COMPARATIVE COST-BENEFIT ANALYSIS OF TWO BOXED BEEF METHODS

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The study compares cost and benefits of carbon dioxide and vacuum packaged boxed beef distribution to retail grocery outlets

In the retail grocery segment of the beef distribution channel, the major portion still moves fresh in the form of hanging quarters or primals. However, a recently important method of shipment to the retail grocery segment is beef in boxed, palletized form. Although no accurate data are available to document the proportion of beef which is distributed boxed versus hanging, industry consensus is that the boxed, palletized method will continue to increase in importance (4).

This study provides the results of a comparative cost-benefit analysis of carbon dioxide and vacuum packaged boxed beef, both of which hold promise for increased utilization in the trade. The intent is not to identify one method as superior in all situations to the other, but rather to analyze relative costs and savings associated with the two methods.

The specific objectives were: 1) to identify additional costs associated with utilization of carbon dioxide and vacuum packaged boxed beef at the packer level, and 2) to evaluate the two systems with respect to shrink, trim loss, and retail case life so as to provide a cost-benefit comparison of the two boxed beef methods.

The carbon dioxide method of boxed beef consists of placing a sheet of polyethylene in a cardboard box, placing either a primal or subprimal cut on the polyethylene which is then folded over the meat. Just prior to box closure, a small perforated polyethylene bag of carbon dioxide pellets (typically about two pounds) is placed in the box which may then be palletized.

The vacuum packaged method is better known and consists of drawing a partial vacuum on a laminated barrier bag containing either a primal or subprimal cut. These vacuum packaged cuts then may be placed in boxes or other master containers for palletized storage and/or shipment.

Methodology

A case study approach was utilized for this research because primary data were collected in conjunction with a test shipment. The logistic difficulties involved in attempting to collect data in conjunction with test shipments over a number of packers, given limited resources, deemed the case study approach necessary.

Cooperators for the test shipment were established and economic data were collected during the first quarter of 1973. The test shipment contained both carbon dioxide and vacuum packaged rounds (I.M.P.S. 163 or 164) and ribs (I.M.P.S. 103 and 104).[1/] Shipment via refrigerated truck trailer was monitored with respect to shrink, bacterial changes, and in-transit temperatures. Total in-transit time was 2 days, one day from packer to distribution center and another from distribution center to the Animal Science Laboratories at Texas A & M University.

Both the carbon dioxide and vacuum packaged boxes of rounds and ribs were processed and loaded in the manner customary for normal shipments. A total of 120 boxes were included in the test shipment. These 120 boxes were composed of 60 carbon dioxide and 60 vacuum packaged boxes. Of the 60 boxes packed with carbon dioxide, 30 contained subprimal ribs and 30 contained subprimal rounds. Similarly, 30 of the 60 boxes containing vacuum packaged subprimals were ribs and 30 were rounds.

To investigate shrink and retail case life, the various subprimals were held in storage prior to fabrication into retail cuts for either 10 or 17 days from kill date. These 10 or 17 day "storage" periods included the previously mentioned 2 days in transit. Of the 30 boxes of carbon dioxide packed ribs, 15 were held 10 days while the remaining 15 were held 17 days. Similarly 15 boxes of the 30 vacuum packaged ribs were held 10 days while 15 were held 17 days. Exactly these same storage treatments prior to retail cut fabrication were applied to the 60 rounds.

After completion of either the 10 or 17 day storage period, retail cuts were fabricated from each subprimal. These individual cuts were retail packaged in the typical tray with over-wrap and placed in a retail case. Each retail cut was evaluated daily for 4 days with respect to product characteristics. Details of the product characteristics such as bacterial count, temperatures, odor and color scores, trim loss, and shrink for both the subprimals and retail cuts are reported in Motycka (1).

Comparative Costs

The additional costs associated with the carbon dioxide and vacuum packaged methods were obtained for three general categories: 1) variable cost of material, 2) variable cost of labor, and 3) fixed cost of capital equipment. These costs are briefly discussed below and may be found in detail in Sporleder and Vastine (3). Truck transportation rates for boxed and hanging were assumed equal. All data are presented on a dollars per hundredweight basis assuming that fed slaughter cattle yield, on the average, a dressed carcass of 675 pounds.

Material Cost

Additional material cost associated with the carbon dioxide operation, including a waste factor of 3 percent on total material cost, was $1.217 per hundredweight (cwt) for ribs and $1.113 for rounds, Table 1. The box and box make-up, exclusive of labor, represented 77.0 percent of total material cost while the cost of the carbon dioxide pellets represented another 13.9 percent of total material cost. Thus, the box and carbon dioxide pellets accounted for nearly 91 percent of the additional material cost necessary for the carbon dioxide method

The material cost associated with the vacuum packaged method, again including a waste factor of 3 percent on total material cost, was $2.525 per cwt. for ribs and $1.530 for rounds, Table 1. The box and box make-up constituted only 37.1 percent of total material cost for ribs, while the barrier bags, clips, and bone-guard accounted for another 61.9 percent. For rounds, the box and box make-up constituted 56.0 percent of total material cost with the bag and clip representing another 41.1 percent of total material cost.

Labor Cost

Labor cost associated with both the carbon dioxide and vacuum packaged methods were determined from the point immediately after fabrication of a carcass into primals or subprimals. Included in the labor cost for rounds was additional table labor for trimming the center shank and removing the Aitch bone. This table work was included since it represented additional labor for a boxed round compared to a hanging round.

For either method, labor cost was calculated at prevailing union scale plus employer contributions of fringe benefits, and averaged $6.31 per hour. No administrative, janitorial, or other overhead labor was included. Labor costs will not be presented

Table 1. Cost of material, carbon dioxide and vacuum packaged boxed rib and round primals.

Item	Ribs CO_2	Ribs Vacuum	Rounds CO_2	Rounds Vacuum
		($/cwt.)		
Boxes 1/	0.938	0.938	0.857	0.857
Liner 2/	0.075	-	0.069	-
Bags, Clips, Bone-guard	-	1.514	-	0.628
CO_2	0.169	-	0.154	-
Miscellaneous 3/	0.035	0.073	0.032	0.045
Total	1.217	2.525	1.112	1.530

1/ All cost incurred for box make-up are also included. Storage, capital equipment for make-up, glue, and the cost of the sealing operation are included, but not labor.

2/ This is the polyethylene liner used inside the box for the carbon dioxide method only.

3/ Includes a 3 percent waste factor on total material cost.

Source: Primary Data, February, 1973 prices.

here in detail due to space limitations.

Total Variable and Fixed Cost

The labor and material costs are additive to total variable cost, Table 2. The material cost component accounted for 61.2 percent of total variable cost for carbon dioxide ribs compared to 63.4 percent for vacuum packaged ribs. For rounds, the proportion of total variable cost attributable to material cost was 42.1 percent for the carbon dioxide method contrasted to 46.3 percent for the vacuum packaged method. Thus, the methods of packaging had a similar relative relationship between labor and material cost.

In both the carbon dioxide and vacuum packaged methods, certain additional capital equipment is necessary. Once a decision is made to box primals, additional capital equipment is necessary but varies substantially between the carbon dioxide and vacuum packaged methods.

Annual fixed costs associated with the two methods were calculated only on the additional capital equipment necessary for the methods, exclusive of general plant overhead, or other fixed costs such as dock space or trucks.

Annual fixed costs were calculated for the carbon dioxide and vacuum packaged methods separately by depreciating each capital equipment item over its estimated useful life. Added to this depreciation is an opportunity cost on invested capital, and a percentage of initial investment for risk, insurance and taxes.

For the carbon dioxide method, the only additional capital equipment items

Table 2. Variable, average fixed, and average total cost of carbon dioxide and vacuum packaged boxed rib and round primals.

Item	Ribs CO_2	Ribs Vacuum	Rounds CO_2	Rounds Vacuum
	($/cwt.)			
Variable Cost				
Labor	0.770	1.458	1.529	1.773
Material	1.217	2.525	1.113	1.530
Total	1.987	3.983	2.642	3.303
Average Fixed Cost*	0.014	0.134	0.013	0.061
Average Total Cost*	2.001	4.117	2.655	3.364

* At capacity
Source: Primary data, February, 1973 prices.

necessary were an automatic scale and miscellaneous capital equipment. The carbon dioxide pellets contained in the perforated bag were shipped in a returnable master container to the plant which cooperated in this study. Thus, no additional capital equipment was necessary for manufacturing the carbon dioxide pellets. Of course, if pellets were manufactured from carbon dioxide gas on premise then additional capital equipment would be necessary for the operation.

For the vacuum packaged method, total fixed cost was composed of cost for these capital equipment items: 1) cradles, 2) tipper ties, 3) shrink tunnel, 4) skate conveyor, 5) automatic scale, and 6) miscellaneous capital equipment items (such as hand trucks). These items represented only the additional capital equipment necessary for vacuum packaging.

Average fixed cost was calculated for ribs and rounds separately for both methods, Table 2. The average fixed cost for either method was determined at capacity of the appropriate line. Thus, the average fixed cost estimated is the low point on the average fixed cost curve. If the capital equipment necessary for either operation were operated at substantially less than capacity for long periods of time actual average fixed costs would be substantially higher than those shown in Table 2.

Comparative Net Benefits

Comparing costs associated with the two methods of packaging boxed beef would be inadequate without comparing benefits and arriving at net benefit comparisons. In comparing benefits, the subprimal must be considered as well as the retail case life of the final retail cut. Differences between the two methods of packaging boxed beef were attributed to savings in shrink, i.e. loss of weight in transit and storage including purge loss; and savings in trim loss for the subprimal. Net benefits were determined by adjusting the value of the subprimal. Net benefits were determined by adjusting the value of the subprimals for shrink and trim loss as well as cost of packaging. Estimated net values were based on mid-June 1973 wholesale prices of \$88.50/cwt. for subprimal ribs and \$80.00/cwt. for subprimal rounds. Obviously, as wholesale prices change the net value comparisons would be directly affected.

Retail case life comparisons made involve the average time cuts remain in the retail case and are considered acceptable to consumers, as well as the number of pull backs (cuts which do not meet minimum consumer acceptance). Many retail meat departments have a policy whereby a steak not sold within two days of the date it was placed on display is either pulled back, reworked, and rewrapped or reduced in price. Under this policy, the incidence of pull backs may be more important to a retail store meat department than average case life, even though they are obviously related.

There was no measurable shrink during either the 10 or 17 day transit and cooler storage periods, for either ribs or rounds in either type of package. Trim losses were determined by trained meat specialists who fabricated the subprimals into retail cuts in a manner typical for retail meat departments. In preparing the subprimals, all nonusable trim was removed and weighed to determine average trim loss. Because there was considerable variability in average trim loss among subprimals, a range in trim loss (a 95 percent confidence interval around the mean) was also determined. Thus, benefits were attributed to differences in three levels of trim loss and are presented in terms of dollars per hundredweight (\$/cwt.).

Retail case life comparisons were made by comparing steaks cut from the appropriate rib or round subprimals which had been stored for 10 and 17 days respectively. One-inch thick steaks were placed on a styrofoam backing board, wrapped with 50 gauge polyvinyl chloride film, and were displayed four days under 12 hour intervals of 80 to 100 foot candles of incandescent light. A trained panel evaluated the cuts daily to determine consumer acceptability of the steaks. The panel used an eight-point hedonic scale to visually score steaks each day for four consecutive days. These scores were used to evaluate retail case life comparisons of the two methods of packaging boxed beef. Comparisons can be made between scores of steaks after 10 days or 17 days of storage. However, comparisons between the two time periods should not be made due to the difficulty of assuring consistency in scoring over time.

Although a four day shelf life may exceed normal operational policy for most retail stores, this period was selected as a normal maximum within which case life comparisons should be made. The proportion of steaks considered as "steaks removed" or pull backs was determined from those steaks which received a consumer acceptability score of less than or equal to 4, "slightly undesirable". It was assumed that steaks scored undesirable by the panel would either be removed from display or reduced in price for quick sale under typical retail conditions.

Ribs

Subprimal ribs stored 10 days had no measurable trim loss, Table 3. Since the carbon dioxide method was \$2.116 per cwt. less expensive than the vacuum packaged method, the latter method would have to have benefits equal to this amount to make the methods comparable.

After 17 days of storage the net wholesale value of trimmed vacuum packaged subprimals exceeded the carbon dioxide method for high, mean, and low trim losses respectively, Table 4. Thus, vacuum packaging of subprimal ribs offered a slight net advantage after 17 days of storage as the reduction in trim loss more than offset cost of packaging differences.

Retail case life scores of steaks from subprimals stored 10 days for the two methods were essentially the same, Table 5. However, steaks from 17 day subprimals received statistically significant higher consumer acceptance scores for vacuum packaging after the first day. Since the average scores exceeded the minimum acceptable level except

Table 3. Net value comparisons of 10 carbon dioxide (CO_2) and 10 vacuum packaged subprimal ribs stored 10 days.

Categories	10 Days Storage CO_2	10 Days Storage Vacuum	Differences (CO_2-Vacuum)
Trim Loss (%)1/	0.0	0.0	0.0
Wholesale Value of Trimmed Subprimal ($/cwt.)2/	88.50	88.50	0.0
Average Total Cost of Packaging Method ($/cwt.)2/	2.001	4.117	(-)2.116
Net Wholesale Value of Trimmed Packaged Subprimal ($/cwt.)	86.499	84.383	(-)2.116

1/ There was no measurable trim loss for either method.

2/ Mid-June, 1973, wholesale price of $88.50 cwt. was used to estimate value.

Source: Primary data.

Table 4. Net value comparisons for 5 carbon dioxide (CO_2) and 5 vacuum packaged subprimal ribs, stored 17 days.1/

Categories		Trim Loss High	Trim Loss Mean	Trim Loss Low
% Trim Loss	Carbon Dioxide	3.902	3.200	2.498
	Vacuum Packaged	1.211	0.497	0.0
	CO_2 - Vacuum 4/	2.691	2.703	2.498
Net Wholesale Value ($/cwt)2/	Carbon Dioxide	83.046	83.667	84.288
	Vacuum Packaged4/	83.321	83.943	84.383
	CO_2 - Vacuum	(-)0.276	(-)0.276	(-)0.095
Net Wholesale Value as % of Mid-June Price3/	Carbon Dioxide	93.837	94.539	95.240
	Vacuum Packaged	94.148	94.851	95.348
	CO_2 - Vacuum4/	(-)0.311	(-)0.312	(-)0.108

1/ Data are from replicated experiment.

2/ Net wholesale value of trimmed packaged subprimal adjusted for packaging costs of $2.001/cwt. for carbon dioxide and $4.117/cwt. for vacuum packaged.

3/ Mid-June price of $88.50/cwt. was assumed.

4/ CO_2 minus vacuum packaging.

Source: Primary data.

Table 5. Retail case life comparisons of rib steaks from 10 carbon dioxide and 10 vacuum packaged subprimals, stored 10 and 17 days.1/

Days of Retail Case Life	Stored 10 Days				Stored 17 Days			
	CO_2		Vacuum		CO_2		Vacuum	
	Consumer Acceptance2/	Steaks Removed3/	Consumer Acceptance	Steaks Removed	Consumer Acceptance	Steaks Removed	Consumer Acceptance	Steaks Removed
1	7.40	0	7.45	0	7.00	0	7.80	0
2	7.16	0	7.16	0	6.27^x	0	7.67^x	0
34/	7.03	0	6.80	0	4.87^x	1	7.07^x	0
4	6.66	1	6.53	1	3.67^x	3	6.33^x	0

1/ 17 day ribs from 5 carbon dioxide and 5 vacuum packaged subprimals.

2/ Consumer acceptance based on 8 point hedonic scale (8 = extremely desirable, 4 = slightly undesirable, 1 = extremely undesirable).

3/ Steaks removed = the number of steaks tested which received a consumer acceptance score $\leq$ 4. It was judged that they would not normally be offered for sale by a retailer at regular price.

4/ A short term increase in temperature occurred for the retail cuts between the 2nd and 3rd days for the 10 day ribs. Thus, comparisons between 10 and 17 days should not be made.

x CO_2 and vacuum were significantly different at 0.05 level.

Source: Motycka (1).

for the fourth day for carbon dioxide, the statistical significance may have little meaning until the fourth day. One might argue that higher consumer acceptability scores would reflect increased merchandising opportunities but no evidence can be presented to that effect. However, the incidence of "steaks removed" for the carbon dioxide method was one of five for the third and three of five for the fourth day compared to none for vacuum packaging.

Rounds

The net value of subprimal rounds adjusted for trim loss was greater for vacuum packaging at both the 10 and 17 day comparisons, Tables 6, 7. Thus, without considering the differences in retail case life, the vacuum packaged method was determined to offer a slight advantage over the carbon dioxide method of packaging boxed beef. After 10 days of storage, vacuum packaging represented an increased net value of 0.08 percent, 0.27 percent, and 0.42 percent for high, mean and low trim losses respectively, Table 6.

After 17 days of storage the difference was greater, Table 7. The respectively higher net value differences for high, mean, and low trim loss levels represented advantages for vacuum packaging of 3.17 percent, 2.84 percent, and 2.26 percent. Thus, the savings in trim loss realized by the vacuum packaged method exceeded the increased cost of the method resulting in a net savings from vacuum packaging. As storage time for the subprimals was increased the savings from vacuum packaging increased.

Steaks from the inside and outside round were cut from subprimals stored for both 10 and 17 days. Inside round steaks from both methods received average consumer acceptance scores which were considered desirable until the fourth day of display for the 10 day carbon dioxide method, Table 8.

A short increase in retail case temperature was experienced between the second and third day of display which probably accounted for the higher incidence of steaks removed as well as the relatively lower consumer acceptance scores between the two time periods. Although this was an unexpected occurrence it does illustrate the importance of temperature control. The carbon dioxide method for 10 days of storage had 30 percent and 40 percent greater incidence of steaks receiving undesirable consumer acceptance scores during the third and fourth days of display, Table 8. Observed differences in incidence of steaks receiving undesirable scores was not as apparent for those subprimals stored 17 days. Ten percent more steaks were removed for carbon dioxide on the fourth day only.

Retail case life comparisons for steaks taken from the outside round subprimals stored 10 and 17 days were almost identical to those made for the inside round steaks, Table 9. The incidence of steaks receiving undesirable scores for carbon dioxide was greater than for vacuum packaging except for the fourth day comparisons after 17 days of storage. The carbon dioxide method had 20 percent more steaks removed for second day, 40 percent for third day, and 70 percent for fourth day from subprimals stored 10 days and 10 percent for third day from subprimals stored 17 days.

The major advantage of the vacuum packaging method for rounds has to be considered the increase in net value of the trimmed wholesale packaged subprimal. Retail case life comparisons tend to favor vacuum packaging but the differences were not as apparent as those observed for the subprimals.

Conclusions

For subprimal ribs, the carbon dioxide method of boxed shipment has a net benefit compared to vacuum packaging for 10 days storage. For 17 days, the vacuum packaging method offers a slight net benefit. This implies that for subprimal storage of up to 17 days from kill date, the carbon dioxide method net benefit is equal to or greater than the vacuum packaging method. However, if more than two days of retail case life is necessary after a subprimal storage period

Table 6. Net value comparisons for 10 carbon dioxide (CO_2) and 10 vacuum packaged subprimal rounds; stored 10 days.

Categories		Trim Loss High	Trim Loss Mean	Trim Loss Low
% Trim Loss	Carbon Dioxide	1.551	1.428	1.304
	Vacuum Packaged	0.582	0.274	0.0
	CO_2 - Vacuum	0.969	1.155	1.304
Net Wholesale Value (\$/cwt.)1/	Carbon Dioxide	76.1042	76.203	76.302
	Vacuum Packaged	76.171	76.417	76.636
	CO_2 - Vacuum	(-)0.067	(-)0.214	(-)0.334
Net Wholesale Value as % of Mid-June Price2/	Carbon Dioxide	95.130	95.253	95.377
	Vacuum Packaged	95.213	95.521	95.795
	CO_2 - Vacuum	(-)0.083	(-)0.268	(-)0.418

1/ Net wholesale value of trimmed packaged subprimal adjusted for packaging costs of \$2.655/cwt. for carbon dioxide and \$3.364/cwt. vacuum packaging.

2/ Mid-June wholesale price of \$80.00/cwt. was assumed.

Source: Primary data.

Table 7. Net value comparisons for 10 carbon dioxide (CO_2) and 10 vacuum packaged subprimal rounds, stored 17 days.

Categories		Trim Loss High	Trim Loss Mean	Trim Loss Low
% Trim Loss	Carbon Dioxide	4.694	3.923	3.151
	Vacuum Packaged	0.642	0.197	0.0
	CO_2 - Vacuum	4.052	3.726	3.151
Net Wholesale Value (\$/cwt.)1/	Carbon Dioxide	73.590	74.207	74.824
	Vacuum Packaged	76.122	76.478	76.636
	CO_2 - Vacuum Pac	(-)2.532	(-)2.271	(-)1.812
Net Wholesale Value as % of Mid-June Price2/	Carbon Dioxide	91.987	92.758	93.530
	Vacuum Packaged	95.153	95.598	95.795
	CO_2 - Vacuum	(-)3.166	(-)2.840	(-)2.265

1/ Net wholesale value of trimmed packaged subprimal adjusted for packaging costs of \$2.655/cwt. for carbon dioxide and \$3.364/cwt. for vacuum packaging.

2/ Mid-June wholesale price of \$80.00/cwt. was assumed.

Source: Primary data.

Table 8. Retail case life comparisons of inside round steaks from 10 carbon dioxide and 10 vacuum packaged subprimals, stored 10 and 17 days.

Days of Retail Case Life	10 Day Storage				17 Day Storage			
	CO_2		Vac Pac		CO_2		Vac Pac	
	Consumer Acceptance 1/	Steaks Removed 2/	Consumer Acceptance	Steaks Removed	Consumer Acceptance	Steaks Removed	Consumer Acceptance	Steaks Removed
1	6.25	0	6.30	0	6.95	0	7.40	0
2	4.93	2	5.20	0	6.13	0	6.76	0
3 3/	4.00^x	5	4.86^x	2	5.06^x	1	6.30^x	1
4	3.73^x	7	4.53^x	3	4.16^x	3	4.70^x	2

1/ Consumer acceptance based on 8 point hedonic scale (8 = extremely desirable, 4 = slightly undesirable, 1 = extremely undesirable)

2/ Steaks removed = the number of steaks tested which received a consumer acceptance score ≤ 4. It was judged that they would not normally be offered for sale by a retailer at regular price.

3/ A short term increase in temperature occurred for the retail cuts between the 2nd and 3rd days for the 10 day steaks. Thus, comparisons between 10 and 17 days should not be made.

x CO_2 and vacuum packaging were significantly different at 0.05 level.

Source: Motycka (1).

Table 9. Retail case life comparisons of outside round steaks from 10 carbon dioxide and 10 vacuum packaged subprimals, stored 10 and 17 days.

Days of Retail Case Life	10 Days				17 Days			
	CO_2		Vac Pac		CO_2		Vac Pac	
	Consumer Acceptance 1/	Steaks Removed 2/	Consumer Acceptance	Steaks Removed	Consumer Acceptance	Steaks Removed	Consumer Acceptance	Steaks Removed
1	7.00	0	6.80	0	7.40	0	7.65	0
2	5.20	2	5.86	0	6.23	0	6.80	0
3 3/	4.40	5	4.76	1	5.43	2	6.26	1
4	3.66 xx	9	4.60 xx	2	4.16	4	4.53	4

1/ Consumer acceptance based on 8 point hedonic scale (8 = extremely desirable, 4 = slightly undesirable, 1 = extremely undesirable).

2/ Steaks removed = the number of steaks tested which received a consumer acceptance score ≤ 4. It was judged that they would not normally be offered for sale by a retailer at regular price.

3/ A short term increase in temperature occurred for the retail cuts between the 2nd and 3rd days for the 10-day steaks. Thus, comparisons between 10 and 17 days should not be made.

xx CO_2 and vacuum packaging were significantly different at the 0.01 level.

Source: Motycka (1).

of 17 days, the vacuum packaging method offers a smaller incidence of pull backs than does the carbon dioxide method. This means that from a retailer's viewpoint, after 17 day subprimal storage, the retail case life benefits associated with vacuum packaging may be significant.

For rounds, the vacuum packaging method offers net benefits slightly greater than the carbon dioxide method after 10 days subprimal storage. As the subprimal storage period was extended to 17 days, the vacuum packaged method had greater net benefits than the carbon dioxide method. In addition, steaks fabricated from the vacuum packaged rounds had a smaller incidence of pull backs after the second day of retail case storage. This again can be an important factor for consideration by a retailer.

The implications are tempered by the wholesale price of beef used in the analysis above. If prices substantially advance beyond those existing at the time of this analysis, vacuum packaging net benefits would likewise increase. The converse is also true.

REFERENCES

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(3) Sporleder, T. L. and W. J. Vastine, Comparative Cost Analysis of Carbon Dioxide and Vacuum Packaged Boxed Beef: A Case Study. Research Report MRC 73-2, Texas Agricultural Market Research and Development Center, Texas A&M University, August, 1973.

(4) Supermarket News, "Boxed Beef: An Accepted Alternative", Vol. 22, No. 36, September 3, 1973, p. 1.

FOOTNOTE

1/ I.M.P.S. is Institutional Meat Purchase Specification, see (2).