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Benefit of Supplemental Forages in Naturalized Pasture Grazing System of the Appalachia Region, North America

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Abstract: Costs and benefits of supplemental forage production using a mix of warm and cool season forages with those from naturalized pasture in the Appalachia region of North America was studied. The objective was to determine the economic costs and benefits of warm-and cool-season forages grown on the same land relative to naturalized pasture and to develop and compare different systems of forage production. A system where Sudan grass, (*Sorghum bicolor* subsp. *drummondii*) was grown in summer and triticale (×*Triticosecale* Wittm. ex A. Camus) in fall produced the highest economic returns when nitrogen was applied @ 200 kg ha^{-1} and glyphosate used as a method of pre-plant vegetation control. Results of this study suggest that Sudan grass can be used to supplement naturalized pasture in summer and triticale (×*Triticosecale* Wittm. ex A. Camus) and a mixture of annual ryegrass (*Lolium multiflorum* Lam.) and turnip (*Brassica rapa*) in fall for high quality and quantity supplemental feeds. Much higher returns are possible if fall annuals are harvested again in spring.

Key words: Benefits % Supplemental forages % Naturalized pasture

INTRODUCTION

Appalachia is a region that stretches along the Appalachian Mountains from southern New York to Northern Mississippi in the USA. The region includes 406 counties including all of West Virginia, with beef production as a major agricultural activity. Beef production is mainly pasture based due to the region's mountainous terrain which limits arable farming. Economic analysis of a grassland system may be conducted using an enterprise budget. The budget represents costs and returns of a given crop or livestock production activity [1] and it guides farmers in decision making.

In a study by [2] the investment potential of using warm-season grasses for beef cattle feeding on hill-land areas such as those in West Virginia was compared with costs and returns of warm-season grasses with those of cool-season grasses. In their comparison they used four grazing systems and various species of cool-season and warm-season forages. They reported that pasture systems incorporating warm-season species yielded higher annual returns than those using conventional, cool-season grasses. In another study by [3] quantified the economic impact of substituting pasture for harvested forage for beef cow production and concluded that extended grazing can be a more profitable option than feeding hay for cow production because of a reduction in production costs. A study by [4] used stochastic budgeting to compare profit and risk levels experienced by grass-finishing and traditional beef producers. Results showed that producers raising beef on pasture face greater costs than those practicing traditional methods because of longer animal retention, more intensive pasture management, processing expenditure and seeding and fencing start-up costs.

Biomass yield and economic potential of several high-yielding annual and perennial crops on prime and marginal, sloping land in Pennsylvania, US was analyzed [5]. Forages evaluated were, reed canary grass (*Phalarisarundinacea* L.) harvested twice per year; switch grass and big bluestem (*Andropogon gerardii*Vitman var. *gerardii*); alfalfa (*Medicago sativa* L.); and sweet sorghum, forage sorghum [both *Sorghum bicolor* (L.) Moench] and maize (*Zea mays* L.). The intercropping of the two sorghum species into reed canary grass and alfalfa was also analyzed. All crops but alfalfa were fertilized with 0, 70, 140, or 280 kg N ha^{-1}, with economic analysis performed assuming 140 kg N ha^{-1}. Sorghums were most productive, with more than 16 t of

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dry matter ha^{-1}. Switch grass was the highest-yielding perennial crop. Costs per ton of biomass produced were lowest for sorghum, somewhat higher for switch grass, higher still for big bluestem and highest for alfalfa and reed canary grass.

Most farmers keep an inadequate accounting of inputs and outputs for the component enterprises of their livestock production systems. They do not know how different components in a pasture based production system contribute to overall profitability. Detailed information about the components is needed to understand costs and benefits of the whole system. There is, therefore, a need to develop and compare different pasture based production systems and determine their profitability for beef production.

This study examined the use of warm-season and cool-season annual forages to meet the feed demand of an Appalachian cow/calf production system in summer and winter. The study analyzed benefits of supplementing naturalized forage with annual forages. The objective of the study was to determine the benefits of warm-and cool-season forages grown on the same land relative to naturalized pasture and to develop and compare different systems of forage production.

MATERIALS AND METHODS

A study was set up in 2004 and 2005 on two adjacent sites in a naturalized grassland at the Reedsville Experimental Farm (39° 50'N lat: 79° 83' W longitude and altitude of 537 meters above sea level), West Virginia, USA, to determine economic benefits of different production systems (Table 1). The soils were in the Wharton series (clayey, mixed, mesic Aquic Hapludults). The systems involved growing various forages in summer and winter on the same land. The forages were naturalized pasture that received 0, 50 and 100 kg N ha^{-1} in summer and in fall.

Enterprise budgets were developed to compare the costs (establishment, fertilizer and harvest) and returns from annual forages compared to naturalized grassland. Total cost of production was estimated using standard budgets that break down costs into two major components, variable and fixed. Variable costs included costs that vary proportionally with the area planted, fuel, labor, machinery, seeds, fertilizer and herbicide. Fixed costs include items such as rent and depreciation that do not vary in the short run. Fixed costs were excluded because they are common to all systems. Thus, net returns are total crop value minus variable costs. The data used in the calculation of net returns were the averages of 2004 and 2005.

Seeds were purchased locally and their costs are given in Table 2. Cost of spraying and burning are based on commercial rates. For a typical commercial boom sprayer, which is 9.144 m (30 feet) wide with a speed of 6.4 km hr^{-1}, the cost of spraying was $ 12.50 ha^{-1} (Source: Rayburn, personal comm.). The cost of glyphosate was $ 17.75 liter^{-1}. The cost of burning based on the recommended rate for Vineyard and Orchard Flamers (Red Dragon GP-1000)*, that uses propane gas was $ 0.50 liter^{-1}. The cost of N fertilizer was $ 0.81 kg^{-1}.

Table 1: Description of alternative forage production systems.

		Sudan grass				Pearl millet				
		Vegetation Control				Vegetation Control				
Summer 1/	N level	Burn		Glyphosate		Burn		Glyphosate		Natural Pasture
	0	Sg, B, 0		Sg, G, 0		Pm, B, 0		Pm, G, 0		NP, 0
	50	Sg, B, 50		Sg, G, 50		Pm, B, 50		Pm, G, 50		NP, 50
	100	Sg, B, 100		Sg, G, 100		Pm, B, 100		Pm, G, 100		NP, 100
Fall		Burn		Glyphosate		Burn		Glyphosate		
		Tri	Mix	Tri	Mix	Tri	Mix	Tri	Mix	Natural Pasture
	0	Tr, B, 0	Mix, B, 0	Tr, G, 0	Mix, G, 0	Tr, B, 0	Mix, B, 0	Tr, G, 0	Mix, G, 0	NP, 0
	50	Tr, B, 50	Mix, B, 50	Tr, G, 50	Mix, G, 50	Tr, B, 50	Mix, B, 50	Tr, G, 50	Mix, G, 50	NP, 50
	100	Tr, B, 100	Mix, B, 100	Tr, G, 100	Mix, G, 100	Tr, B, 100	Mix, B, 100	Tr, G, 100	Mix, G, 100	NP, 100

Key: Tri= Triticale, Sg = Sudan grass, Mix = Mixture, B= Burning, NP = Naturalized pasture, G = Glyphosate, Pm = Pearl millet

Table 2: Type and cost of seeds

Type of Seed	Unit Cost ($ kg^{-1})	Seed Rate (kg ha^{-1})	Total Cost ($ ha^{-1})
Pearl Millet	1.57	454	70.65
Sudan grass	2.11	78	164.58
Turnip	17.49	3.4	59.47
Annual Rrye Grass	1.76	50	88.00
Triticale	0.55	70	38.50

1/ Crops planted in summer were harvested in August and the same land was planted with fall annuals as naturalized pasture acted as a control.

RESULTS AND DISCUSSION

Net returns per hectare over variable costs are summarized in Table 3. Revenues were calculated based on the same price per ton of DM of hay equivalent and the forage yields presented in Table 4. Variable costs include seed, fertilizer, propane gas, herbicide and labor. Machinery cost and labour were included in the cost associated with application of either glyphosate or burning.

The system producing the highest net return haG^{1} was naturalized pasture with 100 kg haG^{1} yG^{1} of N (Table 3). The high net return from naturalized pasture can be attributed to low input cost with no use of seeds, herbicides and establishment costs. As reported by [6], natural pasture moderately grazed may give higher economic returns than those that are intensively grazed. The good economic return from a system where Sudan grass was grown in summer followed by triticale in fall was attributed to high forage accumulation in summer that increased income. The high production in a system with Sudan grass as the species grown in summer is in agreement with the study by [5] who reported sorghum as the most productive annual forage compared to maize. Although systems involving naturalized pasture had higher net annual returns than those involving annuals, the latter can provide higher quantity and quality of forage in summer and fall when demands from weaned

Table 3: Net return per hectare over variable costs for different production systems

System[1]	Net Retur+n[2]		(US$ per ha.)			
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S-F-V-N	Spring	Summer	Fall 1	Fall 2	Total	Rank
0-0-0-1	296	98	114	227	734	1
0-0-0-0	296	137	135	111	678	2
0-0-0-2	296	74	70	211	650	3
2-2-2-2	0	159	-91	337	405	4
1-2-1-1	130	8	-31	232	339	5
1-2-2-2	0	52	-85	356	322	6
2-2-2-0	0	101	-64	278	313	7
1-2-1-2	130	-31	-46	259	312	8
1-2-2-1	0	5	-32	275	247	9
2-2-2-1	0	64	-78	300	222	10
1-2-2-0	0	18	-30	232	220	11
1-2-1-0	130	7	-53	129	213	12
2-2-1-1	130	-100	-63	221	188	13
2-2-1-2	130	-110	-87	245	178	14
2-2-1-0	130	-77	-66	150	137	15
1-1-1-0	130	7	-145	101(104)	93	16
2-1-2-2	0	159	-148	63(189)	74	17
1-1-1-2	130	-31	-139	107(138)	67	18
1-1-1-1	130	8	-128	56(170)	66	19
1-1-2-1	0	5	-35	48(228)	53	20
2-1-2-0	0	101	-134	71(163)	38	21
2-1-1-0	130	-77	-135	97(67)	15	22
1-1-2-2	0	52	-90	49(251)	11	23
1-1-2-0	0	18	-114	72(213)	-24	24
2-1-2-1	0	64	-158	66(193)	-28	25
2-1-1-1	130	-100	-162	102(118)	-30	26
2-1-1-2	130	-110	-168	117(119)	-31	27

Key: 1S-F-V-N, where S refers to summer species; 1= pearl millet, 2= sudan grass and 0 = naturalized pasture. F refers to fall species; 1= mixture of annual ryegrass and turnip, 2=triticale and 0= naturalized pasture. V refers to vegetation control; 0=control, 1= burning and 2=glyphosate. N refers to N level; 0= 0 kg ha-1 yrG^{1} ,1= 100 kg haG^{1} yrG^{1} and 2= 200 kg haG^{1} yrG^{1}

2Net returns= total crop value - total variable costs

Spring harvest= pre-plant harvest

Fall 1= November 15th harvest and Fall 2 refers to May 4th harvest.

Fall 2= May 4th 2006 harvest, numbers in parenthesis refer to revenue from turnip that was not factored in here but was factored in fall 1 net return because turnip harvest involve a whole plant.

Table 4: Forage accumulation from different production systems.

System*	Season				
	Spring	Summer	Fall	Total	Rank
S-F-V-N	kg ha^{-1} DM				
2-1-2-2	0	8573	3160	11649	1
2-2-2-2	0	8573	2230	10886	2
0-0-0-2	4929	2854	2779	10562	3
0-0-0-1	4929	2249	2813	10291	4
1-1-1-2	2163	3835	3351	9929	5
2-1-1-2	2163	4141	2865	9667	6
0-0-0-0	4929	2281	2244	9454	7
2-2-1-2	2163	4141	2346	9357	8
1-2-1-2	2163	3835	2645	9270	9
1-1-2-2	0	5138	3816	8968	10
2-2-1-1	2163	3606	2043	8704	11
1-1-1-1	2163	3403	2471	8570	12
1-2-1-1	2163	3403	2471	8570	13
2-1-1-1	2163	3606	2260	8343	14
2-1-2-1	0	6293	2290	8342	15
2-2-2-1	0	6293	1730	8265	16
2-1-2-0	0	5982	1981	7971	17
1-2-2-2	0	5158	2320	7485	18
1-1-1-0	2163	2836	1633	7286	19
2-2-1-0	2163	3069	1286	7225	20
2-2-2-0	0	5982	1217	7192	21
2-1-1-0	2163	3069	1435	7167	22
1-1-2-1	0	3675	3384	6959	23
1-2-1-0	2163	2836	1280	6832	24
1-2-2-1	0	3675	2203	5977	25
1-1-2-0	0	2982	2111	5100	26
1-2-2-0	0	2982	1536	4512	27

Key: Data are averages of 2 years (2004 and 2005).

*S-F-V-N, where S refers to summer species; 1= Pearl millet, 2= sudangrass and 0 = naturalized pasture. F refers to fall species; 1= A mixture of annual ryegrass and turnip, 2=triticale and 0= naturalized pasture. V refers to preplant vegetation control; 0=control, 1= burning and 2=glyphosate. N refers to N level; 0= 0 kg ha^{-1} yr^{-1}, 1= 100 kg ha^{-1} yr^{-1} and 2= 200 kg ha^{-1} yr^{-1}.

calves or stocker cattle may be higher. However, introducing annual forages in summer and fall require considerable establishment costs.

In summer, the DM production of Sudan grass was higher than that of pearl millet but the higher seed rate and cost lowered its economic ranking. In fall the mixture of annual ryegrass and turnip obtained low ranking because of high cost of turnip seed.

The systems where glyphosate was used as a method of vegetation control before establishing annual forages had higher net returns than those where burning was used. The higher net return of the system using glyphosate was attributed to low machinery and labor cost. The boom sprayer covers six times the width covered with the flame cultivator, thus saving labour costs.

CONCLUSIONS

The results of this study suggest that Sudan grass can be used to supplement naturalized pasture in summer while triticale or a mixture of annual ryegrass and turnip can be used in fall for both high quality and quantity supplemental feeds. Furthermore, fall annuals can be managed for residual harvest in spring increasing productivity and economic returns. Impacts on risk need to be investigated further in research.

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