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## Alternative Annual Forage Crop Options for Northern Great Plains Cattle Producers: A South Dakota Case Study

by

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## Abstract

In the Northern Great Plains region, crop and livestock producers view forage crop production as an important component of their farm management system. During periods of increased environmental risk, alternative annual forage crops may provide producers with a risk reducing alternative to traditional forage crops.

An alternative forage crop production study (20 varieties) was conducted by South Dakota State University. Production yield data was analyzed using alternative decision making teria when outcomes are uncertain. Empirical results provide insight on forage crop planting decisions with respect to the importance of optimal harvest timing, and the ranking of alternative forage crops as a cash crop or as a grazing resource for livestock.

The management decision criteria used to evaluate the economic value of the forage crops included in this study are: a) Expected Value, b) Max-Min, and c) Minimum Variance. Triticale and Barley rank the highest with respect to Expect Value criteria, but Oats and Barley dominate based on risk avoidance criteria (Max-Min and Minimum Variance criteria). Rankings for summer forage crops indicate that sorghum varieties ranked the highest for economic value. However, the millet varieties rank higher with respect to the risk avoidance criteria.

Keywords: alternative forage crops, risk management, case studies

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**Alternative Annual Forage Crop Options for Northern Great Plains Cattle Producers: A South Dakota Case Study**

## Introduction

In the Northern Great Plains, annual forage crops are considered a major supplemental feed for livestock. Alternative forage crops can be of great value in developing a year round forage system. Increased livestock production in this region has fueled a growing demand for alternative forages. In this region, alternative forage corps may provide a risk management tool for livestock producers as protection against the increased threat of drought risk due to changing climate conditions.

Alternative forage crop systems can be used to provide early grazing before perennials are available, to extend the grazing period or to increase hay and silage production. However, these annual forage crops, both spring and summer season, differ in growth pattern and in forage quality. As a result, the estimation of "value of forage crops" would be of interest to producers and farm managers as a metric to gage the "economic advantages" of forage alternatives.

The value of a forage crop to a producer is dependent on individual circumstances. What will the forage crop be used for? Is the producers' goal to generate income or use forage as a risk management tool for livestock operations? Given these alternative economic reasons for planting forage crops, producers may wish to consider alternative management decision criteria to the standard approach of profit maximization. This study will investigate alternative forage crop questions important to producers, a) what is the optimal timing for harvesting forage crops?, and b) how do forage crops rank with respect to alternative management decision criteria?

Our approach to answering these questions is to evaluate biomass yield data collected from a forage experiment conducted by South Dakota State University in Western South Dakota. We use the data to estimate average market and grazing value of ten different species of annual summer and spring forages on rangeland. We evaluate each forage crop based on three commonly used management decision criteria for evaluating production decisions.

**Forage Study Background**

The forage study discussed in this paper considers ten different treatments of both cool and warm season forages. The study area is limited to the counties of Ralph, Oelrichs and Walls in South Dakota. Spring and summer season treatments were planted in six-row plots (5 ft. wide by 30 ft. long) using a John Deere 750 drill, calibrated to provide 10-inch row spacing. Except Glyphosate, no other herbicides were applied to the plots (as a burn down) just prior to planting. Nitrogen fertilizer (28-0-0) was applied at 50 lbs. per acre rate in all three locations.

The time of planting in this study occurred during the first week of April. In Ralph County, only three harvesting dates occurred beginning July 2, and weekly thereafter for cool season forage crops in 2008. For the years of 2009-2010, the number of harvesting periods for cool season is five and four, respectively. For the summer season forage, five harvesting dates starting August 11 and weekly thereafter were considered for all three years of 2008-2010. At each harvest date, forage yield was determined by harvesting four center rows five feet long with a Jeri mower. A subsample of about 500 grams was randomly selected from the harvested sample and dried to determine forage yield on a dry matter basis. Forage samples were collected at each harvest date for all three years to determine forage yield and estimation of benefits of forages.

The forage crops of interest include both cool and warm season forage crops commonly planted in the Great Northern Plains region. The warm season forage crops included: Teff Grass, Foxtail Millet (Manta, Golden German, and White Wonder), Proso Millet, Pearl Millet, Sorghum Sudan (Honey Sweet), and Cowpea. The cool or spring season annual forage included in this study are: pea (Arvika, Mozart), Hairy Vetch, oat (Troy), barley (Haybet), barley/pea, Spring Triticale (common), Spring Triticale and pea, spring wheat (Traverse).

**Economic Estimation Methodology**

The experimental design used in this study was randomized complete block design with four replications. The yield data collected is used to first estimate the economic value of the forage crops as a cash crop. Forage for sale as hay was estimated using USDA-NASS price data for South Dakota to determine gross and net revenue per acre (Box 1) for each forage crop. Next, we use a stocking rate calculation framework to determine the stocking rate for each crop. South Dakota cash rental rates per Animal Unit Month were used to estimate grazing value per acre based on the stocking rate for each variety of the ten annual forage crops (Box 2).

Gross revenue per acre as well as gross grazing value is calculated for each harvesting period of those forage crops. The harvesting period primarily is divided into five different periods to observe the change in amount of yield. Also, yield data for those forage crops is limited to 2008-2011 period. For this analysis, the average yield is calculated from all four replications for each harvesting period. USDA-NASS data for annual hay sale prices for years 2008 to 2011 were collected to estimate the market value of forage crops. The value of production for these specific annual forage crops are varied at each harvesting period.

Net revenue is based on optimal yield (Tables 1 and 2) estimates for each forage crop. Net revenue for forage sold as hay in the cash market and the net value of a forage crop used to graze livestock reflect the assumption that input costs are identical across forage crops except for seed cost. Thus, the net revenue estimates do not include land rental rates, fertile cost, planting and harvesting costs, etc. However, the level of these inputs into the production of the spring and summer forages was held constant across within each group. Thus, net revenue differences between crops reflect differences in market value based on production (yield) and seed cost across crops and harvesting periods. Seed cost data is provided in Tables 3 and 4.

**Empirical Results**

The empirical data collected from the forage crop production experiment is reported for only the harvesting period that produced maximum yield. Data reported in Table 1 identifies the harvesting period associated with maximum yield. The economic evaluation of production outcomes provides estimates for all harvesting periods to demonstrate how harvesting date affects economic outcomes. We begin with yield production results followed by the economic evaluation.

*Spring and Summer Optimal Annual Forage Yields*

Yield data reported is for optimal yield levels for the spring and summer forage production experiments by year and the three year average. Spring and summer forage yield production data is provided in Tables 1 and 2, respectively. Only the harvesting period generating optimal yield is report for each year of the experiment. Rankings are provided for the four best preforming crops in Tables 1 and 2.

The data indicates optimal yields for spring forage crops occur in mid to late July. Optimal yields for summer forage crops occur in late August to mid-September. Livestock producers who incorporate forage crop production into their livestock management system would benefit from developing a rotational gazing system that takes advantage of the six week gap in the optimal harvesting periods between spring and summer forage crops.

*Spring and Summer Optimal Annual Forage Net Revenues from Hay Sales*

Box 1 provides the methodology for estimating Gross and Net Revenue generated by the sale of forage as hay. Figures 1 and 2 provide a graphical presentation of the three year average gross revenue by harvesting period for spring and summer forage crops, respectively. Figures 1 and 2 demonstrate the importance that harvest timing plays in optimizing net revenues from hay sales. The data in Figures 1 and 2 are consistent with optimal yield estimates presented in Tables 1 and 2.

*Spring and Summer Grazing Value of Forage Crops*

Box 2 provides the methodology for estimating the grazing value of the spring and summer forage crops included in this study. Figures 3 and 4 provide a graphical presentation of the three year average grazing value of forage crops by harvesting period for spring and summer forage crops, respectively. The data in Figures 3 and 4 are consistent with the gross revenue estimates presented in Figures 1 and 2.

The grazing value data indicates that a rotational grazing system that incorporates spring and summer forage crops has the potential to provide livestock producers economically feasible feeding alternative for their livestock beginning in mid-summer and extending into early fall. For instance, a rotational grazing system that adopts Barley as a spring forage and Sorghum as summer forage, based on the three year average, will have about $220 per acre of forage value available to feed livestock. The additional advantage for a number of the alternative forage crops included in this study is their resistance to drought conditions (e.g. Sorghum, Millet, and Barley). For additional information see Alternative Field Crops Manual (http://www.hort.purdue.edu/newcrop/afcm/index.html).

**Decision Criteria**

decision to plant alternative forage crops is often motivated by the needs of the individual producer when faced with environmental conditions that increase the risk of traditional crop failure. For those producers who also raise livestock, this risk increases because traditional crop failure also means purchasing feed for livestock or selling livestock off when the land cannot support them.

The traditional farm management approach used to determine which crop to produce is to select the crop the producer believes will generate the highest expect net revenue (gross revenue minus production cost). However, the expected value approach may not always be the appropriate method upon which to base a production decision. In periods when the environmental risk of drought is higher than normal, producers who wish to develop a management strategy for this type of risk may be willing to consider alternative decision strategies that minimize the potential loss associated with a crop production decision.

An area of business studies that regularly deals with management decisions under uncertainty is Operations Management (e.g. Shim and Siegel 1999). Operations Management professionals use a variety of decisions strategy mechanisms that use a systematic approach to analyze production decisions when outcomes are uncertain. The traditional method used is the Expected Value (EV) approach. Assume the producer has a number (j) of crop production alternatives. Each crop alternative has a number (i) of potential grazing value, and net revenue outcomes based on weather, input prices, etc. Each possible outcome has an associated probability of occurring.

This approach requires that all possible outcomes ($O_i$) and associated probabilities ($P_i$) connected to a production decision alternative j be accounted for. The expected value of the $j^{th}$ production alternative is defined as:

1. $EV_j = \sum_{i=1}^{n} P_i O_i.$

The decision maker selects the production alternative with the highest EV. In our study, the expected value for each crop is based upon the three year average for yield, and net revenue.

However, the expected value approach does not take into consideration producer attitude toward financial risk. Economists may recommend the expected value approach to a producer who is indifferent to financial risk. However, for those producers who dislike taking on financial risk, then there are a number of other decision mechanisms producers can use to make production decisions. We will introduce two commonly used methods producers can adopt for the selection of alternative crop production decisions when traditional crop production failure risk is high. These two alternative decision criteria approaches are: a) the Max-Min decision method; and b) the Minimum Variance decision method. Each of these methods will be used to evaluate net revenue and grazing value outcomes for spring and summer forage crops evaluated in this study.

The Max-Min decision strategy advises the producer to examine the worst possible outcome for each production alternative and select the production alternative that has the best possible outcome if the worst case scenario occurs. This decision strategy minimizes financial loss if the worst case scenario occurs. During periods of high drought risk, producers who prefer to avoid excessive losses may view this decision mechanism as a prudent risk management alternative. In our study, we identify each forage crop's lowest annual net revenue and grazing value across the three year period of the study to determine crop rankings based on the Max-Min criterion.

The Minimum Variance decision strategy focuses on minimizing variability in production decision outcomes. This method advocates that the producer examine the variability of possible outcomes for each production alternative and select the production alternative that has the lowest variability. During periods of high drought risk, producers who prefer to avoid excessive variability in production outcomes may view this decision mechanism as a prudent risk management alternative. In our study, we calculate each forage crop's statistical range for annual net revenue and grazing value across the three year period of the study. The statistical range is calculated by subtracting the worst outcome from the best outcome for each production alternative. We then divide each crop's statistical range by its three year average to derive a proxy estimate for each crop's coefficient of variation.[1] The coefficient of variation will be used to determine crop rankings based on the Minimum Variance criterion. The coefficient of variation was selected because of the wide disparity across net revenue mean values for forage crops. Our decision rule for this method is to select the forage crop production alternative with the lowest coefficient of variation.

*Prices used for Alternative Forage Crops*

Tables 5 and 6 present the economic evaluation of summer and spring forage crops, respectively, using the three decision criteria methods discussed above. Economic evaluation in Tables 5 and 6 is based on the three year average for Net Revenue and Net Grazing Revenue for each crop based on optimal yields provided in Tables 1 and 2. Net revenue values were based on USDA reported hay prices: a) $86.58 per ton for the year 2008, b) $67.83 per ton for the year 2009, and c) $71.17 per ton for the year 2010. Animal Unit Month rental rates for western South Dakota were stable over the 2008-2010 per period and averaged $26.50 for all three years (Janssen and Pflueger, 2011).

*Decision Criteria Forage as a Cash Crop*

Decision criteria for the usage of spring forage crops as a cash crop (Table 6) indicates Triticale and Barley dominate the with respect to Expect Value criteria, but Oats and Barley dominate based on risk avoidance criteria (Max-Min and Minimum Variance criteria). For summer forage crops as a cash crop (Table 5) sorghum varieties rank as the top three summer cash crops. However, the millet varieties dominate with respect to the risk avoidance criteria.

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[1] The coefficient of variation is defined as the standard deviation of a random variable divided by its mean. When comparing the variability of two random variables with different means, the coefficient of variation provides a measure of relative variability that is not influenced by scale. We use a common small sample approximation, found in most introductory statistics textbooks for the standard deviation of a random variable: the statistical range divided by two.

*Decision Criteria for Forage Crops as a Grazing Resource*

Decision criteria for the usage of spring forage crops as a grazing resource cash crop (Table 6) indicate Triticale and Oat alternatives dominate the with respect to Expect Value criteria, but Oats and Barley dominate based on risk avoidance criteria. Grazing value for summer forage crops estimates (Table 5) rank the sorghum varieties as the top three summer forage crops. However, the millet varieties dominate with respect to the risk avoidance criteria.

**Empirical Findings and Recommendations**

- Spring and summer annual forage crops included in this study vary with respect to maximum yield and timing of harvest. The annual spring forages are being harvested at first week of July in every year of 2008-2010 whereas the summer annual forages harvested a month later (first week of August). Producers planting alternative forage corps as a source of feed for livestock should select a combination of spring and summer forage crops that will allow extended grazing of livestock from mid-summer to early fall.
- One of the major findings of this research is that the optimal timing of harvesting for both summer and annual forages plays a pivotal role in the management of forage crops. Maximizing the value of forage crops as a cash crop or as forage for livestock is dependent optimal yield at harvest and failure to time harvest correctly will lead to increased forage yield variability.
- The importance of alternative forage crops as a risk management tool can't be neglected from the producers' point of view. While summer forages like honey sweet, honey sweet BMR have a high grazing value throughout 2008-2010, they incur a higher financial risk relative to the millet varieties included in this study. For spring forage varieties, Triticale and Barley rank the highest with respect to Expect Value criteria, but Oats and Barley dominate based on risk avoidance criteria (Max-Min and Minimum Variance criteria).

## Conclusion

Clearly, there are no simple answers to questions on the economics of alternative forage crops and different production and procurement systems. The dollar amounts of those forages as grazing value help discuss the economic return on each harvesting period. The comparative economic analysis of this study will help farmers or ranchers decide regarding the optimal time of harvesting. Each treatment discussed in this study has different optimal time to harvest that should be considered by the producers of Northern Great Plains. However, every decision must start with a clear understanding of the costs involved and the impact of forage on animal performance and income. Costs of alternative feeds and quality of forages as crop and grazing must also be taken into consideration as part of the profit equation. Budgets can be developed to compare the profitability of alternative forage production and feeding systems. These budgets should incorporate any animal performance differences and the resulting effects on income or costs. Finally, during periods of increased drought risk, alternative forage crops do provide producers protection from financial loss that is associated with traditional forage crops.

**References**

Alternative Field Crops Manual (2012). University of Wisconsin-Cooperative Extension-University of Minnesota Center for Alternative Plant and Animal Products-Minnesota Extension Service.
(Also available online at http://www.hort.purdue.edu/newcrop/afcm/index.html accessed on June 30, 2012)

Benson Geoffrey A. and James T. Green, Jr. (2006). Forage Economics working paper. North Carolina Cooperative Extension Service.

Janssen Larry and Pflueger Burton. (2011). South Dakota Agricultural Land Market Trends 1991–2011. The 2011 SDSU South Dakota Farm Real Estate Survey. South Dakota State University Agricultural Experiment Station, USDA. Also available online at http://pubstorage.sdstate.edu/AgBio_Publications/articles/C278.pdf

Patterson Paul E. (2008). Economic comparison of forage crops for the Magic Valley. Proceedings, Idaho Alfalfa and Forage Conference, University of Idaho Cooperative Extension.

Spring and summer annual forage survey data (2012). This survey data and others can be accessed electronically from the SDSU College of Agriculture & Biological Sciences publications page, which is at http://agbiopubs.sdstate.edu/articles.

United States Department of Agriculture-National Agricultural Statistics Service data for Annual Hay Sale prices (2010). Also available online at www.nass.usda.gov/Statistics_by_State/Ag.../AgOverview_SD.pdf

**Figure 1: Average Gross Revenue (spring forage crops) by harvesting period (2008-2010)**

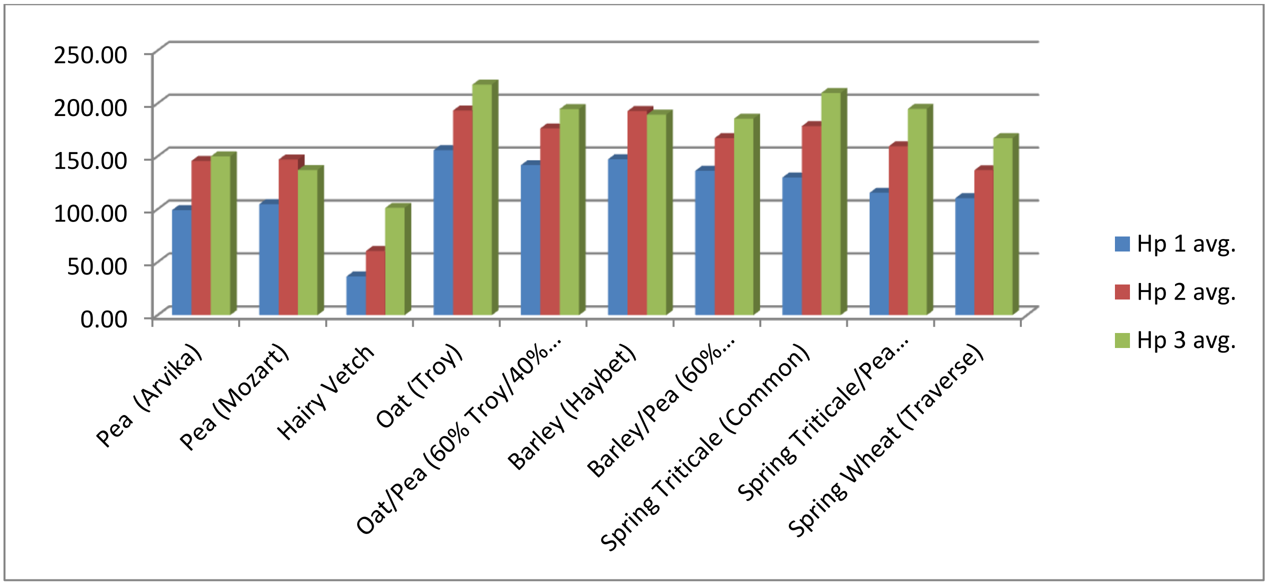


**Figure 2: Average Gross Revenue (summer forage crops) by harvesting period (2008-2010)**

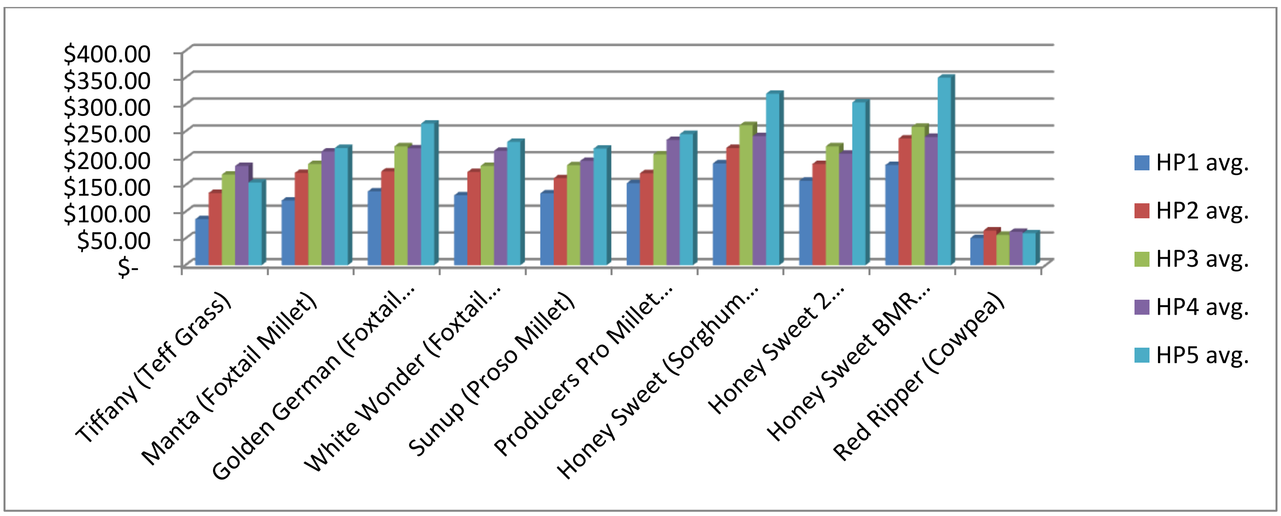

**Figure 3. Average Gross Grazing Value (spring forage) by harvesting period (2008-2010)**

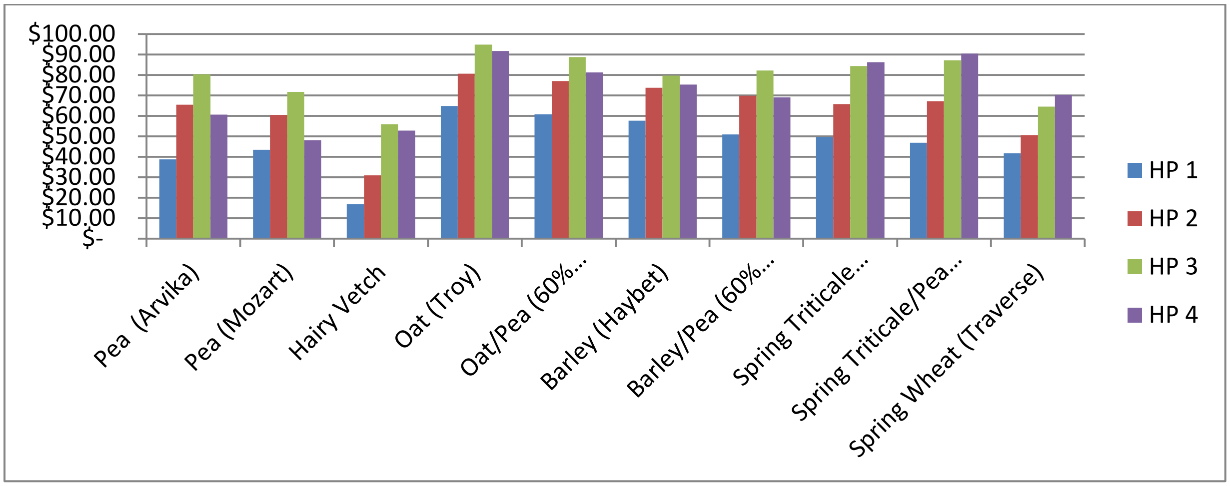


**Figure 4. Average Gross Grazing Value (summer forage) by harvesting period (2008-2010)**

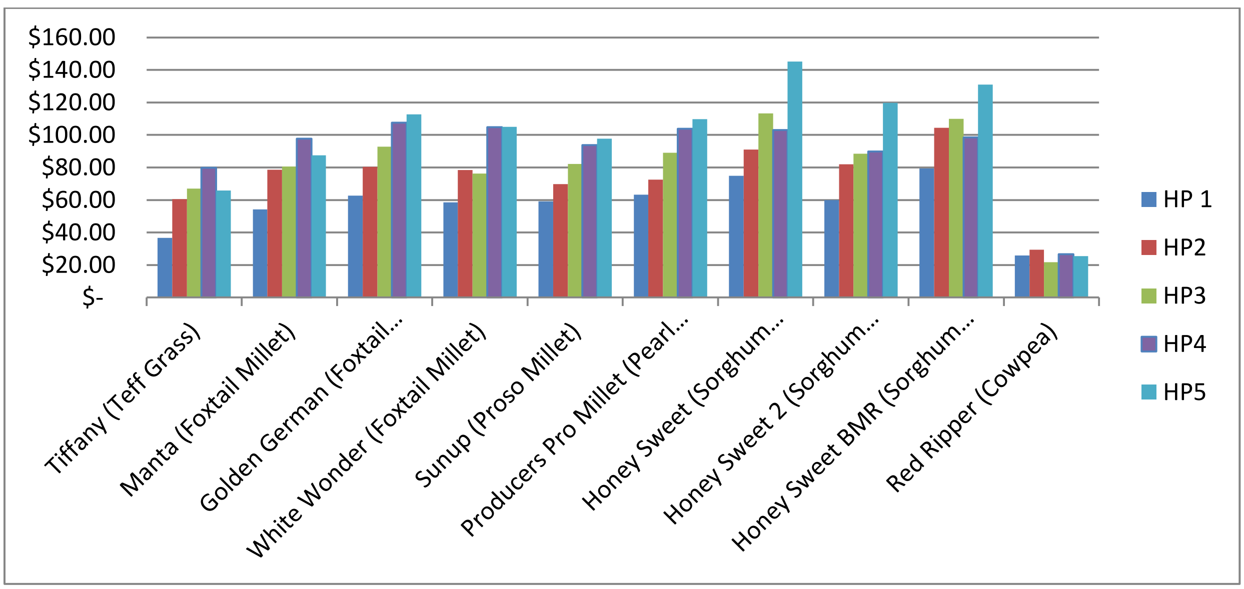

**Table 1. Optimal annual yield and harvesting time of spring annual forage: (lbs. per acre)**

| **Spring Annual Forage (2010)** | **HP1 (7/7/2010)** | **HP2 (7/14/2010)** | **HP3 (7/28/2010)** | **HP4 (8/4/2010)** | **HP5** |
|---|---|---|---|---|---|
| Pea (arvika) | | | 4950 | | |
| Pea (Mozart) | | 5650 | | | |
| Hairy Vetch | | | 4950 | | |
| Oat (Troy) | | | 6550 **(3)** | | |
| Oat/Pea (60% Troy/40% Arvika) | | | 6150 **(4)** | | |
| Barley (Haybet) | | 5150 | | | |
| Barley/Pea (60% Haybet/40% Ar) | | 5050 | | | |
| Spring Triticale (Common) | | | 6650 **(2)** | | |
| Spring Triticale/Pea (60%/40%) | | | 7250 **(1)** | | |
| Spring Wheat (Traverse) | | | 4500 | | |
| **(2009)** | 7/7/2009 | 7/14/2009 | 7/21/2009 | 7/28/2009 | 8/4/2009 |
| Pea (arvika) | | | 4750 | 4750 | |
| Pea (Mozart) | | | 4600 | | |
| Hairy Vetch | | | | | 3150 |
| Oat (Troy) | | | | | 5850 **(3)** |
| Oat/Pea (60% Troy/40% Arvika) | | | | 5350 | |
| Barley (Haybet) | | | | 6150 **(1)** | |
| Barley/Pea (60% Haybet/40% Ar) | | | 5000 | | |
| Spring Triticale (Common) | | | | | 6100 **(2)** |
| Spring Triticale/Pea (60%/40%) | | | | | 5800 **(4)** |
| Spring Wheat (Traverse) | | | | | 5250 |

| **(2008)** | 7/2/2008 | 7/9/2008 | 7/16/2008 | | |
|---|---|---|---|---|---|
| Pea (arvika) | | | 4750 | | |
| Pea (Mozart) | | | 4600 | | |
| Hairy Vetch | | | 2550 | | |
| Oat (Troy) | | | 5250 **(1)** | | |
| Oat/Pea (60% Troy/40% Arvika) | | | 4900 **(4)** | | |
| Barley (Haybet) | | | 5250 **(1)** | | |
| Barley/Pea (60% Haybet/40% Ar) | | | 5000 **(3)** | | |
| Spring Triticale (Common) | | | 4250 | | |
| Spring Triticale/Pea (60%/40%) | | | 4200 | | |
| Spring Wheat (Traverse) | | | 3550 | | |

Source: Field Experiment data at Ralph, SD. Optimal yield rankings for the four highest yielding crops in each production year is denoted in parentheses. HP denotes harvesting period. The three year average optimal yield rankings are: 1) Oat (Troy), 2) Spring Triticale/Pea (60%/40%), 3) Spring Triticale (Common), and 4) Barley (Haybet).

**Table 2. Optimal yield and harvesting time of summer annual forage: (lbs. per acre)**

| **Summer Annual Forage** | **HP1 (8/4/2010)** | **HP2 (8/11/2010)** | **HP3 (8/18/2010)** | **HP4 (8/25/2010)** | **HP5 (9/1/2010)** |
|---|---|---|---|---|---|
| Tiffany (Teff grass) | | 5000 | | | |
| Manta (Foxtail Millet) | | | | 7600 **(4)** | |
| German Golden (Foxtail Millet) | | | | 8600 **(2)** | |
| White wonder (Foxtail Millet) | | | | 8400 **(3)** | |
| Sunup (proso Millet) | | | | | 7600 **(4)** |
| Producers pro millet (Pearl Millet) | | | | | 7200 |
| Honey sweet (Sorghum sudan) | | | | | 9000 **(1)** |
| Honey sweet 2 (sorghum sudan) | | | | 6000 | |
| Honey sweet BMR (sorghum) | | 7000 | | | |
| Red Ripper (cowpea) | 2200 | 2200 | | | |
| | **8/11/2009** | **8/18/2009** | **8/25/2009** | **9/1/2009** | **9/8/2009** |
| Tiffany (Teff grass) | | | | 5700 | |
| Manta (Foxtail Millet) | | | | | 7200 **(1)** |
| Golden German (Foxtail Millet) | | | | | 7200 **(1)** |
| White wonder (Foxtail Millet) | | | | | 6300 **(3)** |
| Sunup (proso Millet) | | | | 6550 **(2)** | |
| Producers pro millet (Pearl Millet) | | | | 6150 | |
| Honey sweet (Sorghum sudan) | | | | | 6200 **(4)** |

| | | | | | |
|---|---|---|---|---|---|
| Honey sweet 2 (sorghum sudan) | | | | 4650 | |
| Honey sweet BMR (sorghum) | | | | 5200 | |
| Red Ripper (cowpea) | | | | 2500 | |
| | **8/11/2008** | **8/18/2008** | **8/25/2008** | **9/2/2008** | **9/8/2008** |
| Tiffany (Teff grass) | | | | 4490 | |
| Manta (Foxtail Millet) | | | | 3445 | |
| Golden German (Foxtail Millet) | | | | | 6685 |
| White wonder (Foxtail Millet) | | | | | 5400 |
| Sunup (proso Millet) | | | | | 4305 |
| Producers pro millet (Pearl Millet) | | | | | 7045 **(4)** |
| Honey sweet (Sorghum sudan) | | | | | 10965 **(3)** |
| Honey sweet 2 (sorghum sudan) | | | | | 12330 **(2)** |
| Honey sweet BMR (sorghum) | | | | | 13935 **(1)** |
| Red Ripper (cowpea) | | | | | 2135 |

Source: Field Experiment data at Ralph, SD. Optimal yield rankings for the four highest yielding crops in each production year is denoted in parentheses. HP denotes harvesting period. The three year average optimal yield rankings are: 1) Honey sweet (sorghum sudan), 2) Honey sweet BMR (sorghum), 3) Honey sweet 2 (sorghum sudan), and 4) Golden German (Foxtail Millet).

**Table 3. Seed cost and seeding rate of spring annual forage**

| Spring forage | Seeding rate | Cost/lb | Cost/ac |
|---|---|---|---|
| Arvika Peas | 100 lb | 0.45 | $45 |
| Mozart Peas | 120 lb | 0.42 | $42 |
| Hairy Vetch | 25 lb | 2.25 | $56.25 |
| Forage oat | 2.5 bu | 10.5 | $26.25 |
| Oat/pea | 100 lb | 0.40 | $40 |
| Barley | 100 lb | 0.40 | $40 |
| Barley/pea | 100 lb | 0.44 | $44 |
| Spring trit | 100 lb | 0.35 | $35 |
| Trit/pea | 100 lb | 0.42 | $42 |
| Spring wheat | 2 bu | 17 | $34 |

Source: Millborn Seed Co. provided cost data and reflects 2012 prices.

**Table 4. Seed cost and seeding rate of summer annual forage**

| Summer annual forage | Seeding rate | Cost/lb | Cost/ac |
|---|---|---|---|
| Tiffany (Teff Grass) | 8 lb | 4.50 | $36 |
| Manta (Foxtail Millet) | 25 lb | 0.50 | $12.5 |
| Golden German (Foxtail Millet) | 25 lb | 0.55 | $13.75 |
| White Wonder (Foxtail Millet) | 25 lb | | |
| Sunup (Proso Millet) | 25 lb | 0.40 | $10 |
| Producers Pro Millet (Pearl Millet) | 20 lb | 1.75 | $35 |
| Honey Sweet (Sorghum Sudan) | 18 lb | 0.85 | $15.3 |
| Honey Sweet 2 (Sorghum Sudan) | 18 lb | | |
| Honey Sweet BMR (Sorghum Sudan) | 18 lb | 1.25 | $22.5 |
| Red Ripper (Cowpea) | 50 lb | | $87.5 |

Source: Millborn Seed Co. provided cost data and reflects 2012 prices.

**Table 5. Management Decision Criteria for Summer Forage Crops (2008-2010 Average)**

| **Summer annual forage** | **Expected Value Net Revenue ($)** | **Max-Min Net Revenue ($)** | **Minimum Variance (CV) (%)** | **Expected Value Grazing Value ($)** | **Max-Min Grazing Value ($)** | **Minimum Variance (CV) (%)** |
|---|---|---|---|---|---|---|
| Tiffany | 193.32 | 193.32 | 35.97 | 94.94 | 26.65 | 35.96 |
| Manta (Foxtail Millet) | 268.67 | 95.45 **(1)** | 32.24 **(1)** | 127.82 | 36.38 **(4)** | 35.77 **(4)** |
| Golden German-Millet | 289.39 | 93.27 **(3)** | 33.89 | 144.64 | 45.80 **(2)** | 34.17 **(3)** |
| White Wonder - Millet | 245.54 | 86.48 **(4)** | 32.39 **(2)** | 121.10 | 42.47 **(3)** | 32.46 **(2)** |
| Sunup - Millet | 275.78 | 94.96 **(2)** | 32.78 **(3)** | 127.82 **(4)** | 46.64 **(1)** | 31.76 **(1)** |
| Producers Pro - Millet | 304.98 **(4)** | 86.48 **(4)** | 35.82 | 121.10 | 42.47 **(3)** | 32.46 **(2)** |
| Honey Sweet - Sorghum | 474.67 **(3)** | 66.13 | 43.03 | 180.92 **(3)** | 32.48 | 41.02 |
| Honey Sweet 2 - Sorghum | 533.77 **(2)** | 71.22 | 43.33 | 203.45 **(2)** | 34.98 | 41.40 |
| Honey Sweet BMR-Sorghum | 603.25 **(1)** | 67.83 | 44.38 | 229.93 **(1)** | 33.31 | 42.76 |
| Red Ripper (Cowpea) | 92.42 | 30.84 | 33.32 **(4)** | 81.65 | 17.24 | 39.44 |

Source: Field Experiment data at Ralph, SD. EV and Max-Min Reported as dollars per acre. CV reflects relative variability around the mean (i.e., the EV). Rankings are provided in parenthesis.

**Table 6. Management Decision Criteria for Spring Forage Crops (2008-2010 Average)**

| **Spring annual forage** | **Expected Value Net Revenue ($)** | **Max-Min Net Revenue ($)** | **Minimum Variance (CV) (%)** | **Expected Value Grazing Value ($)** | **Max-Min Grazing Value ($)** | **Minimum Variance (CV) (%)** |
|---|---|---|---|---|---|---|
| Arvika Peas | 176.15 | 50.87 | 35.56 | 83.25 | 24.75 | 35.14 |
| Mozart Peas | 201.06 | 61.05 | 34.82 | 95.03 | 29.70 | 34.37 |
| Hairy Vetch | 176.15 | 15.26 | 45.67 | 83.25 | 7.43 | 45.54 |
| Oat (Troy) | 242.42 **(4)** | 103.44 **(1)** | 28.67 **(2)** | 110.16 **(2)** | 50.33 **(1)** | 27.16 **(4)** |
| Oat/pea | 218.85 | 98.35 **(2)** | 27.53 **(1)** | 103.44 **(3)** | 47.85 **(2)** | 26.87 **(2)** |
| Barley | 257.58 **(2)** | 96.66 **(3)** | 31.24 **(3)** | 87.45 | 47.03 **(3)** | 23.11 **(1)** |
| Barley/pea | 216.45 | 79.70 **(4)** | 31.59 **(4)** | 84.93 | 38.78 **(4)** | 27.17 **(4)** |
| Spring triticale | 248.92 **(3)** | 71.72 | 35.59 | 111.84 **(1)** | 29.70 | 36.72 |
| Triticale/pea | 257.99 **(1)** | 61.05 | 38.17 | 100.91 **(4)** | 29.70 | 35.28 |
| Spring wheat | 220.78 | 71.22 | 33.87 | 75.68 | 34.65 | 27.11 **(3)** |

Source: Field Experiment data at Ralph, SD. EV and Max-Min Reported as dollars per acre. CV reflects relative variability around the mean (i.e., the EV). Rankings are provided in parenthesis.

**Box 1**

**Net Revenue of forage crop as a cash crop**

Yield per acre (lbs.) = Estimated forage crop yield at each harvesting period.

Gross Revenue = Cash hay price * yield tonnage.

Net Revenue = Gross Revenue - seed cost

**Box 2**

**Grazing revenue estimation framework**

Total available forage = (total production) * (estimated use) * (Allotment size)

= (6580) (0.5) (1acre)

Total available forage = 3790 lbs/acre

Estimated use assumes pasture will be grazed using the: take half, leave half rule (50%)

We assume average animal weight = 1000 lbs.

Forage consumed per day = (animal weight) * (average animal weight conversion factor)

Forage consumed per day = 1000 * 0.02667 = 26.67 lbs

Monthly intake = 26.67 * 30 days = 800 lbs

Stocking rate = Available forage / Pounds eaten per month

Stocking rate = 3790 / 800 = 4.73 animals/month

**Determine number of animals that can be grazed over allotted time:**

Assume, the allotment can be grazed for 1 month

Number of animals = AUM for class of livestock/ Number of month on allotment

Number of animals = 4.73 animals per month/ 1 month = 4.73 animals

**Grazing revenue** = **(cash rental rate per AUM) * (number of animals grazed over allotted time)**

**Net Grazing Revenue = Grazing Revenue – seed cost.**

Note: As the total production varies for every variety of spring and summer forage, the grazing revenue also changes (see figure 3 and figure 4 for details).

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