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EAST AFRICAN MARKETS AND TANZANIAN POLICIES FOR PRICING AND PLANT LOCATION - LIVESTOCK AND MEAT

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SUMMARY

A model of the Tanzanian beef markets was designed to estimate the price difference among markets due to transportation cost, optimum number of plants and plant locations for a variety of conditions.

Using production and consumption data for the 1968-70 period and 1976 transportation costs total transportation cost of live cattle and beef amounted to shs. 73.5 million, but with the assumed addition of three new plants in the interior (Shinyanga, Arusha and Mbeya) transportation cost declined five percent. Had the model taken into account death loss and shrink, the reduction in total cost would have been about double that due to transportation alone. It is quite clear that a new plant in the interior would be a wise investment. Additional plants in Arusha and Mbeya have some merit, but their value depends on expected production increases and live exports.

The specific results of these models suggest that a plant located in Shinyanga in addition to the one at Dar would reduce total transportation cost further to shs. 3.6 million then, the addition of the Mbeya plant increased total transportation cost. This suggests the Mbeya plant capacity would contribute less to economic development than the one at Arusha unless cattle production is increased in the Mbeya area. However, if live cattle continues to move to Kenya the Arusha plant is of doubtful value.

The models yield imputed price differences and these for model I suggest a price premium of shs. 18/cwt. in Dar over West Lake and almost

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16 shs. over Shinyanga. If death loss and shrink are taken into account these premiums would increase to about shs. 30 per cwt. live weight.

The solution of the models illustrates the need for geographic price differences based on cost of reaching alternative markets. Location of plants in the interior reduces the price difference to one-half compared to relying solely on the Dar plant. The saving potential is such that the cost of slaughter and canning capacity could be recouped rapidly considering a saving of an estimated U.S.$.3 million per year from savings in transportation cost, death loss and shrink.

Results of this study can serve as guides to policy decisions. Application to a specific route or price differential must be adjusted for current conditions. Results of the models were consistent with standard principles of geographic price differences with surplus areas having the lowest prices and deficit areas having the highest prices. Specific model results were that prices were generally highest in the Southeast and lowest in the Northwest. Locating a plant in Shinyanga reduced the price difference between Shinyanga and the coast by shs. 7 (U.S.$1) per cwt. liveweight. Dar es Salaam and Mtwara had the highest price for cattle in all models and Northwest areas were the lowest. Shingida-Tabora area would be the lowest price area if movement of live cattle into Kenya were included in the model.

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Introduction

Tanzania for a time regularly exported live cattle to neighboring countries and canned beef to markets in Europe, primarily the United Kingdom. At times it has exported chilled beef to nearby countries. Considering the lack of development of the livestock meat sub-sector and the lack of development of infrastructure it appears it has potential to substantially expand beef exports if certain planned improvements are accomplished.

During 1975 exports became increasingly difficult to arrange, and the cattle industry suffered severely from drought and lack of export markets. A single packing plant located in Dar es Salaam slaughters for canned beef export. It also provides fresh beef for the city. Long trekking and hauling without feed and water results in excessive shrink and death loss.

The cattle-beef sub-sector is characterized by low productivity, high live marketing costs and by market prices controlled by government that do not provide the incentives required to increase output or quality. Analyses are needed to provide policy guides on pricing and plant location

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to increase pricing and physical efficiency of the sub-sector.

A transshipment linear programming model, using data from a relatively stable period was used to provide estimates of optimum plant locations, efficient pricing patterns and potential product flows from Tanzania to East African markets.

Livestock inventory in Tanzania in 1970 was estimated at 13.1 million cattle, 4.4 million goats and 2.8 million sheep. Even though this is slightly more cattle than was estimated for Texas in the same year, the offtake was only a fraction of that in developed countries. It has been estimated at less than 10 percent with market offtake as low as 3 percent.

A livestock development plan is in operation that is based on the hypothesis that slaughter capacity located in the surplus cattle areas will increase marketing efficiency. This study attempts to test that hypothesis and provide additional guides for pricing and market development.

Methodology

A transshipment linear programming model is used to estimate the cost saving in total transportation. This also provides estimates of spatial price differences and optimum plant location. Sources of production, sources and destinations for slaughter, and destinations for consumption are linked to minimize transportation costs.

Supply Capacities for Beef Cattle

Seventeen cattle production regions were chosen as representative

of livestock regions (Figure 1). Data is available for the period 1968-1970 for the average annual offtake of head of cattle. It will be assumed that each animal has an average weight of 5.24 hundredweight; therefore, supply capacity for each region will be in live hundredweight (see Table 1).

Slaughter Capacity for Each Region

Demand requirements of beef for slaughter include the seventeen domestic production regions in addition to three export markets for live animals. The three export markets are: Lusaka, Zambia; Kampala, Uganda; and Kinshasa, Zaire.

Data on slaughter capacity for the seventeen internal markets is nonexistent so it has to be extrapolated from aggregate consumption from larger livestock zones (Table 2). Slaughter capacity for the seventeen regions in Tanzania is calculated by the following equation.

(EQ1.) Total Slaughter Capacity = (Pounds of liveweight of beef/capita/year for $Zone_j$)(Population for $Region_{ij}$)

It is assumed that the pounds of liveweight of beef/capita/year for $Zone_j$ will be equivalent over the entire space of the zone.

Consumption demand for each region

Total consumption capacity for each region was assumed equivalent to its local slaughter capacity. All the cattle which are slaughtered will be consumed in the region except where a commercial slaughter plant is located in the region (Table 3).

Data on slaughter and consumption capacity for the three African

Table 1. Average offtake of cattle by regions in Tanzania

Region	Average offtake of cattle 1968-1970 in Liveweight
	---------(Cwt.)---------
Arusha	313,527
Coast	13,506
Dodoma	254,760
Iringa	84,242
Kigoma	4,994
Kilimanjaro	111,418
Mara	43,100
Mbeya	42,963
Morogora	32,963
Mtwara	23,285
Mwanza	77,843
Ruvuuma	13,674
Shinyanga	256,000
Singida	160,823
Tabora	172,629
Tanga	44,225
West Lake	43,396

Source: Phase II Livestock Development Project. Ministry of Agriculture and Cooperatives, Dar es Salaam, Tanzania, November, 1971, Vol. 4.

Table 2. Human population, total consumption and liveweight per capita consumption of beef by livestock zones

Zones	Population[1]	Consumption of beef in $Zone_j$	Liveweight[2] per capita consumption
		(Head)	(Pounds)
South Western	1,659,200	22,000	7.0
Northern	2,034,000	44,500	11.6
Sukumaland/Lake	3,719,600	40,500	5.7
Eastern	2,636,000	72,100	14.4
Southern	1,434,000	9,000	3.3

[1]Population data is from 1967 national census.

[2]Liveweight/capita consumption was figured by following equation:

$$\text{Liveweight per capita consumption in beef Zone}_i = \frac{(\text{Consumption in Zone}_j \text{ in head of cattle})(5.28)}{\text{Total population in Zone}_j}$$

[3]Assumed one head of cattle equivalent to 5.24 cwt.

Source: Phase II Livestock Development Project. Ministry of Agriculture and Cooperatives, Dar es Salaam, Tanzania, November, 1971, Vol. 4.

Table 3. Basic data required for the model, 1968-1970

Zone	Human population	Per capita consumption	Total slaughter capacity	Total consumption	Total production by region
	--(No.)--	--(No.)--	--(Cwt.)--	--(Cwt.)--	--(Cwt.)--
Zone I: Northern					
Arusha Region	610,400	11.6	70,806	70,806	313,527
Kilimanjaro	652,700	11.6	75,713	75,713	111,418
Tanga	771,000	11.6	89,448	89,448	44,285
Zone II: Eastern					
Coast Region	771,000	11.6	89,448	112,939	13,506
Dodoma	709,300	14.4	102,139	102,139	254,760
Morogora	685,000	14.4	98,640	98,640	32,530
Singida	458,000	14.4	65,952	65,952	160,824
Zone III: South West					
Iringa Region	689,000	.7	48,293	48,293	84,242
Mbeya	969,000	.7	67,851	67,851	42,963
Zone IV: Sukumalund/Lake					
Mara	544,000	5.7	31,008	31,008	43,100
Kigoma	473,000	5.7	26,983	26,983	4,994
Mwanza	1,059,100	5.7	60,140	60,140	77,843
Shinyanga	899,500	5.7	51,271	51,271	256,000
Tabora	562,900	5.7	32,085	32,085	172,629
West Lake	658,100	5.7	37,511	37,511	43,395
Zone V: Southern					
Ruvuuma	393,000	3.3	12,969	12,969	13,675
Mtwara	1,041,000	3.3	34,353	34,353	23,285

Source: Phase II, Livestock Development Project. Ministry of Agriculture and Cooperatives, Dar es Salaam, Tanzania, November, 1971, Vol. 4.

export markets for live animals from Tanzania is an arbitrary quantity simply to allow the model to provide the imputed marginal costs and price differences. The same transportation equations were used to estimate freight rates. Shipments to these markets occur but are erratic due to political and other problems. Inclusion of these three export markets is necessary to represent the East African market for Tanzanian cattle and beef.

Distances Between Markets and Transportation Costs

In each of the seventeen regions, a major town was chosen as the slaughter and consumption center. Transportation costs between market points were estimated from equations fitted to the actual rates available:

(1) Live cattle

$$Y = 6.4338 + .01783X$$

where: Y = total costs/cwt. in Tanzanian shillings for total distance travelled for live cattle or live animal equivalent,

b_0 = fixed costs for shipment of live animals or live animal equivalent,

b_1 = the incremental increase in cost per unit of distance travelled.

(2) Chilled beef in live animal equivalent,

$$Y = 3.9465 + .016457X$$

Description of Models

Model I represents the marketing system presently in operation. One commercial packing plant processes cattle into unrefrigerated carcasses for local trade and chilled or canned beef for export.

Surplus live cattle in the regions are shipped either to Dar es Salaam (Coast Region) where Tanganyika Packers Ltd.'s (TPL) plant is located or to African export markets.

In Model 1, slaughter capacity at Dar es Salaam is assumed to include the regional slaughter capacity for the Coast Region plus capacity to include the surplus cattle production from all domestic regions to allow for export of processed beef.

Consumption capacity for Teheran (a hypothetical export market) is the net difference between the increased slaughter capacity for the Coast Region and consumption capacities for all other locations. Transportation costs from Dar es Salaam to Teheran is lower than from the other markets so all chilled or canned beef leaves from Dar es Salaam.

In Model IV, slaughter plant capacity is assumed for four regions to test the hypothesis: whether slaughter plants located in surplus cattle areas would reduce the total transportation cost for the system. Model II considers one new plant in Shinyanga, the largest cattle surplus area; this plant is currently under construction. Model III considers a third plant at Arusha.

The four regions with slaughter plants (Coast, Arusha, Shinyanga, and Mbeya) have equivalent slaughter capacities and transportation costs in shipping chilled or canned beef to Teheran.

Results

Analysis of the current situation is represented by Model I and illustrates the incentive for exporting live cattle to neighboring countries due to lack of slaughter capacity in the interior (Figure 1). Another factor encouraging live cattle movements is the preference for slaughtering in the city where it is consumed. The general distribution

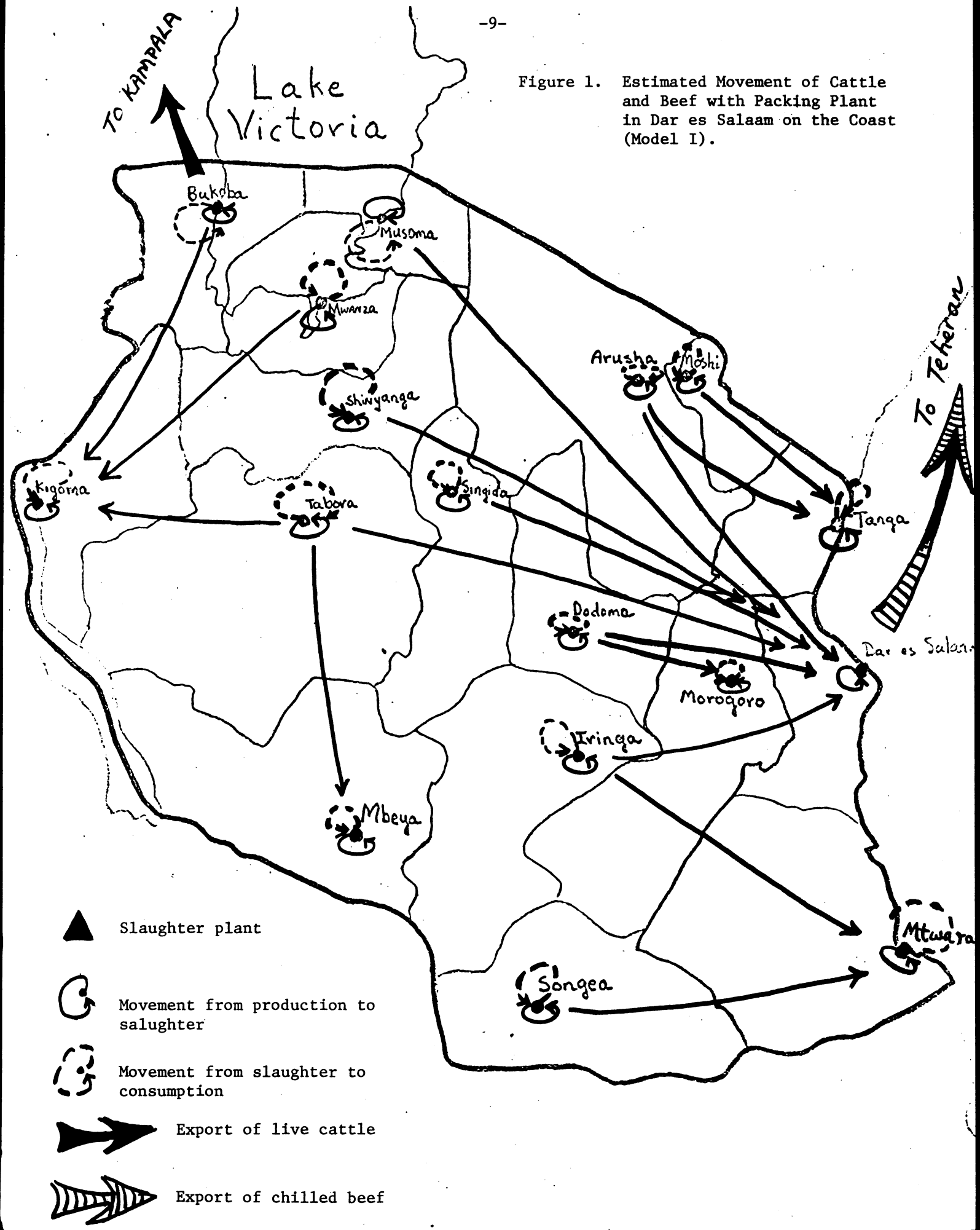
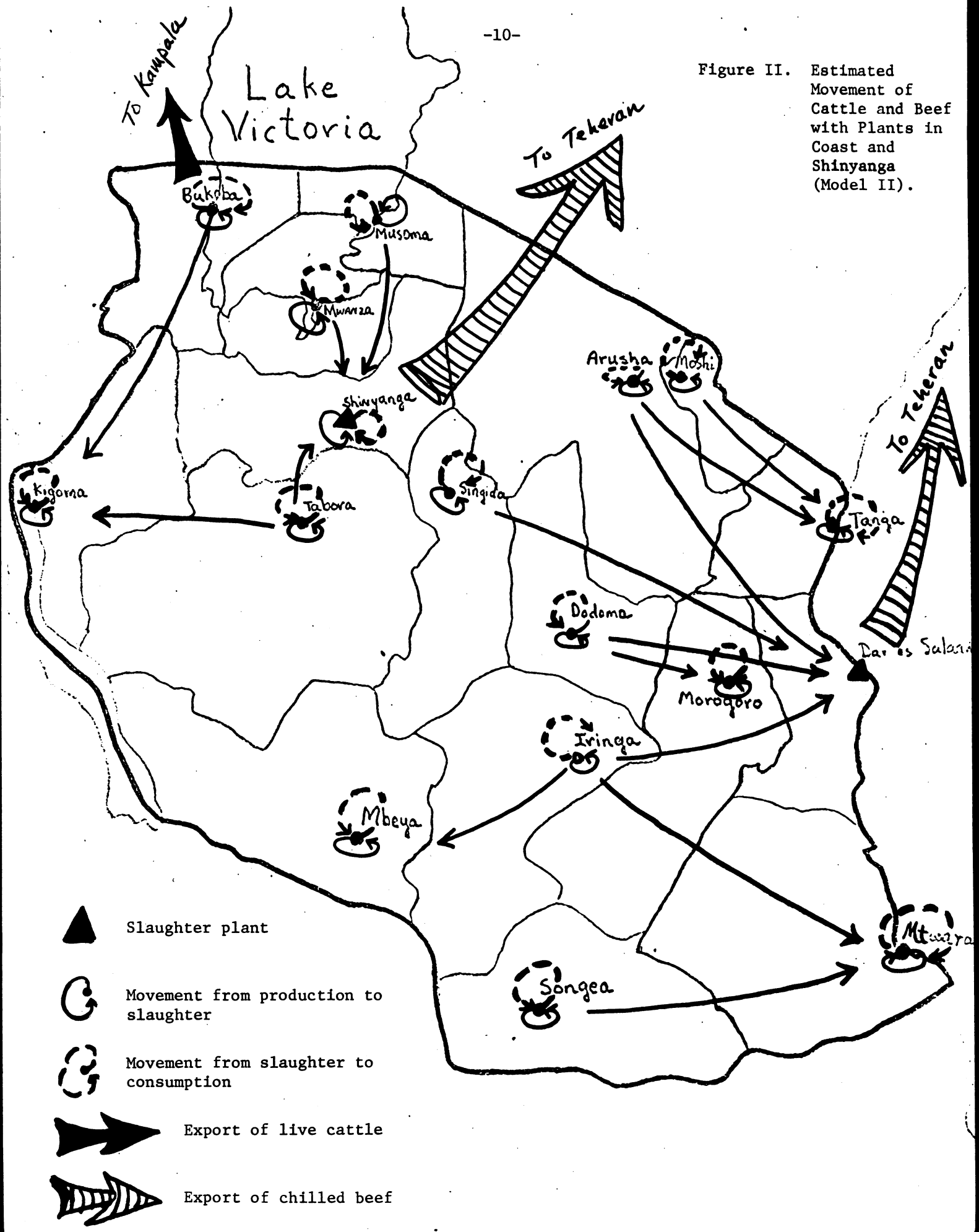


Figure 1. Estimated Movement of Cattle and Beef with Packing Plant in Dar es Salaam on the Coast (Model I).

Figure II. Estimated Movement of Cattle and Beef with Plants in Coast and Shinyanga (Model II).



pattern appears to be in line with the observed situation for the time period on which the data are based.

Models II and III represents the post-1976 situation when it is assumed adequate slaughter capacity can be provided in the surplus cattle areas. Even though shrinkage and death loss is not charged to live cattle movement, total transfer cost is minimized by using slaughter capacity in Arusha, Shinyanga and Mbeya in addition to the plant operating at Dar es Salaam. In fact the total transportation cost was reduced by 3.6 million T.S. per year or 5 percent (Table 4).

Table 4. Comparison of Total Transportation Costs for Model I and Model II

Model	Total Transportation Costs	Savings	
	(TSH)	(TSH)	(Percent)
Model I	73,495,034 [a]		
Model II	71,433,504	2,061,530 [b]	2.8
Model III	69,878,837	3,616,197 [c]	4.9
Model IV	69,908,325	3,586,709 [d]	4.8

[a]Equivalent U. S. $8,646,475.
[b]Equivalent U. S. 242,532.
[c]Equivalent U. S. 425,435.
[d]Equivalent U. S. 421,966.

This suggests that the savings in transportation costs alone to the cattle-beef sub-sector would amount to 3.6 million T.S. per year and would indicate that the capacity in the new locations would be a good investment. This assumes that the necessary adjustments in the economy would

be made to handle chilled meat transportation and sales. This is a heroic assumption and since this condition is not a part of the model a more precise statement of the results is that substantial economic incentives exist to justify expanding slaughter capacity first to the Shinyanga-Tabora area, then to Arusha and next to Mbeya (Table 5) Marginal transportation costs at the final consumption points are substantially reduced by the second plant whereas there is little reduction from adding 2 more plants (Table 5).

Imputed prices may be used to show cattle price differences due to transportation cost. The price pattern shows the Lake Victoria areas having the lowest price with the price rising along the coast reaching its highest point as Mtwara where it was 21.8 T.S. per cwt. above West Lake in Model 1 and 17.8 in Model II (Figure 3). Since death loss and shrinkage were not included in the cost of transportation, these imputed values measure only about one-half of the price differences that would prevail in an open market system. Nevertheless, this general price pattern would be expected to hold with only an increase in the differences if all costs of transfer and cattle losses were included. Actually the Tabora-Shinyanga-Mwanza areas would be the lowest price areas if data were available to reflect the northern movement of cattle across the border.

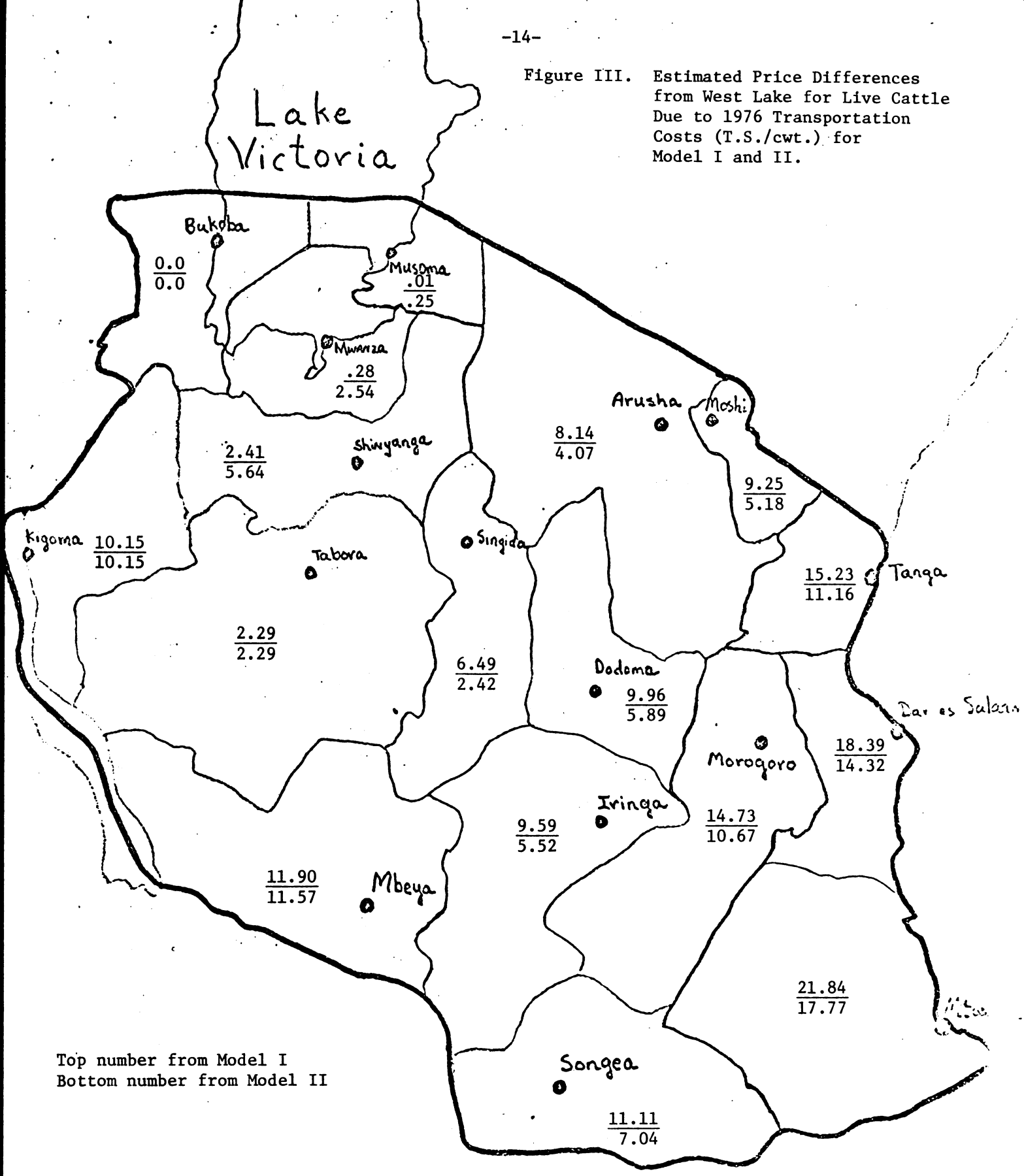
Imputed price differences from Model II show that the location of packing plant capacity at the interior points cuts the price differential between Shinyanga and Dar es Salaam to one-half (from 18.4 - 2.4 = 16.0 in Model I, to 14.3 - 5.6 = 8.7 T.S./cwt. in Model II). The northwestern part of the country remains the lowest price area and the Southeast remains the highest price area for live cattle (Figure 3 and Table 6). This specific result assumes no live cattle being sold in Kenya.

Table 5. Comparison of marginal transportation costs for an added unit of beef consumption by regions as plants are added, 1976.

Region	1 Plant Model I	2 Plants Model II	3 Plants Model III	4 Plants Model IV
	(T. S./live cwt. equiv.)[a]			
Arusha	23.16	19.09	20.30	20.30
Kilimanjaro	23.59	19,52	20.69	20.69
Tanga	26.57	22.50	24.02	24.02
Coast	28.84	24.77	24.96	24.96
Dodoma	24.87	20.27	20.69	20.46
Morogoro	27.52	22.70	23.01	22.89
Singida	23.21	18.42	18.38	18.42
Mbeya	28.15	23.11	22.26	22.26
Iringa	25.54	21.47	21.89	21.66
Mara	18.67	17.76	15.64	15.64
Kigoma	23.26	20.60	20.60	20.60
West Lake	18.06	16.22	17.50	16.22
Mwanza	19.49	17.84	15.13	15.13
Shinyanga	21.21	16.12	16.12	16.12
Tabora	22.82	17.98	17.98	17.98
Mtwara	32.32	28.25	28.67	28.44
Ruvuuma	26.38	22.31	22.73	22.50
Lusaka, Zambia	37.39	33.00	33.00	33.00
Kampala, Uganda	15.67	14.76	14.76	14.76
Kinshasa, Zaire	39.10	38.19	38.19	38.19
Teheran, Iran	95.47	91.40	91.40	91.40

[a]Converted to carcass beef, these values would need to be multiplied by 2.

Figure III. Estimated Price Differences from West Lake for Live Cattle Due to 1976 Transportation Costs (T.S./cwt.) for Model I and II.



Top number from Model I
Bottom number from Model II

Table 6. Comparison of Imputed Price Differences for Live Cattle as Packing Plant Capacity is Added.[a]

Region	1 Plant Model I	2 Plants Model II	3 Plants Model III	4 Plants Model IV
		(T. shs. per live cwt.)		
Arusha	8.14	4.07	9.85	8.95
Kilimanjaro	9.25	5.18	8.46	7.56
Tanga	15.23	11.16	13.54	13.54
Coast (Dar)	18.39	14.32	14.51	14.50
Dodoma	9.96	5.89	6.08	6.08
Morogoro	14.74	10.67	10.86	10.86
Singida	6.49	2.42	3.81	2.90
Mbeya	11.90	11.57	11.76	11.76
Iringo	9.59	5.52	5.71	5.71
Mara	0.01	0.25	1.43	0.53
Kigoma	10.15	10.15	10.15	10.15
Weat Lake	0.00	0.00	0.00	0.00
Mwanza	0.28	2.54	2.54	2.54
Shinyanga	2.41	5.64	5.64	5.64
Tabora	2.28	2.29	2.29	2.29
Mtwara	21.84	17.77	17.96	17.96
Ruvuuma	11.11	7.04	7.23	7.23

[a] Price differences are premium prices per cwt. above West Lake. They do not account for shrink and death loss in transporting. Actually in recent years the West Lake area has had a deficit of live cattle and a more accurate price level would probably be a little above Mwanza. Arusha area price would also be higher if live movements into Kenya had been estimated.

Since other production and marketing costs are not included in the models these data show only the change due to location of packing plant capacity, and the relative market price differences by regions due to transportation costs. Export markets in Zaire and Zambia have the highest marginal transportation cost with costs declining in other regions toward the interior of Tanzania, and further toward the Lake Victoria area in the northwest. Specifically, these models assume an open market and the necessary infrastructure to adjust to an optimum marketing solution given the specified availabilities, requirements and transportation costs. Some of the estimates may therefore, be unrealistic, but the analysis does illustrate the general price distribution patterns that would prevail when resources were being used efficiently.

The current (1976) pricing policy for live cattle is a flat minimum price with no direct quality, seasonal or geographic differential. A weight differential is applied that is associated with quality. This policy results in lower quality cattle being shipped long distance by railroad without feed or water. The shrinkage and death losses are unusually high. Furthermore, the policy of fixing maximum retail price by districts or regions creates further distortions, although these prices do recognize a spatial price difference relative to the coast. Some adjustment in geographic pricing has been approved but not operating in July 1976.

When the plant under construction at Shinyanga is completed the price on the coast will still need to be higher, but the difference compared to Model I would be cut to one-half (Table 5).

Finally, results of the analysis support the hypothesis that marketing efficiency can be substantially increased by locating slaughter

capacity in the interior. This result supports the recommendation of the study made for the Ministry of Agriculture and the Development Bank in 1971 (1). If market incentives are adjusted to encourage producers to adopt better production and marketing practices the offtake should increase to allow the industry to supply East African markets with live cattle and beef on a continuing basis.

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