A TARGET MOTAD ANALYSIS OF A CROP AND LIVESTOCK FARM IN JEFFERSON COUNTY, FLORIDA

David J. Zimet and Thomas H. Spreen

Abstract

An analysis of a typical crop and livestock farm in North Florida is presented. The analysis incorporates the potential competition and complementarity among crop and beef cattle enterprises. A Target MOTAD model is developed to account for risk in a decision framework.

The results indicate that when income risk is ignored, peanuts, watermelon, and stocker cattle are the only enterprises included in the optimal solution. When income risk is heavily weighted, the optimal solution includes peanuts, watermelon, stocker cattle, cow-calf, and irrigated soybeans. The results suggest that the persistence of cow-calf production may be explained as a stabilizer of income.

Key words: beef cattle, linear programming, risk, Target MOTAD.

Beef cattle production is an important agricultural enterprise in the Southeast. In the 1982 Census of Agriculture (U.S. Department of Commerce), commercial beef cattle operations were found in all but one county in Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina. Despite the widespread presence of beef cattle production, agricultural economists have found that cow-calf production is less profitable than stocker cattle production and competing crop enterprises. Musser et al. have characterized this phenomenon as "conspicuous production." They argue that the satisfaction and prestige embodied in a cattle operation must be considered to explain the persistence of cow-calf operations.

The objective of this paper is to analyze optimal farm organization for a typical Coastal Plains farm. Potential competition and complementarity among crop and beef cattle enterprises, as well as risky returns, are incorporated into the decision framework.

PREVIOUS STUDIES

Numerous studies of farm organization have been conducted. Only recent studies which focus on the South are discussed. Musser et al. used a deterministic linear programming model to analyze a representative farm in the Georgia Piedmont area. They determined that the profit maximizing solution included a cow-calf herd with 16 brood cows. Stocker cattle operations were not considered. Survey data indicated that most farms of the size class studied had cow herds ranging from 50 to 100 head. The authors' explanation for the difference between profit maximizing and observed herd sizes was that farmers derived a non-monetary satisfaction from beef cattle production for which they coined the term "conspicuous production."

Wise and Saunders reported results from deterministic linear programming models for representative farms located in 23 sub-regions in the South. Cow-calf, stocker, and crop enterprises were considered. In the optimal solution for most sub-regions, cow-calf enterprises were included at levels far below average observed herd sizes. Backgrounding purchased weaned calves predominated the beef enterprises.

Wise et al. conducted a similar study based on the 1978 cost of production survey conducted by USDA. In several sub-regions, the optimal solution included no cow-calf herds, but backgrounding purchased weaned calves was included.

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The authors gratefully acknowledge helpful comments provided by the editors and several anonymous reviewers. Florida Agricultural Experiment Station Journal Series No. 7584.

Angirasa et al. used the Texas A&M beef cattle simulation model to develop the coefficients for a linear programming model of an east Texas cow-calf operation. The model did not consider backgrounding purchased calves nor commercial crop alternatives. Their results differed from other studies in that cow-calf enterprises entered the optimal solution of a deterministic linear programming model. Their analysis also included the use of MOTAD to account for risky returns. When the objective function of the model was penalized for large absolute deviations in net returns, the optimal solution switched from a cow-calf operation to an integrated cow-stocker operation in which weaned calves were retained and grazed to heavier weights.

Of previous studies, only Angirasa et al. explicitly included risk considerations in their analyses. Angirasa et al., however, did not consider commercial crop alternatives nor backgrounding purchased calves. In the present study, both crop and livestock enterprises are considered and the impact of risky returns is included in the decision framework.

FRAMEWORK OF ANALYSIS

The principal objective of this study is to develop a whole farm model that conforms with the subjective decision framework of farmers. It was hypothesized that such a model would include beef cattle herds in the optimal production plan. In order to accomplish this objective, personal interviews with 80 farmers in Jefferson County, Florida were conducted.

Jefferson County is located in the Florida Panhandle. The Panhandle is typical of the Coastal Plains in that its relatively mild winters allow cultivation of cool season pastures which can support winter backgrounding enterprises. Warm season crops grown include corn, soybeans, peanuts, cotton, watermelons, and small plots of vegetables. Cow-calf enterprises utilize both improved and native pastures in the warm season.

The interviews were designed to elicit the views of producers regarding various forage and herd management practices. Specific information related to current production practices was also obtained. Analysis of the data indicated that risk played an important role in the decisionmaking process of producers.

A Target MOTAD model (Tauer) of a typical commercial crop and beef farm was formulated. The Target MOTAD methodology offers two principal advantages. First, it incorporates risk into a linear programming framework. Secondly, it has been shown that the solution set of a Target MOTAD model is contained in the set of production plans which are second degree stochastic dominance efficient (Tauer).

The mathematical representation of the Target MOTAD model is:

$$\text{Max } E(z) = \sum_{j=1}^{n} f_j x_j,$$

subject to:

$$\sum_{j=1}^{n} a_{ij} x_j \leq b_i, \quad i = 1,\ldots,m;$$

$$\sum_{j=1}^{n} c_{hj} x_j + Y_h \geq T_h, \quad h = 1,\ldots,s;$$

$$\sum_{h=1}^{s} P_h Y_h = \lambda;$$

$$x_j; Y_h \geq 0;$$

where:

- f_j = expected net return per unit of enterprise j;
- x_j = level of enterprise j;
- c_{hj} = the return of enterprise j in the period h;
- n = total number of enterprises;
- a_{ij} = use of resource i by one unit of enterprise j;
- b_i = total availability of resource i;
- m = total number of limited resources;
- T_h = total income target for period h;
- Y_h = the negative deviation from target income in period h;
- s = total number of periods considered;
- P_h = the probability of period h; and

λ is a parameter to be varied from zero to some large number.

The objective function of the model is to maximize expected net returns. The first set of constraints impose the usual resource restrictions. The second set of constraints define the deviations below target income (Y_h) in each time period. The third constraint sums the negative income deviations times their probability of occurrence. In this study, $P_h = 1/s$. This sum is represented by a parameter λ which should be loosely interpreted as the expected deviation below target income. The model is successively solved by varying λ from zero to a large number. When λ is sufficiently large, the model is equivalent to a deterministic linear programming model. For λ equal zero, no negative income deviations are allowed in any time period, which is analogous to a safety first decision rule.

MODEL SPECIFICATION

Crops included in the model were those commonly grown in Jefferson County, Florida. The warm season crops included corn (dryland and irrigated), peanuts, soybeans (dryland and irrigated), and watermelons. Cool season crops included winter wheat for grain and rye-ryegrass pasture. Bahia grass-clover pasture and native grasses were warm season forages included in the model. All forages were considered to be intermediate products with no commercial value.

Data published by the Georgia Cooperative Extension Service provided the basis for the costs of all commercial crops except watermelon. Cost of production estimates for watermelons were based on the cost estimates prepared by Hewitt and Westberry. Estimated production costs for all crops were verified with producers and agricultural scientists. Land rent for the commercial crops was charged in a separate subset of activities. Different rents were charged for irrigated and non-irrigated land. Land used for peanut production was charged the same rental rate as irrigated land. Product prices and yields per acre were obtained from the Florida Agricultural Statistics (Florida Crop and Livestock Reporting Service, 1973-83b) and the U.S. Department of Agriculture (1973-83a and 1973-83b). Estimated net returns to land and labor per acre for seven crop alternatives are shown in Table 1. These values are expressed in constant 1977 dollars.[1]

Several types of beef cattle enterprises were included in the model. These included cow-calf enterprises, summer conditioning program for calves born the previous fall, and warm and cool season backgrounding programs. Purchase of calves for backgrounding was permitted only in the cool season.

Four basic cow-calf enterprises were considered. These differed by month of calving, either March or November, and weaning weight, either 350 or 450 pounds. The difference in weaning weight was accounted for by a longer period prior to weaning (i.e., weaning at 7 months instead of 6) and a lower stocking rate for the cow-calf enterprise that produced a 450 pound calf. Monthly nutritional requirements for a Brahman-cross cow were estimated (Melton). The age of the cow and pregnancy and lactation status influenced the estimated nutritional requirements. The age distribution and the months of calving and weaning of a typical cow were applied to the estimated nutritional requirements to obtain the nutritional requirements for the cow herd.

Four cow-calf enterprise options used bahia-clover pasture to meet warn season nutritional requirements. Four other cow-calf options used native grass pastures instead of bahia-clover. Cattle grazing native grasses were stocked at lower levels. For example, for the heavier weaning alternative, cows were stocked at 1.5 acres per head compared to 1.2 acres per head for improved pasture. In addition, enterprises that utilized native grass required additional supplemental feed to meet nutritional requirements.

In order to determine the number of calves available for sale, certain assumptions were made. A calving rate of 92 percent and a 2 percent calf mortality rate were based upon survey data from Jefferson County beef cattle producers. Given a herd with 100 cows, 90 calves would be weaned. It was assumed that 15 heifer calves were required for replacements which implied that 75 calves were available for sale. Since calves starting a post-weaning production option must start at one of the two possible weaning weights, then 1.33 cows (one cow divided by 0.75 calves per cow) were required to produce one calf entering a post-weaning production option.

Backgrounding enterprises differed based upon the beginning weight, stocking rate, season, and length of the backgrounding program. These enterprises are summarized in Table 2. The summer conditioning program entailed placing calves, weaned in the spring, on bahia-clover pasture and selling short yearlings in September. Spring calves may enter one of two grazing programs. These animals grazed bahia-clover pastures from weaning to October and rye-ryegrass pastures

[1] Gross returns were deflated by the index of prices received by farmers while costs were deflated by the index of prices paid by farmers (USDA, 1973-84a).

TABLE 1. ESTIMATED ANNUAL DEFLATED NET RETURNS BY CROP AND YEAR, NORTH FLORIDA, 1973-83[a]

Year	Crop						
	Dryland corn	Irrigated corn	Peanuts	Dryland soybeans	Irrigated soybeans	Watermelons	Wheat
1973	17.41[b]	52.28	110.95	10.45	1.44	183.51	-20.06
1974	15.28	61.61	177.11	72.82	93.79	125.20	-7.50
1975	-50.49	-75.59	276.63	-15.94	-17.53	480.23	-25.78
1976	-16.77	63.84	123.42	47.39	92.06	205.59	-9.77
1977	-121.80	-167.60	131.71	19.90	24.10	157.60	-18.30
1978	-75.43	-134.47	240.85	-9.16	-17.92	101.53	-8.00
1979	-24.92	2.18	170.81	45.89	42.28	65.31	14.88
1980	-5.73	38.54	129.50	14.59	19.06	402.43	-3.59
1981	-26.31	-47.96	181.90	-31.66	-54.09	214.56	0.71
1982	32.20	-54.84	123.68	-10.46	-21.50	135.54	-6.23
1983	53.00	78.06	70.76	18.64	32.60	3.70	-6.25
Mean	-18.51	-16.72	157.94	14.77	17.66	188.66	-8.17

[a] In constant 1977 dollars. Values are net of land, rent, labor, and management charges.
[b] Dollars per acre.

TABLE 2. INITIAL AND FINAL WEIGHTS, BEGINNING MONTHS, NUMBER OF MONTHS, AND STOCKING RATES OF SPECIFIED POST-WEANING PROGRAMS, NORTH FLORIDA

Item	Initial weight	Final weight	Beginning month	Number of months	Stocking rate by Bahia-clover	Stocking rate by Rye-ryegrass
	---lbs.---				---(hd/ac)---	
Conditioning:						
Light calf	350	515	April/May	4	2.0	NA[b]
Heavy calf	450	592	June	3	1.0	NA[b]
Heavy calf	450	510	June	3	2.0	NA[b]
Backgrounding of fall calf:						
Light calf	350	767	April/May	12	1.0	1.5
Light calf	350	746	April/May	12	2.0	2.0
Heavy calf	450	856	June	10	1.0	1.0
Heavy calf	450	796	June	10	2.0	1.5
Backgrounding of spring calf:						
Light calf	350	670	October	7	5.0[a]	1.5
Light calf	350	642	October	7	5.0[a]	2.0
Heavy calf	450	727	November	6	5.0[a]	2.0
Backgrounding of purchased calf:	400	658	December	5	5.0[a]	2.0

[a] For the month of April only.
[b] NA denotes not applicable.

from November to March. Fall calves, which were kept for backgrounding, grazed rye-ryegrass pastures from weaning to March and grazed bahia-clover for April only. Weaned calves kept for backgrounding were priced into the backgrounding enterprises at market prices.

An enterprise which involved purchase of 400 pound calves in late fall was included. These calves grazed rye-ryegrass pasture from December to March and bahia-clover in April. A linked cow-calf and purchased stocker enterprise was also formulated. The cow-calf activity had spring weaning at 450 pounds. In late fall, for each brood cow in the herd six stocker calves were purchased. All animals grazed rye-ryegrass until March. The stocker cattle grazed bahia-clover at 5 head/acre in April and then were sold. The cow herd grazed the bahia-clover pasture the remainder of the summer.

Weight gain of calves produced under the conditioning and backgrounding options was estimated by a growth simulation model for stocker cattle (Spreen et al.). Final weight was reduced by 2 percent to account for death loss. Final weight was multiplied by the appropriate monthly price (Florida Crop and Livestock Reporting Service, 1973-83a). A marketing fee of 1.5 percent was deducted to determine estimated gross returns for the post weaning enterprises. The average net returns for each beef cattle enterprise are shown in Table 3.

RESOURCE CONSTRAINTS

The linear programming model contained both technical constraints related to the fixed resources of the model and non-technical constraints which were required to incorporate risk into the model. The technical constraints were limits on the availability of land, labor, and capital. Land was divided into four categories: permanent pasture, irrigated crop land, unirrigated and unfenced cropland, and unirrigated fenced cropland. Resource availability corresponded to the actual resource base for a producer in the study area. This farm was the template for the model of a typical farm. Two hundred acres of irrigated cropland, 325 acres of unirrigated and unfenced cropland, 125 acres of unirrigated fenced cropland, and 90 acres of permanent pasture were available. Land was not transferable among categories.

Unlike land, labor was considered to be homogeneous. Labor available was based upon the employment of two full-time workers — an owner/manager and a full-time employee. Consistent with work load requirements, both the employee and farm operator were assumed to work more hours during the warm season than during the cool season. The employer was also assumed to perform proportionately more work during the cool season. These assumptions conform with the practice of using the off-season to compensate employees for overtime worked during the cropping season. Monthly labor availability ranged

TABLE 3. FINAL WEIGHTS AND AVERAGE DEFLATED GROSS RETURNS, COSTS, AND NET RETURNS PER HEAD OF PRINCIPAL BEEF ENTERPRISES, NORTH FLORIDA, 1973-1983

Item	Final weight	Average deflated gross returns	Average deflated costs	Average deflated net returns
	--lbs.--	--dollars per head--		
Cow-calf on bahia-clover:				
Fall calf weaned light	350	165.39[b]	196.68	−31.29
Fall calf weaned heavy	450	195.81[b]	200.83	−5.02
Spring calf weaned light	350	142.07[b]	163.46	−21.39
Spring calf weaned heavy	450	169.49[b]	186.86	−17.32
Cow-calf on native grass:				
Fall calf weaned light	350	165.39[b]	151.73	13.66
Fall calf weaned heavy	450	195.81[b]	157.93	37.88
Spring calf weaned light	350	142.07[b]	127.34	14.73
Spring calf weaned heavy	450	169.49[b]	160.61	8.88
Conditioning:				
Light calf	515[a]	218.74	300.07[c]	−81.33
Heavy calf	592[a]	256.44	332.90[c]	−81.46
Heavyy calf	510[a]	216.62	303.59[c]	−86.97
Backgrounding of fall calf:				
Light calf	767[a]	316.90	390.10[c]	−73.20
Light calf	746[a]	308.23	359.30[c]	−51.07
Heavy calf	856[a]	357.81	413.76[c]	−55.95
Heavy calf	796[a]	332.73	367.40[c]	−34.67
Backgrounding of spring calf:				
Light calf	670[a]	280.06	286.77[c]	−6.71
Light calf	642[a]	267.68	280.21[c]	−12.53
Heavy calf	727[a]	303.89	319.81[c]	−15.92
Backgrounding of purchased calf	658[a]	274.06	215.18	58.88
Cow-calf linked with purchased stocker calf:				
Fall calf weaned heavy	450	195.81[b]	159.46[d]	36.35
Purchased calf	658	274.06	226.33	47.73

[a] Corresponds to weights in Table 2.
[b] Includes income from cull cows.
[c] Includes cost of cow-calf operation at production of 1.33 cows per stocker calf.
[d] Does not include the cost of improved summer pasture which is charged to the stocker operation.

from 294 hours in November to 473 hours in July and August.

Capital constraints were imposed for each year of the 11-year period of analysis. The right-hand-side of these constraints was based on the value of land owned by the producer. In 1983, the estimated value of farmland in this area was placed at $400 per acre. This value times 740 acres gives $296,000 of available capital in 1983. Capital availability for the other years was determined by applying the index of farm land real value (U.S. Department of Agriculture, 1973-83a).

The capital requirements of the crop and livestock enterprises were based solely on out-of-pocket expenses. The fixed cost of capital items such as machinery and land were excluded. The cost of capital was the interest rate for farm loans reported by the Georgia Extension Service.

Consistent with the view of survey respondents that beef cattle enterprises are residual users of land, labor, and management, no charges were made for labor or cropland used by beef cattle enterprises in the model. Labor used in crop enterprises was charged at the prevailing minimum wage. A fixed charge for land used in crop production was included in separate land rental activities. Rental rates were $31.70/acre for irrigated land and $21.00/acre for dryland.

Income Constraints

Eleven constraints were required to define the annual deviation below target income. Based on the Jefferson County survey, $15,000 was considered to be a good farm income in 1983. To this figure was added $9,000 to account for payments for capital items such as machinery, buildings, and other equipment. This sum was deflated to 1977 dollars using the consumer price index, giving an estimated income target of $14,000.

Other Constraints

Inspection of the net return data indicated that peanuts and watermelons were, by far, the most profitable alternatives available. Peanuts were assumed marketed under the higher price afforded under the peanut quota. A farmer of this size (750 acres) was assumed to be able to market, at most, the peanuts produced by 90 acres under the quota price. Thus, peanut acreage was limited to 90 acres.

Watermelon harvest is concentrated in a few days and two workers are not sufficient to perform the tasks required in harvesting. Furthermore, availability of short-term hired labor for strenuous work is limited. Thus, watermelon acreage was limited to 40 acres to account for limited short-term hired labor.

EMPIRICAL RESULTS

The parameter λ which controlled the expected deviation below target income was initially set at a large value. In this case, the Target MOTAD model was equivalent to deterministic linear programming. As λ became smaller, basis changes occurred. At each change of basis, the value of λ and the corresponding optimal solution were reported.

The optimal cropping plan, expected net returns, and corresponding values of λ at which basis changes occurred are shown in Table 4. Expected net returns ranged from $29,572 when negative income deviations were ignored to $22,260 when negative income deviations were prohibited.

For λ greater than 1,692.5, the Target MOTAD model was equivalent to a deterministic linear programming model. The optimal solution in this case was to plant 90 acres of peanuts, 40 acres of watermelons, and purchase 250 calves in the fall for stocker cattle production, which required 125 acres of fenced cropland for rye-ryegrass pasture. The only commercial crops included in the optimal cropping plan were peanuts and watermelons at their upper limit. Cool season stocker cattle production was at its upper limit since fenced cropland was exhausted and no cow-calf production was included. As λ was decreased, tightening the requirement that target income be met, the cropping plan was altered to include irrigated soybeans. Production of purchased stockers was reduced and cow-calf enterprises were introduced. The cow-calf enterprise was linked to the stocker cattle operation. For λ equal zero, peanut and watermelon production were still at their respective upper bounds and nearly 85 acres of irrigated soybeans were planted. Stocker cattle production was 113 head and two cow-calf herds were included, one grazing native pastures (40 head) and one grazing improved pastures (19 head). Both cow-calf enterprises involved fall calving and weaning at 450 pounds.

The cow-calf herd which grazed improved pasture in the optimal solution set was linked to the stocker herd, while the cow-calf herd which grazed native grasses in the optimal solution set was independent of the stocker herd. The variance-covariance matrix of net returns of the six enterprises included in the optimal solution set is presented in Table 5. The covariance between the stocker enterprise and the cow-calf enterprise that utilizes native grasses was low. This relationship explains in part why the cow-calf operation was used to stabilize income when λ decreases.

Resource use in the optimal production plan for λ greater than 1,692.5 and target income equal to $14,000 is shown in Table 6. Similar information on resource use for λ equal zero is shown in Table 7. Resource utilization was well below resource availability in both solutions. In the deterministic linear programming solution ($\lambda > 1,692.5$), only non-irrigated fenced cropland was exhausted, while 160 acres of irrigated cropland, 235 acres of non-irrigated unfenced cropland, and nearly all pasture were idle. Labor use was well below labor availability in all months. For those fixed resources in disposal, the imputed marginal values (shadow prices) were zero. The imputed value of an additional acre of fenced non-irrigated cropland was $95.46. In the solution for λ equal zero, all resources were in disposal and hence all imputed marginal values were zero.

The apparent surplus of land suggests that few profitable uses of land are available to farmers in North Florida. Peanuts produced under quota, watermelons, and cool season stocker cattle production are apparently profitable enterprises. Irrigated soybeans and small cow-calf herds are useful in stabilizing incomes since stocker cattle production is subject to years of high negative returns. No other enterprises are included even though surplus land and labor were available.

SENSITIVITY OF THE MODEL TO ALTERNATIVE SPECIFICATIONS

Varying Target Income

A potential drawback of Target MOTAD is the sensitivity of the results of the model to the level of target income specified. Given a value of λ, there exists a target income, denoted by $T_L(\lambda)$, such that a model with a target income less than $T_L(\lambda)$ will be identical to deterministic linear programming. There also exists another target income value, denoted by $T_U(\lambda)$, such that a model with a target income exceeding $T_U(\lambda)$ is infeasible. It is expected that $T_L(\lambda)$ and $T_U(\lambda)$ are both increasing functions of λ.

Table 4. Optimal Net Returns and Product Mix for Varying Levels of Negative Deviation from Target Income for a Typical North Florida Farm, 1973-83

λ	Expected net return	Peanuts	Watermelons	Irrigated soybeans	Purchased stockers	Brood cows[a]	Native brood cows[b]
	----dol.----	----acres----			----head----		
≥ 1692.50	29,572	90.0	40.0	0.0	250	0	0
1181.50 to 1692.50	29,166	90.0	40.0	0.0	214[c]	35	0
652.70 to 1181.50	26,919	90.0	40.0	160.0	214[c]	35	0
465.90 to 652.80	25,738	90.0	40.0	160.0	193[c]	32	8
0.00 to 465.90	22,259	90.0	40.0	84.6	113[c]	19	40

[a] These cows graze improved pastures in the warm season with fall calving and weaning at 450 pounds in the spring. The cow-calf enterprise is linked to a backgrounding operation.

[b] These cows graze native pastures in the warm season with fall calving and weaning at 450 pounds in the spring.

[c] These stocker cattle are linked to the cow-calf enterprise.

Table 5. The Variance-Covariance Matrix of Net Returns of the Six Enterprises Included in the Optimal Solutions of a Target MOTAD Model of a Typical North Florida Farm, 1973-83

Enterprise	Enterprise: Cow-calf with stocker	Stocker	Native grass cow-calf	Watermelons	Peanuts	Irrigated soybeans
	dol.					
Cow-calf with stocker	4,715.09	1,670.52	2,419.98	−5,789.38	−345.16	−248.05
Stocker	1,670.52	3,366.10	54.19	−2,675.26	374.64	−896.17
Native grass cow-calf	2,419.98	54.19	2,181.29	−1,469.30	−764.99	392.21
Watermelons	−5,789.38	−2,675.26	−1,469.30	19,652.50	3,753.64	−1,612.21
Peanuts	−345.16	374.64	−764.99	3,753.64	3,573.92	−904.51
Irrigated soybean	−248.05	−896.17	−392.21	−1,612.74	−904.51	2,165.28

TABLE 6. RESOURCE USE IN THE OPTIMAL CROPPING PLAN FOR λ GREATER THAN 1,692.5 FOR A TYPICAL NORTH FLORIDA FARM, 1973-83

Month	Irrigated cropland	Non-irrigated fenced cropland	Non-irrigatged unfenced cropland	Pasture	Labor
	acres				Man-hours
January	–	125	–	–	–
February	40	125	–	–	40
March	40	125	90	–	215
April	40	–	90	50	285
May	40	–	90	–	195
June	40	–	90	–	170
July	40	–	90	–	130
August	–	–	90	–	180
September	–	–	90	–	90
October	–	125	–	–	50
November	–	125	–	–	25
December	–	125	–	–	25
Availability	200	125	325	90	–[a]

[a] Labor availability varies from month-to-month, ranging from 294 to 473 man-hours.

Analyses were conducted in which λ was held constant and parametric programming of the target income was performed. For λ = 0, T_L (λ) was estimated to be $791.70, while T_U (λ) was $16,544.16. For λ = 1,692.5, T_L, (λ) was $14,002.78, and T_U, (λ) was $23,048.17. The enterprise mix included in the optimal solutions was similar to those shown in Table 4. The exception was that dryland soybeans were produced when target incomes were large.

Eliminating Land Rent

The optimal solutions to the initial specification of the model for all values of λ had cropland in disposal. In this scenario, the rent per acre of irrigated cropland was $31.70 and was $21.00/acre for dry cropland. An alternative specification of the model in which all land rents were set to zero was considered. As λ was ranged from zero to a large value, only two different optimal solutions were determined. For λ ≥ 152 (equivalent to deterministic linear programming), the optimal solution included 90 acres of peanuts, 40 acres of watermelons, 160 acres of irrigated soybeans, and 250 head of purchased stocker cattle. For λ < 152, the cropping pattern was identical, but the purchased stocker operation was comprised of 237 head and a small cow-calf herd with 16 brood cows was included. The Target MOTAD frontier was quite flat as the expected income from the two solutions differed by less than $280.

When this set of solutions is compared to the optimal solutions of the model with positive land rents, the production patterns are quite similar. Even when its rent was zero, 235 acres of dry unfenced cropland remained idle. Another observation is that when land rent is zero, the riskiness of the farm operation is reduced. This result is consistent with the notion that producing on land on which cash rent must be paid increases the risk borne by the farmer.

TABLE 7. RESOURCE USE IN THE OPTIMAL CROPPING PLAN FOR λ EQUAL ZERO FOR A TYPICAL NORTH FLORIDA FARM, 1973-83

Month	Irrigated cropland	Non-irrigated fenced cropland	Non-irrigated unfenced cropland	Pasture	Labor
	acres				Man-hours
January	–	76.5	–	–	18.1
February	40	76.5	–	–	49.1
March	40	76.5	90	–	289.3
April	124.6	29.5	90	22.6	350.2
May	124.6	60.0	90	22.8	321.4
June	124.6	60.0	90	22.8	267.1
July	124.6	60.0	90	22.8	245.7
August	84.6	60.0	90	22.8	233.1
September	84.6	60.0	90	22.8	147.5
October	–	76.5	–	22.8	114.8
November	–	76.5	–	–	151.1
December	–	76.5	–	–	35.0
Availability	200	125	325	90	–[a]

[a] Labor availability varies from month-to-month, ranging from 294 to 473 man-hours.

Limited Availability of Operating Capital

In the initial specification of the model, it was assumed that the farmer could borrow up to $300,000 (1983 dollars) to meet short-term credit needs. This figure implied that the farmer had ready access to operating capital. In this period of financial stress for agricultural firms, operating capital is limited. To examine the impact of limited borrowing capacity, capital availability was reduced to $120,000 (1983 dollars).

Three optimal Target MOTAD solutions were determined. For $\lambda \geq 678.4$, the optimal solution included 90 acres of peanuts, 40 acres of soybeans, 149 head of purchased stocker cattle, and two cow-calf herds with fall calving totaling 50 head. For $678.4 \geq \lambda \geq 547.8$, the optimal solution included the same enterprises as the solution for $\lambda \geq 678.4$ except 21 acres of dryland soybeans were also produced. For $547.8 \geq \lambda \geq 0$, the optimal cropping plan was 90 acres of peanuts, 40 acres of watermelons, 111 acres of dryland soybeans, 121 head of purchased stockers, and a cow-calf herd with 57 brood cows. The Target MOTAD frontier was flatter than the frontier for the base model with the expected income from the three solutions differing by approximately $1,800.

The impact of restricted availability of operating capital is that cow-calf enterprises were included in the optimal solution for all levels of λ. The level of stocker production was reduced which suggests that stocker cattle production is more suitable for those producers with stronger balance sheets. As λ was reduced, dryland soybeans were included in the optimal cropping plan as means of stabilizing income. This outcome differed from the case of less restricted capital in which irrigated soybeans were used to stabilize income as λ was reduced.

CONCLUDING REMARKS

The purpose of this paper is to address the apparent paradox that even though cow-calf production persists throughout the entire Southeast, previous economic studies have shown that cow-calf enterprises are not highly profitable. A Target MOTAD model of 740 acre farm in Jefferson County, Florida was developed. Results of the model indicate that when income stabilization is ignored, peanuts, watermelons, and cool season stocker cattle production were the only enterprises included in the optimal solution. As income stabilization was given a greater weight (decreasing λ), cow-calf production and soybeans were included in the optimal solution. The results suggest that the role of cow-calf enterprises has been to assist in stabilizing farm income as well as making productive use of marginal land and surplus labor.

Results of the Target MOTAD analysis explain the persistence of beef cattle production despite its low net returns. In the case when uncertain returns are ignored (large λ), cow-calf enterprises are excluded from the optimal solution. Peanuts, watermelons, and purchased stocker cattle are included at their upper limit. When negative deviations to target income are not permitted ($\lambda = 0$), stocker cattle production is reduced and two cow-calf herds with a total of 59 brood cows are included in the optimal plan. This result offers an alternative explanation for the presence of cow-calf production to the "conspicuous production" argument of Musser et al. Cow-calf production offers a means to stabilize income and make productive use of resources that would otherwise remain idle. The results of the Target MOTAD analysis are not sufficient evidence to reject the notion of conspicuous production. It is plausible, that for individual cases, either conspicuous production or income stabilization would be appropriate explanations for the presence of a cow-calf enterprise.

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