of annual legumes should be compared with perennial crops; further work may be required to assess their cost/benefits. The emphasis on extending the grazing season should be continued and other perennial based systems should be explored to replace annuals. The accomplishments on annual forages report a test of legume species, which in itself is unremarkable but is redeemed by an in-depth assessment of physiological processes. Panel members suspect the achievement has much greater depth than is apparent from the description because it is published in a reputable journal. Management to improve forage persistence should be a key goal to reduce establishment cost and reduce risk of soil erosion. Can the same principles used to assess native grasslands also be applied to seeded forages?

G. The efforts to study livestock-forage interactions related to dairy cattle on mixed-species and cool-season pastures, address narrowly defined issues that have localized importance, or validate established principles within specific conditions. Observations on the link between pasture biodiversity and animal performance is an exception and one that could be examined in greater detail and broader scope. Limited-resource farmers who manage pastures with complex mixtures of forage species are concerned that large changes in the botanical composition of these species-rich pastures may cause unstable and lower herbage nutritive value, and compromise livestock production. Using forage mixtures in pastures can increase forage yields but mixtures may be more difficult to manage. Farmers will only adopt mixtures with potential for greater net profit. This is the first study indicated that actually looked at profitability of management practices on a whole dairy farm. Results for this type of dairy using the assumptions of the model could be used to evaluate a variety of similar research results. Understanding the human dimensions (sociology) of these practices could further show acceptability and adoptability of the different practices. ARS scientists determined how rapidly alfalfa yield changes relative to quality in the spring, early summer, late summer, and fall in Idaho, Pennsylvania, and Wisconsin. This effort would certainly be a candidate for inferences on how changing harvest times affect other activities on the farm, what impacts those have on production, and other related questions. It would also seem that there should be a discussion of harvest time on total yield over all cuttings.

H. The Panel requested that better alignment occur between the Accomplishment Report and the Action Plan for this problem statement.

J. Projects are making significant progress; however, projects need to further demonstrate the environmental and economic benefits of biomass production for biofuel production. Understanding how the production and harvest of species for feedstock production on marginal lands will be important as producers make decisions related to what to do with CRP lands. The practices and information gained from this program have the potential to enhance economic viability by introducing a new enterprise to the farm. Evaluation of environmental effects needs additional study. Understanding the impacts of different management options will be important, but until the economics of the different practices are incorporated, it will be difficult for farmers to make rational decisions. Selected herbicides were tested on stand establishment and subsequent yields of adapted upland switchgrass cultivars in Nebraska, South Dakota, and North Dakota as well as lowland ecotypes in both Nebraska and North Dakota. ARS researchers discovered an herbicide regime to assist in establishment. This research effort would be stronger if it was combined with some profitability studies. Utilizing nitrogen fixing legumes in a bioenergy cropping system could provide nitrogen for grass or tree growth plus additional bioenergy feedstocks. It appears to be a potential source of feedstock, but more research is needed. No indication that it will be useful in the production systems identified.

K. Development of molecular tools and linkage maps for cool-season and warm-season turfgrass have made significant progress, and now need to be applied by plant breeders to increase resistance to specific pathogen and insect problems. The genes involved in cutworm resistance and the role of peroxidases in insect resistance could be expanded to other turfgrass and forage grass species. The role of NTEP should be expanded to help introduce value-added improvements in turfgrass cultivars, such as drought, salinity, heat, or insect/disease resistance. A naturally occurring bio-herbicide was discovered from soil bacteria that arrested the development of *Poa annua* and jointed goatgrass. There is a need to increase the amount of cultured bacteria to identify genetic regions regulating the herbicide and isolate the chemical structure. The bio-herbicide also inhibits the fire blight pathogen of apples and pears. Commercial synthesis of a bacterial herbicide would have major economic implications and ecological benefits. Expand search for other bacterial or fungal metabolytes that have biological control potential. Develop beneficial endophytes for turf grasses that will increase plant vigor, drought tolerance and increase disease resistance. The utilization of agricultural and mining wastes to construct and management sports fields and urban parks needs to be continued.