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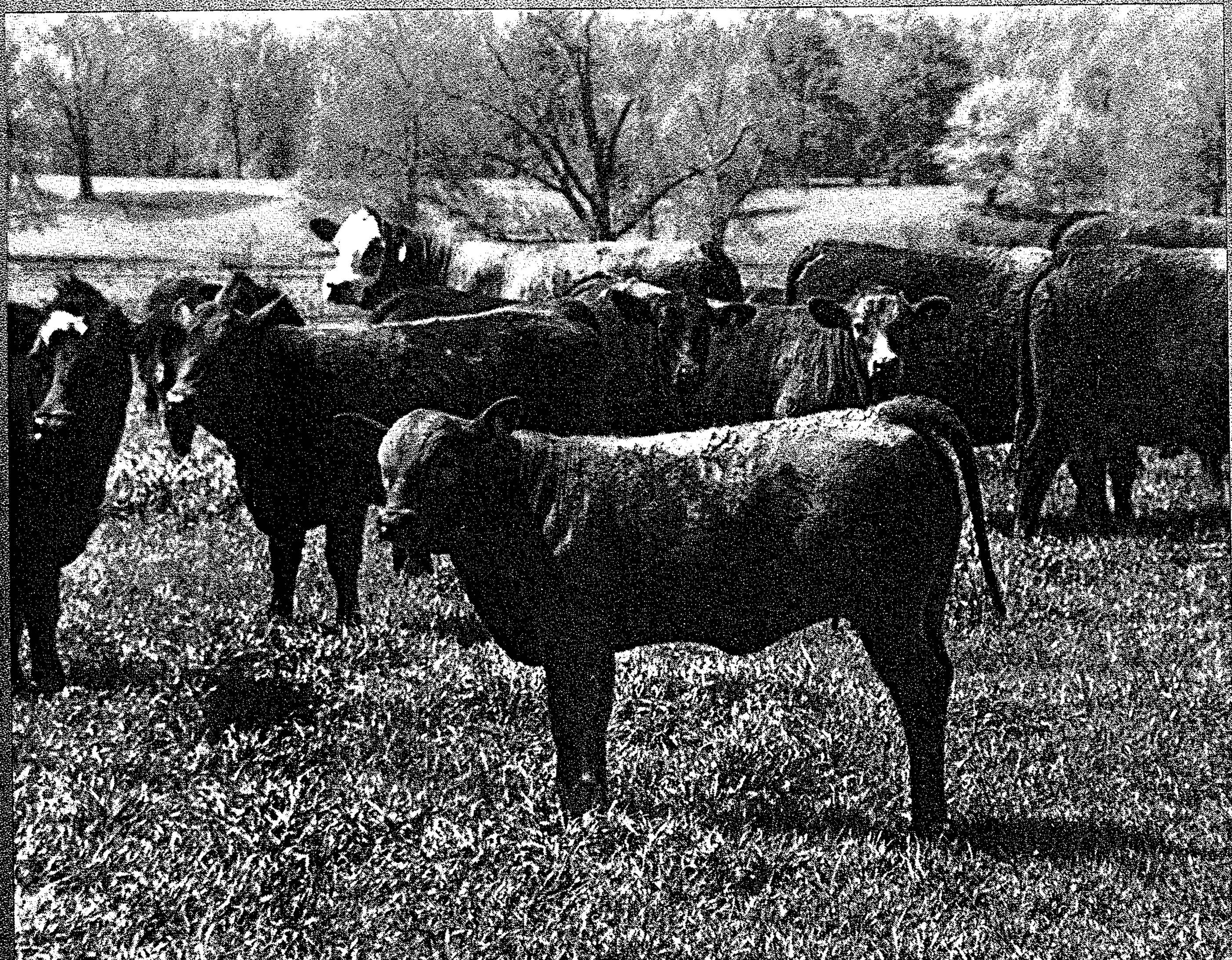

Economic Comparison of Cow-Calf Forage Systems
with Four Stocking Rates for South Mississippi

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Introduction

There continues to be a debate on whether costs, returns, and profits should be calculated on a whole-farm, per-head or per-acre basis. Another question often debated is if and how opportunity costs should be included in the farm financial statement.

A national standardized analysis for cow-calf production was developed by the National Cattlemen's Association (NCA) Cow-Calf Financial Analysis Subcommittee and the National Coordinating Committee on Integrated Resource Management (IRM). This group developed software for Standardized Performance Analysis (SPA) for financial and economic analyses (SPAF) to standardize analyses, terminology, and calculation procedures for cow-calf production nationwide. A clear distinction is made between financial and economic analysis. The economic analysis includes opportunity costs (McGrann, et al., 1991).

The primary purpose of this bulletin is to demonstrate how the SPAF analyses can be used to assess the finances and economics of various cow-calf production enterprises.

Bahiagrass and bermudagrass are important to cow-calf production systems throughout the lower coastal plains. The production, utilization, and profitability of either grass is affected by numerous individual management practices. Research indicates that higher stocking rates require higher production inputs, particularly nitrogen fertilizer (Allison, 1972; Cope et al., 1972; Neville and McCormick, 1976; Welch and Adams, 1963). Rotational grazing studies have shown that more frequent rotations with a larger number of paddocks can support higher stocking rates (Kingsbury, 1986; Pogue, 1987).

Experimental Procedures

In December 1986, an experiment was initiated using 76 pregnant cows calving in January and February of 1987 and 1988 (total of 152 calves). Data generated by these animals were used to compare the production and economics of four grazing systems with two replicates:

System A15. Alicia bermudagrass pasture with an intensive 15-paddock rotational grazing system (2- to 4-day grazing period followed by a 14- to 28- day rest period under normal conditions) and a stocking rate of 0.75 A/head.

System A3. Alicia bermudagrass pasture with conventional three-paddock rotational grazing and a stocking rate of 1.0 A/head.

System B15. Pensacola bahiagrass pasture with an intensive 15-paddock rotational grazing system and a stocking rate of 1.5 A/head.

System B3. Pensacola bahiagrass pasture with conventional three-paddock rotational grazing and a stocking rate of 2.0 A/head.

Pastures with three paddocks were permanently cross-fenced while those with 15 paddocks used Polywire® for temporary cross-fencing. Water was available to animals at all times. The study conducted was neither a stocking rate study nor a comparison of the number of paddocks in rotational grazing but a combination of the two.

Bermudagrass pastures (A15 and A3) were fertilized once annually with 200 lb/A of ammonium nitrate (early April and late May for nonoverseeded and overseeded pastures, respectively) and P_2O_5 and K_2O to soil test recommendations. Bahiagrass pastures (B15 and B3) received no fertilizer except residual fertilizer from overseeded ryegrass. Intensive rotational grazing was managed so that cows were rotated to new paddocks two or three times per week (A15 and B15). Grass height was estimated before and after pasture rotations so that grazing began before the sward was 6 inches tall and grazing terminated when grass height was between 1 and 3 inches. Grass taller than 6 inches was allowed to grow and was harvested for hay. After bermudagrass hay was harvested in System A15, 200 lb/A of ammonium nitrate fertilizer were applied to the harvested area. Hay yield (tons/A) was estimated by the number of large round bales.

Winter pasture area per cow was the same for all systems. A portion of each pasture system (0.67 acre per cow) was overseeded with Marshall ryegrass in October by using a broadcast seeder (35 lb/A) and chain-link harrow to cover seed after light disking. Ryegrass received 200 lb/A of ammonium nitrate at planting and again in February. (Overseeded areas were rotated to a different area within the respective systems annually.) All land area in System A15 was overseeded to ryegrass, and animals were wintered on hay fields outside their system until grazing began. Sixty days prior to calving, cows were fed hay and a 24% protein block (Purina Sup-R-Block®) *ad libitum.* Postpartum cows and calves limit grazed ryegrass pastures when forage was available, and continuously grazed when sufficient forage became available.

Cows were blocked according to breed type (1/2 Brahman, Beefmaster, and Barzona x 1/2 Hereford) across all forage systems and allotted to treatment groups. Sire breeds (Brangus and Simbrah) of the calves were represented across all systems. Nonpregnant and unsound cows were culled prior to calving and replaced by pregnant cows. After calving, cows that lost calves were replaced by cow-calf pairs. Calves were identified at birth and bull calves castrated. Cow weight and body condition scores were taken five times annually (mean dates = March 27, June 1, August 7, September 28, and December 8). Calves were weighed at birth, three times prior to weaning (March 27, June 1, and August 7) and at weaning (October 8, 1987 and September 19, 1988).

Only pesticides currently registered for use on pastures, hay fields, and beef cattle were used during the course of this study, with strict adherence to all label instructions. A commercial salt-mineral mix (12% Ca and 12% P) was available *ad libitum*. A high magnesium mix with 14% Mg was used during winter grazing periods to reduce the possibility of grass tetany.

Statistical analyses were conducted using the SAS GLM procedures. The linear model included year, system, and year x system interaction in a generalized randomized complete block design. The linear model for weaning weight included age of calf as a covariate and least squares means for weaning weight were computed for each system.

Replacement heifer cost of production was based on the following assumptions:

(1) One-half of heifer calves were retained at weaning as replacements.

(2) At 15 months of age, 23% of the heifers were culled based on weight, frame size, and/or pelvic area.

(3) Pregnancy rate for remaining heifers was 90%.

(4) Eighty percent of the first-calf cows rebred and were used as replacements in the mature cow herd.

These assumptions would require 48 acres of pasture to raise replacement females for a 100-cow mature herd at a 15% replacement rate. This replacement rate equals the expected culling rate of mature cows so that there would be no net change in herd size. All calves from mature cows were assumed to be born alive and live until weaning. Therefore, 15% culling of the mature cow herd is based on pregnancy, soundness, and other reasons (St. Louis, et al., 1990).

Budgets for each forage system were prepared following the format used in the Farm Management Handbook published by the Agricultural Economics Department, Cooperative Extension Service, Mississippi State University. When actual income and expense figures were not available, assumptions were made to approximate the economic situation in south Mississippi. Fixed expenses for replacement cows were based upon a replacement program used at the South Mississippi Branch Experiment Station since 1986 (St. Louis, et al., 1990). Heifers were calved at 2 years of age and were pregnant with their second calf before being classified as mature cows.

Financial and economic summary reports were generated using the SPA financial and economic analyses (SPAF). A distinct difference is made in SPAF between financial and economic costs.

A financial analysis uses basic accounting practices to determine the profitability of an enterprise. While information from other financial statements are important, an accrual-based income statement provides key data for a financial analysis. The income statement accounts for revenues and expenses, including cash operating expenses, interest, and noncash expenses such as inventory changes and depreciation.

An economic analysis includes both financial costs and a charge for the use of owned resources such as land and owner equity. This charge or opportunity cost is the return that a resource would earn if it were invested in another alternative.

The SPAF analyses are based on the number of mature cows and heifers of breeding age at the beginning of the year. Data from this study entered as inputs to SPAF reflect the operation of a 120-cow beef herd (100 mature cows

Table 1. Performance of cow-calf systems with conventional or intensive grazing of Alicia bermudagrass or Pensacola bahiagrass. MAFES South Mississippi Branch White Sand Unit, 1987-88.

		Grazing Management			
		Bermuda		Bahia	
SYSTEM		**Intensive A15**	**Conventional A3**	**Intensive B15**	**Conventional B3**
Stocking Rate	A/head	0.75	1.00	1.50	2.00
Paddocks per system	15	3	15	3	
CALF DATA					
Number of calves	head	32	48	32	40
Birth weight[a]	lb/head	70	74	75	76
Adj 205-day WW[a]	lb/head	479	487	491	503
Weaning weight[a]	lb/head	540	542	561	561
Least-Squares Means, Weaning weight[b]	lb/head	538	546	554	563
COW DATA					
Weight at weaning	lb/head	1,067	1,139	1,143	1,124
BCS[c] at weaning	5.0	5.2	5.5	5.4	
WW/CW[d] ratio	lb/head	.45	.43	.44	.45
PASTURE DATA					
Weaning weight	lb/A	718	542	376	280
Ammonium nitrate	cwt/A	4.23	2.73	1.37	1.37
Hay Production	t/A	1.07	1.34	1.04	0.53
Hay fed	t/A	2.48	0.62	0.82	0.37
Hay surplus (deficit)[e]	t/A	(1.41)	0.72	0.22	0.16

[a] Differences between mean values are not significant at the 5% level of probability.
[b] Least-squares means adjusted for year and age of calf.
[c] Body Condition Score.
[d] Weaning weight/cow weight.
[e] Hay surplus is sold from the mature cow herd, deficit is hay purchased.

plus 20 two-year-old first-calf cows). All costs in a cow-calf enterprise were included except labor, management, general overhead (telephone, utilities, etc.), and debt repayment costs. It was assumed that all land was owned and that 10% of the land was idle. The value of the owner's house, farm buildings, and homestead and cattle watering system were not included in assets. Direct noncash expenses for depreciation of machinery, equipment, buildings, and improvements were assumed to be the same for all systems except for fencing costs, which were adjusted for the number of acres. Miles of fencing have a direct relationship to stocking rate measured in acres per head.

Results and Discussion

Animal performance on a per head basis was similar (P=0.20) among the four systems. Weaning weights showed an inverse relationship to stocking rates — as stocking rates decreased, weaning weights increased. This is more apparent with least-squares means for weaning weights adjusted for replicate, year, and age of calf (Table 1). Lower cow weights and body condition scores in System A15 are a reflection of higher stocking rates (P=0.43). Weaning weight per acre reflect the differences in stocking rates.

Hay production was affected by stocking rates, fertilizer rates, and grazing management. System B15 produced more hay than System B3, yet System B15 had the higher stocking rate. The grazing management of 15 paddocks in System B15 allowed more land area to be used for hay production during periods of rapid forage growth than with three paddocks in System B3. System A15 produced less hay than System A3 even though it received more ammonium nitrate (Table 1). More paddocks and increased fertilizer in System A15 could not compensate in hay production for the increased grazing demand of the higher stocking rate. Extra nitrogen fertilizer was added to System A15 after hay harvests to insure sufficient grazing.

Table 2. Different evaluation criteria of a 120-cow herd using conventional or intensive grazing of Alicia bermudagrass or Pensacola bahiagrass. MAFES South Mississippi Branch White Sand Unit.

	Grazing Management			
	Bermuda		Bahia	
SYSTEM	**Intensive A15**	**Conventional A3**	**Intensive B15**	**Conventional B3**
Paddocks per system	15	3	15	3
Total acres[b]	171	172	228	283
Stocking rate, A/head[c]	0.75	1.00	1.50	2.00
ASSETS[d]	$/farm			
Livestock	113,600	113,600	113,600	113,600
Machinery & equipment[e]	44,887	44,887	44,887	44,887
Fencing[e]	4,786	4,798	5,519	6,156
Real estate assets[f]	114,115	114,691	151,728	188,765
TOTAL ASSETS	277,388	277,976	315,734	353,408
NET FARM INCOME-financial[g]	12,113	21,674	21,934	22,545
NET FARM INCOME-economic[h]	5,874	6,720	5,269	6,334
NET INCOME PER COW-financial	100.95	180.62	182.79	187.87
NET INCOME PER COW-economic	48.95	56.00	43.91	52.78
NET INCOME PER ACRE-financial	70.77	125.99	96.38	79.62
NET INCOME PER ACRE-economic	34.31	39.06	23.15	22.37
	percent			
FINANCIAL RETURN ON ENTERPRISE ASSETS (ROA)[i]	5.39	8.64	7.63	6.96
ECONOMIC RETURN ON REAL ESTATE INVESTMENT	19.13	20.67	13.29	11.99

[a] Mature cow herd = 100 head plus 20 head first-calf cows.
[b] Land for 100 mature cows plus 48 acres for replacement females and extra land for hay production.
[c] Stocking rate for 100 mature cows.
[d] Current assets (feed, bank accounts, etc.) not included.
[e] Market value of machinery, equipment, and fencing = 50% of cost.
[f] Real estate market value = $600/acre; no buildings (except pole barn); 10% idle land included.
[g] From Table 3.
[h] From Table 4.
[i] Gross margin from Table 3 divided by total assets x 100. Interest not included.

The entire pasture in System A15 was overseeded to provide 0.67 acre of ryegrass per cow for winter grazing. (The entire system provided 0.75 A/head. Remaining 0.08 A/head after planting ryegrass was not enough for winter feeding and calving.) Therefore, more hay was required in System A15 because there was less fall and spring grazing of bermudagrass. System B3 had 1.33 A/head remaining for grazing after 0.67 A/head was overseeded. Because of the larger area of bahiagrass pasture per cow, grazing in System B3 extended later into the fall and began earlier in the spring than in other systems. This reduced the amount of hay required. The growth of summer grass was delayed due to competition where ryegrass was overseeded.

Since weaning weights were not different (P=0.20) between production systems, an average weaning weight of 550 pounds was used for economic comparisons of systems. Steer calf weights were similar to heifer calves at weaning. It is a common practice to save the heaviest heifer calves for replacements and sell the rest. The average weight of steer calves was 50 pounds greater than the average weight of culled heifer calves. This difference was used in the economic comparison.

To adjust for price fluctuations, cattle prices used were the average for the 5-year period (1987-1992). Assets and expenses listed in Tables 2 through 4 were for 1990 and 1991 in Poplarville,

Table 3. SPAF whole enterprise financial analysis of a 120-cow herd using conventional or intensive grazing of Alicia bermudagrass or Pensacola bahiagrass. MAFES South Mississippi Branch White Sand Unit[a].

	Grazing Management			
	Bermuda		Bahia	
SYSTEM	Intensive A15	Conventional A3	Intensive B15	Conventional B3
Paddocks per system	15	3	15	3
Total acres[b]	171	172	228	283
Stocking rate, A/head[c]	0.75	1.00	1.50	2.00
	$/farm			
REVENUE[d]				
Calf sales	40,753	40,753	40,753	40,753
Culled heifers	3,040	3,040	3,040	3,040
Culled cows	9,300	9,300	9,300	9,300
Hay sales[e]	0	3,600	1,650	1,600
GROSS REVENUE	53,093	56,693	54,743	54,693
DIRECT CASH OPERATING EXPENSES				
Hay harvest cost[f]	10,674	4,664	5,104	4,104
Protein block	1,496	937	1,310	1,086
Summer pasture[g]	4,100	5,112	2,027	2,417
Ryegrass pasture[h]	8,753	8,753	8,753	8,753
Other[i]	9,013	9,014	9,050	9,082
TOTAL DIRECT CASH EXPENSES	34,036	28,479	26,243	25,441
TOTAL DIRECT NONCASH EXPENSES[jk]	4,100	4,182	4,410	4,630
TOTAL DIRECT OPERATING EXPENSES	38,139	32,662	30,654	30,071
GROSS MARGIN	14,954	24,031	24,089	24,621
INTEREST EXPENSES[m]	2,840	2,356	2,155	2,076
TOTAL PRETAX FARM EXPENSES	40,979	35,018	32,808	32,148
NET FARM INCOME[k]	12,113	21,674	21,934	22,545
	$/cwt			
BREAKEVEN PRE-TAX SALE PRICE[n]	83.76	71.57	67.06	65.71

[a] Standardized Production Analysis - Financial (NCA-IRM-SPAF).
[b] Land for 100 mature cows plus 48 acres for replacement females and extra land for hay production.
[c] Stocking rate for 100 mature cows.
[d] $85/cwt steer calves; $80/cwt heifer calves; $80/cwt cull yearling heifers; $65/cwt cull open heifers; $50/cwt cull open cows.
[e] Hay sales @ $50/ton. Differs from Table 1 to account for hay used for replacement females and deficit hay raised in designated hay fields.
[f] Pasture clippings $20.00/ton @ 1 ton/A.
[g] Alicia bermudagrass = $40.40/A, bahiagrass = $5.69/A.
[h] Prepared seedbed = $99.22/A, overseeded ryegrass = $78.07/A.
[i] All other expenses (grain, mineral, vet, medicines, breeding, interest, property tax, marketing, repairs). Labor, debt service, income tax, and overhead not included.
[j] Depreciation of machinery, equipment, and fencing.
[k] Cash available would be the total of net farm income plus noncash expenses. This would be used for debt service, family living expenses, income taxes, and overhead before retained earnings could be calculated.
[m] Assumes 12% interest on direct cash expenses. All assets are owned and no long-term debt to repay.
[n] Based upon total pounds of calves sold.

MS. When hay harvested from pastures was not enough to meet the needs of cows and heifers (systems A15 and B3), additional land was designated for hay fields to produce 6 tons/ac. The differences between Alicia bermudagrass and bahiagrass systems do not reflect fixed costs for establishment.

The underlying variable inputs, such as weaning weights, were not statistically different, so average values were used in the financial and economic analyses. A statistical analysis of dollar values would reflect differences that are fixed by design such as land area, fertilizer applied, prices, etc., and would not be very meaningful. Significance from an economic perspective is usually measured by assessing risk, debt service, return on assets, and other criteria. Differences in return on assets are calculated for this comparison, but debt service and risk assessment are not addressed.

Utilizing information provided in this analysis, producers with different objectives can determine which system may best fit their needs. Table 2 shows the rate of return on assets and the financial and economic net income for each system. Net income is shown on a whole-farm, per-cow, and per-acre basis. An economic analysis would be preferred to a financial analysis if the objectives of a cow-calf producer were to compare what he could "expect to earn on capital in an alternative investment with similar risks" (McGrann, et al., 1991). An economic analysis accounts for opportunity cost of land, raised feed, and equity capital invested in the enterprise.

The return on assets for the enterprise may be one of the most universally recognized ways of ranking alternative business investments. The value not only allows the producer to evaluate the four production systems but also to compare the cow-calf enterprise with other investment opportunities. Previous research has shown that a stocking rate of 1.0 A/head is as profitable on bahiagrass as bermudagrass pastures (St. Louis, et al., 1990). The Alicia bermudagrass system (A3) at 1.0 A/head using a three-pasture rotation with 200 lb/A of ammonium nitrate on summer pasture would be the system of choice for a producer wishing to maximize his return on assets (Table 2). A whole enterprise financial analysis indicated that the three-pasture rotation system on bahiagrass (B3) at 2.0 A/head is the most profitable as measured by net farm income (Tables 2 and 3). When opportunity costs for land and owned assets are included in an economic analysis, the top-ranked system would be A3 (Tables 2 and 4). The per cow net income ranking, by definition, gives the same results for the financial and economic analysis as does the whole farm values.

These rankings can be interpreted by the producer using the following criteria. Assume a producer owns 283 acres, 120 cows plus heifers with no debt, and currently uses system B3 with low stocking rates. To switch to the more profitable A3 system (as measured by return on assets) would depend upon his willingness and ability to sell or rent land and invest the money in other alternatives or to increase the number of cattle to 220 cows and heifers. If the producer is not willing to do either of these, then he would probably consider the financial analysis more appropriate to his operation. He would be more concerned with cash flow and profits and less concerned with opportunity costs and return on assets. He would probably want to continue under his current system.

If a new producer wished to invest in the cattle business, land and equipment would have to be purchased or rented. His best choice would be System A3 as measured by both return on assets and the economic net income figure. These measures are influenced by the value or cost of all assets used in the cow-calf enterprise. The return on assets and net income values may be higher than what could be expected because farmstead real estate, general overhead, and labor have not been included in the figures. Pasture establishment cost is included in the value of the land.

Many producers may be interested in their opportunity costs and return on assets but, until SPAF was developed, these were difficult to calculate. Any producer may use the SPAF program and software to analyze his own cow-calf enterprise. He can customize inputs to reflect his own stocking rate, income, expenses, debt load, and other considerations not included in this study. This standardized tool allows a producer to compare the finances of his operation with others nationwide. It allows him to decide which measures of profitability best suit his production system. Integrated Resource Management (IRM) and SPAF for cow-calf producers were introduced in 1992 by the Mississippi Cattlemen's Association and the Mississippi

Table 4. SPAF whole enterprise economic analysis of a 120-cow herd using conventional or intensive grazing of Alicia bermudagrass or Pensacola bahiagrass. MAFES South Mississippi Branch White Sands Unit[a].

	Grazing Management			
	Bermuda		Bahia	
SYSTEM	**Intensive A15**	**Conventional A3**	**Intensive B15**	**Conventional B3**
Paddocks per system	15	3	15	3
Total acres[b]	171	172	228	283
Stocking rate, A/head[c]	0.75	1.00	1.50	2.00
	$/farm			
GROSS REVENUE[d]	53,093	56,693	54,743	54,693
DIRECT CASH EXPENSES				
Protein block	1,496	937	1,310	1,086
Other	9,013	9,014	9,050	9,082
Market value raised feed[e]	4,013	6,700	7,800	5,300
Opportunity cost of grazing land[f]	15,957	16,986	14,908	16,306
TOTAL DIRECT CASH EXPENSES	30,479	33,636	33,068	31,774
TOTAL DIRECT NON-CASH EXPENSES[g]	4,103	4,182	4,410	4,630
TOTAL DIRECT OPERATING EXPENSES	34,582	37,818	37,478	36,404
GROSS MARGIN	18,511	18,875	17,265	18,289
Interest expenses[h]	2,840	2,356	2,155	2,076
Opportunity cost of non-real estate capital[i]	9,796	9,797	9,840	9,879
TOTAL PRETAX EXPENSES	47,219	49,972	49,473	48,359
NET FARM INCOME	5,874	6,720	5,269	6,334
	$/cwt			
BREAKEVEN PRETAX SALE PRICE[j]	96.51	102.14	101.12	98.84

[a] Standardized Production Analysis - Financial (NCA-IRM-SPAF).
[b] Land for 100 mature cows plus 48 acres for replacement females and extra land for hay production.
[c] Stocking rate for 100 mature cows.
[d] Gross revenue from Table 3.
[e] Hay valued @ $50/ton. Differs from Table 1 to account for hay used for replacement females and hay raised in designated hay fields.
[f] Opportunity costs on land = $18.14/acre rental value plus cost of fertilizer, herbicides, and fuel. All land is owned.
[g] Depreciation of machinery, equipment, and fencing.
[h] Assumes 12% interest on direct cash expenses. All assets are owned and no long-term debt to repay.
[i] 6% of market value.
[j] Based upon total pounds of calves sold.

Cooperative Extension Service. An interdisciplinary approach has been underway since then at the state and county level (Extension Veterinary Medicine, 1994).

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