ANALYSIS OF PASTURE SYSTEMS TO MAXIMIZE THE PROFITABILITY AND SUSTAINABILITY OF GRASS-FED BEEF PRODUCTION

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Abstract

Three different pasture combinations of grass-fed beef production were evaluated for profitability and sustainability in the Gulf Coast Region. Systems 1 and 2 yielded higher profit than System 3. System 3 produced the lowest greenhouse gas impact. A trade-off was found between profitability and greenhouse gas impact among the systems.

Introduction

- Grass-fed beef production predates grain-fed beef production as a practice of raising cattle. Studies conducted during the 1970s and 1980s comparing grass-fed and grain-fed beef reported more favorable carcass qualities with grain-fed beef (Oltjen et al. 1971; Young and Kaufman 1978; Aberle et al. 1981; Fishell et al. 1985).
- Grass-fed beef has a growing niche that coincides with increased health and animal welfare concerns, as well as environmental perspectives (Fanatico et al. 1999; DeRamus 2004; Lozier et al. 2005; McCluskey et al. 2005).
- Production of grass-fed beef is considered to be not only a sustainable agricultural practice, but it also has animal welfare implications (Fanatico et al. 1999). DeRamus (2004) reported that grass-finished beef production helped in improving nutrient cycling and soil and water conservation, and reducing dependence on non-renewable resources.
- Umberger et al. (2002) found that 23% of consumers were willing to pay a $3.00/kg premium for grass-fed beef. Cox et al. (2006) reported 33% preferred forage-fed beef and were willing to pay premiums of $2.38-$5.63/kg. Prevatt et al. (2006) also reported a segment of U.S. consumers that preferred grass-fed beef.
- Gerrish (2006) found that selection of the highest energy pasture was crucial for grass-finished beef production. Of three grazing systems tested by Comerford et al. (2005) to evaluate animal performance and economics, animal performance did not differ by system, but net return did differ.
- The beef industry is important to the U.S. Gulf Coast Region. This region has abundant forage resources during most of the year. Bermudagrass, ryegrass, and wheat are the most common monocultures in this region. This region has potential for grass-fed beef production. Realizing the increasing importance of grass-fed beef production and the potential of this region to produce it, this study was designed to analyze the profitability of grass-fed beef production in three different combinations of pasture systems.

Experimental Data and Analytical Techniques

Treatment	Summer	Winter
System 1	Bermudagrass	Ryegrass
System 2	Bermudagrass	Ryegrass, rye, clover mix (berseem, red and white clovers), and dallisgrass
System 3	Bermudagrass, sorghum sudan, soybean	Ryegrass, rye, clover mix (berseem, red and white clovers), and dallisgrass

- The field experiment was conducted at the Iberia Research Station (IRS) in Jeanerette, LA, from 2009-2010 to 2011-2012. Three forage systems were managed in different sub-paddocks. 54 Fall-born steers were blocked at weaning by weight into 9 groups (6 steers/group). Each group was randomly assigned to 1 of the 3 treatments, each of which was replicated 3 times. During lean periods, animals were fed hay produced in the paddocks allocated to the system/replication group. Portable shades were available for animals in each pasture. They were moved with animals when rotated.
- Detailed cost, input, and output records were kept for each steer group. Thus, there were 9 sets of records per year, for a total of 27 sets of records for the 3 years.
- Differences in fixed costs, variable costs, returns, and net returns among the treatments were determined using a mixed model with fixed treatments, and year as a fixed repeated measure effect. The **Kenward- Roger Degrees of Freedom** method was used.
- Soil carbon emission data and soil samples were collected and analyzed by soil scientists. Net global warming potential (GWP) in kg of CO_2 equivalent for each treatment was determined similar to that conducted by Liebig et al. (2010), which included nitrogen fertilizer production and application (NPA), CH_4 emission from enteric fermentation (EF), change in soil organic carbon (ΔSOC), the atmospheric CH_4 flux, and the N_2O flux. Since the experiment was run for only three years, change in soil carbon was barely noticeable. Therefore, we used CO_2 flux instead of change in soil carbon for the GWP calculation. Carbon prices that would entice farmers to switch management practices (treatments) were determined.

Sorghum Sudan Pasture (System 3)

Animals under Shed on Bermudagrass Pasture

Results and Discussion

Table 1. Revenue, Expenses and Profit by Treatment (Dollars per Animal)

Activities	System 1	System 2	System 3
Steer Income	1327.83	1333.67	1315.06
Hay Income	833.24[bc]	669.81[ac]	474.35[ab]
Total Income	2161.07[bc]	2003.48[ac]	1789.41[ab]
Fertilizer Cost	238.37[bc]	173.50[a]	157.80[a]
Pesticide Cost	48.72	45.80	56.69
Livestock Cost	610.72	612.91	613.35
Other Cost	8.96[ab]	7.91[a]	7.41[a]
Seed Cost	8.52[bc]	144.28[ac]	204.11[ab]
Minerals and Medicine Cost	17.17[b]	17.91[a]	17.52
Diesel Cost	78.56[bc]	59.24[a]	50.85[a]
Repair & Maintenance	65.15[bc]	51.93[a]	48.28[a]
Interest Cost	46.87	48.43	46.59
Total Direct Cost	1183.70	1162.00	1199.57
Return over Total Direct Cost	977.30[c]	844.37[c]	589.74[ab]
Fixed Cost	218.15[bc]	172.98[ac]	150.35[ab]
Total Expenditures	1401.89	1335.07	1350.00
Return over Specified Expenses	759.07[c]	671.30[c]	439.31[ab]
Land Rent	82.17[bc]	74.17[ac]	72.01[ab]
Residual Return	676.67[c]	597.06[c]	367.26[ab]

Notes:
- Superscripts a, b, and c indicate the means differ from those of Systems 1, 2, and 3, respectively at $p < 0.05$.
- Residual Return = Total Return - Direct Expense - Fixed Expense - Land Expense

Table 1 presents return, expense and profit estimates.
- Steer income did not differ among the treatments.
- Hay income was highest for System 1 and lowest for System 3.
- Fertilizer expense for System 1 was greater than for Systems 2 and 3. This was due to higher usage of N-fixing legumes in Systems 2 and 3, which substituted for commercial N fertilizer.
- Seed cost differed among the systems with the lowest in System 1 and highest in System 3. This was due to the diversity of forages in System 3 as opposed to only bermudagrass and ryegrass in System 1.
- Diesel cost was higher in System 1 primarily because of the greater use of machinery for hay cutters and balers.
- Total direct expense did not differ among the systems, the major reasons being relatively high fertilizer and diesel costs in System 1 and higher seed and pesticide costs in System 3.
- Net profits per steer were $678, $597 and $367 for Systems 1, 2, and 3, respectively, with the net profits of Systems 1 and 2 being significantly greater than for System 3. Net profit per steer per year is presented in Figure 1.

Figure 1: Net Profit per Animal per Year

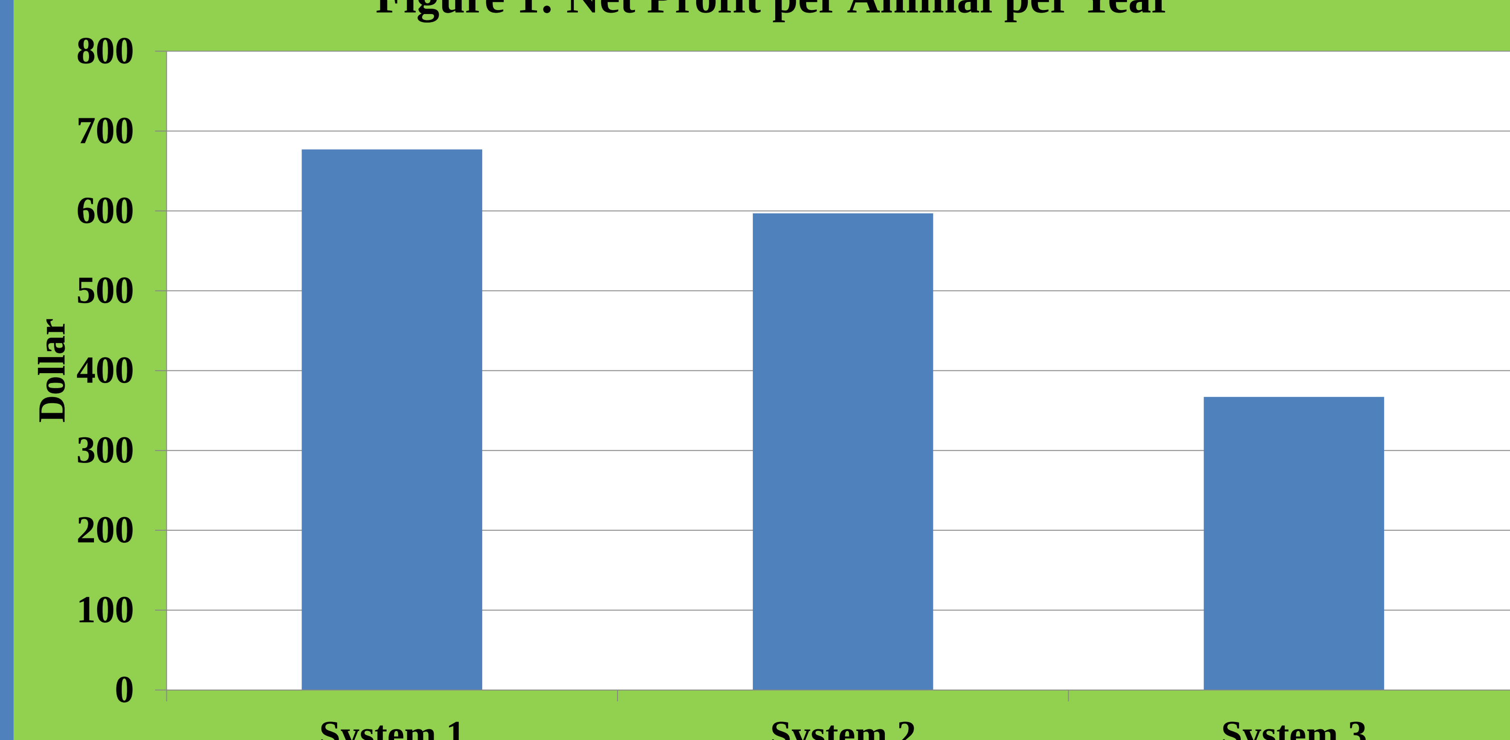
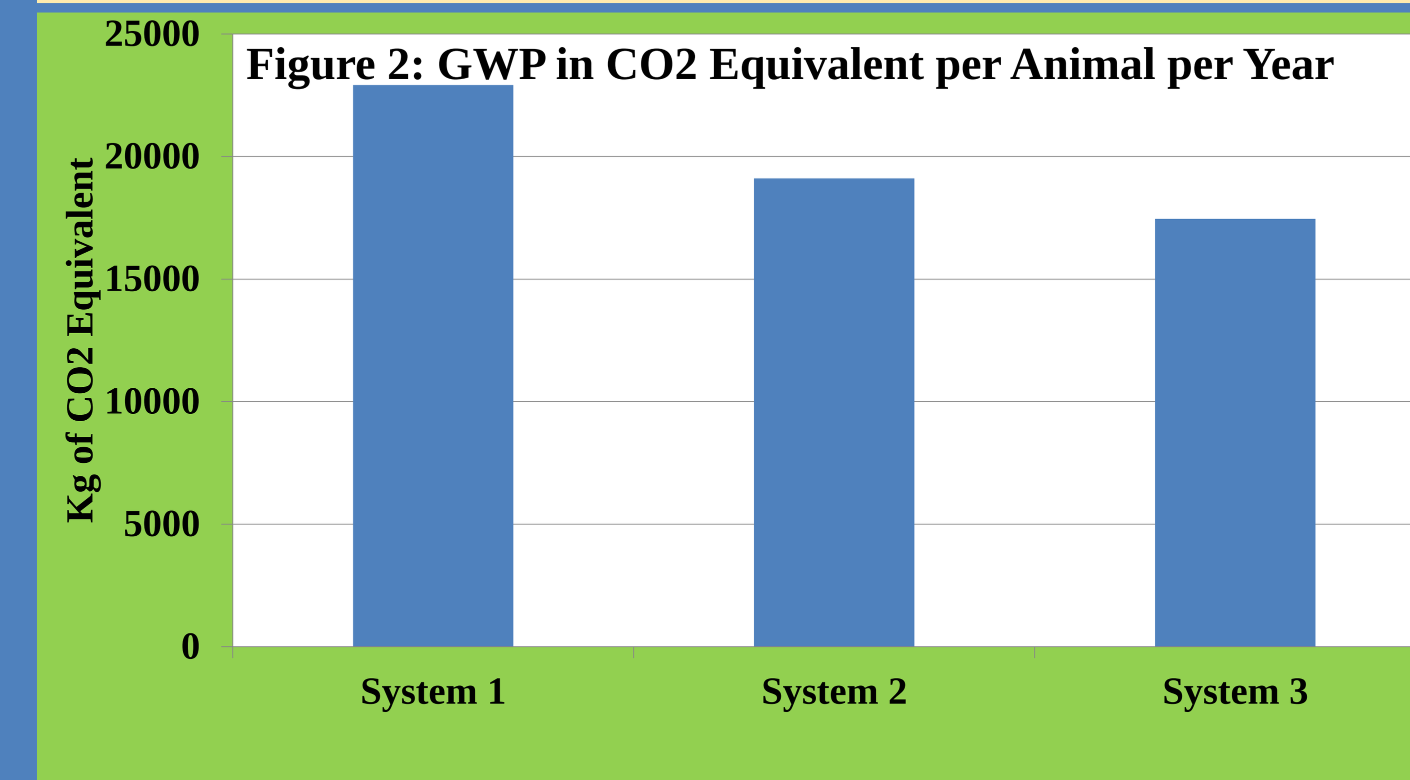


Table 2 Global Warming Potential as kg CO2 Equivalent per Year Among Systems

System	Kg CO2 Equivalnet per Year from Different Sources and Total as GWP						
	NPA	EF	CH4 F	N2O F	CO2 F	GWP	GWP/animal
System 1	5859	29401	2276	120970	253994	412499	22917
System 2	4325	29401	819	33164	276142	343850	19103
System 3	3966	29401	2007	36520	242364	314258	17459

Global warming potential in terms of kg of CO_2 equivalent per year for each system is presented in Table 2 and Figure 2.
- System 3 produced the lowest GWP per animal; System 1 produced the highest.
- Due to higher use of nitrogen fertilizer, CO_2 produced through NPA, CH_4 F, and NO_2 F is highest in System 1, which contributed to the highest GWP relative to the other pasture systems.

Figure 2: GWP in CO2 Equivalent per Animal per Year



Comparing results of Tables 1 and 2, the following trade-offs can be made:
- **System 2 versus System 1**: System 2 had 3,814 kg lower CO_2 equivalent GWP than System 1. Although net profit was lower in System 2, it was not statistically different from System 1. Since System 2 had lower CO_2 equivalent, it may dominate System 1.
- **System 3 versus System 1:** System 3 had $310 lower net profit and 5458 kg lower CO_2 equivalent GWP than System 1. If reduced CO_2 equivalent emission were valued at $0.06/kg, then Systems 1 and 3 would be economically equivalent.
- **System 3 versus System 2**: System 3 had $230 lower net profit and 1644 kg lower CO_2 equivalent GWP than System 2. If reduced CO_2 equivalent emission were valued at $0.14/kg, then Systems 2 and 3 would be economically equivalent.

Conclusion

From an economic point of view, Systems 1 and 2 are more profitable than System 3. There is no conclusive evidence that bermudagrass/ryegrass combinations differ in profitability as compared to bermudagrass, ryegrass, rye, dallisgrass and clover mix combinations. From a GWP point of view, System 1 produced the highest CO_2 equivalent GWP while System 3 produced the lowest. If reduced CO_2 equivalent emission were valued at $0.06/kg, then Systems 1 and 3 would be economically equivalent. Similarly, If reduced CO_2 equivalent emission were valued at $0.14/kg, then Systems 2 and 3 would be economically equivalent. System 2 may dominate System 1 because it produced statistically equivalent economic profit and has lower GWP than System 1.

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