United States Department of Agriculture
Research, Education and Economics

Agricultural Research Service
Date: 12-4-07

Natural Resources Research Update

Title: Strategic and Tactical Prediction of Forage Production in Northern Mixed-Grass Prairie

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Keyword (select one):

	Water Resource Management
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	Air Quality
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	Rangeland, Pasture, & Forages
	Manure & Byproduct Utilization

	Integrated Agricultural Systems
	Water Availability & Watershed Management
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Summary:

Predictions of forage production derived from site-specific environmental information (e.g., soil type, weather, plant community composition, and management) could help land managers decide on appropriate stocking rates of livestock. This study assessed the applicability of the Great Plains Framework for Agricultural Resource Management (GPFARM) forage growth model for both strategic (long-term) and tactical (within-season) prediction of forage production in northern mixed-grass prairie. An improved version of the model was calibrated for conditions at the USDA–ARS High Plains Grasslands Research Station in Cheyenne, Wyoming. Long-term (1983–2001) simulations of peak standing crop (PSC) were compared to observations. Also, within-season (1983) forecasts of total aboveground biomass made for 1 March onward, 1 April onward, 1 May onward, and 1 June onward were compared to observations. The normal, driest, and wettest weather years on record (1915–1981) were used to simulate expected values, lower bounds, and upper bounds of biomass production, respectively. The forage model explained 66% of the variability in PSC from 1983 to 2001. The cumulative distribution function (CDF) derived from long-term simulated PSC overestimates

cumulative probabilities for PSC greater than 1338 pounds per acre. The generated CDF could be used strategically to estimate long-term forage production at various levels of probability, with errors in cumulative probability ranging from 0.0 to 0.16. Within-season forecasts explained 77%–94% of biomass variability in 1983. It was shown that monthly updating of the forage forecast, with input of actual weather to date, improves accuracy. Further development and testing of the forage simulation model will focus on the interactions between forage growth, environmental perturbations (especially drought), and grazing.

Text:

We illustrate the use of the above simulation results through 2 examples, 1 each for strategic and tactical planning. For strategic planning, Rancher A at the northern mixed-grass prairie site in Cheyenne, Wyoming, would like to determine the peak standing crop (PSC) that is equaled or exceeded 80% of the time (exceedance probability of 0.8). The rancher would like to base the long-term stocking rate on this level of forage production. Assume that a long-term record of PSC is not available. Rancher A uses the cumulative distribution function (CDF) of predicted PSC (Fig. 1) to estimate the PSC that has a 0.8 probability of being equaled or exceeded (i.e., cumulative probability = 1.0 – 0.8 = 0.2). Note that cumulative probability is simply one minus exceedance probability. From the predicted CDF in Figure 1, Rancher A determines that PSC = 870 lbs per acre (975 kg per hectare in Fig. 1) has a cumulative probability of 0.2. The rancher then estimates the number of livestock that can be supported by 870 lbs per acre of forage production.

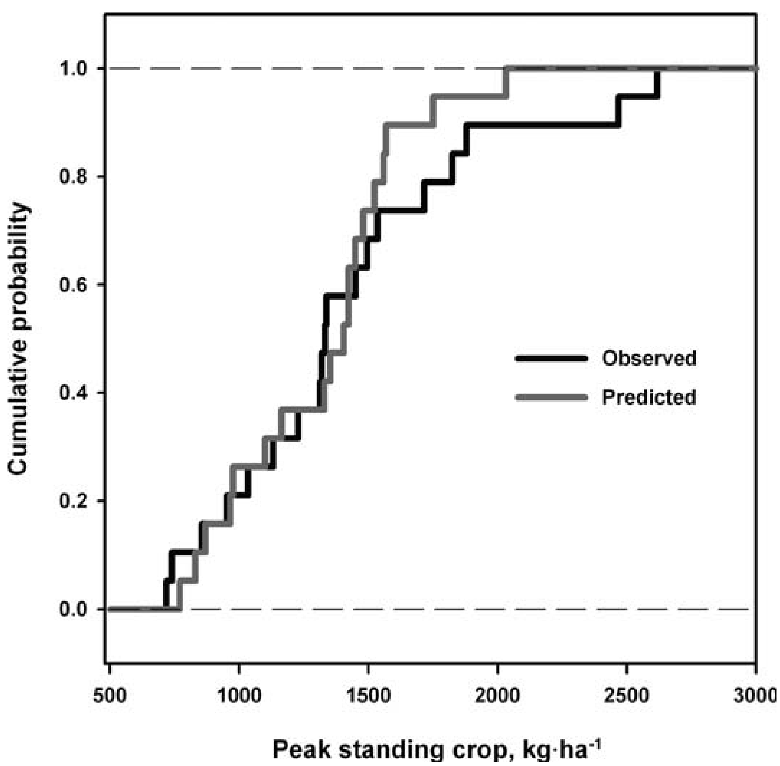

Figure 1. Empirical cumulative distribution functions of observed and simulated peak standing crop (1982–2001) at the northern mixed-grass

prairie site in Cheyenne, Wyoming.

For tactical planning, Rancher A wanted to adjust the stocking rate on 1 May 1983 based on forecasted forage production. At this date, the rancher knew that the average volumetric soil water content was 0.2. A nearby airport had a weather station with long-term records of daily weather. Rancher A had a consultant who previously calibrated the forage simulation model for the ranch. The consultant ran the model using the normal, driest, and wettest weather years on record to generate Figure 2. Rancher A knew that the ranch received 4.5 inches (113 mm) of precipitation in April 1983. The National Weather Service projected that precipitation in May 1983 had an equal chance of being above or below the long-term average. Rancher A then speculated that the ranch would receive the normal amount of precipitation in the April–May period. Therefore, Rancher A looked at the line for initial soil water content (SWCi) = 0.2 in Figure 2, took the point at normal April–May precipitation (5.9 inches = 150 mm); and determined that a peak standing crop of 1106 lbs per acre (1240 kg per hectare) could be expected. Rancher A then adjusted the stocking rate to a level that could be supported by 1106 lbs per acre of forage production.

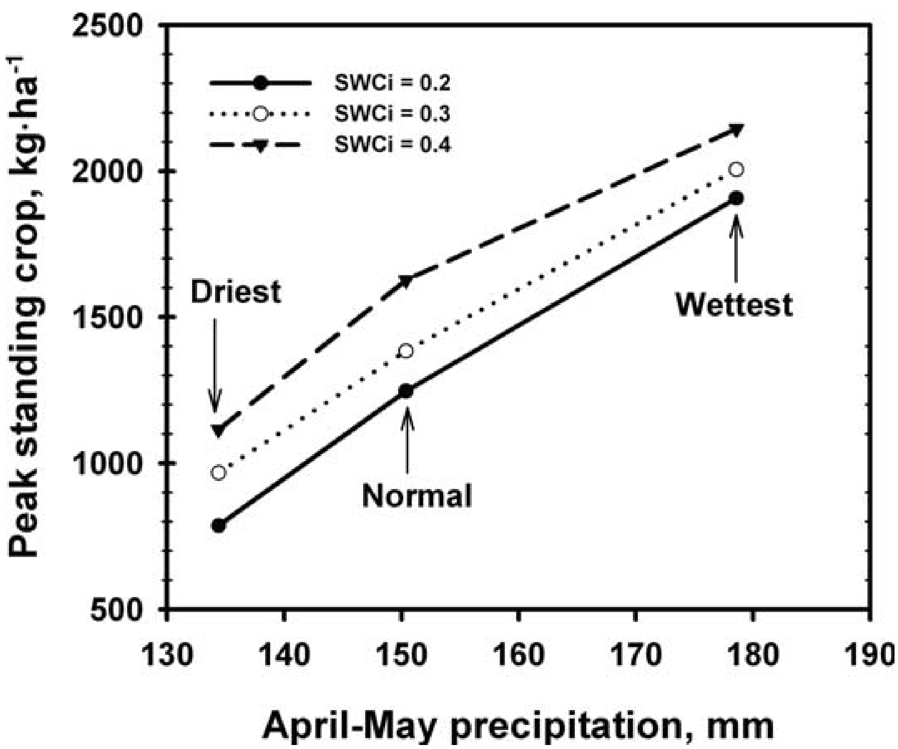

Figure 2. Peak standing crop forecasted for the period 1 May 1983 onward, related to April–May precipitation and initial volumetric soil water content (SWCi) on 1 May 1983 in the top 2 soil horizons (0–81cm) at the northern mixed-grass prairie site in Cheyenne, Wyoming.

The 2 examples assumed that adequate information was available to calibrate the forage simulation model and that the forecasts were reliable. Similar applications of the model at other locations will require at least 1 season in which biomass growth, preferably by functional group, has been observed or sampled. Soil layer textures (% sand, silt, clay) and bulk densities of a representative soil profile must also be available for input to the model. Daily weather records may be from an on-site or nearby weather station. Also, long-term weather records are needed to generate a simulated cumulative distribution function of PSC. These are also needed to identify the normal, wettest, and driest weather years.

Reference

Andales, A.A., J.D. Derner, L.R. Ahuja and R.H. Hart. 2006. Strategic and Tactical Prediction of Forage Production in Northern Mixed-Grass Prairie. Rangeland Ecol Manage 59:576-584.