USDA-ARS Pasture, Forage, and Rangeland Systems Customer Workshop
March 15-17, 2011 ~ Denver, Colorado

Breakout Session I: Identify problems and opportunities associated with Economic Viability, Environmental Sustainability, and Rural Communities

Breakout Session II: Identify possible solutions to problems and options for developing opportunities and where appropriate convert to Research Strategies and Activities

Breakout Session III: Review, refine, and prioritize from previous day sessions and identify possible collaborations

Breakout Session IV: Identify research components and writing teams for Action Plan; begin identifying problem areas

Breakout Session V: ARS writing teams finalize problem areas; begin development of measures of research progress

Blue Group (East Group 1)

How can ARS address these issues, potential solutions, research needs?

1. Consensus amongst range-pasture-forage customers
    a. Need to define sustainable
2. Slaughter-processing
    a. Inform other USDA agencies of need
3. Forage-ruminant interactions (include rumen microbiology)
    a. Optimize production systems for different regions and soil types
    b. Determine large vs. small ruminant differences
    c. Genomics of grass-endophyte interaction
    d. Use of grass finishing, effect on animal and economics
    e. Need digestible fiber for dairy produced on farm not purchased
    f. Intake and digestibility of forages in grazing animals

4. Marginal land use, fallowed land and reclaimed land back in production
    a. Use of liquid and composted manure on soil health
    b. Use of deep tillage
    c. What species can be used
    d. Weed management before reclamation
    e. Economics-cost and benefit of practices
    f. How to use grazing to reclaim land
    g. Measure C and N cycling
    h. Nutrient translocation in plants and nutrient cycling across landscape

5. Tall fescue endophyte
    a. How to manage endophyte infected areas
    b. Endophyte genome interaction with the plant; how endophyte enhances plant persistence
    c. Competition with weeds
    d. Fluxuation in infection rate in seed

6. Turf and urban ag
    a. Genomics of common grass species
    b. Low input turf system needed
    c. Basic research to elucidate stress physiology: water use, drought, salt tolerance
    d. Improved germplasm, molecular markers for MAS (partner with ARS in other crops)

e. Test new germplasm in field using existing stakeholder/customer groups (i.e. National Turfgrass Federation)
f. DNA markers to identify varieties and protect IP
g. Environmental services of turf
h. Issues in urban-wild interface
i. Use of soil amendments to enhance establishment

7. Environmental benefits of forages, turf, pastures
    a. Nutrient cycling
    b. C sequestration
    c. Water quality

8. Climate change and invasive species, parasites
    a. Changes in weed populations
    b. Nutritional/toxicity issues of new weeds
    c. Resilient forages so reduce weed invasion

9. Alternative forages needed but not creation of new invasive plants

10. Feedstock alternatives

11. Forage systems with new cultivars

12. Raw milk nutrition

13. Fencing options to reduce stream damage, total vs. partial exclusion
    a. Data to affect policy

14. Biofuels and livestock
    a. Use of byproducts
    b. Multipurpose forages-graze or use for biofuels
    c. Nutrient Issues

15. Consensus amongst range-pasture-forage customers
    a. Need to define sustainable

16. Slaughter-processing
    a. Inform other USDA agencies of need

17. Forage-ruminant interactions (include rumen microbiology)
    a. Optimize production systems for different regions and soil types
    b. Determine large vs. small ruminant differences
    c. Genomics of grass-endophyte interaction
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    e. Need digestible fiber for dairy produced on farm not purchased
    f. Intake and digestibility of forages in grazing animals

18. Marginal land use, fallowed land and reclaimed land back in production
    a. Use of liquid and composted manure on soil health
    b. Use of deep tillage
    c. What species can be used

d. Weed management before reclamation
e. Economics-cost and benefit of practices
f. How to use grazing to reclaim land
g. Measure C and N cycling
h. Nutrient translocation in plant and across landscape, nutrient cycling

19. Tall fescue endophyte
    a. How to manage infected areas
    b. Genomics of plant-endophyte interactions
    c. Weed management and new cultivars

20. Turf and urban ag
    a. Genomics of common grass species
    b. Low input turf system needed
    c. Basic research to elucidate stress physiology: water use, drought, salt tolerance
    d. Improved germplasm, molecular markers for MAS (partner with ARS in other crops)
    e. Test new germplasm in field using existing stakeholder/customer groups (i.e. National Turfgrass Federation)
    f. DNA markers to identify varieties and protect IP

21. Environmental benefits of forages
    a. C sequestration
    b. Water quality
    c. nutrients

22. Climate change and invasives, parasites

23. Alternative forages but not invasive

24. Feedstock alternatives

25. Forage systems with new cultivars

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1. Societal benefits of forages
    a. C sequestration
        i. Data needed for C sequestration in harvested forage systems
    b. Nutrient cycling
    c. Water quality issues
        i. Investigate fencing options to reduce stream damage: investigate total vs. partial exclusion
        ii. Develop decision tools (modeling and meta-analysis) for fencing needs in sensitive areas (riparian areas, buffer areas)
        iii. Measure pathogens and sediments under different management practices
    d. Increase forage diversity for wildlife use
    e. Environmental services of turf

2. Grazing systems
    a. Extend the grazing season to minimize the need for stored feed
    b. Minimize fertilizer inputs by use of legumes
    c. Management to adapt to changing practices, climate, stress

i. Important aspects of small farm research

d. Animal performance with new plant germplasm/cultivars
e. Efficient use of forages
f. Develop best management practices for multi-species animal grazing
g. Use and management of new cultivars

3. Forage-ruminant animal interactions (including rumen microbiology)
   a. Optimize production systems for different regions and soil types
   b. Determine large vs. small ruminant animal differences
   c. Use of grass finishing and its effect on animal performance and economics
   d. Identify animal phenotypes that do well on low input forage systems
   e. Develop diverse forages (annuals and perennials, grasses and legumes) for low input systems
   f. Improve nutrient utilization for animal production systems (including alfalfa utilization)
   g. Measure intake and digestibility of forages in grazing animals
   h. Maximize forage system for optimal animal performance
   i. Use animal behavior to maximize forage use
   j. Forage related animal disorders
      a. Tall fescue toxicosis
         i. How to manage infected areas
         ii. Endophyte genome-plant interactions: when are alkaloids produced?
         iii. Weed management
      b. Bloat
      c. Sulfur toxicity associated with Brassica consumption

4. Resilient systems in changing climates
   a. Changes in pests, pathogens, parasites and weed populations
   b. Nutritional/toxicity issues of new weeds
   c. Resilient forages
      i. reduce weed invasion
      ii. maintain productivity
      iii. enhance stress tolerance

5. Improved productivity of marginal, fallowed and reclaimed land
   a. Effect of liquid and composted manure on soil health
   b. What species can be used; natives, annual species
   c. Management practices for establishing new cultivars (particularly orchard grass)
   d. Weed management before reclamation
   e. Economics: costs and benefits of practices
   f. How to use grazing, deep tillage and other management methods to reclaim land
   g. Measure C and N cycling
      - Apply Rick Haney's (Temple, TX) rapid soil test
   h. Nutrient translocation (nutrient cycling) in plants and across the landscape
   i. Develop indicators for recovery of degraded pastures
   j. Develop integrated NRCS conservation practices in a systems approach
   k. Revisit use of non-native species for revegetation/grazing
   l. Insure transfer of information on new cultivars to NRCS and other end users

6. Turf and urban agriculture

   <u>Logan</u>: Stress physiology water use, drought stress, salt tolerance
   - ☐ Kentucky blue grass, inland salt grass
   - ☐ Alternative species for traffic tolerance and survivability

- ☐ Enodphyte research

Beltsville:

- heat tolerance and disease resistance (brown patch and dollar spot)
- functional genomics of disease resistance
- native grasses for low input sites

Tifton: warm season grasses: salt tolerance in reclaimed water
Madison: bentgrass resistance to dollar spot, brown patch and snow mold
Beaver: remediate poor growing sites, edaphic factors, traffic tolerance, compaction, soil factors

Test new germplasm in field situations using existing stakeholder/customer groups (i.e. National Turfgrass Evaluation Program)

7. Slaughter, animal processing, and products
    a. Need for facilities at peak production times
    b. Find ARS and other USDA partners
    c. Conduct on-farm research
    d. Investigate risks (food safety) of on-farm slaughter and processing particularly pathogens
    e. Investigate raw milk nutrition

8. Energy production in animal and forage systems
    a. Small scale on-farm energy production (beyond biodiesel)
    b. Feedstock alternatives
    c. Solar-wind-water power for fencing and water systems to make operation self-sustaining
    d. Biofuels and livestock
        i. Use of byproducts
        ii. Multipurpose forages for grazing or use for biofuels
        iii. Nutrient issues
        iv. Investigate potential for weediness in biomass feedstocks

9. Harvesting equipment
    a. Optimal traffic patterns for forage crop production
    b. Maximizing alfalfa yields and quality and minimizing machine inputs, i.e. fewer cuts

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Purple Group – East Group 2

Summary of topics below:

Turf/grasses: carbon capture per unit water. Adaptability of grass to grazing, turf, biofuels. Minimize effects to water quality.

Determine the most efficient use of land resources for grazing animals. Priorities include the following:

- management to extend the grazing season
- amount of fertilizer needed to maximize forages in a system and how can legumes offset use of fertilizer
- adaptive management for a changing landscape
- use of newer plant germplasm – how will they perform (animal performance, forage mass and persistence) compared with conventional forages
- grazing efficiency (most production or pounds produced per unit forage or input)

Cropping systems: alfalfa management, harvesting, site specific recommendations

Other: on-farm energy production

Systems/production/productivity Quality/profitability/risks	Temporal scale	Scales (spatial)
Grazing Harvested Turf/urban restoration Germplasm Nutrient cycling Water use/availability/quality Inputs/management	Seasons/year round Drought/rainfall	Field Farm Watershed Genomic/physiology

<u>Grass and legume forages for grazingland:</u>

Short term: quantifying grazing impact with simulation models.

Incorporation of legumes in low input systems to combat the cost of diesel and nitrogen – from grazing standpoint.

Not enough forage (and turf) variety testing programs available to develop recommendations for producers. There was a loss in support for these programs. Suggestion to use golf course roughs for research plots to test forage varieties (for livestock or other) or rather a greater collaboration of different entities (turf, forage, biofuels) with some common goals.

What is our present day equivalent of the "Crime of the Century" and what can we learn from history. Integrate crops/livestock – close nutrient cycle.

Forage related animal disorders, such as tall fescue toxicosis, bloat, and others that need attention. We need forages or forage systems to minimize these health problems. (last 5 yr plan: produce a nonbloat legume)

Orchardgrass establishment – farmers not keeping stands; these are primarily management issues of overgrazing, overstocking, etc.

New novel endophyte tall fescue varieties will be available in the next 18 months.

Grazing standpoint: impacts on water quality, soils, carbon; provide indicators when a system can recover and when it can't from an acute stressor.

Grazing: desire to extend the grazing season, minimize the need for stored feed.

Grazing: adaptive management vs. comparing across contrasting systems.

How to optimize a grazing cow's productivity considering all the different sub-systems (reproduction, nutrition, water quality, forages, etc.).

Grazing systems for duel use: bioenergy and cattle production for example.

Grazing behavior/training: animals teaching animals how to utilize forages, especially lower quality forages.

Multi-species grazing: addressing practical problems that occur by using this practice.

(Grass/forage based cattle production)

Development of a phenotype beef cattle that does well in a low input forage system. Development of forage diversity and efficiency in a low input system.

Grain vs. forage finishing: provide optimal forage system and compare to conventional grain system, but do not finish to certain weight, but rather age (18 mos) and found no difference in quality and tenderness. Thus, need to focus on quality forage systems for forage finished beef (lamb, etc.).

Grazing as a sub-issue: forage fed beef (include legumes as well as grass). Dispel myths vs. realities (internet).

Crops:

Harvesting equipment standpoint: controlled traffic systems; what is the optimal traffic patterns on crop systems and benefits of such. Maximizing yield and minimizing harvest/machine inputs for alfalfa or other crops.

Integrating various management inputs (rotations, systems) to optimize alfalfa production for multiple applications.

Turf or efficient use of water:

Need for water management strategies for turf production, better management of germplasm developed, quantify environmental benefits of turf, urban CEAP program, provide quality recreation areas/urban landscapes

Examination of biotic and abiotic stress to turf. There are problems with too much and too little water.

Develop water efficient grasses, management of salts, sodium, use of marginal water.

Systems Research:

An economic component should be added to Systems research – this is not used for university trials.

Performance and dynamics of NRCS conservations practices. Sometimes single practices are recommended, but a systems approach would be more beneficial.

Other:

Can small scale energy producers (low input/low output) be made for on-farm use using cellulose materials.

Development of a machine to integrate solar power, wind power using water pumping system.

Brome grass used widely for road use, etc.; it was “outlawed” because it was an introduced species. However, it and other similar forages are still very valuable. Can we revisit the restrictions on some of these forages.

New germplasm is not making its way to NRCS and approved list of users, potential endusers. How can we change this. We use small portion of available plant material. How can we transfer to endusers? FSA, NRCS lists need systematic updates on available germplasms. NTEP programs to convey plant germplasm benefits to customers for different purposes.

Landscape level of research to turn around issues confronting agriculture (for example, Chesapeake Bay, sage grouse).

Spatial variation vs. time for land management.

There is an increase in number of small farms with lower acreage. Research needs to be able to apply to these small farms.

Tech transfer issues: impact factors of journals vs. trying to reach maximum number of producers. Systems research difficult but important to get published.

Better use of naturalized plants that are now established in the landscape.

There are a number of forages that are beneficial in some environments and harmful to some part of the system in others (tall fescue, sericea lespedeza, etc.).

Foster in depth long term research; from genomics to application or end user.

Restoration techniques for reseeding areas. Are there ecological processes that need to occur for greater success? How might the use of annuals facilitate a restoration? Are there native varieties to help in the restoration? How to use ESD, state transition models to support successful restoration. Must be researchable with adaptive management context.

Green Group (West Group 1)
Solutions to problems-1

- Monitoring (remote sensing, GPS)
  - Reducing labor needs associated with monitoring
  - need for cross-walking of new approaches (e.g., high resolution aerial, satellite imagery) to long-term ground-collected data (legacy information from many ARS research stations)
  - innovative uses of GPS technology
  - statistically rigorous monitoring for adaptive management
- Restoration of invasive species-dominated (including poisonous plants) lands
  - Disruption of fire cycles
  - Emphasis is currently on post-fire restoration , but seeding success is inherently low
  - Need for lower cost forb and shrub seed/establishment techniques for restoration of cheatgrass-infested lands
  - Need for staged research plan (decadal) on seedling emergence/establishment information and enhanced success rate to increase restoration efforts following burning of cheatgrass-dominated lands

Solutions to problems-2

- Ecological Site Descriptions (restoration pathways, ecosystem states/transitions/thresholds, riparian areas)
  - Northern Rockies area is a need for Forest Service
  - Restoration pathways research in concert with changing climate
  - ARS role focus transitions and thresholds between/among states ("tipping points")
    - Across scales – plots to landscapes (cumulative impacts)
- Grazing as a management tool
  - Length of time animals on a unit of land vs. stocking rate
  - Landscape approaches
  - Outcome-driven management
- Multi-species grazing
  - Using livestock to reduce invasive weeds and for fuel load reduction
  - Economic aspects of this need to be determined

Solutions to problems-3

- Economic aspects (quantifying/estimating ecosystem services, cost:benefits of management/conservation practices)
  - Pull ERS down to practical farm/ranch level applications?
  - targeting limited resources on landscapes
- Climate variability and production systems
  - Drought management responses, adaptive management, enterprise flexibility
  - Invasive species concerns
  - Possibly convert rangelands from a sink for GHGs to source
  - Development of new forage species
  - Matching livestock to the environment
- Water quality/quantity issues
  - Coordinate with NP211

Solutions to problems-4

- Grass fed beef/pasture-based systems for lambs and goats
  - Handout from Sheep industry
  - economic considerations of finishing livestock on grass
  - needs interactions with NP101 (animal scientists)
  - wildlife concerns can be international (e.g., grassland birds)
- Coordination with customers
  - Science distribution to land managers
  - Use of ARS Information Staff to help distribute information
    - Have them write the accomplishment reports, assessment report
  - "Cliff Notes" of research for public
  - Synthesis of accomplishments – key findings and interpretations for public
  - Coordination of dissemination with Extension

March 16, 2011: Green Dot session: Justin Derner Facilitator.
Summary of Green Dots and Red Dots. Charge is to reduce to 4 major issues.
Mark Weltz emphasized that we need to be somewhat specific in the problems and objectives. Some of the issues on the board are not ARS issues and could be eliminated as we narrow things down.

(1) Restoration of degraded systems:

Restoration of degraded systems, through fire control, why are we only get 3-5% success, we need to get something going on restoration, fire, grazing etc. we need to get something going on restoration.
Targeted grazing, health benefits, control of invasive species, save endangered species

(2) Climate variability

Forest Service: Need ARS to participate in data collection, climate change, vegetation responses, ecological changes, climate variability. Need more support from ARS.

(3) Monitoring/Assessment needs

Economic Assessments, what is the cost. Economics is important in each of this priorities.

(4) Forage-based livestock systems

Overarching issues:

Economics

Distribution of outputs.

Ev Byington Comment:
Get very specific, no new money so if we start something new we will need to let something go.

Bring a group across stations to bring the power of the network or team to address rangeland restoration. Processes properties and involving multiple stations.

(1) Restoration of degraded systems:

Problem: ID what sites to restore and appropriate restoration practices.

a. Develop a restoration handbook, when we restore do we plant species to ensure success. ARS outputs should be a little broader, a set of tools to understand persistence and individual attributes for successful and long term restoration. Develop tools.

Objective: Understand the ecology of restoration, failures and successes.
-Multi scale triage
-Use of multiple tools including livestock grazing
-Need for new plant materials

Multi-scale triage principles, identify risks
Tools: Decision support tool for identifying key sites, ID
Sites: Great Basin, other areas Rocky Mountains region, treatment created. This is greater than the great Basin, identify the important sites before you ID species.
One example, how do you reduce the invasion of Kentucky Blue grass in the Great Plains. What's most important area. Intermountain region.

Management tool, cattle goats and sheep in place of using herbicides.
New plant materials

(2) Climate Variability:

Climate variability effects on production systems, forage quality (how does CO_2 affect quality) at enterprise level. C3 C4 line will shift and this may cause livestock producer to change strategies. Identify vulnerable production issues, i.e. calving time vs. forage quality or quantity. Effect of climate variability in production systems, at enterprise level.
Problem:
Limited flexibility at enterprise level, impacted by climate variability. Many enterprises operate on limited funds and slight shifts in climate may have economic impact.
Objective:
-Influence of climate variability on production systems at the enterprise level.
-Retrospective analysis of climate and production variables
Tools:
-Drought response strategies to include drought recovery

(3) Monitoring/Assessments

Need statistical help to improve ground cover that is defensible in court, a better job of monitoring. Need from ARS, how to develop remote sensing tools and how to interpret that data and apply a tool that will evaluate cover, protein, residual etc. for wildlife. Agency issues, ARS may not be able to help with Stats. at this level.
Problem:

- Increase ability to make informed management decisions at multiple scales in space and time by integrating multiple info sources, chrono sequence.
- Grass land birds, sage grouse issues brought up and remote sensing
- Standardize variable and integration of multiple
- Groups still not on same page for rangeland monitoring,

Objective:
-linking ground base sampling with remote sensing

-Integrating legacy data from Fed. Land and Private land into remote sensing and retrospective analysis of management practices
-Integrating legacy data into remote sensing tool. Will still need to rely on aerial imagery because satellite imagery is still not at the level of detail to meet the needs.
-Align monitoring metrics with management objectives, or outcomes (sage grouse populations).
Tools:
-Techniques and protocols for cross-walking data from various sources. (e.g. plot, aerial P., Sat)
(4) Forage-based livestock Systems
Problem:
-Lack of information, research needs for consistency for grass fed beef. This question goes across disciplines; production of animal; what is product endpoint (quality and consistency), human nutrition—matching forage quality with animal needs.
Objective:
-Matching forage quality with animal needs
-increase uniformity of end-product and quality and production system
-Work with NP 101 and human nutrition NP to develop cross-program emphasis.
- Impact of grass-based systems on the ecosystems services
Tools:
-Decision support system, forage quality for finishing
-Standards of quality; operational and product
-extending the grazing season

Identification of Problems

1. More participation among federal agencies at the Washington DC level
    a. Provides communication and coordination at the field level
    b. Leveraging of scarce resources
2. Monitoring
    a. Land management agencies overwhelmed with current workload, reduce labor needs
    b. Remote sensing – major advances by ARS already
        i. Need for cross-walking of new approaches (e.g., high resolution aerial, satellite imagery) to long-term ground-collected data (legacy information from many ARS research stations)
    c. Use of GPS technology
        i. Invisible fence
        ii. Animal use of landscapes
        iii. Prioritize treatment areas
3. Invasive species
    a. Kentucky bluegrass in Dakotas is a primary concern, smooth brome less so
4. Ecological Site Descriptions
    a. Pathways of restoration are a major need
        i. Factors that influence successful restoration
        ii. Climate change impacts
        iii. More environmental variability
    b. Fundamentals of ecosystems – ARS role in ESDs and S/T models (focus on transitions and thresholds between/among states)
        i. Processes, mechanisms – leading to thresholds (“tipping points”)

ii. Across scales – plots to landscapes (cumulative impacts)
iii. Predictive modeling (and explicit experimental testing) of transitions/thresholds
iv. Role of human dimensions?
    1. Connection to end users
    2. Link to general public
    3. Biophysical data linked to social and economic implications

5. Focus on grassfed beef for private landowners
    a. economic considerations of finishing cattle on grass
    b. needs interactions with NP101 (animal scientists)
    c. wildlife concerns can be international (e.g., grassland birds)
6. Rangeland/Pasture water quality/quantity issues
    a. Nitrogen, Phosphorus, sediment
    b. Strengthen linkage to NP211
    c. Non-point source modeling and quantification
7. How to manage and restore rangelands to ensure safe and continual food source for US/global demand
    a. West of continental divide – cheatgrass domination results in loss of re-establishment of perennial grasses
        i. How to stop fire cycle with cheatgrass?
        ii. Emphasis is currently on post-fire restoration , but seeding success is inherently low
        iii. How to get system back to "pre-fire" conditions in terms of productivity and diversity – targeting limited resources on the landscape? What is the dollar figure here that promotes enhanced probability of restoration success?
        iv. What comes after cheatgrass? Annual ecosystem is degrading – so what is next "state" in state-and-transition model?
        v. Ecological and socio-economic concerns – exacerbated by climate change?
        vi. Need for lower cost forb and shrub seed/establishment techniques for restoration of cheatgrass-infested lands
        vii. Understanding needed for seedling emergence/establishment information and enhanced success rate to increase restoration efforts following burning of cheatgrass-dominated lands
            1. Identification of environmental factors
            2. Nurse crops?
            3. Need for a staged research plan (decadal) to address this issue
            4. Prescribed grazing included here
8. Economic aspects involving rangeland/pastures
    a. Monetize resource benefits (value and risk) from conservation practices
        i. Does ARS take this on?
    b. Pull ERS down to practical farm/ranch level applications?
    c. Economic impacts of grazing land improvements on private rangelands for producers
    d. Cost:benefits – targeting limited resources on landscapes
        i. e.g., NRCS dollars for sagegrouse habitat
9. Habitat condition/Rangeland Health – lots of assessments, but lacking uniformity/standardization
    a. Need for common metrics
    b. How to measure changing conditions (climate change, adaptive management)

   c. What is appropriate subsequent monitoring?
10. Prescribed grazing – new approaches
   a. Length of time animals on a unit of land vs. stocking rate
   b. Need to evaluate short time periods of grazing with long rest periods
   c. Use livestock as a management tool
      i. Landscape approaches
      ii. Outcome-driven management
   d. targeted grazing and multi-species grazing (sheep, goats, cattle)
      i. Example: use of livestock to reduce invasive weeds and for fuel load reduction
      ii. Economic aspects of this need to be determined
11. Interaction of climate variability and production systems (and associated resource conditions) is most important for SW US rangelands (according to GCM projections)
   a. Typical response is energy input (e.g., feed inputs during drought)
   b. Flexibility in ranch enterprises is limiting in terms of current herd structure
      i. Cow-calf vs. mix of cow-calf base and flexible numbers of yearlings to match forage availability
   c. Economic impacts and analyses are needed (but see Torell et al. 2010 REM article)
   d. Insect responses?
12. Coordinate with LCC (Landscape Conservation Cooperatives, Dept of Interior)
   a. Climate change emphasis
   b. ARS to help provide science and distribute science findings (tech transfer opportunities)?
13. Rural communities aspect – how does ARS fit here?
   a. Production systems to keep ranchers on land – adaptive and flexible to meet climate variability
   b. Adding values to commodities (e.g., biofuel example)
   c. Pasture-based dairies
   d. Ethic population changes at regional levels
   e. Firebreaks for reducing fire risks (suburban residents)
   f. Problems associated with re-introduction of wolves
   g. Interactions with Rural Development?
      i. ARS to address the ecological aspects

Identification of Possible Solutions to Primary Problems (not in prioritization order)

1. Monitoring (remote sensing, GPS)
   a. Reducing labor needs associated with monitoring
   b. need for cross-walking of new approaches (e.g., high resolution aerial, satellite imagery) to long-term ground-collected data (legacy information from many ARS research stations)
   c. innovative uses of GPS technology
   d. statistically rigorous monitoring for adaptive management
2. Restoration of invasive species-dominated (including poisonous plants) lands
   a. Disruption of fire cycles
   b. Emphasis is currently on post-fire restoration , but seeding success is inherently low
   c. Need for lower cost forb and shrub seed/establishment techniques for restoration of cheatgrass-infested lands

    d. Need for staged research plan (decadal) on seedling emergence/establishment information and enhanced success rate to increase restoration efforts following burning of cheatgrass-dominated lands
3. Ecological Site Descriptions (restoration pathways, ecosystem states/transitions/thresholds, riparian areas)
    a. Northern Rockies area is a need for Forest Service
    b. Restoration pathways research in concert with changing climate
    c. ARS role focus transitions and thresholds between/among states ("tipping points")
        i. Across scales – plots to landscapes (cumulative impacts)
4. Grass fed beef/pasture-based systems for lambs and goats
    a. Handout from Sheep industry
    b. economic considerations of finishing livestock on grass
    c. needs interactions with NP101 (animal scientists)
    d. wildlife concerns can be international (e.g., grassland birds)
5. Water quality/quantity issues
    a. Coordinate with NP211
6. Economic aspects (quantifying/estimating ecosystem services, cost:benefits of management/conservation practices)
    a. Pull ERS down to practical farm/ranch level applications?
    b. targeting limited resources on landscapes
        i. e.g., NRCS dollars for sagegrouse habitat
7. Lacking standardized assessments (chronological challenges, different among agencies)
    a. Need to crosswalk among different agency (federal/tribal/state/private) approaches
    b. Need to crosswalk among legacy ground-collected data and contemporary remote sensing data
8. Grazing as a management tool
    a. Length of time animals on a unit of land vs. stocking rate
    b. Landscape approaches
    c. Outcome-driven management
9. Climate variability and production systems
    a. Drought management responses, adaptive management, enterprise flexibility
    b. Invasive species concerns
    c. Possibly convert rangelands from a sink for GHGs to source
    d. Development of new forage species
    e. Matching livestock to the environment
10. Coordination with customers
    a. Science distribution to land managers
    b. Use of ARS Information Staff to help distribute information
        i. Have them write the accomplishment reports, assessment report
    c. "Cliff Notes" of research for public
    d. Synthesis of accomplishments – key findings and interpretations for public
    e. Coordination of dissemination with Extension
11. Multi-species grazing
    a. using livestock to reduce invasive weeds and for fuel load reduction
    b. Economic aspects of this need to be determined

Red Group (West Group 2)

1) 20 participants
2) **INTRO** by Tony describing organization
   a) Why and how to operate
   b) 2 range groups
   c) First describe problems – everything on the table
   d) Follow up with solutions
   e) Finally summarize with both range groups combined
   f) Steering committee for ARS will meet in the evening
   g) Tomorrow format is flexible – could be very small groups if desired
   h) When customer leave ARS will integrate all of the input
      i) Attempt with linkage between locations
   i) Very specific OK but also look at across locations objectives
      i) Look at big enough time frames (Long term issues 5-15yrs)
      ii) Suggest short term goals too (less than 5 years)
3) **PROBLEMS**
   a) Water
      i) Use efficiency, range land stability, pollution, quality, supply
   b) Early spring grazing, extending the grazing season - grasses
      i) High nutrition (both early and late)
      ii) Also critical for summer
      iii) New germ plasma or management to preserve quality
      iv) regionalization
   c) Better forage systems for 700 to 800 wt cattle getting prepared for the feedlot - regional
      i) After weaning (4 to 5 wt cattle to gain – better stocker program "don't take grass away from cows"
      ii) Support by other
   d) Sustainability very important, less intensity, less fuel, change from 400 lb calf to 700 feeder, difference in system, need grasses that will support different system, forages to stay greener longer in dry season (geographically specific)
   e) Better management techniques for native vegetation
      i) Especially earlier green up and late season
      ii) Manage for better nutrition, grasses, forbs and browse
   f) Supplements to alter grazing preference – to enhance utilization of forages used lesser
   g) What about public lands
      i) Declined in Nevada, due to fire with brief periods of green forage quality, address multi use with new germ plasma
      ii) Concerns – annual grass lands are dying replaced by burr buttercup in region of 5 to 10 inches 100,000+ acres critical W**hy are annual grasses disappearing?**
      iii) Wind erosion extreme – plants to minimize maybe shrubs revegetation
         (1) Crested wheat grass and forage kochia did not work but need anything
      iv) How do we help sage hens ? but it is everything disappearing

v) Poor soils very difficult to reestablish very hard to reverse

h) Current plants cannot meet the needs of the rangeland or the function,
   i) Invasive plants, wildfires etc. cause desertification
i) Need systems to restore it needs to be stepwise and organized
   (1) How can you recover the sites in a step wise method.
   (2) Responses change depend on repetition of disturbance (what is going on in the soil)
      (a) Accumulative effects how do they interact?

4) Learning from cheat grass problems in eastern Wyoming
   a) We need to learn from them in the great basin
   b) What is the new understanding of these repeated insults
      i) Line in the sand is bare ground – layer in forage production for livestock and wildlife
      ii) Mountain plover vs. livestock are not compatible but need both
      iii) May need multiple locations to work together to get it out to folks on the ground
         (1) Need to get information out – not just completion out
      iv) State and transitions models
5) Research needs to communicate new ideas not just publish
   a) Need to work on problem not just the symptom
6) Research needed in soil health – what about microbes and infiltration and retention?
   a) How about water quality quantity tied to soil health?
   b) Do organisms influence repulsion of water?
   c) Water use efficiency how is it tied to soils?
   d) What are interseeding/plant cocktails effects on soil health?
7) Coordinated sage grouse effort
   a) Need a focus on systematic work and partnership
   b) Good quality research to counter emotion
   c) Look at habitat structure stand point up to devise research objectives
   d) Vegetation treatments are taken off the table when it comes to sage grouse they all should be tested (combinations of treatments)
8) Pinon juniper work is essential
      i) Especially a product with utility
      ii) Habitat, water, soil health "understand management of woody species"
      iii) Bio mass is a possible use – when , how, best to harvest juniper
      iv) What does the harvest treatment do?
      v) All woody plants? On a regional research scale.
9) Quantification of outcomes of management what are they?
   a) Markets for ecological services – monitoring and accounting techniques
   b) Understanding trade off of different management schemes benefits and negatives
      i) Ecological, social, economic
      ii) There is a disconnect between research and what happens on the ground
10) Using livestock for a desirable benefit for ecological services – How?
11) Do all "sage brush sites" operate the same? Will management have the same impact in different sites (cause and effects)
   a) Disturbance response groups wildfire goes across all types of sites will they respond the same
12) Fire – as a management tool – how do we use it and what will be the outcomes for….

a) Protect water shed, habitat improvement, diversity

13) How should genomics go? With exotics or natives?
    a) Genetic variability
14) Poisonous plants – find how to utilize when sites are dominated
    a) What about toxins in biofuels? Needs to be coordinated with all agency work.
15) How can ARS help with measurement in current grazing practices? More than bad effects vs. no grazing. We need more than that. How can we keep grazing and determine trends?
16) Remote sensing – on the web to plan for next year on a landscape scale
    a) Plant diversity, degree of use
        i) Also need comparable measurements for soils
17) Increase production in hay ground meadows – irrigated and sub
18) Riparian issues - how to develop a riparian health description need data
    a) How important are these system to wildlife, how do they interact with the uplands, how do we keep them connected?, How do you monitor trends in riparian areas?
    b) Can we manage riparian zones in such a way that the only way to manage by agency want cattle off (There is more than no grazing or destructive grazing how can they be used with negative consequences) How about time (season)and time(period)
19) Communication of results to land managers
20) What is the cost to achieve objectives? We need to look for optimization of management decisions?
    a) Cost benefit relationships
21) Need to improve dry land production.
22) Action points from customers representing Utah
    a) Current plant do not meet the needs
    b) Invasive plants contribute to rangeland losses
    c) Current forage production do not meet productivity potential
    d) 10 points
        i) Regarding rangeland ecology restoration - plants material
        ii) Revegetation strategies
        iii) Plant materials for arid, saline and mine lands
        iv) Novel north American legumes
        v) Gene discover for adaptive plant traits
        vi) Sustainable livestock production
        vii) Extend grazing early spring and late fall
        viii) Legume mixture
        ix) Plant materials to reduce inputs
        x) Legumes for grazing land
        xi) Genetic plant mechanisms for robust sustainability for livestock
        xii) Drought heat and salinity tolerance, fertility requirements
23) Native seed production for NRCS to be plant materials clearing house for all plant materials
    a) Especially to standardize recommendations

SOLUTIONS

1) Communication – Landscape tool box on the WEB, monitoring methods guide
    a) More, better, faster
    b) Make material accessible, through other agencies

c) Make annual report a collection of summary
d) NRCS, BLM Forest service field people need to receive research results
2) Categories
a) Communications – ARS outreach of findings
i) Agency to agency
ii) All agency to stakeholders
b) Multi-locations, with universities, various people
c) Forages
i) Plant materials
ii) Extend grazing season
d) Degradation
i) Restoration
ii) Quantification of practices
(1) Cost benefit

WEDNESDAY MORNING DISCUSSION
PROBLEMS – SOLUTIONS - SPECIFICATIONS

1) Need Problem statement, Objectives and Outputs or products
2) Climatic variability
a) Proactive
b) Reactive
3) ESD need to be completed
a) NRCS and Land Grants
b) State and transition models
4) Mgmt system at landscape level that addresses multiple Ecosystem services
a) Cost benefit analysis – assessment per and post
b) Identify trade offs
c) Using livestock as a tool to achieve services
d) Need to include energy systems and soil health
5) Forage based systems
a) Extend grazing season
b) Grazing animal as a harvester
c) Low quality forages
d) Promoting plant diversity by management
e) Genomics of plants – to associate to get the plant to do what we need
i) Characteristic
ii) Phenotypic plasticity
iii) Western wheatgrass with higher digestibility
6) Example of livestock as a tool – utilizing grazing in fall to reduce cheat grass

a) Livestock as a tool
7) Problem statement why do not know how to revegetation cheat grass lands?
a) Cheat grass is dying off why? Why is to Great Basin continuing losing vegetation?

b) Partners – BLM (mapping die off) Nevada, Idaho, Oregon, Utah and university
c) How do we develop vegetation systems to create invasion resistant systems?
    (1) How does the soil carbon impact this system
    (2) What are the systems needed to start new species (especially in cheat grass)

8) Problem with invasion by exotic species Kentucky blue grass, crested wheat, how do land manager manage these invasion? Why do they happen?
9) Improvement of desirable native species such as blue bunch wheatgrass (as a replacement)
    a) Need native species with characteristics for:Drought resistance and saline soils genetic , in northern great plains,
10) Sage grouse habitat is degraded. Can ASRS develop forbs to attract lacking insects
    a) Need insects, forbs to enhance habitats in intact environments.
    b) What is the management approach to sustain population?
    c) How do we use livestock to create habitats and/or ecological services.
11) We do not understand trade offs (cost both dollars and ecological services) and are there any benefits? when energy development occurs – site specific
    a) Sage grouse
    b) Weed transport
    c) Grazing exclusion
    d) Vegetation impact
12) Develop research based metrics for ecosystem services
    a) What are the values? What is it worth? Ecological "uplift" or depression. Such as infiltration water rates
13) Encroachment by woody species what is the cost on hydrology
    a) What happens after removal?
    b) What are the trade off when restoration occurs?
14) How do you use grazing to improve biodiversity? Such as vegetation and wildlife – especially specific species. At multiple scales for soil health enhancement. Site specific solution.
15) Need to devise monitoring to a multiple scales to assess success.
16) How to use targeted grazing for specific goals?
    a) Management of invasive species
    b) How to use grazing to improve soil health.
    c) Grazing to improve plant vigor.
    d) Grazing to improve hydrology.
    e) Grazing to improve entire system.
    f) Presently we cannot adequately quantify the effects on ecosystem services.
17) How can ARS embrace variability in its research effort that mimics variability normally found in the environment?
18) AES needs a better understanding of the transitions in the ESD.
19) What are the trade offs in large land areas with no management with new land owners?
20) Coordinate and strengthen work that is ongoing , distribution of findings
    a) Consider important priorities
21) Problems are well defined
22) Good definition of problems

March 16, 2011:
Summary of Green Dots and Red Dots. Charge is to reduce to 4 major issues.

Mark Weltz emphasized that we need to be somewhat specific in the problems and objectives. Some of the issues on the board are not ARS issues and could be eliminated as we narrow things down.

(5) Restoration of degraded systems:

Restoration of degraded systems, through fire control, why are we only get 3-5% success, we need to get something going on restoration, fire, grazing etc. we need to get something going on restoration.
Targeted grazing, health benefits, control of invasive species, save endangered species

(6) Climate variability

Forest Service: Need ARS to participate in data collection, climate change, vegetation responses, ecological changes, climate variability. Need more support from ARS.

(7) Monitoring/Assessment needs

Economic Assessments, what is the cost. Economics is important in each of this priorities.

(8) Forage-based livestock systems

Overarching issues:
Economics
Distribution of outputs.
Ev Byington Comment:
Get very specific, no new money so if we start something new we will need to let something go.
Bring a group across stations to bring the power of the network or team to address rangeland restoration. Processes properties and involving multiple stations.

(3) Restoration of degraded systems:

Problem: ID what sites to restore and appropriate restoration practices.

b. Develop a restoration handbook, when we restore do we plant species to ensure success. ARS outputs should be a little broader, a set of tools to understand persistence and individual attributes for successful and long term restoration. Develop tools.

Objective: Understand the ecology of restoration, failures and successes.
-Multi scale triage
-Use of multiple tools including livestock grazing
-Need for new plant materials

Multi-scale triage principles, identify risks
Tools: Decision support tool for identifying key sites, ID
Sites: Great Basin, other areas Rocky Mountains region, treatment created. This is greater than the great Basin, identify the important sites before you ID species.
One example, how do you reduce the invasion of Kentucky Blue grass in the Great Plains. What's most important area. Intermountain region.

Management tool, cattle goats and sheep in place of using herbicides.
New plant materials

(4) Climate Variability:

Climate variability effects on production systems, forage quality (how does CO_2 affect quality) at enterprise level. C3 C4 line will shift and this may cause livestock producer to change strategies. Identify vulnerable production issues, i.e. calving time vs. forage quality or quantity. Effect of climate variability in production systems, at enterprise level.
Problem:

Limited flexibility at enterprise level, impacted by climate variability. Many enterprises operate on limited funds and slight shifts in climate may have economic impact.
Objective:
-Influence of climate variability on production systems at the enterprise level.
-Retrospective analysis of climate and production variables
Tools:
-Drought response strategies to include drought recovery
(3) Monitoring/Assessments
Need statistical help to improve ground cover that is defensible in court, a better job of monitoring. Need from ARS, how to develop remote sensing tools and how to interpret that data and apply a tool that will evaluate cover, protein, residual etc. for wildlife. Agency issues, ARS may not be able to help with Stats. at this level.
Problem:

- Increase ability to make informed management decisions at multiple scales in space and time by integrating multiple info sources, chrono sequence.
- Grass land birds, sage grouse issues brought up and remote sensing
- Standardize variable and integration of multiple
- Groups still not on same page for rangeland monitoring,

Objective:
-linking ground base sampling with remote sensing
-Integrating legacy data from Fed. Land and Private land into remote sensing and retrospective analysis of management practices
-Integrating legacy data into remote sensing tool. Will still need to rely on aerial imagery because satellite imagery is still not at the level of detail to meet the needs.
-Align monitoring metrics with management objectives, or outcomes (sage grouse populations).
Tools:
-Techniques and protocols for cross-walking data from various sources. (e.g. plot, aerial P., Sat)
(4) Forage-based livestock Systems
Problem:
-Lack of information, research needs for consistency for grass fed beef. This question goes across disciplines; production of animal; what is product endpoint (quality and consistency), human nutrition—matching forage quality with animal needs.
Objective:
-Matching forage quality with animal needs
-increase uniformity of end-product and quality and production system
-Work with NP 101 and human nutrition NP to develop cross-program emphasis.
- Impact of grass-based systems on the ecosystems services
Tools:
-Decision support system, forage quality for finishing
-Standards of quality; operational and product
-extending the grazing season

Rangeland management systems

<u>Associated text for component (couple of paragraphs maybe):</u>
Multiple ecosystem services, livestock production and conservation (restoration). Application of management/conservation practices at landscape scales. Use of legacy data (retrospective analyses for determinations of climate variability effects on livestock production, assessment of effectiveness of conservation/restoration practices applied on BLM, FS and private ranches). Monitoring/assessment efforts to target ESDs, crosswalking of ground-based to

remote sensing, crosswalking of plots to landscapes. Management within context of climatic variability (proactive and reactive approaches, proactive is adaptation and resiliency, reactive is restoration and degradation). Incorporate administrative priorities of food security and climate change.

Problem areas (consensus is for 3)

1) Management systems for livestock production including enterprise scales (food security and adapting to climate change)

   [**Stacy, Mark P. and Kip** lead this effort: Need paragraph or two of explanatory text here tying below objectives all together; Need to develop diagram showcasing collaborations among locations]

   a. Grazing based livestock production systems

   Products: extended grazing season, cow efficiency

   Locations: Logan, Miles City, Mandan, El Reno, **Woodward**

   b. Livestock as a management tool influencing plant communities and ecosystem services within climatic variability (address tradeoffs here)

   Products: Retrospective analyses of legacy data regarding livestock production and climate, Drought response strategies (post-drought recovery)

   Locations: Cheyenne, **Miles City**, Dubois, Mandan, Burns, Logan (Panter), Woodward, El Reno, Boise

   c. Poisonous plants

   Products: Less Dead animals

   Locations: **Logan (Panter),** Miles City, Logan, Dubois

2) Managing rangelands using landscape approaches for multiple ecosystem services (adapting to climate change)

   [**Chad and Mark W**: Need paragraph or two of explanatory text here tying below objectives all together; Need to develop diagram showcasing collaborations among locations]

   a. Restoration of degraded lands and conservation of non-degraded lands

   Products: Development of integrated tools involving grazing (multiple species, targeted grazing), Retrospective analyses of legacy data from prior application of restoration practices for determination of effectiveness (from BLM, FS, private ranches)

   Locations: Logan, Woodward, El Reno, Reno, **Burns**, Boise, Mandan, Miles City, Logan, Las Cruces

   b. Application and assessment of management practices at multiple scales (landscape management)

   Products: Decision support tools for determination of where on the landscape to apply practices to increase effectiveness, Development of integrated tools involving grazing (multiple species, targeted grazing)

Locations: Las Cruces, Mandan, **Reno**, Burns, Boise, El Reno

3) Basic science (climate variability, spatial and temporal aspects, GraceNet, CEAP)
(explanatory text here from Jeff Herrick related to ESD document involving NRCS, BLM and FS with ARS responsibilities. Explain where these products/information are used in problem area 1 and 2 above)

[**Kevin, Fred and Jeff**: Need paragraph or two of explanatory text here tying below objectives all together, Need to develop diagram showcasing collaborations among locations]

a. Development of genetics and germplasm materials

Products: Plant germplasm releases

Locations: **Logan**, Woodward (other ties to pasture germplasm development?)

b. Ecological processes (plants, soils, water – transitions/thresholds/restoration pathways for S/T models included here)

Products: STM models, interpretations of ESDs, Data for GraceNet, CEAP products (models), Cross-walking of ground-based data with remote-sensed data, Cross-walking of plot to landscape data, Plant germplasm releases

Locations: **Boise**

seedlings (Burns, Woodward, Reno, Boise, Logan)

GraceNet (Mandan, Cheyenne, Woodward)

Soils (Miles City, Las Cruces)

ESDs/STMs – focus on plant community changes (transitions/thresholds/restoration emphasis) (Las Cruces, Cheyenne, Burns, Logan, El Reno, Woodward, Miles City, Dubois)

Hydrology and wind erosion (Reno, Boise, Las Cruces, Tucson-NP211 stuff)

c. Landscape analysis

Products: remote sensing platforms, statistical/survey design, ground-based indicators

Locations: **Las Cruces**, Mandan, El Reno, Boise, Boise, Reno

<u>Tasks:</u>
Webinars (Las Cruces)
Working group with Pastures: Tony/Lance
Lead locations determined for each objective (see bolded location)
All locations in each objective send couple sentences to lead Location (bolded) in next 10 days.
Send template on this to all
April 29 timeline for DRAFT completion of Action Plan
Send documents to Tony/Justin

All Groups Combined 3/16/11

Comments on Customer portion of the meeting
Need professional facilitators
Range group needed specificity (maybe split out by regions)
Pasture folks got more specificity
Small groups worked well
Public vs. private lands for rangelands
Pre-action plan information was largely covered by customers
Potential cross National Program issues (forage-based systems), good effort to remove stovepipes
More comfortable split of ARS scientists and customers
Clearer presentation of the "big picture" of ARS and NP215
Many scientists in forages and harvested forages areas went to bioenergy part of the meeting
Maybe have 2-3 regional meetings (western, central, eastern)
More agency representation this time (had Forest Service this time)
How to get more self-employed producers to the meeting?
Could we get customer input/recommendations via email or website prior to meeting?

Draft Action Plan
Define problem areas that are reflected in PDRAMs – needs to be a tight linkage
Need a diagram to show collaborations among locations
How to handle economics?
Cost-benefit analyses, life cycle analyses?
Do need to show economics for impact
Need economics in impact part of the accomplishments submitted for annual report (and green sheets)
Where does it fit well, where does it put us into a box?
4 components: rangeland, pasture, harvested forages, turf
Components need to have additional text (1/3 page)
Then problem statement (and associated objectives – showcases national collaboration)
How to do CEAP and climate change? – maybe as objectives under problem statements
Do we use last action plan as a template to begin efforts on the new one?

Thursday, March 17, 2011

Component 2: Pasture
Problem Statements
1) Plant materials and related development tools
    a) Germplasm collection and cultivar development (Logan, El Reno)
    b) Tools to support germplasm development (Logan),
2) Pasture-livestock production
    a) Forage based production systems (lowering costs, reduced off-farm inputs, forage-animal efficiency, increased production, improved forage quality) (Logan, mixed pastures, Boonville, Beaver, Raleigh, Madison, El Reno, University Park (?)
3) Conservation tools
    a) Water quality (University Park, Beaver, Boonville, Watkinsville (?), Mandan, Las Cruces, Madison, Lexington, El Reno, Bowling Green (?))

b) Greenhouse gases and resilience to climate change (University Park, Mandan, Lexington, Beaver, Boonville, Watkinsville (?), El Reno)

Products

1) Higher digestible fiber forages, genomics of common grass species, genetic stocks for orchardgrass, genetic markers/QTLs and maps for trait based selection,
2) Management practice to extend grazing season, legumes in grass pastures to reduce fertilizer use, novel endophytes and pasture management for endophyte control, animal phenotypes that do well on low-input forage systems, best management practices for multi-animal species grazing, small ruminant pasture systems to minimize parasites, improved N use efficiency, optimal grass/legume combinations .
3) a) Forage Suitability Group definitions, pastureland assessment and monitoring technology, BMPs for manure (nutrient) management on pastures, indicators for recovery of degraded pasture, integrated NRCS conservation practices in a systems approach b) BMPs to sequester soil C and reduce soil and animal greenhouse gas emissions, management practices to adapt to changing climate, tests for rapid assessment of soil C and N

Collaborations:
Rumen methane (Animal GRACEnet): Beaver, Lexington, University Park, Boonville, Madison (?)
Small ruminant: Beaver, Boonville, Lexington, El Reno, Clay Center
GRACEnet: Mandan, University Park, Watkinsville, Boonville, Beaver, Raleigh
CEAP: El Reno, University Park, Beaver, Boonville, Mandan, Watkinsville, Madison, Las Cruces, Coshocton, Lexington, Brooksville, Temple, Fayetteville
Endophyte: Boonville, Lexington, Logan, Corvallis (?), Beaver, Beltsville, St Paul

Component 3:Sustainable harvested forage systems for livestock, bioenergy and bioproducts

Importance of harvested forages and their relationship to national priorities
Environmental services: water, C, nitrogen, soil
Animal nutrition and animals/animal products for human consumption
Biofuels

Problem Statement H: Need for improved plant materials that enhance the environment while improving the efficiency of harvesting and using grasses and forage legumes for livestock, bioenergy, and bioproducts.

Objective H1: Provide the scientific knowledge and technologies needed to develop plant materials that can be produced economically and efficiently converted to high-value products. (St. Paul, Logan, Madison, Lincoln, Prosser, others TBD)

Anticipated products and potential benefits:

- ☐ DNA markers and genetic stocks associated with traits of agronomic importance including yield and forage quality, abiotic stress tolerance (salt, drought), biotic stress tolerance (diseases, nematode and insect pests), and nutrient use efficiency.
- ☐ Identify microbes associated with forage plants that enhance plant health and productivity and improve soil quality and carbon sequestration.
- ☐ Knowledge of the key plant parameters required for increased digestibility, utilization, and bioproducts.

Objective H2: Develop improved grass and forage legume germplasm and varieties that can be produced in diverse environments and efficiently converted into livestock, bioenergy, and bioproducts. (St. Paul, Logan, Madison, Lincoln, Prosser, others TBD)

- ☐ Germplasm with for enhancing nutrient use efficiency, stress tolerance, and improving soil quality and soil health.
- ☐ Germplasm with improved quality for ruminant animal nutrition.
- ☐ Germplasm for grass-legume mixtures to satisfy diverse production systems and uses.
- ☐ Native legumes for drought and salt tolerance and increased nitrogen use efficiency. (Utah sweet vetch, cicer milk vetch, sanfoin)
- ☐ Germplasm for reduced input management systems.

Problem Statement J: Need for energy efficient and environmentally enhancing production systems for harvested forages.

Objective J1: Provide improved management practices that enhance the environment and increase the economic viability of growing, harvesting and storing forage grasses and legumes for livestock, bioenergy and byproduct systems.

- ☐ Management systems that increase biomass production while reducing inputs and retaining quality.
- ☐ Management systems for improved nutrient utilization, diverse production systems and environmental services.

Component 2. Pasture Management Systems and Components To Improve Production efficiency and Enhance the Environment

There is a need to develop and transfer sustainable technologies, germplasm, management practices and integrative strategies to improve the conservation and use of pasture agro-ecosystems to support livestock production and other natural resource values.

Problem Statement D: Need for appropriate plant materials to improve the production efficiency and enhance the environment in pasture-based livestock systems.

Research Needs: The research needs identified for this problem area are addressed in the following research objectives:

Objective D.1: **Collect or develop and evaluate new plant cultivars that are biologically diverse, tolerant of biotic and abiotic stresses, more competitive, improved quality, and are easier to establish and maintain in pastures**. (College Station, Logan, Woodward, Lexington, Madison)

Anticipated Products and Potential Benefits

Objective D.2: Provide greater efficiency in developing improved germplasm though collecting and characterizing germplasm; improving physiological, biochemical, and genomic techniques to describe and identify useful genetic traits; and improving tools and methods for developing improved forages. (Beaver, College Station, Corvallis, El Reno, Logan, Lexington, Madison)

Anticipated Products and Potential Benefits

Problem Statement E: Need for efficient pasture-based-livestock management systems.

Objective E.1: Develop forage-based livestock production systems that will lower

production costs, reduce the need for harvested feedstuffs, reduced inputs, increase marketable yields of animal products, while providing improved pasture management practices to improve and maintain forage production and quality. (Beaver, Booneville, Lexington, Raleigh)

Anticipated Products and Potential Benefits

Problem Statement F: Need for sound conservation practices to maintain and enhance the environment.

Objective F1. Refine and enhance pasture-–based conservation practices that reduce sediment and nutrient movement off farm, (University Park, Beaver, Booneville, Watkinsville, Mandan, Madison, Lexington, El Reno, Langston)

Objective F2. Develop pasture-based livestock systems to reduce greenhouse gas emissions, and increase resilience to changing climate. (University Park, Mandan, Lexington)

Anticipated Products and Potential Benefits

Component 2 Resources
Research objectives of 13 ARS CRIS projects coded to NP215 address the research needs of Component 2. ARS lead scientists for these projects are:
Beaver: David Belesky. Joyce Foster
College Station: Byron Burson
Corvallis: Gary Banowetz
El Reno: Bradley Venuto
Langston: Paul Bartholomew
Lexington: James Strickland
Lincoln: Kenneth Vogel
Logan: vice-Jerry Chatterton
Madison: Michael Casler
Raleigh: Joseph Burns
Tifton: Jeffrey Wilson
University Park: Matt Sanderson

Component 3. Sustainable Harvested Forage Systems For Livestock, Bioenergy and Bioproducts
Bioenergy production has the potential to increase farm profits and to utilize crop surpluses while conserving soil and water resources and reducing our dependence on foreign oil. However, improvements in germplasm, management practices and production systems are needed to increase the economic viability and environmental sustainability of using harvested grasses, alfalfa, and other forages for bioenergy, and bioproducts in a way that is compatible with livestock production and conservation objectives.

Problem Statement H: Need for improved plant materials that enhance the environment while improving the efficiency of harvesting and using grasses and forage legumes for livestock, bioenergy and bioproduct production.

Research Needs: The research needs identified for this problem area are addressed in the following research objectives:

Objective H.1: **Provide the scientific knowledge and technologies**

needed to develop plant materials that can be produced economically and efficiently converted to high-value products while enhancing the environment. (Albany, Lincoln, Madison, St. Paul, Peoria)

Anticipated Products and Potential Benefits

Objective H.2: Develop improved grass and forage legume germplasm and varieties that can be more efficiently converted into livestock, bioenergy, and bioproducts that can be produced in a variety of environments. (Albany, Corvallis, Lincoln, Madison, Raleigh, St. Paul, Tifton)

<u>For Alfalfa and Other Forage Legumes</u>

Anticipated Products and Potential Benefits

<u>For Grasses</u>

Anticipated Products and Potential Benefits

Problem Statement J: Need for energy efficient and environmentally enhancing production systems for harvested forages.

Research Needs: *T*he research needs identified for this problem area are addressed in the following research objectives:

Objective J.1: Provide improved management practices that enhance the environment and increase the economic viability of growing, harvesting, and storing forage grass and legumes for livestock production, bioenergy and byproduct systems. (Corvallis, El Reno, Lincoln, Mandan, Madison, Peoria, St. Paul, Tifton, University Park St. Paul, Booneville)

Anticipated Products and Potential Benefits

Component 3 Resources
Research objectives of 12 ARS CRIS projects coded to NP215 address the research needs of Component III. ARS lead scientists for these projects are:
Beltsville: Gary Bauchan, Nichole O'Neil
Corvallis: Gary Banowetz
El Reno: Bradley Vanuto
Lincoln: Kenneth Vogel
Madison: Michael Casler, Rod Hatfield
Mandan: Jonathan Hanson
Prosser: George Vandamark
St. Paul: Deborah Samac
Tifton: Jeffrey Wilson
University Park: Matt Sanderson

Plant Improvement Subgroup
STRESSES…Turf (particularly cool-season grasses) and Alfalfa Industry….wants basic research

to develop parents (germplasm) that companies can put into their breeding programs for cultivar development.

A: Salt Tolerance..Mechanisms (Pathways)
Species

- Inland saltgrass - Logan
- Seashore paspalum - Tifton
- Alkaligrass – Madison
- Alfalfa – (Logan)

Mechanisms - Pathways

- Functional genomics
- May need to narrow to preliminary work to one (two?) species

B: Water (drought/heat) –

- % decrease in water use
- Increased water use efficiency (tie into carbon sequestration)
- Heat tolerance
- Reduce peak demand
- Recuperative potential
- Physiological factors associated with drought (flowering)

Mechanisms – Pathways

- Functional genomics

Species:

- Alfalfa – Beltsville/Prosser/California….(geneticist)
  Prosser….Verticillium; Stem nematodes
- Perennial ryegrass – (Logan-water use efficiency/drought/heat/….
  Beltsville-biotic factors flowering insect/disease/heat….)

C: Diseases/Insect…Host plant resistance….
currently have that capacity…but takes a long time…

- Grubs (turf)
- Blackgrass (forages) …no location
- Billbug (turf) …no location
- Alfalfa weevil (forages) … no location
- Leaf Hopper (Alfalfa/St Paul and Prosser, WA)
- Endophyte..interaction…(Lexington, KY, Logan, UT)
  - How do endophytes influences response to stresses (drought, insects, heat)
    (Kentucky/Logan; tall fescue..turf)….Collaborate with entomologist
  - Understanding the relationship of Novel endophyte (non ergot producing)
    to stresses (Kentucky/Logan; tall fescue…turf)
  - Endophyte viability in stored seed….
- Orchardgrass (choke…Corvallis, OR)
- Agrostis brown patch/dollar spot/general snow molds (Turf….Beltsville/Madison)

Need for resistance…

D: Production Efficiency –

- Alfalfa…

(US Dairy forage lab, St. Paul Unit, Prosser…..need west site for production
and water use efficiency research..California)

1. reducing frequency of cuts with higher biomass to maintain quality
2. two year rotation to be utilized in corn production area…requires production in the establishment year.
3. Alfalfa/grass mixtures (US Dairy forage lab and St Paul)

E: Nutrient use efficiency –

- N-cycling…N fertilizer, reduce leaching…need provide alternatives (i.e., species) that can tolerate low inputs. (Poverty grass [*Danthonia*], Beltsville; Alfalfa, Madison)

F: Winter forage species…(reduce fall winter feed costs) … increased forage quality through fall and winter….tall Statured….wildryes, crested wheatgrass, Siberian wheatgrass, forage kochia, tall wheatgrass, intermediate wheatgrass…..(Logan, UT)