Forage Grass-Legume Mixtures for Maximizing Profit

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Forage grown for hay production in Wyoming is the state’s most important crop in terms of value (the total value in 2013 was $390, according to Wyoming 2014 Agricultural Statistics). The area of grass hay production in Wyoming is also large. In 2013, for example, nearly 55% of the 990,000 acres planted in hay was cultivated with grass (the remaining was in alfalfa). Grass hay growers in the state use a substantial amount of nitrogen (N) fertilizers to increase productivity. Chemical fertilizers, however, increase production costs and can degrade the soil and environment if not used appropriately. Moreover, grass hays can be low in nutritive quality and are often supplemented with protein to feed cattle, which increases the cost of cattle production. Since legumes fix free atmospheric N, grass-legume mixtures may be a better option to reduce production costs, improve net economic return by boosting productivity and quality of hay, and lessen environmental impacts. However, information comparing the economics of grass and legume mixtures and monocultures is sparse for Wyoming.

Objectives
The objective was to compare the net economic return of N-fertilized monoculture grass, monoculture legume, and 50-50% grass-legume mixture in hay production systems.

Materials and Methods
The study was conducted at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle from 2011 to 2014. Five treatments were used with varying seeding ratios of two grasses (meadow bromegrass and orchardgrass) and one legume (alfalfa). Treatments included N-fertilized monoculture meadow bromegrass, N-fertilized monoculture orchardgrass, monoculture alfalfa, 50-50% alfalfa-meadow bromegrass, and 50-50% alfalfa-orchardgrass. Nitrogen fertilizer at 134 pounds N per acre as urea was applied to only monoculture grass plots. The experimental design was a randomized complete block with three replicates. Plots were harvested three to four times each year from 2012 to 2014. Forage dry matter yield was recorded at each harvest.

The economic analysis was performed by using a net present value (NPV) approach with a 3% discount rate to identify the most profitable treatment (discount rate refers to the interest rate used to determine the present value of future cash flows). The budget for production costs, inputs, and revenues for each treatment and year was calculated based on actual operations at the study site. The prices for alfalfa, alfalfa-grass mixture, and grass hay were obtained from the U.S. Department of Agriculture’s National Agricultural Statistics Service database. The unit price of hay was based on crude protein content.

Results and Discussion
Variations were observed among the treatments for the total NPV during the four-year study period. The 50-50% mixture of alfalfa-meadow bromegrass (Figure 1) provided the highest total NPV at $1,512 per acre, followed by the 50-
50% mixture of alfalfa-orchardgrass at $1,306 per acre over the four years (Table 1). The 50-50% mixture of alfalfa-meadow bromegrass provided 44 and 211% more net economic return than alfalfa and meadow bromegrass, respectively. Similarly, the 50-50% mixture of alfalfa-orchardgrass provided 25 and 292% more net economic return than alfalfa and orchardgrass, respectively. The higher net economic return from grass-legume mixtures was due to increased hay productivity (Table 1), even accounting for a decreased value of hay on a per-unit basis when compared to the monoculture alfalfa system. Another reason for increased economic return was due to reduction in fertilizer costs (compared to N-fertilized grass) and seed costs (compared to alfalfa). This could help hay producers reduce production costs and maximize profits.

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**Table 1. Effects of different combinations of grass-legume mixtures on total net present value (NPV) at SAREC from 2011 to 2014.**

<table>
<thead>
<tr>
<th>Treatments (ALF-MB-OG*)</th>
<th>Dry matter yield (ton/acre/4-year)</th>
<th>Total NPV ($/acre/4-year)</th>
<th>% Increased net economic return†</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-0-0</td>
<td>10</td>
<td>1047</td>
<td>-</td>
</tr>
<tr>
<td>50-50-0</td>
<td>15</td>
<td>1512</td>
<td>211</td>
</tr>
<tr>
<td>50-0-50</td>
<td>13</td>
<td>1306</td>
<td>292</td>
</tr>
<tr>
<td>0-100-0+N**</td>
<td>11</td>
<td>486</td>
<td>-</td>
</tr>
<tr>
<td>0-0-100+N</td>
<td>9</td>
<td>333</td>
<td>-</td>
</tr>
</tbody>
</table>

*ALF=alfalfa; MB=meadow bromegrass; OG=orchardgrass.

**N=nitrogen applied at the rate of 134 pounds per acre as urea.

†Based on N-fertilized 100% grass.