LOSSES OCCURRING IN MARKETING CATTLE, AND EFFECTS OF REGAIN ON LIVE WEIGHT AND CARCASS COMPOSITION IN TROPICAL AREAS

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ABSTRACT

LOSSES OCCURRING IN MARKETING CATTLE, AND EFFECTS OF REGAIN ON LIVE WEIGHT AND CARCASS COMPOSITION IN TROPICAL AFRICA

The production and marketing of livestock and related products is one of the largest and most important industries in tropical Africa. Unfortunately little research on marketing systems in general and transport and related problems in particular has been done.

In Africa historically, cattle have been moved to urban markets by trek, but recently cattle have been shipped in trucks and railroads in order to minimize losses.

There are many kinds of losses occurring in market cattle during transportation. The well known losses are shrinkage, bruising, crippling, lost animals and death.

Shrinkage may take place while the animal is in transit, at the market or in holding pens of the packers. Some of the more evident factors affecting shrinkage are the amount of fill, time of transit or distance shipped, weight of the animals, type of transportation, disturbance of animals, temperature-weather.

Losses from bruising, death and crippling are largely influenced by the type of transportation used and by many other factors such as the distance and time of shipment, the season.

Where a choice of transport methods is possible among trekking, trucking and railroad, it should be worth making careful assessment of losses to be incurred and the costs they represent. There is no standard recommendations to be applied to every situation.

In any method of transportation, lack of care and poor judgement might increase losses and lower the net return. Thus, much should be done to control excessive losses by adequate preparation for shipment.

To be efficient, the marketing system as a whole must allow cattle to be assembled, transported, bought and sold with minimum delay, movement and cost; timely marketing information must be available to help buyers and sellers channel meat to consumers in an orderly manner and consumer demand must be reflected back to enable producers to effectively plan resource allocation, production and marketing.

Restricted nutrition at any age not only retards growth in general but also affects the tissues differentially. The organs with an early period of maximum growth can draw on or have prior claim on, the nutrition of those having a later period of growth. However when restricted cattle are slaughtered after a period of realimentation and at the same weight as unrestricted cattle, there have generally not been significant differences in body composition although some differences exist in fatness.

Cattle on natural grasses without supplemental feeding in West Africa may loose 10 to 33 percent of their weight by the end of the dry season, but within four to six weeks on the young grass of rainy season they may regain their weight.

For practical implication in regain there is a need to identify cattle of different growth potential and to match them to appropriate feeding systems. However, in many areas in West Africa adaptation to the specific climate and environment conditions is much greater significance than size as such.

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PART I

INTRODUCTION

The production and marketing of livestock and related products is one of the largest and most important industries in tropical Africa. Millions of producers depend upon livestock raising and marketing for a livelihood. Unfortunately little research on marketing systems in general and transport and related problems in particular has been done. Marketing systems differ from country to country and variations occur within countries, but all have one primary purpose that is to move products from producer to consumer as efficiently as possible. In Africa historically, cattle have been moved to urban markets by trek (on foot), but recently cattle have been shipped in trucks and by railroads because it was assumed that trekking resulted in large weight losses in cattle and often deaths. The growth of urban areas with the increasing proportion of the population unable to supply their own food has led to greater movement of stock from the producing to consuming areas. Since the distances involved are often very great, this movement has led to various effects such as shrinkage, bruising, crippling, mortality, straying, carcass weight loss, change in carcass composition. Consequently, transportation costs represent a large part of the total expense of marketing livestock.

Several alternative methods of livestock transportation are available:

trekking (on foot)
railroad
trucking

The best method will depend within the specific conditions of each area upon the relative costs, services and convenience.

Cost includes not only the out-of pocket cash paid for the transportation service but also opportunity cost of tied capital, losses from death, bruising, crippling and shrinkage of the live animal, the deterioration of meat quality and carcass weight loss in transit. Some of these losses such as shrinkage or meat deterioration and carcass weight loss can be minimized by resting and feeding practices (Harston, 1959).

The net production of animal protein from any sector is a result of the yield of the production system of the animal less the losses which occur through the marketing channel.

In most tropical countries, capital and technical inputs are being directed toward increasing the production efficiency of the livestock population by increasing or improving quantity and quality of feed production, improved management, disease control, and breeding improvement. The net gains obtained in production by these efforts may be drastically offset by the losses incurred in moving livestock to points of processing and consumption. These losses will affect the various segments of the beef industry, depending upon where and to what extent they occur. They will be reflected back to the

producer in lowering the prices he is paid and will be costly to the trader and to the processor, limiting their margins and affecting the flexibility of the market for meat.

Governments are concerned about the losses incurred in marketing livestock and are interested in reducing such waste, but have little objective information at their disposal with which they can plan effectively. There is relatively little information on what the losses are, the basic factors causing them and the requirements for minimizing losses of cattle moved long distances. Research on livestock marketing has been given a low priority and even among these studies done on the subject most have been conducted by economists having little background in animal science. Unless reliable and accurate information on the specific context of tropical areas is available it is difficult to plan strategies to reduce these wastes and to improve beef production and distribution policies. There is a need to know specifically what is required to get maximum benefit for livestock investments. An awareness of actual losses may also serve to motivate governments to act in providing adequate cattle transit schemes. Moreover, research on regain is lacking and needs to be carried out in order to determine its economic importance and its feasibility.

There are many works done in developed countries on the different patterns of losses and regain but unfortunately there is no attempt to extrapolate their outcomes to tropical areas characterized by very hot weather, poor management systems, a dominantly on hoof transportation system and very stressed animals.

This study geographic area of focus essentially involves eight countries: Mali, Niger, Upper Volta which are the major producers, and exporters of cattle in West Africa and Ivory Coast, Nigeria, Ghana, Benin and Togo which are the major consumers and importers of cattle of the region. Together the eight countries handle almost the totality of cattle trading in West Africa.

OBJECTIVES

This study will be directed at two components:

I. Description of the cattle marketing systems in eight West African countries with the following specific objectives:
   a. To describe the different marketing/transportation systems for cattle in West Africa.
   b. To describe and identify the nature and causes of losses occurring in marketing cattle and to make recommendation for their reduction.
   c. To estimate and compare the costs associated with marketing losses for each system of transport.
   d. To identify current approaches used to reduce losses for the purpose of making recommendations for the African situation.
   e. To identify the strategies, priorities, interventions and policy implications for the improvement of the marketing system.

II. Regain
   a. To analyze patterns of short-term and long-term regain and their effects on cattle composition and yield.
   b. To Analyse cattle regain experiment study with market animals in Honduras.

METHODOLOGY

Source of Data

Needed data was obtained from available secondary sources and interpreted in the light of my personal experience as a chief of the marketing division in a livestock project in Mali.

Descriptive data for Part I are based on reports by international consultants, international organizations, researchers and academic texts.

Method of Analysis

Part I — Objective (c) will be met by comparing simple averages and percentages in order to estimate the financial and economic costs per unit of each method of shipment. Costs include freight cost or driver fees, shrinkage cost, mortality costs, capital costs, bruising, crippling and taxes.

Part II — Objective (a) will be met through comparing approaches used in Africa to reduce losses and technology a ailable elsewhere and applicable in Africa. Objective (b) will be dealt through discussion on statistical report from Honduras Project.

Chapter II

Background

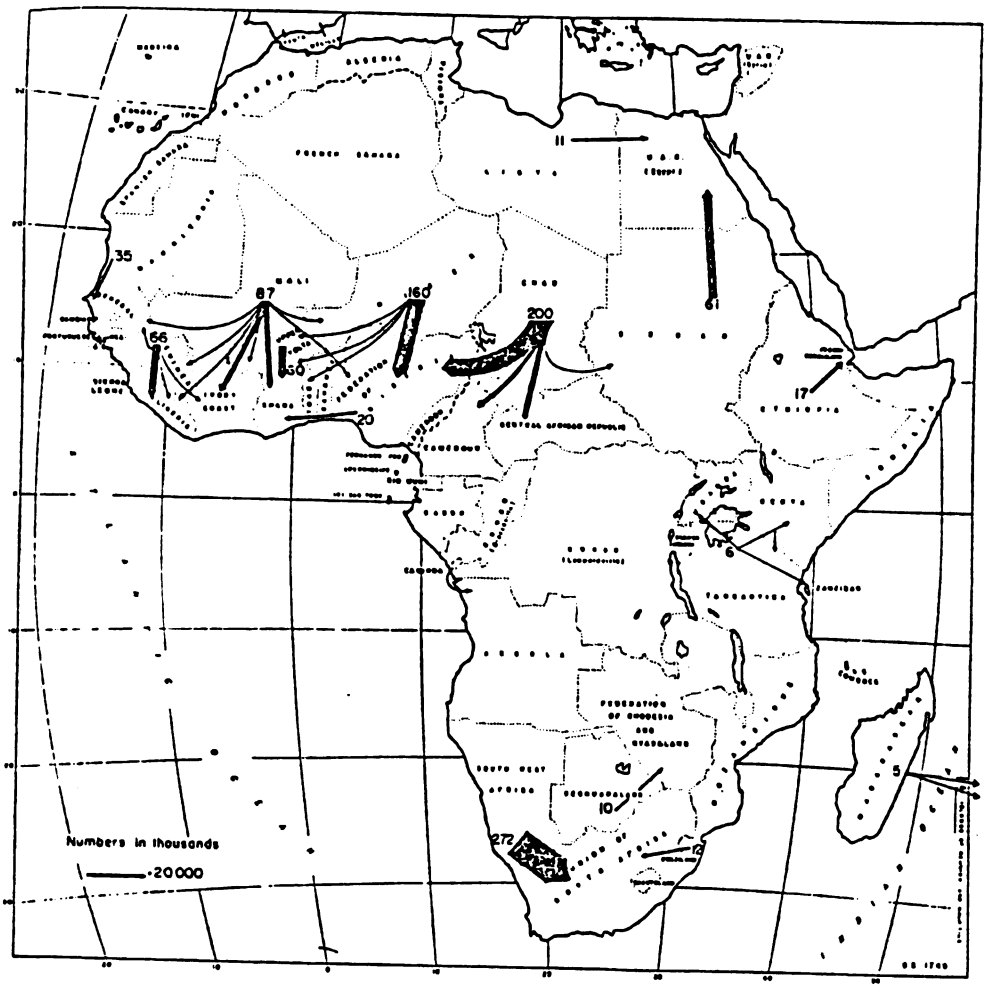
A BRIEF DESCRIPTION OF CURRENT WEST AFRICAN LIVESTOCK PRODUCTION, DISTRIBUTION, AND CONSUMPTION SYSTEM

Livestock Producing Zones

In West Africa, as shown in Map I, there is a northern surplus producing zone which sends cattle, sheep and goats to the south. This zone includes Niger, Upper Volta, Mali and northern Nigeria. This is a semi-arid region, with a long dry season and a short wet season, and as a result there is a low density of livestock population. Pastures are abundant during the rainy season, which is irregular, but generally extends from June through September. After the rains stop, the moisture soon disappears and the movement of livestock to the south begins. With the exception of a few low areas near the major rivers and lakes, there is no green forage available for seven to nine months of the year. During this period, the breeding stock remaining in this region suffer greatly from malnutrition, resulting in high mortality and low calving rates. Also, it is estimated that 40 percent of the calves born never reach maturity (Bishop, 1972).

The offtake rate or the proportion of animals slaughtered annually in relation to the total livestock population is approximately 12 percent for

Map I. MAIN CATTLE EXPORT MOVEMENTS: AFRICA 1957-59



Source: Mittendorf, 1961.

Sahelian cattle, and 10 percent for Savannah cattle (Delgado, 1980).

Under the harsh prevailing weather conditions and low output per animal unit, producers have been unable to adopt modern methods of livestock husbandry. Practically the entire region is one vast open, public range. Privately owned, fenced, ranch type operations are virtually nonexistent. Livestock owners are free to move and graze their animals almost anywhere without interference, or at least within those areas where they have traditional and tribal grazing rights.

This type of land tenure has resulted in overstocking the ranges often beyond their carrying capacities. Overgrazing by sheep and goats is becoming more prevalent throughout the region. When land in the northern, more arid part of this region is overgrazed, it does not respond or responds poorly to the next wet season and becomes a barren sand dune in some Sahelian zones.

Most of the human population in this region live in rural areas, and the majority of these are engaged in livestock raising. There is about one head of cattle and two head of sheep and goats per inhabitant* (Bishop, 1972). this means that there are only a few head of livestock per operator. Converting the present system into units large enough to permit the use of modern techniques would leave the majority of the rural population unemployed and displaced from land to which they have traditional tribal rights.

*Household data not available.

Livestock Deficit Areas

A southern zone composed of Ivory Coast, Togo, Benin, Ghana, and Nigeria is a livestock importing area. Although the northern part of Nigeria produces a substantial surplus of livestock for shipment to the southern part, the country as a whole is a deficit zone.

The southern zone as a whole has abundant forage most of the year and adequate water supplies. The limiting factor in practically all of this region is the prevalence of the Glossina Tse-Tse fly which infects cattle with Trypanosomiasis, a generally debilitating disease. Only cattle that are resistant to this disease can be raised successfully in this region. These resistant breeds (N'dama and other Taurin breeds) are considerably smaller than those raised in the northern, semi-arid region. Cattle numbers in the southern zone are low, and a large part of the abundant forage produced is unutilized.

The zone as a whole produces only two thirds of its cattle requirements but over 90 percent of its sheep and goat requirements.

Breeds of Livestock

In the northern zone various types of Zebu cattle are raised, some with long horns (Bororo breed in Niger) and some with short horns, Maure breed. There are some which attain a carcass weight of over 200 kilos, but the average Zebu of this region seldom exceeds 150 kilos. The taurin breeds of cattle which are resistant to Trypanosomiasis are raised in the southern zone (south of Mali), Ivory Coast, Ghana and Nigeria. The carcass weight of these average less than 100 kilso.

Sheep native to the semi-arid region are large types which produce meat of relatively good quality. The sheep in the southern region are Trypanosomiasis and humidity tolerant and survive well under adverse conditions and are of small size. The type of goats follow the same pattern that is, large breeds in the north and small ones in the south.

Livestock Numbers

According to FAO figures, the cattle population for the eight West African countries considered in this study was approximately 26.5 million head in 1981. Most of the 12.5 million head of cattle in Nigeria are located in the northern part of the country and are of the Zebu breeds. The Tse-Tse fly zone extends across the southern part of Upper Volta and Mali and as a result an important number of the cattle in those countries are of the Taurin breeds, while the largest number are Zebu. Virtually all of the cattle in Niger are Zebus, while practically all in the Ivory Coast, Ghana, Togo and Benin are Taurins, since the Tse-Tse fly zone covers all of these countries.

Livestock Production and Trade

The three exporting countries (Mali, Niger, Upper Volta) produce approximately 1.3 million head of slaughter cattle annually and export about 33% of the production to the five coastal countries, as shown in Tables I and II. Niger exports the largest proportion of its production or about 40 percent. Upper Volta exports 21 percent and Mali 17 percent.

TABLE 1. PRODUCTION AND TRADE IN LIVESTOCK FOR SLAUGHTER

	CATTLE		
Exporting Countries	Production 1,000 head	Export Trade 1,000	Percent
Niger	480	190	40
Upper Volta	311	66	21
Mali	523	111	17
TOTAL	1,314	367	22

	CATTLE		
Importing Countries	Production 1,000 head	Import Trade 1,000	Percent
Ivory Coast	61	147	71
Togo	27	8.6	24
Benin	85	1.7	1.96
Ghana	87	1.3	1.4
Nigeria	950	330	26
TOTAL	1,210	489	29

Source: Bishop, 1972; and CRED Volumes I, II, and III, 1975, 1976.

TABLE II. CATTLE TRADE BY COUNTRIES - 1971-78.

	EXPORTING COUNTRIES					
	Niger	Upper Volta	Mali	Chad	Mauri-tania	Total
IMPORTING COUNTRIES			1,000 head			
Ivory Coast	.07	58	91	-	1	150
Togo	2.0	6.6	-	-	-	8.6
Benin	8	0.3	-	-	-	8.3
Ghana	.8	3.1	5.	-	-	9.8
Nigeria	165	-	15	150	-	330
TOTAL	176	69	111	150	1	506

Source: Bishop, 1972; CRED Volumes II and III, 1975.

Nigeria is the largest cattle importer, taking 58 percent of the total imports of the five countries. Ivory Coast takes 30 percent. The remaining 12 percent is imported by Ghana, Togo and Benin. The importing countries as a whole import one third of their cattle requirements but only 8 percent of their sheep and goat consumption.

The importations are utilized to cover the needs of not only the urban markets but the country markets as well.

Niger is the largest cattle exporter, with an annual movement of around 190,000 head, of which 85 percent normally goes to Nigeria. Chad is an important supplier to the West Africa area, shipping approximately 150,000 head annually, practically all to Nigeria. Approximately 83 percent of the exports from Mali and Upper Volta go to Ivory Coast, as shown in Table II. About 1,000 head of cattle from Mauritania reach Ivory Coast via Mali.

Nigeria is the largest sheep and goat importer taking around 400,000 head annually, mostly from Niger. Ivory Coast imports about 340,000 head, with Mali and Upper Volta the principal suppliers.

Per Capita Meat Consumption

Very little real evidence exists concerning actual consumption of animal proteins in West Africa, particularly in rural areas. However, some studies estimate the per capita meat consumption basis is low even in the surplus producing countries. Twelve kg per capita including, beef, mutton, goat meats in 1977 consumed in Mali (Delgado, 1980), and 21.40 kg including offals. In Niger

it was 14.6 kg in 1972 and 15 kilograms in Upper Volta in 1977 excluding offals in both cases (Larry Herman, 1983, p. 41). In the five deficit countries it is less. In Ivory coast the per capita consumption per year is estimated at 8.9 kg (Staatz, 1980), 2.44 kg in Ghana in 1977 (Sullivan, 1979), 7.7 kg in Nigeria in 1972 (Larry Herman, 1983), 6.7 kg in togo in 1975 (Josserand, 1979) and 8.35 kg in Benin in 1976 (Josserand, 1979).

The per capita meat consumption in urban areas is estimated five times higher than rural areas and two times higher than semi-urban areas (SCET International 1972).

However, the deficit countries consume large quantities of fish and other sea food. Beef, mutton and goat meats are not the only sources of proteins. Other important sources include: fish, poultry, pork and dairy products. Imported frozen meat (mutton, goat and beef) from Europe and South America mainly is consumed in Ghana and Ivory Coast.

LIVESTOCK MARKETS

Markets in the Surplus Producing Zone

The areas where most of the cattle are purchased for export lie north of a line passing from Bamako in Mali to Bobodioulasso and Ouagadougou in Upper Volta to Niamey in Niger. In Mali, the principal markets are located at Mopti, Fatoma, Niono, Nara, Kati, Gossi, Gao and Ansongo. In Upper Volta, the markets are at Markoye, Puytenga, Dori, Kaya, Bobodioulasso, Ouagadougou, Koudougou, Barani and Ouahigouya. In Niger, they are located at Ayorou, Gotheye, Abella, Niamey, Tahoua, Maradi, Zinder, Diffa and Agades. Each of these markets usually handle over 5,000 head of cattle annually and several of 25,000 head. They also handle about an equal number of sheep and goats and a smaller number of camels, donkeys and horses (Bishop, 1972).

Most of the markets consist of an open field near the edge of town. As a rule, there are no fences, corrals or pens to restrain or segregate the animals, making it necessary to have a large number of herdsmen to keep the various lots of livestock offered for sale separated. Some of the markets have a small holding pen with a chute for performing vaccinations on cattle, a requirement for all animals destined for export. Markets for each type of livestock are held in separate locations adjoining the cattle market. Most of the markets operate only one day per week, except at major transfer points and consuming centers such as Bamako, Ouagadougou, Bobodioulasso and Niamey, where they operate daily.

In general, the markets operate under the jurisdiction of the Livestock Divisions or Livestock Marketing Office of the Department of Agriculture of the various countries. Officials of the departemnt reside at all the principal markets, where they have responsibility for making sanitary inspections and vaccinations, compiling statistics on the number, origin, destination and prices of the various types of livestock handled by the market. They also sometimes collect fees and taxes.

The sellers at the primary markets are either producers with a few head of livestock or small buyers who have collected a few head in the bush. Most of these have less than five head of cattle to market. The buyers at the primary markets purchase the largest and best quality cattle for export to the terminal markets on the coast. Those of lower quality are used for local consumption in the larger cities and towns within the country. Six year old steers are preferred for export because these bring a better price and also because they are strong enough to stand the long journey to the market.

Cattle buyers assemble herds varying in size from 50 to 200 head, with the average size around 100 head, and move them to the final market. The rural assembler usually buys a few head at a time over a period of 1 month or longer, until he has assembled a herd of 50 to 100 head. He then treks them to the terminal market and sells them before returning to buy more cattle. Since the trip to market requires two or three monts and he must wait 10 to 40 days to receive payment for the animals after selling them, he can make only about 3 or 4 trips per year. The large cattle buyer, on the other hand, can finance

several herds of 100 to 200 head at a time, and usually has several employees assisting him in purchasing animals and assembling herds.

Since the average rural cattle producer has only a few head to offer, the primary rural buyer must make a large number of transactions in order to form a herd. Payment to the producer in cash is the rule, making it necessary for buyers to have large sums of cash on hand in order to acquire a herd. Since the livestock routes are often international, buyers must juggle various kinds of currency (CFA, CEDIS, NAIRA) and run the risk of unannounced devaluation and exchange restrictions.

Most countries require livestock merchants to secure licenses in advance for the number of cattle or other types of livestock they expect to trade per year.

The cattle trader usually makes all of his purchases through a broker. At the large markets custom and tradition prohibit direct interactions and transactions between seller and buyer. However, at some of the smaller markets, direct negotiations are permitted because there are no brokers. The cattle broker is a profession recognized by law and custom and usually requires a license in order to operate. In accordance with tradition, a broker is permanently attached to some particular markets (2 or 3) and does not engage in other business.

Except in Mali, there is no official or published information available at the markets as to current livestock prices, so it is difficult for the producer to

determine the actual value of his cattle. Sales are made on a per head basis rather than by weight, adding to the existing system's difficulty. As soon as the producer arrives at the market, he is quickly approached by a broker, who persuades him to allow him to find a buyer for his animals. Often the function of broker is assumed by the producer landlord in town. This service does not cost the producer anything, in theory, since it is the buyer who pays the broker's commission. Bargaining between the producer and the broker and between the broker and the buyer is frequently done with enough secrecy that neither the producer nor the buyer knows how much the middleman is getting out of the transaction in addition to his authorized commission. In addition, there are numerous speculators who attempt to interpose themselves somewhere between the seller and the buyer in order to make something out of the transaction.

Terminal Markets in the Deficit Countries

The principal terminal market in Ivory Coast is located in Abidjan. There are also important markets at Bouake, Dimbokoro, Gagnoa, San Pedro, Sassandra, Aboisso. The two main markets in Ghana are at Accra and Kumasi, the latter being the most important. In Nigeria, the largest markets are at Lagos and Ibadan in the west and Port Harcourt in the coast.

At the market in Abidjan, there are numerous small pens for holding cattle until sold, with a roof over the entire area to protect the cattle from the sun. None of the other markets have such modern facilities. There are no large meat packing organizations or privately owned slaughterhouses at any of the markets. All of the abattoirs are of the traditional municipal types, where the government owns the facilities and leases space to numerous small butchers

who purchase a few head of cattle and do their own slaughtering. Under these conditions, the livestock merchant is unable to sell his entire herd to one buyer and instead must engage in a large number of transactions and depend upon commission men and speculators to find buyers. After the merchant has sold his herd, he must wait one or two months before receiving payment because the small butchers generally in debt do not have access to formal credit and do not have sufficient operating capital. This practice to stay in business is largely used by urban small butchers.

Chapter III

TRANSITORY PHASE

An important step in the marketing of livestock involves the physical movement of the live animals and their products. Where cattle are produced and consumed in the same ares such as in some African cities' with surrounding feedlots, the problem of transporation does not exist. But where livestock is produced in one area and slaughtered and consumed in another area, the problem of transportation is extremely important. The major methods of transportation used in Africa are: trekking, rail hauling and truck hauling. Although boats are used in some areas such as in Sierra Leone for the transport of cattle, this method is relatively unimportant and will not be analyzed in this study. Lastly, there is, in some areas (e.g., Upper Volta - Mali - Ivory Coast) a combination of at least two methods of transportation: (1) on hoof and railroad or (2) trucking and rail hauling.

Trekking

In many parts of Africa, particularly in the western region, railways and motor roads have not yet penetrated the cattle producing areas. Thus, trekking is by far the most common means of moving cattle according to Mittendorf (1962). Almost 100 percent of cattle are moved on foot to domestic markets and 50 percent of export cattle are moved on foot. It is also the most labor intensive, as shown in comparative study in Table III, involving hired drovers

who walk the cattle along pre-established trek routes. The number of drovers depends on the size of the heard to transport and the risk of crop damage through the season. In general, 3 drovers are required for the shipment of 50 head of cattle to consumption areas in dry seasons and 4 drovers in rainy seasons. The time required depends on the season, the area and the distance to cover and the type of management since it is customary to graze the cattle and even to fatten them along the way. The average trekking is approximately 10 miles per day with 8 miles per day in cultivated areas in rainy season and 12 miles a day in dry season (Staatz, 1980). Cattle often cover 930 miles in 90 days from Gao (Mali) to Kumasi (Ghana). (This explains why only mature animals over six years old are able to withstand such journeys.)

Stock routes generally have been developed by traders but sometimes governments provide facilities such as provision of water, organization of grazing areas, and veterinary control posts along the routes. The mainstock routes in West Africa are:

Cattle Routes to the Ivory Coast

The main route from Upper Volta to the Ivory coast, as shown in Map II, begins at Markoye, passes through Ouagadougou and Bobodioulasso, crosses into the Ivory Coast near Ouangolodougou, and passes through Bouake to Abidjan, a total distance of 1,600 kilometers. Cattle come to Ouagadougou from Markoye and surrounding markets and from Ouahigouya. Others are collected in the Ouagadougou area. Thus, an important number of cattle is assembled at

TABLE III. TIME AND LABOR REQUIREMENTS FOR EXPORTING FIFTY HEAD OF CATTLE FROM NIONO TO ABIDJAN UNDER DIFFERENT OPTIONS. (In Man-Days)

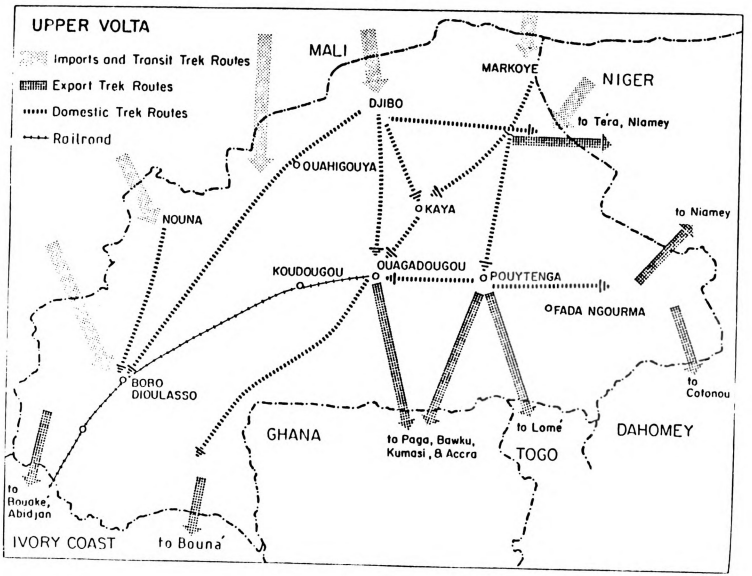
	Trek to Bouake, then Rail to Abidjan	Trek to Ferkessedougou, then Rail to Abidjan	Truck to Abidjan
Time Required for Malian Formalities after Purchase	7 trader-days	7 trader-days	7 trader-days
Time Required for Trekking	57 days x 3 drovers	45 days x 3 drovers	-0-
Time Required for Shipping	2 days x 2 drovers	2 days x 2 drovers	3 days x 2 drovers
Time Required for Marketing in Abidjan[a]	11 trader-days 5 days x 2 drovers	11 trader-days 5 days x 2 drovers	11 trader-days 5 days x 2 drovers
Number of Days Capital is Tied up[b]	77 days	65 days	21 days
Number of Trader-Days Required	18 days	18 days	18 days
Number of Drover-Days Required	185 drover-days	149 drover-days	16 drover-days

Sources: Times taken from Staatz, 1979 (Chapter Six), based on interviews with traders and drovers. Where data is missing (such as from Niono to Koutiala), trekking times are calculated assuming that a herd covers 16 km per day. Cited by CRED Volume III, 1980.

[a]Includes unloading, marketing, roundtrip travel for trader, and return travel to Mali for drovers.

[b]The capital involved is greater for trucking.

Map II. CATTLE FLOWS IN UPPER VOLTA



Source: Larry Herman, 1977.

Ouagadougou, almost all of which are moved to the Ivory Coast by rail. Further, cattle are moved from Koudougou, Bobodioulasso and Bonfora. A total of 58,000 head of cattle was exported in 1975 from Upper Volta to Ivory Coast (Larry Herman, 1983).

The main trek route from Mali is the circuit which runs from southern Mali (Segou, Koutiala, Sikasso and Bougouni) to Tingrela and Boundiali which are the most important border crossing points and the largest cattle markets in northern Ivory Coast.

Another route from Mali begins at Mopti, passes through Sikasso and enters the Ivory Coast. Formerly, this route from Mopti passes through Bobodioulasso and follows to the same route as the cattle from Upper Volta to Abidjan. But, because of the transit tax per head imposed by Voltan authorities, Malian cattle no longer use this circuit.

A third route begins at Bamako and enters Ivory Coast at Odienne. An important number of cattle from Mauritania and from the vicinity of Bamako use this route annually. The estimated total movement of Malian cattle to Ivory Coast is around 91,000 head in 1976 (Delgado, 1980; Staatz, 1980). All these routes are shown in Map III.

Cattle routes to Ghana

The main trek route goes from Gao in Mali to Dori and Puytenga in Upper Volta and to Bolgatanga and Kumasi in Ghana, with a branch to the east coming from Ayerou and Gotheye in Niger. The principal markets in Upper Volta at

which buyers assemble herds for driving to Ghana are Markoye and Puytenga. The main trail runs through the export control post at Bittou to the quarantine station just inside the Ghana border at Bwaku.

In the period of the sixties, Ghana was the leading importer of Malian and voltan cattle, but during the last decade, Ghana's relative share of cattle exports went from just over half in 1967 (16,826 from Mali and 23,268 from Upper Volta) to a very small amount in 1977 (5,000 head from Mali and 4,000 from Upper volta), (Delgado, 1980).

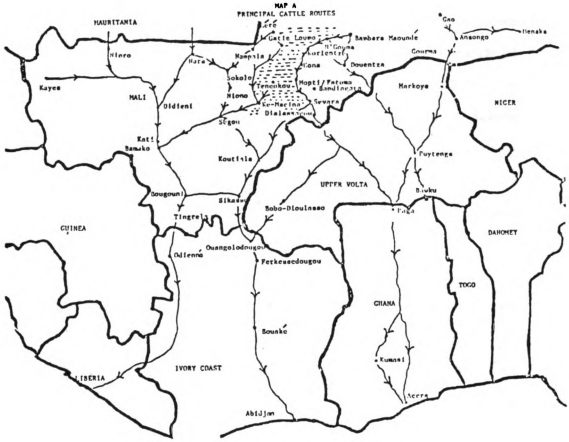
Cattle Routes to Togo

The principal route from Niger begins at Gotheye on the west bank of the Niger rive, passes through Puytenga and Tenkodogo in Upper volta, enters Togo near Dapango, and passes through Sokodo and Atakpame to Lome, a distance of 1,4000 kilometers. Most of the cattle from Upper Volta originate at Markoye, proceed to Puytenga and follow the same route as those from Niger. Approximately 7,000 head from Niger and 3,000 head from Upper Volta enter Togo annually according to Bishop (1972).

Cattle Routes to Benin

The main route begins at Ayerou in northwestern Niger, passes through Niamey, enters Benin at Malaville and passes through Parakou to Cotonou, a distance of 1,400 kilometers. The annual volume along this route is around 8,000 head. Cattle from Upper Volta are generally assembled at Diapaga in the southwestern part of the country, enter Benin near Banikoara and

MAP III. PRINCIPAL MALIAN CATTLE ROUTES



proceed to Parakou, where they are loaded on the train to Cotonou. Only about 2,000 head pass along this route per year.

Cattle Routes to Nigeria

At the Niger-Nigeria frontier, there are 16 important control posts (some of them are shown in Map IV) through which pass 165,000 head of cattle of Nigerien origin, plus 90,000 head in transit from Chad and 15,000 head in transit from Mali. From the western sector of Niger, 55,000 head enter Sokoto province. From Maradi and Agadez, 30,000 head enter Kano province. From the Diffa zone, 30,000 head of Nigerien cattle and 90,000 head from Chad enter Bornu province. Approximately 60,000 head of cattle from Chad pass through Cameroon enroute to Nigeria (Bishop, 1972).

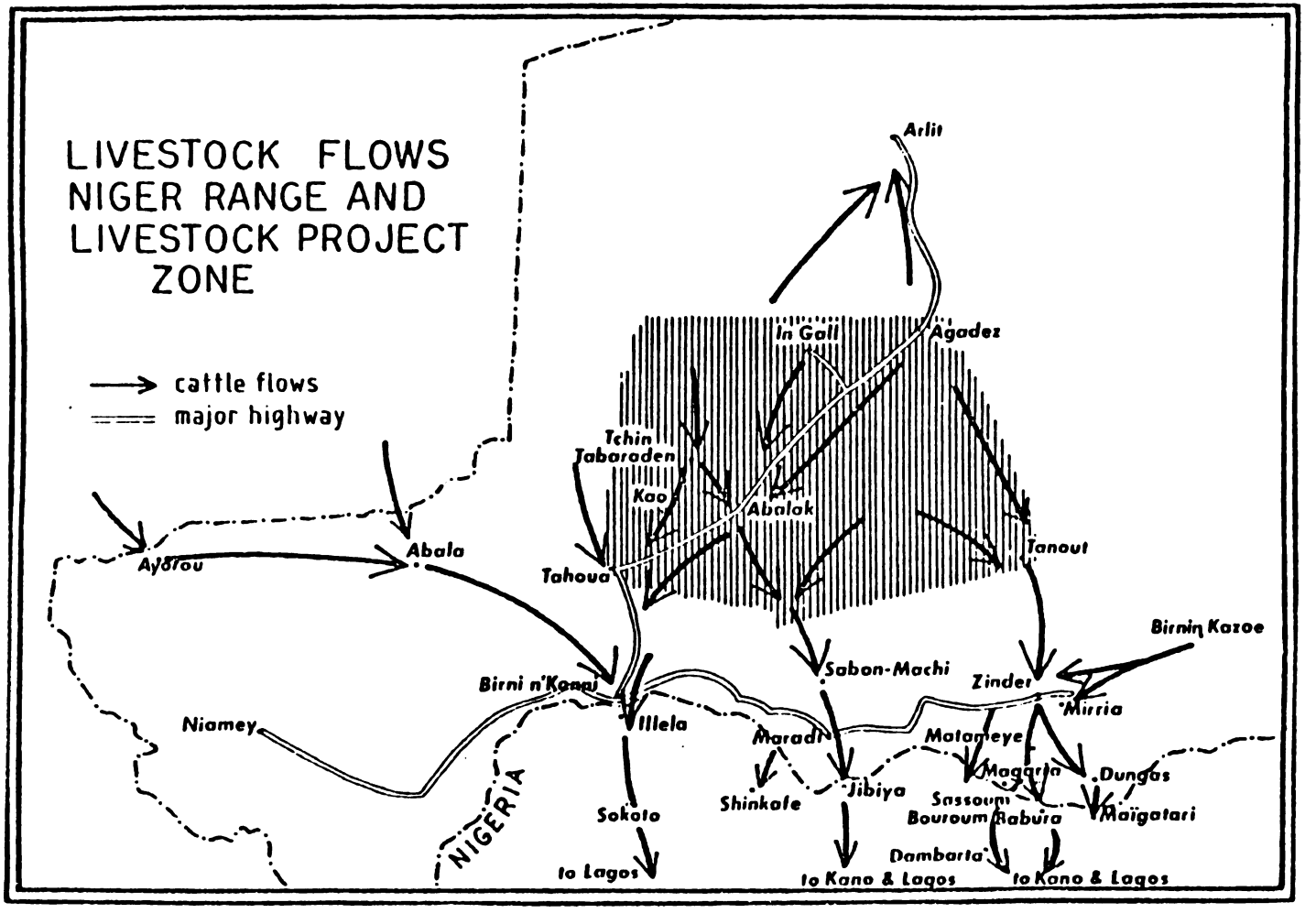
Within Nigeria there is a large movement of cattle from the north to the Urban region along the coast. A total of 410,000 head are moved south annually, of which 220,000 pass through Sebba enroute to the Port Harcourt region.

Costs of Cattle Transport

The cost of moving livestock along such routes includes many economic and financial aspects, as shown in Table IV. Although this chapter is not a cost evaluation chapter, it is important to specify the various components involved that are mainly:

1. Drover's fees and other direct expenses enroute (veterinary fees,

Map IV.



Source: Ariza-Nino, 1982.

trips, living expenses, trade cattle tax, marketing charges, including bribes and tips).

2. The loss of animals through straying, theft, accident and disease especially in infested Tse-Tse fly areas of southern markets.

3. Forced sales at low price cattle not able to reach final destination.

4. Weight and quality losses.

5. Indeminity for damaged fields in cultivated areas.

6. Indirect costs such as capital opportunity costs during the route period, which could generate return, feed used during trek period which could be used to fatten other animals and the effect on land management systems since cattle have to be kept longer (over six years) in producing areas than would be necessary in case of truck and rail transportation systems.

Rail Transportation

Although the present rail network in West Africa (see Map V) is very limited, rail transportation is the second most common method of transportating cattle. Two lines are especially important:

That from Ouagadougou through Bobodioulasso (Upper Volta to Abidjan (Ivory Coast) a distance of 1,200 kilometers carries about 50,000 to 60,000 cattle a year.

TABLE IV. COSTS OF TRANSPORTING CATTLE ON FOOT

Category	Sokoto to the West		Kano to the West		Bornu to the West		Bornu to the East	
	Cost ₦/head	% of Total	Cost ₦/head	% of Total	Cost ₦/head	% of Total	Cost ₦/head	% of Total
Mortality cost	.44	5.5	.57	6.1	.78	5.2	.72	6.1
Salvage cost	.89	11.2	1.14	12.0	1.51	10.0	1.45	12.2
Shrinkage cost	3.76	47.2	4.43	46.9	7.35	48.5	5.55	46.8
Other expenses	.40	5.0	.40	4.2	.40	2.6	.40	3.4
Drover's fee	1.00	12.6	1.19	12.6	1.98	13.1	1.40	11.8
Food money	.17	2.1	.20	2.1	.34	2.2	.24	2.0
Interest cost	.37	4.6	.40	4.2	.65	4.3	.50	4.2
Water and Feed cost	.93	11.8	1.12	11.9	2.14	14.1	1.60	13.5
TOTAL	7.96	100.0	9.45	100.0	15.14	100.0	11.86	100.0

Source: Kellogg, 1971.

The second line Lagos-Kano in Nigeria a distance of 1,126 kilometers carries about 200,000 cattle a year. The railroad is used in general to ship cattle long distances and meet short term and seasonal fluctuations in demand. But the percentage of cattle handled by rail is declining in all lines due to the frequent unavailability (often for two weeks) of cattle cars and also due to the long time averaging 3 - 4 days that the cattle spend in transit without feed or water between the time they are loaded and when they are unloaded at final destination. The labor required is generally one caretaker per car of 27 cattle average capacity. The costs of moving cattle by rail, as shown in Table V, fall into the following categories:

- Caretaker's fees and living expenses.
- Rail car renting costs and unofficial costs (bribes) to get a car
- Cattle loading and unloading costs.
- Forced sales at low prices at final destination.
- Shrinkage.
- Death loss.
- Crippling and bruising.
- Import taxes for international shipments.

Truck Transport

The movement of cattle in West Africa by truck is not well organized. There is no schedule of rates as on the railways, and charges vary according to supply and demand. The main constraints to the extended use of this flexible and time saving method of transportation are the lack of good roads which

TABLE V. TRANSPORT COSTS OF CATTLE BY RAIL FROM OUAGADOUGOU TO ABIDJAN (3-7 DAYS TRANSPORT TIME).

Costs*	Per herd (25 head)	Per head
Loading cattle cars	750	30
Preparation of wagon	4,000	160
Food and salary	8,000	320
Car rental	104,780	4,191
Unofficial costs (bribe)	0-20,000	0-800
Mortality	32,000	1,282 (21%)**
Unloading fees	500	20
TOTAL	150,091 + (20,000)	6,003 + (800)

Source: Larry Herman, (1978).

*Shrinkage costs are not included.

**Percentage of loss costs from total transport costs.

reduce the effective life of a truck to 12-18 months that makes its amortisation rates high, unpassability during wet seasons and inadequate bridges. Therefore, road transport of cattle in West Africa is limited to short distances over good roads, especially in those areas where there is no rail line or in response to a temporary shortage of cattle in a consumption market or in the forest one where trekking becomes difficult and costly because of the dense vegetation and heavy Tse-Tse infestation. However, there is an increasing use of trucks to move export cattle in Mali, Niger and Upper Volta, since their capacity increases from 10 to 20 and even 25 head by the use of semi-trailer units, and because of the decline in rail use.

Trucking is being used mainly from Mali to Ivory Coast and from some northern domestic markets of Ivory Coast to Bouake or Abidjan. A very few cattle are transported by truck in Nigeria compared to rail and trekking.

A trip from Kano to Lagos by truck takes about 3 1/2 days and it takes almost the same time from Bamako or Niono (both in Mali) to Abidjan.

The labor required in trucking is generally one or two drovers per truck of 25 head capacity, to take care of any animals that fall down.

The costs, as shown in Table VI, involved in truck transport include:

- Fees of drovers and their living expenses.
- Rental of truck.
- Cattle loading costs.
- Forced sales at low price.
- Weight losses.
- Crippling and bruising effects.
- Death loss.
- Payments (bribes) to police.

Combination Method of Transportation

This combination method (trek-rail or truck-rail) is used mainly for export cattle, from Mali to railroads at Bouake, Ferkessedougou, or Ouangolodougou in Northern Ivory Coast or Bobodioulasso in Upper Volta or for cattle from Niger and Northern Nigeria at Kano.

The advantage of this combination method is to reduce the time of shipment and overcome feed shortage or other danger in certain areas. For those reasons, some traders switch methods of transport depending on the season - e.g., trek in wet season, trek plus rail in dry season.

TABLE VI. COST OF TRANSPORTING FIFTY HEAD OF CATTLE FROM KOUTIALA (MALI) TO ABIDJAN BY TRUCK 1976-77 (IN F CFA)***

Expense*				
1.	Salary of drovers	2 @ 5,000 = 10,000	200	
2.	Food of drovers	1,000	20	
3.	Return trip for drovers	2 @ 6,000 = 13,000	260	
4.	Roundtrip for owner	13,000	260	
5.	Food for owner in Abidjan: 7 days @ 200 CFAF/day	1,400	28	
6.	Health certificate	4,000	80	
7.	Indemnity for damaged fields	-0-	-0-	
8.	Salt for animals	-0-	-0-	
9.	Loss of animals	2.0% of 50 animals @ 40,000 CFAF per animal = 40,000	800	
10.	Forced sales	1.0% of 50 animals @ 20,000 CFAF loss per animal = 20,000	400	(4%)**
11.	Cattle market tax: Abidjan	25,000	500	
12.	Malian cattle merchants' license, vaccination, and export taxes	220,000	4,400	
13.	Transport charges			
	Rental of truck/train car	2 trucks @ 350,000 =700,000	14,000	
	Straw	-0-	-0-	
	Loading/Unloading	2,500	50	
	Other[a]	-0-	-0-	
14.	Unofficial charges	100,000	2,000	
15.	Gift to the landlord	0-5,000	0-100	
TOTAL COST (excluding weight losses):		1,149,900-1,154,000	22,998-23,098	
Days in transit		3		

Source: Staatz, 1979; pp. 234-5. Cited by CRED Volume III, 1980.

[a]Includes unofficial payments to RAN employees for reserving a train car and other services.

*Excluding weight losses.

*Percentage of lost costs from total transport cost per head.

***One CFA Franc = $2.50.

Chapter IV

LOSSES

Although studies exist on beef production in tropical Africa because of food concerns, unfortunately little is known about the patterns of losses occurring in market cattle during transportation and about the effects of regain on total shrinkage or on carcass composition in tropical areas. The little that is known about death, weight and quality losses and costs of different methods of transport and their related losses comes from economic analysis of transportation as part of total costs. Mittendorf (1961) found that transportation is one of the most difficult marketing problems in Africa and described four methods (truck, rail, air and boat) of livestock transport. Ferguson (1967) reported in "Nigeria Beef Industry" that transportation fees favor on hoof marketing. However, he found also that losses from deaths and shrinkage were much less when cattle were shipped by rail (p. 67). Heever et al. (p. 150; 1967) observed very little effects of losses due to prolonged rail transportation on slaughter cattle in South Africa. Kellogg (1971) described several model experiments that identify the likely consequences that alternative policies may have on the beef distribution system. Larry Herman (1978) observed the problems involved with long distance train transportation of cattle. John Staatz (1978), John Holtzman et al. (1979) described three means of moving cattle in Cameroon and in Ivory Coast. Delgado (1980) found in Mali

that the principal problems facing herdsmen when cattle are shipped on the hoof are lack of watering points in the north and crop damage conflicts with farmers in the south.

From the above studies one notes that there is little reference to the patterns of losses occurring during the transportation in tropical Africa.

Although some interesting studies have been conducted outside Africa, Kirton et al. in New Zealand (1966, 1968, 1970, 1979) found the percentage of cattle live weight losses is greatest in all cases over the first two days of starvation, even if they have access to water. Raikes (1979) found differences in live cattle shrinkage during transportation due to feeding practices (housing conditions), distance, time of transit, weather and other effects of management. Other authors such as Brotherton (1957) Brownson (1956) Henning (1962); Harston (1959) found the same effects in their studies on shrinkage. Heever (1967) and Carr (1970) found that fasting up to four days did not affect carcass yield or marketing grade.

Although shrinkage is a very important variable, it is not unique. Many other kinds of losses occur in transporting cattle. The most important among them are: bruising, crippling, lost animals and death. An understanding of factors influencing and effects of these losses will aid traders in making marketing decisions since these losses have cost significance to the businesses. In this chapter, losses will be analyzed in detail not in terms of percentage but rather in terms of trend since in general, data obtained may vary from one experiment to another according to specific conditions of each experiment.

1. Shrinkage

Every farmer or trader knows that in most cases, cattle weight less when they reach final market than they did when they left the origin (farm, range or feed lot). Such loss in weight is called shrinkage. Shrinkage may take place while the animal is in transit, at the market or in holding pens of the packers as shown in Table VII. When the shrinkage represents a loss in tissue weight, it may be classed as a direct economic loss that affects the return to the producers or traders and it may be considered as a part of total marketing costs. However, excretory shrinkages can also be a loss to the trader if it affects the appearance of the animal and hence its sale price if it is sold "onsight" or on a live weight basis.

1.1. Types of Shrinkage

Weight in cattle can be classified according to two types of shrink:

a) Excretory Shrink. The excretory shrink or loss of fill occurs when cattle are held off feed and water for a relatively short period. It constitutes a loss in live weight but does not change the weigth of the carcass. It takes a relatively short period on feed and water to refill the stomach and bring an animal's weight back to normal if shrinkage was due only to excretory shrink (Brownson, 1976). During the shipment, the excretory shrink takes place at a rapid rate (about 4%) in the early part of the transit period (the first 2 or 3 hours, particularly for fat cattle), to increase at a decreasing rate as time in transit increased. The maximum excretory shrinkage is reached around 10 to 12 hours of shipment. However, at an undefined stage in the movement, both excretory

TABLE VII. SHRINKAGE LOSS DUE TO DIFFERENT HANDLING CONDITIONS

Hours in Treatment	Percent Shrink
8 hours dry hot stand	3.3
16 hours dry hot stand	6.2
24 hours dry hot stand	6.6
8 hours in moving truck	5.5
16 hours in moving truck	7.9
24 hours in moving truck	8.9

Source: Roger Brownson, 1976.

and tissue shrinkage losses occur simultaneously. During the latter part of the shipment, tissue shrinkage is relatively more important.

b) Tissue Shrinkage. Tissue shrinkage can be defined as a decrease in the carcass weight of the animal. Tissue shrinkage occurs on long extended hauls or during long periods of fast. It takes longer for cattle to recover from tissue shrink than from excretory shrinkage. Tissue shrinkage begins at an undefined but early stage during the shipment and continues until cattle reach the plant to which they are shipped for slaughter (Brownson, 1976). Kirton (1972) found in an experiment on effect of pre-slaughter starvation in cattle that live weight loss was greatest over the first two days of the experiment and then slowed for the third and fourth days of starvation. Live weight had been reduced by 10% of the initial weight after 4 days of starvation. The estimated carcass loss presented in Table VIII indicated that starvation had no effect for the first 3 days but began to cause carcass loss by the fourth day.

The data obtained after 8 days starvation, live weight losses were 15% of initial weight, and loss of carcass weight was estimated as 14% as shown in Table IX.

1.2 Factors Affecting Shrinkage

Studies of shrinkage in transit of cattle have revealed some factors that tend to affect the rates at which it takes place. Some of the more evident among these are: amount of fill, time in transit or distance shipped, weight of the animals, type of transportation, method of loading railroad cars and trucks, the disturbance of the animals and the temperature and weather (climate).

TABLE VIII. EFFECTS OF STARVATION ON CATTLE LOSSES FROM 0 TO FOUR DAYS.

Days	0	1	2	3	4
Live Shrink %	-	4.7	8.4	9.2	10.2
Cattle Dress %	47.6	46.4	47.5	46.5	45.0
Mean Age (years)	4.3	5.3	4.4	4.6	4.6

Source: Kirton, et al., 1972.

TABLE IX. EFFECT OF "STARVATION ON CATTLE LOSSES FROM FOUR TO EIGHT DAYS.

Time (Days)	0	4	8
Weight Loss (%)	-	9.7	14.7
Edible Meat (%)	60.42	60.47	59.90
Carcass Loss (kg)	-	13.0	22.2
Excess Fat (%)	11.82	9.36	7.53
Perinephric Fat (%)	3.03	1.69	1.37
Dressing (%)	49.3	44.9	43.0

Source: Kirton, et al., 1972.
New Zealand

Shrinkage also is likely to be affected by physical characteristics of the animal. Some of these factors are however, difficult to evaluate accurately.

1.2.1 Shrinkage in Relation to the Amount of Fill

The amount of fill at the time of weighing is one of the most important factors that determine the amount of shrinkage between the farm, range, or shipping point and the market or slaughterhouse. Since shrinkage is generally measured by the difference in weight between the point of origin of the shipment and its destination, the heavy or light fill of the animals when either weight is taken will in itself make the shrinkage appear large or small. If the fill of the animals at the point of origin is greater than the fill when they are weighed at destination, the rate of shrinkage will appear relatively large. Conversely, if the fill at destination is greater than the fill at the point of origin, the shrinkage figure will appear relatively small, or a gain in weight may even be shown. It is evident, therefore, that the difference between the shipping weight and the weight at destination may be entirely accounted for by a difference in fill instead of shrinkage in body weight. If the animal when weighed at destination has the same amount of fill as when weighed at point of origin, the net difference in weight will be shrinkage, or, more correctly, tissue shrinkage.

In Africa, the opinion is common among export traders of livestock that animals transported to market will stand shipment better and lose less weight in transit if they are not heavily filled when loaded into cars or motor trucks. This also is supported by studies of shrinkage, and of the best methods of handling livestock in transit. And according to Harston (1959), the larger the

fill at loading time, the larger will be the off-car shrink. The practice is rather common at public markets so as to make them weigh more when sold. Cattle handled in this manner are likely to have small shrinkage and may actually show a gain in weight at the market compared with the weight when shipped. Some shipments, however, contain animals that have a heavy fill at the point of origin and may not be fed at the market, or may not take much feed if they are fed upon arrival, and they will show high shrinkage. Such overfilled cattle are uncomfortable and often become sick during the shipment. Discomfort brings nervousness, excessive pushing and crowding. However, some preconditioning by feeding hay a few days before shipment may be useful for the fillback at the sale yards.

The merit of the practice, common at terminal markets, of giving livestock feed and water before offering them for sale is that it offsets, as far as possible the loss in weight between the farm or shipping point and market, so that the different lots of animals will tend to have nearly the same amount of fill when sold.

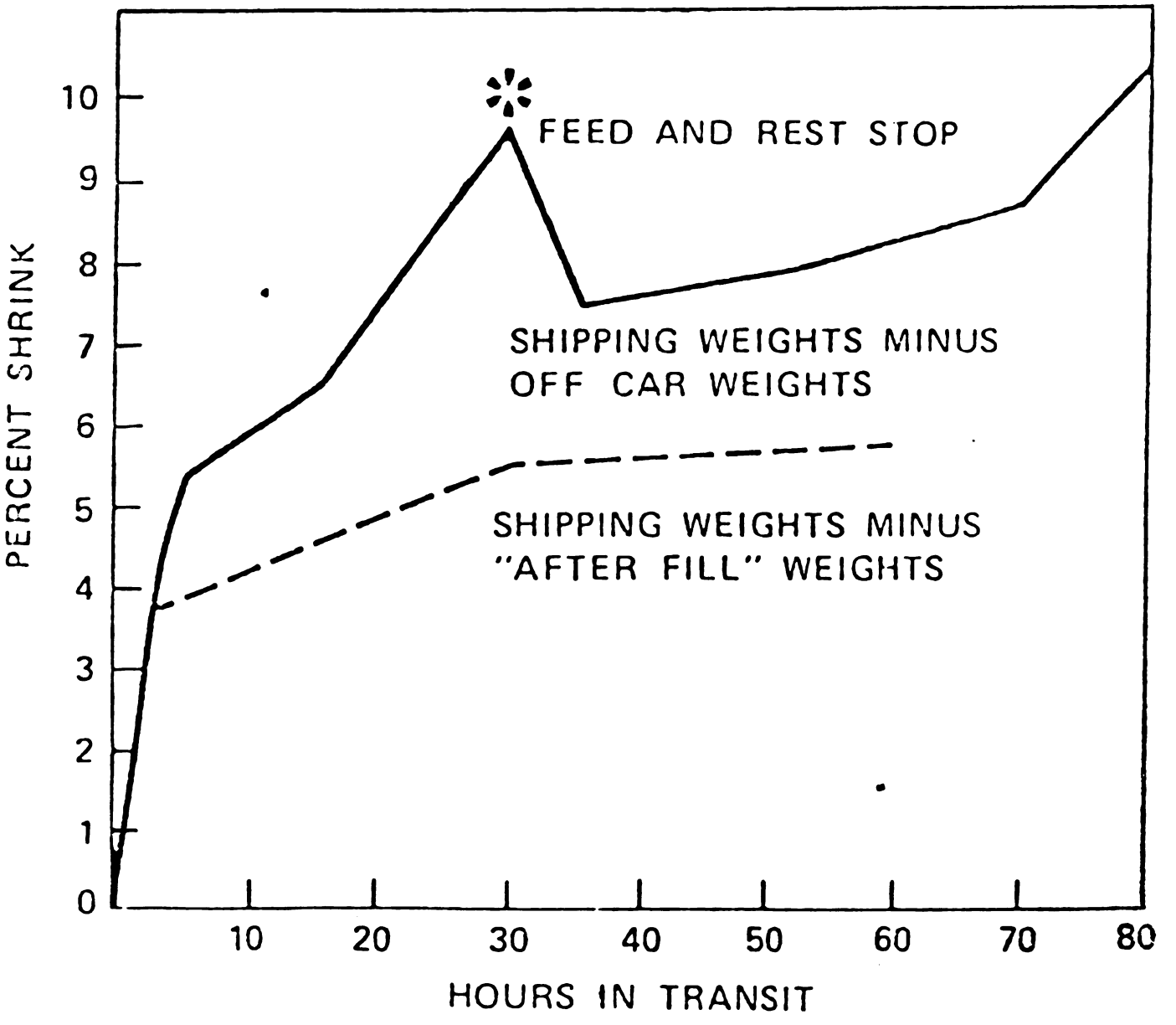
However, when an animal consumes feed and water at a market, it increases its live weight, but the carcass weight is not increased. The dressing yield of filled animals decreases because the weight of the carcass becomes a smaller percentage of the live weight. It is the weight of the carcass when slaughtered that a butcher should have in mind when he bids on livestock, and this has not been changed by feeding at the market. However, the butcher's perception of the carcass weight may have been changed since the sale is on an on-sight basis.

1.2.2. Shrinkage in Relation to Time.

The increase in shrinkage as time in transit increases applies both to tissue and excretory shrinkage. As stated earlier, and shown in Figure I. (Brownson, 1976; p. 34), the greatest proportion of the loss in weight during the early part of the transit period is due to excretory shrinkage. Tissue shrinkage, on the other hand, tends to continue throughout the period in transit. In some studies, shrinkage was found to increase with the increase in the distance shipped. Shrinkage is probably more closely associated with the time in transit than with distance, but comparisons have shown that the distance moved and the time required to ship livestock between two given points are closely associated. Finally, distance to market and time in transit are the two big single factors having an important bearing on shrink, although, there are some exceptions in trekking associated with adequate grazing.

According to Bjorka (1941), the loss in tissue weight is presumably caused by the disturbed condition of the animals while they are in transit. Trekking, loading and unloading, the jostling about in transportation by rail or motor truck, the handling by strangers, some of whom are inclined to be careless, and the continual change from one environment to another tend to produce nervous disturbances in the animals, and this in turn causes shrinkage of tissue. Unusually hot or unusually cold weather when the livestock are enroute or confined in uncovered stock pens, in railroad cars, or in motor trucks also affects adversely the comfort of the animals. Then, too, when several animals are together, there is a tendency for some to fight and thereby to disturb not only themselves but others in the lot.

FIGURE I. SHRINKAGE INCREASES AS HOURS IN TRANSIT INCREASE (FAT CATTLE).



Source: Brownson, 1976.

1.2.3. Shrinkage in Relation to Cattle Characteristics

a) Weight. According to many studies, shrinkage does not seem to be closely associated with weight of cattle except as the weight is correlated with the degree of fatness (Brownson, 1976; Harston, 1959). Animals of different weights but with a comparable degree of finish shrink about the same percentage under the same marketing conditions. However, highly finished cattle shrink less than those with less finish. Here are possible reasons: 1) the inside of a highly finished animal is small because of the fat deposits and because a smaller stomach capacity required to handle concentrates, 2) fat animals are heavier than thin animals of the same type and age and the same number of pounds of shrink represents a smaller percentage of total weight, and 3) fat cattle have a lower water content than thin cattle. Shrinkage of fat cattle would be lower except that they heat up more than others during transit if they have been on concentrates. Grass-fed cattle usually are better travelers than grain-fed cattle of camparable finish. In tropical Africa most market cattle are grass-fed and only a small percentage of cattle from feed lots are grain-fed.

b) Sex. Number of studies found that heifers shrink more than steers but the difference is not great and may be due to the difference of amount of belly content. However, bulls usually shrink a lot because of disturbing circumstances and strange animals nearby.

c) Breeds. The breeding line does not significantly affect shrinkage according to some studies, but others indicate that animals inherit a tendency for heavy or light shrink. (Brownson, 1976).

1.2.4. Shrinkage in Relation to the Climate

Extreme temperatures (hot and cold) have an effect particularly on fat cattle shrinkage during marketing. But in general, other things, wind, rain, snow, humidity, and other weather conditions seem to have more effect than temperature alone.

In tropical Africa, shrinkage tends to increase when temperature tends to be high from March to May in association with the dry Harmattan wind from Sahel. Moreover, the big thunderstorms of the southern part of West Africa are very stressing for trekking cattle. But the relative discomfort due to cold from November to January may not have a real effect on shrinkage. However, a change in climatic conditions and grasses eaten by trekked cattle during marketing as it often occurs to export cattle from dry and hot Sahelian regions to humid and rainy coastal regions, can have a greater effect on shrink than constant climatic conditions and same types of grasses.

Moreover, it is worthwhile to note that the feed consumed during the rainy season includes relatively less proportion of dry feeds than those consumed during the dry season. The consequence is that tissue produced by succulent feeds tends to be less firm than tissue produced by dry feed and the softer tissue of rainy season shrinks at a more rapid rate than the firm tissue of dry season.

1.2.5. Shrinkage in Relation to Type of Transportation

The available data on shrinkage of cattle shipped by rail, truck or on foot are not conclusive in general and particularly in tropical Africa.

Opinions are divided on the economics of each among the three methods of transportation. It seems that the mode of transportation has less effect on shrinkage than the time in transit and the manner of transport management. Often the method of transportation has been credited or blamed for shrinkage incurred when other things were the real cause.

This lack of definiteness in the conclusions of studies on this point was emphasized by the fact that considerable variation existed in shrinkage among individual lots shipped by the three methods.

a) Trek. M. G. Fenn found in marketing livestock and meat (about Africa) "on some very long and arduous routes, the loss in live weight can be 20% or more, representing a serious shrinkage of fat and tissues." Kellogg* uses 2.5% live weight shrinkage per 100 mile approximately in his study. In other circumstances there may be no serious loss in weight, but a significant loss of carcass quality. John Staatz found in his study (Livestock and Meat Marketing in Ivory Coast) even a gain of weight if cattle are trekked slowly. Harston claimed that amount of feed on the trail, availability of water and ease of handling affect shrinkage. Even some experienced cattle traders agree

*Kellogg, 1971; p. 45.

that feeder cattle shrink less when trailed easily and gently than when trucked. Mittendorf after finding live weight losses ranging from 15 to 30 percent in a study on the stock route from Upper Volta to Accra (Ghana) in 1952 claimed "It is clear that losses can be reduced if the cattle were driven carefully and received sufficient food, water and rest".

b) Truck. The shrinkage of trucked cattle depends, in addition to the manner of transport management, on the state of roads, truck shock absorber systems and speed and the load. Poor roads and bad shock absorber systems, and truck conditions, increase considerably the jostling of cattle in transit which in turn may foster the shrinkage. In addition to the jostling, the time in transit may increase in case of poor roads that would lead to more shrinkage since time in transit has been found to be closely associated with the rate at which animals shrink weight. In tropical Africa, with the exception of Nigeria and Ivory Coast's road networks, most of the roads are in very poor condition and even sometimes impassible during the entire rainy season.

Therefore, trucking cattle in these areas appears to engender a higher level of shrinkage. Figure 1. shows a relationship of live weight shrinkage to time in transit in trucking.

c) Rail. The exact level of rail transport shrinkage depends of course on the manner of transport management (loading, unloading, handling, etc.) but also on the conditions of the rail cars, availability of facilities for feeding and watering and the time in transit.

It is obvious that poor ventilation of cattle cars will lead to overheating and bad condition of the railroad system increases the time in transit. Both are very important factors of shrinkage and are common to African rail systems. Another factor of weight loss in transit frequent in Africa, is the poor management system in cattle cars. Cattle often are not packed tightly in the wagon to prevent their lying down and being trampled on. Moreover, cattle are kept in the train often more than 30 hours without unloading for rest, feeding and watering. In a general manner, all data found about weight losses in Africa in both, rail and truck shipment, seem unrealistic, thus, they are not reported here.

1.2.6. Other Factors Affecting Shrinkage

A number of other factors apparently affect shrinkage in transit. Among these are:

a) The number of animals loaded in a rail car or motor truck. It is estimated that shrinkage will increase about 15% higher than normal shrinkage in both overloading and underloading by 15 to 25% of full capacity, (Harston, 1959).

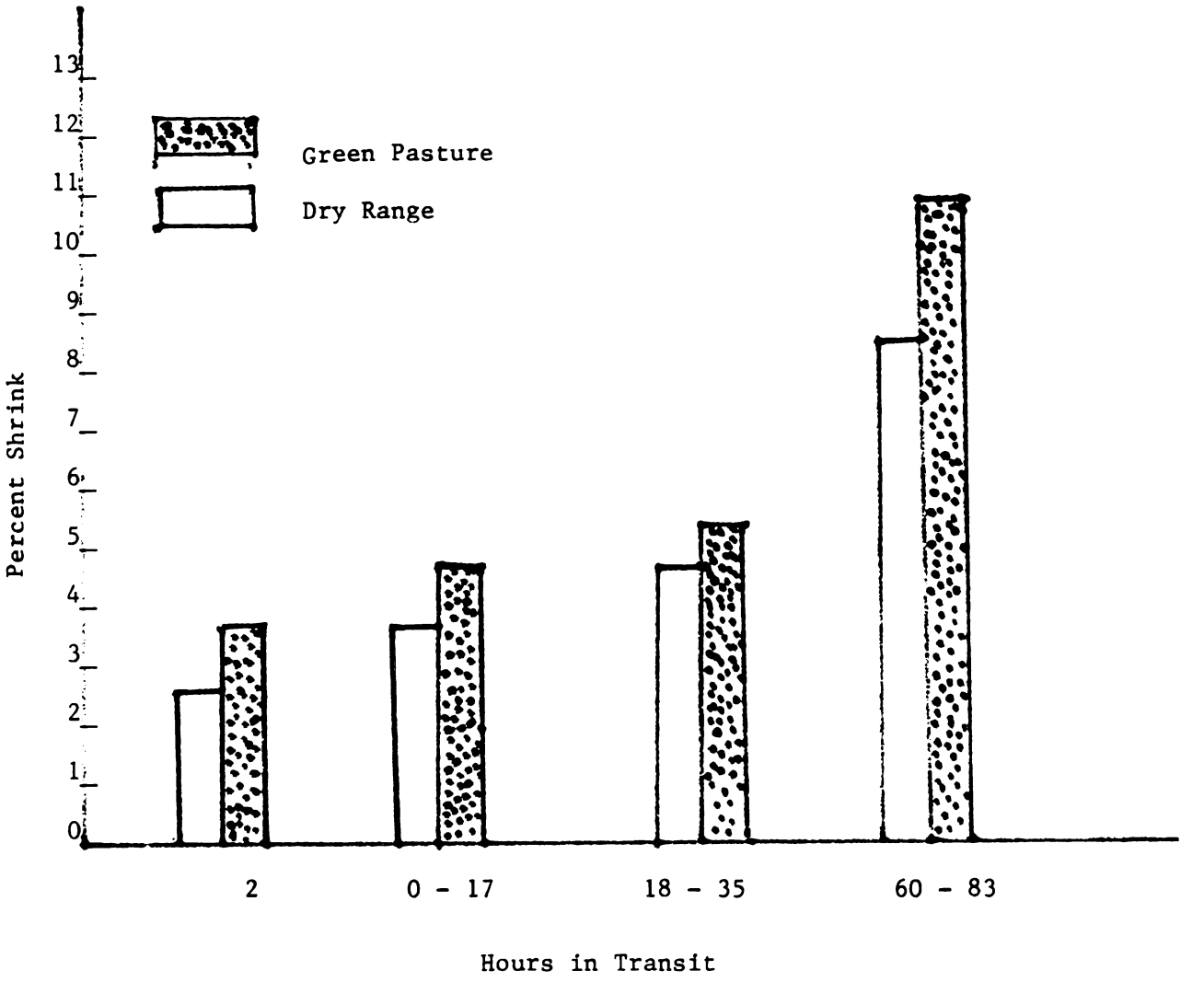
b) Handling, loading, and excitement in shipment. They all have a greatest influence on shrinkage because of disturbance and excitement occurring during miscellaneous operations in transit.

c) The kind of feed and the time of feeding. The kind of feed cattle receive before shipment affects the amount of shrinkage. As shown in Figure II, animals taken from green pasture have the most extensive shrink. Cattle being fed hay shrink less during marketing than those on any other type of feed. There are times when cattle should be fed an increased amount of dry feeds, particularly hay, for a few days before shipment.

It is evident that the comfort of the animals is very important in keeping shrinkage at a minimum.

d) Housing condition, marketing arrangement, interaction of housing condition and marketing arrangement, and rate of gain during the final month of feeding. Those factors associated with shipping distance have been found affecting significantly live weight shrinkage of fed cattle by Raikes et al. (1979). Moreover, the same factors (except shipping distance) associated with quality grade, yield grade and final feedlot weight do affect hot carcass weights. Thus, shipping distance does not affect hot carcass weight but does affect live weight. On the other hand, final feedlot weight, quality grade, and yield grade do affect hot carcass weights but do not affect percentage of live weight shrink.

FIGURE II. COMPARISONS OF SHRINK OF CATTLE FROM GREEN PASTURES WITH CATTLE FROM DRY RANGE.



Source: Harston, 1959.

The impacts of housing conditions, marketing arrangements, and rate of gain have been found affecting both live weight shrink and hot carcass weights. It is useful to define what housing condition and marketing arrangement stand for:

- Housing condition refers to shelter with three alternatives: no shelter; partly sheltered; and confinement.
- Marketing arrangement refers to feed and water supplies with five alternatives: hold at farm without feed and water; hold at farm without feed; hold at plant without feed and water; terminal markets; and no restrictions.

These factors discussed in this part (d) have been used by Raikes et al. (1979) in forecasting procedures for live weight shrink and hot carcass weight.

FORECASTING PROCEDURES FOR SHRINKAGE

Since some variations were found between the different experiments conducted on live weight losses and carcass weight losses, (in particular the influencing factors and their manner of occurring, as seen in this chapter), it is not easy to project exactly how much animals will lose at any given distance and at any given time. Nevertheless, Ronald Raikes, Gail M. Sieck, H. L. Self and M. Peter Hoffman in "Weight Loss of Fed Steers and Market Decision Implications" (1979) using factors discussed above have attempted to set up a procedure for loss forecasting which is very useful for both feeders and buyers in making marketing decisions. The following formula for forecasting has been proposed by them:

(1) Formula For Live Weight Shrink Forecasting

Shrink = 3.06 + housing conditions impact estimator + marketing arrangements impact estimator + interaction of housing conditions and marketing arrangement impact estimator + (0.15 x daily rate of gain in pounds) + selected or calculated shipping distance impact estimator.

(2) Formula For Hot Carcass Weight Prediction

H.C.W.P. = -43.79 + housing condition impact estimator + marketing arrangement impact estimator + (-2.99 x daily rate of gain in pounds) + (0.63 x feed lot weight in pounds) + (0.84 x quality grade code) + (6.52 x yield grade).

All impact estimator values are reported in worksheets conceived by authors and are attached. Data 3.06 in live weight shrink forecasting and -43.79 in hot carcass prediction are constants.

Moreover, for making comparison between live weight bids and hot carcass bids, the authors have developed some guidelines for feeders. For that, it is necessary to first express bids on a comparable basis.

(a) To convert live weight bids to a comparable basis, the following expressions has been elaborated.

$$\left(1.0 - \frac{\text{(pencil shrink + predicted shrink)}}{100}\right) \times \text{live weight bid per CWT} -$$

transportation cost per cwt. of live weight = adjusted live weight bid per cwt.

(b) To convert carcass weight bids to a comparable basis with live weight the following equation is used:

$$\frac{\text{(predicted hot carcass weight)}}{\text{feedlot weight}} \times \text{(hot carcass weight bid per cwt. of carcass)} - \text{transportation cost per cwt. of live weight} = \text{adjusted carcass weight bid per cwt.}$$

Although these procedures are very interesting, they are not as such applicable in West Africa livestock production conditions. Some parameters need to be adjusted to fit among other tropical realities, the grazing system of production, and the quality and yield grade variables. Research to determine appropriate parameters for tropical areas may be worthwhile, particularly for parameters such as marketing arrangement, interaction housing condition, marketing arrangement and constant impact estimator coefficient. It should be remembered that in West African countries, shrinkage is not explicitly taken into account to justify the use of this kind of marketing arrangement.

LIVE WEIGHT SHRINK PREDICTION WORKSHEET I

Variables	Impact estimators	Impact estimator entries
Constant	3.06	3.06
Select on impact estimator for each housing condition, marketing arrangement and two-way interaction.		
Housing condition		
No shelter	0.14	0.14
Partly sheltered	0.36	
Confinement	-0.50	
Marketing arrangement		
1 - Hold at farm without feed and water	0.26	
2 - Hold at farm without feed	-0.39	
3 - Hold at plant without feed and water	0.93	0.26
4 - Terminal market	0.04	
5 - No restrictions	-0.84	
Interaction (housing condition x marketing arrangement)		
No shelter x 1	-0.08	
No shelter x 2	0.37	
No shelter x 3	0.07	
No shelter x 4	0.44	
No shelter x 5	-0.06	
Partly sheltered x 1	-0.08	-0.08
Partly sheltered x 2	0.87	
Partly sheltered x 3	-0.16	
Partly sheltered x 4	-0.15	
Partly sheltered x 5	-0.48	
Confinement x 1	0.16	
Confinement x 2	-0.50	
Confinement x 3	0.09	
Confinement x 4	-0.29	
Confinement x 5	0.54	

Multiply the daily rate of gain in lbs. by the impact estimator.

Rate of gain	0.15 x 2.1-	0.315

Select the impact estimator for distance or enter miles and determine impact estimator.

Shipping distance

Less than 40 miles	-0.46	
40 - 79 miles	-1.04 + (0.0415 x)	-0.17
80 - 119 miles	-.032 + (0.0055 x)	
greater than 119 miles	0.34	

Total the column of impact-estimator entries. _____

_____

Predicted live weight shrink percentage. 3.525

HOT-CARCASS-WEIGHT PREDICTION WORKSHEET II

Variables	Impact estimators	Impact estimator entries
Constant	-43.79	-43.79
Select one impact estimator each for housing condition and marketing arrangement.		
Housing condition		
No shelter	-3.19	
Partly sheltered	-4.30	-3.19
Confinement	7.49	
Marketing arrangement		
1 - Hold at farm without feed and water	-0.76	
2 - Hold at farm without feed	8.75	
3 - Hold at plant without feed and water	-3.85	-0.76
4 - Terminal market	-2.64	
5 - No restrictions	-1.50	
Multiply the daily rate of gain in lb., feedlot weight in lb., quality grade and yield grade by their corresponding impact estimators.		
Rate of gain	-2.99 x 2.1 =	-6.28
Feedlot weight	0.63 x 1087 =	684.81
Quality grade a/	0.84 x 6 =	5.04
Yield grade	6.52 x 2 =	13.04
Total the column of impact estimator entries.		
Predicted hot-carcass-weight.		684.87

a/ Code quality grade as follows: Low standard -1. Average standard -3. Low good -4. High prime -12.

CONCLUSION

From the factors identified as major variables influencing shrinkage, the following function may be used as a conclusion.

$$S = f(ti, d, hm, f, s, tm, en, cl, pc, hc, fc)$$

1	ti	=	time in transit
2	d	=	distance shipped
3	hm	=	handling and management
4	f	=	amount of fill
5	s	=	length of starvation
6	tm	=	method of transport
7	pc	=	physical characteristics
8	hc	=	housing conditions
9	fc	=	feeding conditions
10	en	=	environment
11	cl	=	climate

2. Bruising, Death and Crippling

Losses from bruising, death, and crippling that occur during the marketing process represent a part of the cost of marketing cattle. Such losses result from a great variety of causes. But they are largely influenced by the type of transportation used and by many other factors such as the distance and time of the shipment, the season, etc. Knowledge of the nature and causes of these losses can help establish practices for reducing the extent of such losses. For the purpose of reducing such losses, a set of recommendations have been made in Chapter VII along with recommendations on shrinkage reduction.

a) Bruising. Live cattle, during the process of marketing, are often injured by bruising. Bruising may result from accidents or from improper handling and may be done to different parts of the animal. The cattle may be injured while being loaded onto motor trucks or onto railroad cars at the local shipping point; while en route to market or slaughterhouse; or while being handled at the market or after delivery is made at the plant. All meat that is damaged from bruising should be condemned as unfit for human food, even though, this is not in practice in West Africa. The bruised parts of carcasses may be cut out and used for various inedible by-products. Since bruising usually cannot be detected until after the animals have been slaughtered, it is not practicable, under the live weight method of marketing, to charge the loss to those who are responsible for it. However, packers in developed countries take the probable losses into account in the prices that are offered for the live animals. Losses from bruising, therefore, are shared by all producers -- those whose animals are free from bruises and those whose animals are badly bruised. In Africa, however, these probable losses generally are not taken into

account in the prices offered for live cattle, unless in cases of big gashes or cuts.

Types of Bruises

Bruises may exist in a number of forms, but the only types that are usually possible to detect in the live cattle are those in the form of cuts and gashes. However, of greater economic importance are those bruises which occur as inflamed spots and areas (fire bruises) and as deep-tissue bruises. These constitute the major portion of bruises, and they cannot be detected until the hides are removed at slaughtering time. The deep-tissue bruises cannot be detected until the carcasses are broken down into the wholesale or retail cuts. Some of the worst bruises occur when cattle go down in cars or trucks and are trampled by other cattle.

Location of Bruises

The greatest amount of bruising is most often located in the region of the higher priced cuts (Dowell, 1941) and (Fowler, 1961). Most of them are on the ribs, loins, and rounds. A survey conducted by USDA (Rickenbacker, 1959) and presented in Tables X and XI, revealed that the hip and shoulder areas account for about 68 percent of total trim bruises and about 70 percent of untrimmed fire bruises. The rib area sustained only 12 percent of the trim bruises and 7 1/2 percent of fire bruises.

TABLE X. BRUISE LOSS PER 100 HEAD BY TYPE OF CATTLE AND CARCASS LOCATION.

Type of Cattle and Carcass Location	Number "trim" Bruises	Number "fire" Bruises	Pounds Trim Tissue
Hip			
Steers	29	25	21.0
Heifers	19	29	10.1
Rib			
Steers	13	7	6.6
Heifers	5	8	1.8
Shoulder			
Steers	29	42	15.1
Heifers	29	34	10.0
"Other"			
Steers	16	21	8.1
Heifers	15	21	5.3
Whole Carcass			
Steers	87	95	50.8
Heifers	68	92	27.2

Source: Rickenbacker, USDA.

TABLE XI. BRUISE LOSS PER 100 HEAD BY CARCASS LOCATION.

Carcass Location	Number "trim" Bruises	Number "fire" Bruises	Pounds Trim Tissue
Hip	25	26	16.9
Rib	10	7	4.8
Shoulder	29	39	13.2
"Other"	16	21	7.0
Whole Carcass	80	93	41.9

Source: Rickenbacker, USDA.

Causes of Bruising

The causes of bruises are varied and many. According to Dowell and to Fowler, an important part (10%) of all bruises are man made resulting from careless use of clubs, canes, or whips, as shown in Table XII.

In addition to these man made factors responsible for bruises, there are some major factors which are:

- Trampling as a result of failing to select the size of cattle in some cars and trucks (weak cattle, crippled and lowered resistance animals are vulnerable to bruises).
- Overcrowding in cars and trucks.
- Underloading cars and trucks without precautions to prevent excessive jostling.
- Placing upper decks too low for the size of the cattle in the lower decks.
- Failing to open gates wide when driving cattle through.
- Hooking by horned cattle.

Because of the many factors involved, it is difficult and in many cases impossible to determine the specific cause. However, according to Fowler (1951), the high percentage (two-thirds) of bruises in the hip area of cattle may be largely accounted for by cattle being rushed and crowded through gateways and alleys and into and out of cars and trucks. the horn-bruise damage for cattle usually varies in direct proportion to the length of time that horned cattle are confined in close contact in the loading pens, cars, or trucks, or in

the sales pens or packer's pens. The horns rake and bruise the sides when cattle that are crowded closely raise and lower their heads. A survey of Livestock Conservation, Inc. cited by Fowler (1961) revealed that about three percent of the bruises in cattle are the direct result of horns. This percentage may be more heavy in the case of African long horn range cows.

TABLE XII. MAJOR CAUSES OF CATTLE BRUISES - According to Livestock Conservation Inc., cited by Fowler, 1961.

Crowding, Bumping, and Rushing	66%
Trampling	14%
Cane-Whip-Club	10%
Horned Cattle	3%
Other Causes	7%

According to this table one would deduct that in Africa bruising may be considerable in truck or car transported cattle since they are subject to much rough handling throughout the marketing process. This is due, in part, to failure to appreciate the effect on the carcasses and hides since damage from bruising usually cannot be detected in the live cattle and, also because it does not appear as an item of cost in the account of sales. Thus, there is no reason for traders to adopt practices that would reduce or eliminate such losses if they are not associated with other losses such as shrinkages.

However, bruise losses have a great effect on butchers' margins, on consumer prices (discount price) and on total supply of edible meat. Some studies are needed to assess the proportions of bruise damage in the African cattle marketing process according to each of the main factors used in Livestock Conservation Inc.'s table and their impact on the meat supply side -- and on consumer's price.

b) Losses From Death and Crippling. In addition to extensive bruise losses, many cattle arrive at the market or plant either dead or crippled from injuries received in loading or in transit. Others are injured or die after arrival at the market and before they are sold and slaughtered by the butchers. Part of these on-the-market deaths are due to the condition of the cattle before shipment (diseases, hunger) others are due to fatigue, diseases (e.g. trypanosomiasis in trekking) to injuries received in transit (rail and truck shipment in particular) or at the yard. The cattle that are crippled en route to the plant or the the market are sold at a lower price, but cattle that die on the way to market or at the market or to the plant are a total loss to the owner. However, the total loss cases are rare. Usually animals are sold before they die.

The term crippled is sometimes very confusing. Indeed it has a very broad definition. Usually an animal that arrives in such condition that it cannot walk into the pens unassisted is recorded as a cripple. In some instances, cattle that limp badly and those that show evidence of pain are recorded as cripples at the time of unloading, even though they are able to move out of the cars or trucks without assistance. In addition, cattle that are

unable to move through the yards with the rest of the lot because of emaciation or exhaustion frequently are recorded as crippled. In general, however, a crippled animal may be defined as one that must be hauled regardless of whether the difficulty is due to injury, emaciation, or exhaustion.

Note that in Africa all the losses from death and crippling of cattle are not due to improper handling in transit or in the yards. There is a common practice among stockmen (not traders) to ship emaciated and crippled cattle of the herd to market as a means of salvaging them.

Relationship of Losses to Distance

Normally, losses from death and crippling would be expected to increase with the distance that cattle are transported. This is based upon two assumptions: first, that for a given type of transportation, distance reflects the time en route and second, that all factors other than distance (loading, care, speed, etc.) remain constant. If the first assumption is reasonably correct (it may require about twice the time to haul a truck or car load of cattle a distance of 100 kilometers as to haul the load 50 kilometers) the second assumption, that factors other than distance remain constant, on the contrary, does not hold true for shipments to many markets. In some instances losses may decrease with distance, in others, losses may increase. According to Dowell (1949) and Fowler (1961) losses from death and crippling are often lower on shipment than on those moving much shorter distances. The explanation for this lies in the fact that it is a human failing to be less careful in observing the rules of good shipping when the distance to market is short.

On short shipments, less care is exercised in bedding, loading, droving, and cattle trucks and cars are often overloaded to save transportation costs.

Relationship of Losses to Time of Transit

Losses from death and crippling that occur between the time of loading or departure at the local shipping points and the time of unloading or arrival at the markets or plants vary by condition of cattle and by type of transportation. A survey conducted by National Livestock Loss Prevention Board, Union Stock Yards, Chicago (Smith, H. R., 1938) found that death losses up to the time of unloading were two times higher and crippling losses were three times higher among cattle when shipped by truck than when shipped by rail. The same survey found also that losses from death and crippling in transit are higher among thin, emaciated cattle than among cattle that have been properly fed. Although the reason for these differences between effects of type of transportation on losses has not been given, it seems that they may be due to the poorly-equipped truck condition and the state of the roads at that time. That assumption is supported by the survey conducted by Rickenbacker which showed that in 1956 in the same Midwestern area death losses are only one time higher and crippling are almost equal in truck and rails shipping. However, in Africa, the negative influencing factors still remain, since in most African areas, the state of roads and other conditions prevailing are equal or even worse than conditions prevailing in the U.S. in 1938. Moreover, the condition of the cattle in Africa, in general, at the time of marketing is influenced by the feed supply situation. Drought and dry season conditions may result in the marketing of emaciated cattle, which are therefore, more exposed to losses; while an abundance of feed during the rainy season and the

post harvest period usually results in feeding to heavier weights, thus, cattle in these periods are less subject to losses from death and crippling.

Losses In Relation To Season

In the case of most animal species there is a fairly pronounced seasonal variation in losses from death and crippling.

In the case of cattle there is much less seasonal variation in death losses. However, there is a fairly pronounced seasonal variation in losses from crippling (USDA, Rickenbacker, 1958), likely due to snow and ice in winter. However, for West Africa, that may not be true and death losses may be higher in the dry season because of lack of fodder and water supplies.

Losses In Relation to Consignments

The amount of loss from death and crippling during the marketing process is also influenced by the method of feeding during the growing and/or the finishing periods and by the uniformity (same size) of the cattle shipped in the same car or truck, or on trek. Cattle that are emaciated because of lack of feed or disease and those that carry excess weight or are deficient in bone development are more subject to crippling than normal cattle. Those in cars or trucks that go down en route frequently are trampled and badly injured or killed before reaching the market. Even though they are able to move out of the cars or trucks into the unloading pens, they may be so exhausted that it is necessary to haul them to the slaughterhouse. Losses from death and crippling are in general higher in mixed loads of cattle containing bulls or other unruly

animals (Dowell and Bjorka, 1941).

Losses In Relation to Bedding

The kind and condition of the bedding used in cars and trucks have an important effect on losses from death and crippling. Crippling is more common in cars with slippery floors than in cars where good footing is provided. The objectives in bedding cars and trucks, therefore, are to add to the comfort of the cattle and to prevent slipping. But attention may be paid to the kind of bedding to be used. Sometimes the use of much straw bedding or sand during hot weather may cause a higher rate of death losses than other types of bedding.

Losses In Relation To Handling Care

Some of the losses from death and crippling are due to careless handling during the marketing process. This occurs at the local loading point or between the time of loading and the time of slaughter. Staatz (1975) has estimated 0.6 percent of losses in trekking 1,618 cattle and 8 percent in mixed trek-train transport of 442 head, all from Mali.

Lost Animals Through Straying and Theft

Losses from straying and theft are encountered only among cattle on hoof. These phenomena are unfortunately more and more frequent when the herds reach dense vegetation areas and around big cities. The deterioration of social conditions of populations in African big cities such as Bobodioulasso,

Bouake, Lagos, etc. are some of the reasons that can explain the increase of banditry.

Both straying and theft are financial loss to the owner since the total value of the animal is lost. But contrary to the death, they are not an economic loss to society; only a transfer of ownership. Data on the incidences of losses and forced sales of cattle during trekking and mixed rail-trek transport are from Staatz (1979) and presented in Table XIII.

Meat Quality Losses

In addition to shrinkage, bruising, death and crippling occurring during the marketing of cattle, it is also necessary to consider the possible effects on the eventual quality as distinct from the weight of the meat carcass. In some cases, a reduction in quality may be directly associated with tissue shrinkage, since the ratio of the relative weights of meat and bone in a given weight of carcass are unfavourably affected. Also, if an animal has been kept in a state of nervous tension, physically strained and not properly fed and watered for a long time before slaughter, it loses fat and the texture of its carcass is adversely altered. The muscular parts become more watery due to a significant depletion of the equilibrium level of muscle glycogen. This can be caused by prolonged road or rail transport (Howard and Lawrie, 1956; Shortose, Harris and Bouton, 1972).*

*R. A. Lawrie, "Problem of Beef Quality in Relation to Transportation," 1974.

TABLE XIII. COST OF TRANSPORTING FIFTY HEAD OF CATTLE FROM KOUTIALA (MALI) TO FERKESSEDOUGOU BY TREK AND RAIL FROM FERKESSEDOUGOU TO ABIDJAN

Expense*		TOTAL	PER ANIMAL	
1. Salary of drovers	2 @ 15,000 + 1 @ 12,500[a] =	42,500	850	
2. Food for drovers		25,000	500	
3. Return trip for drovers	3 @ 2,500[b] =	7,500	150	
4. Round trip for owner		13,000	260	
5. Food for owner in Abidjan: 7 days @ 200 CFAF/day		1,400	28	
6. Health certificate		4,000	80	
7. Indemnity for damaged fields		250	5	
8. Salt for animals		500	10	
9. Loss of animals	1.5% of 50 animals @ 40,000 CFAF per animal =	30,000	600	
10. Forced sales	2.0% of 50 animals @ 20,000 CFAF loss per animal =	20,000	400	(10%)**
11. Cattle market tax: Abidjan		25,000	500	
12. Malian cattle merchants' license, vaccination, and export taxes		220,000	4,400	
13. Transport charges				
Rental of truck/train car	2 H12 cars @ 62,558 =	125,000	2,502	
Straw		1,000	20	
Loading/unloading		2,500	50	
Other[c]		2,500	50	
14. Unofficial charges		-0-	-0-	
15. Gift to the landlord		0-5,000	0-100	
TOTAL COST (excluding weight cost):		517,266-517,266	10,345-10,445	
Days in transit:		.31		

Source: Staatz, 1979; pp. 234-5 Cited by CRED Volume III, 1980.

[a] Three drovers accompany the cattle to Ferkessedougou but only two continue on from Ferkessedougou to Abidjan by train.

[b] The RAN provides free return transit to Ferkessedougou for the two drovers who accompanied the animals to Abidjan by train. The cattle merchant has only to pay their passage between Ferkessedougou and Koutiala (2,500 CFAF per person).

[c] Includes unofficial payments to RAN employees for reserving a train car or other services.

*Excluding weight losses.

**Percentage of lost costs from total transport costs per head.

The quality of a carcass can also be seriously damaged if the animal has recently suffered knocks and bruises. This consideration is often neglected because the damage cannot be seen until after the animal has been slaughtered and dressed. Bruised areas then show up as dark, bloody patches in the flesh and must be removed before the meat can be sold.

It is worthwhile to recall what quality in beef means. In the present context this will mean eating quality and freedom from microbial spoilage (Lawrie, 1977). Eating quality involves four attributes:

- The color, which is largely due to the muscle pigment myoglobin.
- The water holding capacity and juiciness, which are determined by the physico-chemical state of the muscle proteins.
- The texture of tenderness, which is a function of the size of muscle fibres and the degree of their cross-linking.
- The flavor, which comprises taste and odor and is due to derivatives of fat, proteins and carbohydrates.

All these four attributes of eating quality are variable and may be influenced by many factors such as breed, sex, age, stress, plan and nature of nutrition, etc.

CHAPTER V

COMPARATIVE ADVANTAGES AND DISADVANTAGES AND COSTS OF TRANSPORTATION METHODS

The special characteristics which make livestock producers dependent upon an adequate and flexible transportation system may be grouped into three major categories.

One is the extent to which livestock products depend on geographic movements to acquire their market value. In West Africa these movements are over long distances, and perishable livestock products have very short time tolerances. The second, even more critical, is the extent to which natural factors determines where, when and in what quantities transportation services will be needed. The third is the costs and the high level of losses involved in the shipments. Therefore, the choice of any appropriate method of transport should take into account these special characteristics.

The three major methods of transporting cattle from producing areas to consuming regions in tropical Africa that we have discussed in this study are trekking, rail and trucking. These methods will probably continue to be important for a long time. Therefore, information about advantages and disadvantages and about the costs of losses involved in these methods is

important to policy makers and cattle traders interested in improving beef transportation. Some studies on various aspects related to transport cost of trekking, rail and trucking in West Africa have been done, but very little information is available on costs of losses.

Policy makers and cattle traders can identify in this study major advantages and disadvantages and major cost categories within each method, compare the same data item among methods, and compare total differences among the various methods.

The data given in this study should not be considered highly accurate; more studies, more research on more areas and on the various parameters and relationships must be done to attain higher levels of accuracy. However, the information used is the best available. Organizing this information into an integrated framework should help in the policy process and decision making that seek to improve the performance of the West African cattle transportation system.

1. Trekking

a) Advantages and Disadvantages. In most of West Africa, especially in the Sahelian zone that includes: Mali, Niger, Upper Volta and Mauritania, it is common for cattle to cover all of the long journey to market on foot. Herds assembled by traders in the remote cattle producing areas of Mali, Niger, Upper Volta or Mauritania may be driven more than 1,500 miles, taking several weeks to reach their terminal markets or transfer points to truck or rail transport. Much of this traffic crosses international boundaries; for example from Mali through Upper Volta into Ghana or from Niger through Upper Volta to Ivory Coast.

In many cases, there is no feasible alternative to droving since the producing areas are remote and thinly populated, and are not served by all-season roads. The herdsmen and their cattle are accustomed to long seasonal treks over the rangelands, and so the eventual journey to markets or transport terminals is just an extension of their normal way of life. The marketing of cattle on foot has special advantages where good grazing conditions are found all the way to the abattoir, particularly in the rainy season (July to September) or during the post harvest period, October to December. Under those conditions stock can be expected to gain weight during their journey to market in almost all areas if driven slowly (Mittendorf, 1961; Fenn, 1977; Staatz, 1978).

By contrast, there are cattle evacuation routes which involve great hardships and result in serious losses of weight and quality because they pass through areas where fodder and water are scarce, particularly in the Sahelian areas in the dry season, February to June, or where lack of common lands, high density of population and busy motor traffic cause the herds to be harrassed and hurried along their way, particularly in the southern cultivated or forest zones of West Africa.

The traditional market routes from Sahelian producing countries to deficit coastal countries Nigeria, Ghana and Ivory Coast have these disadvantages, and also pass through areas infested with Tse-Tse fly. Consequently, in recent years cattle consigned from the north to these coastal markets have increasingly been transported by road or rail at least when they reach the southern stages of their journey.

b) Direct and Indirect Costs. In assessing the costs of moving cattle on foot, the question of relative transport costs, loss of weight and 'quality' and the risk of casualities (bruising, crippling, death) may well outweight all other factors in econoimc importance. African traders normally know from experience what costs they incur in droving over particular routes in various seasons, and if there were a better alternative means of transport, they would no doubt use it. However, the adoption of road, rail or other means in place of trekking may not be possible without prior investment or provision of services by the public authorities. Even the improvement of existing facilities for droving may call for public investment in stock routes, watering points and supporting services. Therefore, it may be necessary for the policy makers also to know as accurately as possible the costs of evacuating cattle, in particular

the costs arising from losses of weight and 'quality' and from casualties. It is worthwhile to note that in most West African markets for meat, there is not a high premium paid for high quality meat, so loss of quality may not be a large economic loss.

It is difficult to measure these costs by experimental work under practical conditions, but in some instances the observations and information provided by traders may be sufficient to show whether investments in new transport methods are justified. However, special experiments may be conducted if it is feasible to weigh a selected group of slaughter cattle before they begin their journey, and record the experience of the journey itself and the live weights and condition of the animals at point of slaughter. Such an experiment of course has more immediate value if it is possible to test an alternative means of transport with a similar herd of cattle at the same time. In those conditions the carcass weights and qualities of the two groups can be analyzed and compared in order to judge how live weights, death losses and carcass quality are affected by the alternative methods. But this is not the case in most of the studies conducted so far in West Africa. In general, the costs involved in trekking live cattle fall into the following categories: drover's fee, food money, marketing fee, salvage costs, shrinkage costs, loss and mortality costs, investment costs, water and supplementary feed costs, trade cattle tax, and indemnities for damaged field. It is obvious that all these variables do not have the same value in all West African countries and even within the country, they may change according to time periods, to areas and to methodology of data collecting. Therefore, data will be presented country by country and the focus will be on costs of losses specifically imputable to trekking. The other costs will be found in Appendix Tables.

Mali

Ombevi (Paper No. 100, 1978) reports a 5 percent loss of live weight for herds moving on foot in the dry season between Mopti and Bouake a distance of 800 km.

John Staatz (1980) charged the opportunity cost of tied-up capital at 20 percent per annum, pro-rated to reflect the number of days involved in trekking, and 1 percent cost for loss of animal and 1 percent cost for forced sales from the overall percent of investment in exporting fifty head of cattle from Niono to Bouake. Dirck Stryker (1975) estimates 0.5 percent of death and forced sales losses and shrinkage is estimated at 10 percent.

Upper Volta

Larry Herman (1983) estimates 1.5 percent of forced sales loss, 0.6 percent for lost animal and 0.6 percent for death losses from the total costs of trekking cattle within Upper Volta.

Ivory Coast

John Staatz (1980) reported 0.4 percent cost for indemnity for damaged fields and 1.6 percent cost for lost animals and forced sales of total costs of transporting fifty head of cattle from Tingrela to Bouake.

Nigeria

Kellogg (1971) reports in eight surveys covering all of Nigeria 46 percent of the total transport cost for shrinkage, 12 percent for loss of value and 5 percent for mortality cost. The large shrinkage, salvage and mortality losses (which account for approximately 63 percent of the total transport cost in this report are apparently due to a great extent to the trypanosomiasis disease contracted as the cattle walk through the Tse-Tse fly belt.* Note that Kellogg based his findings on secondary data.

c) Conclusion

Obviously, there is very little information available on the subject of losses during trekking. The data given above did not help very much to increase the understanding of the economic significance of losses. Neither the clear magnitudes nor the exact nature of the losses have been well established in these studies. Moreover, the shrinkage which is the main component of losses in trekking is ignored except in Staatz and Kellogg's studies. And even in those cases, excretory and tissue shrinkage are not considered separately to appraise the conomic significance of the shrinkage since only the loss in tissue reduces the weight of the edible carcass.

More research is needed to obtain higher levels of accuracy of economic variable's values in the trekking transportation system.

*Kellogg refers to Frederick Hunger's unpublished manuscript, "Analysis of Cost Structure on Hoof Transport."

2. Trucking

a) Advantages and Disadvantages. The advantages of truck transport of cattle arise mainly from its speed and reliability over good roads and the fact that it enables traders to exercise more freedom as to the time and place of marketing. The great increase in its use in recent years has therefore depended on the extensive development of all weather (international) roads between cattle producing area's markets and main population centers. Once good motorable roads are built, vehicle-transport of cattle can greatly reduce the time of transit and thus losses of weight and quality that are associated with trucking in unfavorable conditions. Other reasons for increases in the use of trucks in recent years are in response to some special brisk demands in coastal countries, to avoid poor trek routes due to the drought and the lack of rail cars for cattle during a long time.

By far the most important disadvantages of truck shipment are high shrinkage, mortality, freight charges, due to the lack of good domestic roads and inadeqate bridges in most areas. Other factors causing losses are poor mechanical condition of trucks, overloading and driver stress from driving too long without rest.

b) Costs of Losses in Trucking. The direct loss costs involved in trucking are mainly: mortality costs, shrinkage costs, forced sales of animals and severe bruises, causing a discounting in price or a trimming out of much valuable muscles at the abattoir and for which a value estimation

is generally not made in Africa, although that have a very important economic significance. But here again, the following data should be treated with reserve as well as in trekking data.

John Staatz (1980) reports 9 percent mortality cost and 4 percent for forced sale cost of 50 head of cattle shipped by truck from Niono (Mali) to Abidjan, a distance of 1,100 km, as shown in Table XIV. No data on shrinkage is reported. Meanwhile, Sedes (1973)* reports 10 to 20 percent of total costs per head due to weight loss in truck shipment from Mali to Ivory Coast or to Ghana. Staatz (1980) in "Meat Supply in Ivory Coast 1967-1985" estimates an average of 5 to 7 percent of carcass weight loss per head, an equivalent of 12 to 13 percent of total cost per head; 4 percent for mortality cost; an equivalent of 2 percent per 24 hours; carcass weight loss, and 2 percent for forced sale cost in a truck shipment of 50 head of cattle from Koutiala (Mali) to Abidjan (distance of 600 km). In transporting cattle within Ivory Coast from Tingrela to bouake by truck, he reports 1.6 percent cost for mortality, 0.6 percent cost for forced sales and about 3.5 percent to 5.5 percent carcass weight loss per head. Earl Duane Kellogg (1971) reports in his Nigerian survey an average total cost per head of 4.6 percent due to mortality cost and 30.7 percent due to shrinkage cost. Figures are present in Table XV.

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*Stryker (1975) Marketing of Malian Cattle, p. 23, Table V.

TABLE XIV. COST OF EXPORTING FIFTY HEAD OF CATTLE FROM NIONO TO ABIDJAN IN 1977 ($ = 450 FM)

Transportation Costs*	Truck to Abidjan
Salary and expense of drovers	48,000 FM
Ivorian health certificate	8,000 FM
Indemnities for damaged fields	-0-
Salt for animals	-0-
Loss of animals	150,000 FM (13%)**
Forced sales of animals	60,000 FM
Truck transport charges	1,400,000 FM
TOTAL	1,666,000 FM

Source: CRED Volume III, 1980.

*Shrinkage cost is not included.

**Percentage of loss from total transport costs.

TABLE XV. COSTS OF TRANSPORTING CATTLE BY TRUCK IN NIGERIA

Category	Sokoto to the West		Kano to the West		Bornu to the West		Bornu to the East	
	% Cost /cow	% of Total	% Cost /cow	% of Total	% Cost /cow	% of Total	% Cost /cow	% of Total
Mortality cost	.54	4.3	.63	4.54	.98	5.0	.81	4.9
Shrinkage cost	4.25	34.2	4.46	32.20	5.09	26.1	5.05	30.6
Other expenses	.40	3.2	.40	2.90	.40	2.0	.40	2.4
Freight costs	7.25	58.3	8.37	60.36	13.06	66.9	10.25	62.1
TOTAL	12.44	100.0	13.86	100.0	19.53	100.0	16.51	100.0

Source: Kellogg, 1971.

3. Rail

a) Advantages and Disadvantages. A railway's ability to compete for cattle transport largely depends on the level of freight rates, the speed and frequency of the services it can offer over longer distance and on the relative security against delays and breakdowns. Ideally, the railway may provide entire cattle trains of properly equipped wagons. Competent handling of the cattle at loading and unloading and adequate supervision and care during the shipment are also essential. If the shipment takes longer than about 30 hours, it may be appropriate to provide a stop for feeding, watering and rest to reduce the shrinkage.

The convenience of rail transport is also greatly increased if proper holding grounds or pens with fodder and water can be provided at the loading and unloading points. Cattle should be allowed to begin their hard rail shipment in the best condition (and not be made to wait for departure under starving conditions), and to have a regain before sale. Unfortunately in West Africa, the two major lines of railway (Kano-Lagos and Ouagadougou-Abidjan) for cattle transportation are both inefficient. On both lines, cattle cars are frequently unavailable for two weeks or more, forcing cattle traders to truck or walk their animals or incur additional expenses in maintaining the herds while waiting for cattle cars. After the cattle are loaded, the train usually waits several hours for customs clearance (case of Ouagadougou-Abidjan railway) or for other reasons before being able to depart. The trips also take much longer now than they did about 10 years ago because of the bad condition of the trains. For example, the journey of about 950 km from Kano to Apapa takes 72 to 80 hours, while it took 50

hours in 1960 (Fenn, 1977) and the journey of about 1,200 km from Ouagadougou to Abidjan takes 72 to 96 hours while it took only 48 hours in 1965 (Bishop, 1972). During the shipment time, cattle are neither fed nor watered. The cattle cars do not have adequate ventilation so that animals become overheated while in transit. All those factors contribute to increased shrinkage, death losses, and casualties in rail shipment.

b) costs of Losses in Railing. Like in trucking, the direct loss costs fall into the following categories: shrinkage costs, mortality costs, forced sales of animals and severe bruising costs.

According to Herman (1978) the carcass weight loss is estimated at 10 percent per head on the rail trip from Ouagadougou to Abidjan. This 10 percent is equivalent to about 16 percent of purchase price. The mortality and forced sale losses are estimated at 2.25 percent of purchase price. He estimates mortality at 2 percent, an equivalent of 21 percent of total per head cost, and forced sales at 2.16 percent of total 94 herds. (Herman, 1983.)

Staatz (1979) estimates 9 percent loss of carcass weight for the Ouagadougou-Abidjan trip (the largest single cost in rail per head except taxes). This represents 26.7 percent of the total cost per head. The cost of mortality and forced sales is estimated to be 5 percent of the total costs per head.

According to Kellogg (1971) mortality and shrinkage losses account for approximately 40 percent of the total transport costs for rail shipment on important market routes of Nigeria.

Mortality cost per head is about 2 percent, and shrinkage cost is about 45 percent of total per head cost. Those figures are presented in Table XVI.

TABLE XVI. COSTS OF TRANSPORTING CATTLE BY RAIL FROM SOKOTO TO THE WEST

Category	Sokoto to the West		Kano to the West		Bornu to the West		Bornu to the East	
	Cost ₦/cow	% of Total	Cost ₦/cow	% of Total	Cost ₦/cow	% of Total	Cost ₦/cow	% of Total
Mortality cost	.15	1.8	.12	1.6	.25	2.7	.21	2.1
Shrinkage cost	4.00	47.9	3.34	44.5	4.84	42.0	4.83	48.2
Other expenses	.40	4.8	.40	5.3	.40	3.5	.40	4.0
Freight costs	3.20	38.3	3.05	40.7	5.10	44.2	3.83	38.3
Attendant cost	.60	7.2	.59	7.9	.94	8.1	.74	7.4
TOTAL	8.35	100.0	7.50	100.0	11.53	100.0	10.01	100.0

Source: Kellogg, 1971.

4. Conclusion

Cattle traders in West Africa have three main transportation options in shipping cattle from producing areas to consuming regions. Where a choice of transport methods is possible, or where investment might be made to lessen the rigours of shipment, it should be worth making careful assessment of losses to be incurred and the costs they represent. There are no standard recommendations to be applied to each situation since factors to consider depend quite often upon local conditions and opportunities may differ from one area to another. Nevertheless, those general considerations such as the level of changes, the quality of service or the combination of both have to be considered when choosing an option.

a) Trekking

On some very long and arduous routes, the loss in live weight and the mortality can be very high. That is particularly true for Sahelian regions in the dry season and for southern Tse-Tse fly infested areas. In addition to weight losses and Trypanosomiasis, trekking may involve the loss of animals through straying, theft and other disease. However, in other circumstances, cattle may gain weight, particularly in the rainy season if they are trekked slowly.

No significant investments in capital equipment are involved in trekking; the system is simple and flexible, and cattle can be easily added or distributed along the route as occasion requires. Moreover, where weight loss and mortality are not affected, the direct costs of trekking cattle are normally small, provided that forage and water along the route are available and free of charge.

On the other hand, trekking has some serious disadvantages once the traditional marketing channels begin to give way to modern systems using more capital investments and seeking greater reliability and faster turn-over. Under a long-range trekking system, the supply of cattle cannot always be accurately programmed, and in any case, the capital represented by the animals is tied up for a long time in each shipment, as illustrated in Table XVII. Moreover, the cattle often need to be fully mature in order to be able to make a long and hard journey on foot. For this reason, many steers in Africa are kept on the rangelands until they are six years or more old. That is one of the major problems of range mangement. If more cattle could be marketed at four years of age, productivity could be greatly increased.

Finally, trekking is not suitable for cattle that have been well finished under intensive conditions such as in feed lots, in ranches or in the peasant feeding system.

b) Railing

In all rail lines used in West Africa for transporting cattle, the number of cars is insufficient to allow the running of special high-priority cattle trains with all related services and facilities. Traders are often obliged to wait for

TABLE XVII. TIME AND LABOR REQUIREMENTS FOR EXPORTING FIFTY HEAD OF CATTLE FROM NIONO TO ABIDJAN - (In Man-Days)

	Trek to Ferkessedougou, then Rail to Abidjan
Time Required for Malian Formalities after Purchase	7 owner-days
Time Required for Trekking	45 days x 3 drovers
Time Required for Shipping	2 days x 2 drovers
Time Required for Marketing in Abidjan[a]	11 owner-days 5 days x 2 drovers
Number of Days Capital is Tied up[b]	65 days
Number of Owner-Days Required	18 days
Number of Drover-Days Required	149 drover days

Sources: Times taken from Staatz, 1979 (Chapter Six), based on interviews with owners and drovers. Where data is missing (such as from Niono to Koutiala), trekking times are calculated assuming that a herd covers 16 km per day. Cited by CRED Volume III, 1980.

[a]Includes unloading, marketing, roundtrip travel for owner, and return travel to Mali for drovers.

[b]The capital involved is greater for trucking.

several weeks for an allocation of cattle cars. The journey takes a long time during which the animals are neither fed nor watered. Forced sales, mortality and shrinkage, although sometimes less than those of arduous trekking because of shorter shipment time, remain important. Bruising and other injuries are high and constitute an important economic loss although the traders do not pay fully for them.

These factors of inefficiency in the operation of railroads in West Africa have resulted in decline in the use of trains for the transport of cattle within the past ten years. Nevertheless, over very long distances (e.g. 1,000-1,500 km) it is more practical to ship cattle by rail than to trek or truck them. To avoid capital being tied up for long time, poor grazing and excessive weight loss particularly in the dry season and Tse-Tse infested areas, the railway may be better than trekking. Trucking cattle long distances is also more expensive and less profitable than rail transport.

c) Trucking

Most traders favor the convenience provided by trucks of being able to load their animals out at the farm, ranch, or feed lot of shipment directly to the final destination. Of further convenience is the fact that trucks also provide more flexibility since they are not limited by fixed routes, nor do they have to follow definite schedules.

The main limitation on the extended use of this flexible time saving method of transport is the lack of good roads, particularly in Mali, Upper Volta and Niger. As a result, the freight costs are expensive, as shown in

Table XVIII, because of the high rate of vehicle amortisation, high cost of fuel and maintenance. In areas with bad roads, trucking appears to have a higher incidence of injury and mortality than does trekking and even shipment by rail. The shrinkage is also significantly high. For all those reasons, road transport of cattle should be limited to good roads, especially in those areas where there is not rail line. Another reason is, the movement of livestock by truck is yet unorganized. There is no schedule of rates, and charges vary according to supply and demand and the season. For example, between Mali and Ivory Coast, the peak rates occur during the rice harvest in Mali and the cocoa and coffee harvest in Ivory Coast, between November and January. Truck owners dislike to ship cattle during this period.

However, on good roads such as in Ivory Coast, in Nigeria the use of truck may be the best method of cattle shipment. In Mali and Niger where there is no rail the use of truck may be rationale in cases of severe shortage of cattle in terminal markets causing higher prices.

Combined Method

If within the savannah, trekking is more suitable than trucking, in the forest zone trekking becomes more difficult and costly because of dense vegetation and heavy Tse-Tse infestation. Therefore, it is necessary to find an alternative method of transport to bypass those obstacles. The use of truck or rail depends on factors of losses incurred which have already been discussed. But again, if rail cars are available at the border it seems to be more profitable to use railway than roads.

TABLE XVIII. COST OF TRANSPORTING FIFTY HEAD OF CATTLE FROM TINGRELA TO BOUAKE BY TREKKING AND BY TRUCK: 1976-77 (IN CFA F)

	Trek			Truck		
	Total		Per Animal	Total		Per Animal
1. Salary of drovers	3 @ 10,000 =	30,000	600	2 @ 5,000 =	10,000	200
2. Food for drovers		15,000	300		-0-	-0-
3. Return trip for drovers	3 @ 10,000 =	7,500	150	2 @ 2,500 =	5,000	100
4. Round-trip for owner		5,000	100		5,000	100
5. Food for owner in Bouake 7 days @ 200 CFAF/day		1,400	28		1,400	28
6. Health certificate		2,000	40		2,000	40
7. Vaccination		1,750	35		1,750	35
8. Amortization of cattle/merchant's license		12,100	242		12,100	242
9. Indemnity for damaged fields		475	10		-0-	-0-
10. Loss of animals	1.0% of 50 animals @ 40,000 CFAF per animal =	20,000	400	1.6% of 50 animals @ 40,000 CFAF per animal=	32,000	640
11. Forced sales	0.6% of 50 animals @ 20,000 CFAF loss per animal =	6,000	120 (22%)**	0.6% of 50 animals @ 20,000 CFAF loss per animal =	6,000	120 (14%)**
12. Truck rental		-0-	-0-	2 trucks @ 87,500 CFAF each =	175,000	3,500
13. Unofficial costs		-0-	-0-		10,000	200
14. Cattle market tax: Bouake		10,000	200		10,000	200
15. Gift to landlord		0-5,000	0-100		0-5,000	0-100
TOTAL COST (excluding weight loss)		111,225-116,225	2,225-2,325		270,250-275,250	5,405-5,505
Days in transit		30			1	

Source: Staatz, 1979; pp. 206-7. Cited by CRED Volume III, 1980.

*Shrinkage costs are excluded.

**Percentage cost of loss from total transport costs per head.

The final conclusion of the transportation chapter analysis is that it appears that movement of market cattle is a very serious economic problem in West Africa. The railroads are deteriorating, the road system is relatively undeveloped and the trucking industry is plagued by many structural problems. In some areas trekking is becoming more difficult as agriculture and urbanization restrict access to fodder and water and potential damage to crops and properties are increasing.

Research Needs

The need for more information has been previously noted. An adequate evaluation of various losses occurring during the marketing of cattle is not yet possible, since the results of some studies made in this field are based on very limited studies and populations.

Basically, the research needs can be divided into finding what the values of variables (death, shrinkage, injuries) are more accurately, according to each method of transport used and what economic impact they might have. More information is needed in comparative surveys involving all methods of transport in the same studies in order to have more accurate statistical relationship data.

The relationship between live weight shrinkage and real tissue loss is also very important in discovering the amount of edible meat loss. This also can be determined by conducting adequate experiments.

The estimation of economic loss occasioned by bruises, and other carcass damage during rail and truck shipment and the more accurate effects of trypanosomiasis in trekking are needed. These kinds of information will have an important effect on the better understanding of losses occuring during cattle marketing in West Africa, particularly in determining the best strategies in marketing systems.

CHAPTER VI

RECOMMENDATIONS FOR REDUCING SHIPMENT LOSSES

From the local shipment point to the terminal market or to the slaughterhouse, there are many points along the marketing route where lack of care and poor judgment might increase losses and thus lower the net return of the cattle traders. One such point is that of making proper and adequate preparation for shipment. Another point is the regain after arrival before the slaughtering to cut back the shrinkage. This chapter will deal only with the preparation for shipment. The regain will be discussed in part II of this study.

Preconditioning Cattle Before Shipment

While careful planning for shipment can contribute much to increase net returns through reducing losses from deaths, shrink, bruises, and crippling; poor and inadequate preconditioning may easily overshadow any advantage gained through a wise selection of the time and the place to market the cattle. Therefore, much should be done to control excessive shrinkage and to have cattle yielding the maximum weight as possible.

Among the major reasons to consider in reducing unfavourable conditions of shipment, loading facilities, handling, loading and unloading conditions, distance and time of transit, weather, amount of fill, condition of vehicle, road conditions are essential.

If cattle are to be loaded, appropriate holding pens and loading chutes are necessary so that the cattle may be easily and quietly walked into the trucks or rail cars. With the use of chutes, loading and unloading are not only more expedious, but there are fewer bruises.

Before loading, cars and trucks should be carefully inspected for cracks and broken boards and for poor bedding or footing. In general, too much straw is not recommended when it is very hot since straw bedding generates heat. It is preferable when straw is used to have it over a layer of sand to insure better footing and thus, prevent frequent slipping and falling. Cattle that go down in the truck or car in transit are trampled, resulting in extensive bruises and sometimes death. When sand is used with or without straw, it should be free of stones to prevent slipping. Moreover, a stone inbedded in a hoof may cause crippling and will be reflected in a lower value for the animal. One or two inches of clean sand is sufficient. Good footing in a truck or car means a lot in cattle comfort.

Slow and careful handling at all times is very important for cattle to reach their destination in good condition. They should be moved slowly and quietly to avoid bumping and jostling against gate posts and overcrowding in the loading chute. Like all animals, cattle too, are shy about going into

strange places such as trucks and rail cars and even pens and they should not be rushed into the new environment if undue nervousness with an increased amount of shrinkage is to be avoided.

To avoid bruises during loading, canes, whips, and clubs should not be used extensively and the cattle caretaker should avoid hitting an animal on a meaty part of the body. The striking area should be limited to the head and shanks. Cars or trucks must never be overloaded since overloading is one of the primary causes of crippling and mortality in transit. Tight loading during hot weather will increase animal heat and cause fatigue. Althoug it is not easy to determine exactly how many head of cattle make a load because of the non-uniformity of animal sizes, a knowledge of recommended loading capacity, as shown in Tables XIX and XX, can help in estimating an average of how many head of cattle make a load. It should also be remembered that underloading without adequate partitions to prevent excessive free movement can result in bruising and crippling.

It does not pay to overfill cattle before shipment because the larger the fill at loading time, the larger will be the off-car shrink. Moreover, the first day fill-back is usually less for overfilled cattle than for animals loaded with a normal fill. An overnight stand, or at least a few hours, off feed and water before loading may result in less shipping shrink, and animals will be more likely to eat at their destination because of hunger and thirst. Cattle overfilled are in general uncomfortable and often become sick during transit. Discomfort brings nervousness, excessive pushing and crowding. They are not only upset upon arrival so that they are slow to take a fill, but also dirty and rought. The preconditioning before shipment however, may not be

TABLE XIX. RECOMMENDED NUMBER OF CATTLE TO BE LOADED PER TRUCK*

Average Weight	450	600	800	1,000	1,200	1,400
8 ft.	8	7	5	4	4	3
10 ft.	10	8	7	6	5	4
12 ft.	13	10	8	7	6	5
15 ft.	16	16	10	9	8	7
18 ft.	20	16	13	11	9	8
20 ft.	22	18	14	12	10	8
24 ft.	27	22	17	15	13	11
28 ft.	31	35	20	17	15	13
30 ft.	34	27	22	19	16	14
32 ft.	36	29	23	20	17	15
36 ft.	41	33	26	22	19	17
42 ft.	48	39	31	28	22	20

*Recommended by Livestock Conservation, Inc. Cited by Fowler, 1961; p. 426.

TABLE XX. RECOMMENDED NUMBER OF LIVESTOCK TO BE LOADED PER RAILROAD CAR.*

	Cattle Per Railroad Car											
Average weight	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400
36-ft. car	60	50	42	37	33	30	27	25	23	22	21	19
40-ft. car	67	56	46	40	37	33	30	27	25	23	22	21

*From Swift & Company's Agr. Res. Bul. No. 20. Cited by Fowler, 1961; p. 423.

totally negative, particularly for cattle fed on dry range hay, because cattle being fed hay shrink less than those on some other types of feed, in particular green pasture, concentrates and succulent feeds. Concentrates cause heating, while green feed and succulents may have laxative effects.

For cattle shipped long distances, more than 72 hours, it is important to make full use of the feed and rest stops to fill and rest. But extra feed and rest period over 36 hours may not payoff since the main objective of these actions of feeding and resting is to restaure the excretory shrinkage.

To prevent the losses caused by the effects of weather, mainly extreme temperatures and humidity accompanied by wind or rain, it may be useful to check empirically or through weather services if possible, the weather forecast when planning cattle shipments, to provide adequate protection from bad weather, such as the use of covered trucks against rain, the use of well ventilated cars against heat or by making the shipment during the cooler portions of the day, or night rather than at mid-day.

If cattle are moved on foot, they should be moved carefully, slowly, and allowed a few hours per day to rest, to drink and to feed. That implies, routes may warrant improvement and organization. Especially cattle routes should be equipped with regular watering points in the north and grazing areas in the south to avoid crop damage conflicts and to facilitate regain before access to market. Adequate measures should be taken to protect cattle against diseases and in particular, trypanosomiasis, by use of trypanocidal and vaccinations if they walk throughout Tse-Tse infested areas in the forest areas.

Where the market for the carcass meat demands quality, attention must be given to protecting the cattle from stress before they are slaughtered. In addition to measures already mentioned to avoid exciting, frightening or exhausting the cattle at any stage of the marketing process whatever the method of transport used, it is important for cattle to be rested at least 24 hours before slaughter. During these periods, cattle may be watered but not fed. Otherwise, if an animal is slaughtered while still under stress, the bleeding of the carcass may be impaired and the meat tissue could be contaminated by bacteria passing the gut wall and the blood and lymph systems. This may affect the color and the texture thus, the quality of meat and will reduce the time for which it can be kept before it begins to putrify (Forrest, 1975). This point is very important for the conservation of meat under tropical conditions.

A particular recommendation should be directed to provide incentives, or education and awareness to people who are involved in the business, particularly, drovers and conveyers, because most losses as we have seen throughout this chapter, reflect human attributes: short tempers, impatience, hurry, carelessness, unfortunate callousness, connected with the professional view toward shrinkage, bruises, crippling and death. But most of them occurs either because people do not realize how much damage is done or because they have not learned that it is very much within their power to reduce these losses or they do not have incentive to treat the animals better. Thus, it may pay off to make people in the business more aware of the costs associated with cattle losses and to give rewards such as extra salary, permanent jobs, gifts, etc. to conscientious workers in their handling of animals. It is a matter of good business and future job security to be able to deliver cattle at minimum shrink,

free of cripples, with no "deads", and with no bruises showing up at the market or inside the plant.

CHAPTER VII

TRANSPORT OF MEAT VS. LIVE CATTLE

A shift from the transport of live cattle to the transport of meat is often considered an approach to greater marketing efficiency. It is argued that by avoiding losses of weight and quality in the live cattle, saving feeding and labour costs and carrying only the saleable part of the carcass, the overall transport costs could be reduced greatly. This may be true. But the question in reality whether it is better to transport live cattle or meat, largely depends on whether an abattoir should be located nearer the sources of cattle supply or nearer the ultimate market for the meat. Other significant factors might be; lower labour costs, employment and abattoir operating costs in the rural producing areas, electricity supply warranty and other services near the cities. The market for by-products of slaughter is also very important in West Africa.

Each of the factors must be taken into account, but the issue of transport, its costs and its implications for marketing arrangements is the most important. The following aspects of transport should be considered in such decision making.

a) Refrigeration. The transport of meat over considerable distances requires that the marketing system as a whole, be equipped to handle refrigerated supplies. The meat is chilled before transport and the cold chain must then be maintained, at least until the product is offered to sale in

butchers' shops. This calls also for proper handling and storage facilities at the market center where the meat can be kept chilled while on display because if it warms up before it is sold to customers, its appearance will deteriorate. It is questionable whether those conditions will be met in the near future in most West African countries.

b) Weight saving. The dressed carcass of a good steer in Africa is in general about 45 to 50 percent of the live weight. Thus, if only the carcass is required at the consuming center, there are savings in weight in transporting only dressed carcasses instead of live cattle. But in African countries most of the fifth quarter is used for human consumption and may go along with the carcass meat, therefore, the transport and marketing of both red and white offal may also be an important aspect to consider. Generally, there is a strong demand in the coastal countries for the offals and by-products - a much higher demand than in the Sahelian countries - and this affects the profitability of just shipping meat.

c) Losses during transport. The transport of cattle over considerable distances involves shrinkage, bruising or more serious injury. It may also involve other expenses for holding and feeding. Under good organization, the transport of meat should involve very small losses in weight. Raikes et al. (1979) claimed that shipment distances of 120 miles or less do not affect hot carcass weights. Moreover, there is almost no product damage in meat shipment provided there are no breakdowns or delays. But where operating conditions are difficult, the risk of deterioration or spoilage as a result of transport delays can be a serious matter.

d) Transport investment and operating costs. The capital cost and operating costs of refrigerated vehicles for meat transport must be compared with the costs of live cattle transport vehicles. The cost of a refrigerated meat van is normally higher than the costs of a truck or equal freight capacity. Maintenance, running costs are also higher, especially if road conditions are poor. In addition, it is likely to be more difficult to organize return loads for the refrigerated meat vans than for the general-purpose vehicles that are often employed for cattle transport.

CONCLUSION

As a result of this brief assessment, the shift from live cattle to meat transport may not be efficient for the time being and in the short-term future because of the lack of the basic infrastructure in almost all West African countries and the amount of investment needed for them yet not affordable.

CHAPTER VIII

MARKETING POLICY

Even though livestock marketing has relatively recently emerged as a field subjected to study, it has long been a target of government intervention throughout West Africa. The objectives and motives behind such interventions vary from country to country but most often include: 1) a desire to provide urban centers with adequate and cheap supplies of meat; 2) claims of inefficient marketing practices; 3) balance of trade considerations; 4) effort to promote livestock production through producer prices.

To function well, the livestock marketing system must do a number of things efficiently in each of its phases: livestock must be assembled, transported, bought and sold with minimal delay, movement and cost; livestock must be converted into many kinds of meat and meat products at the lowest possible cost; timely marketing information must be made available to help buyers and sellers channel meat to consumers in an orderly manner and consumer demand must be reflected through the entire system to enable producers to effectively plan their production and marketing.

In this context, vertical coordination, the process by which the various functions at different levels in a subsector are brought into harmony, is required. What to produce and market, when, where, and how to produce and market it, and what adaptions are needed to respond rapidly to change in demand, new technology, or other shifts in the enviroment, may play a determinant role. the beef subsector for example includes: cattle producers, assemblers, merchants, shippers, brokers,

meat processors, wholesale and retail butchers. Looking at a subsector rather than an industry allows one to see how the various stages in the production and distribution of a commodity are linked together and how decisions at one level in the system affect the behavior of market participants at other levels.

The performance of the system will be defined as how well the subsector contributes to the achievement of the goals that society has set for itself such as efficiency in the use of resources, equity in the distribution of wealth, employment, economic growth, development, responsiveness to the consumer's desires, etc. The market performance variable most used is marketing efficiency. An efficient marketing system serves as a link between producer and consumer. As such, it is more than simply a delivery system. Efficiency of the marketing system in West Africa may be judged on three interrelated criteria:

1. Low Cost Distribution

An efficient marketing system can maximize the welfare of consumers and producers by reducing to a minimum the margin between prices paid by the consumer and those received by the producer by the best use of available technology consistent with prevailing factor prices; for example, using more labor intensive technologies and less capital intensive ones since the capital costs are relatively high. This implies that trekking is still the lowest cost method of moving market cattle in most parts of West Africa. Providing watering points in Sahelian areas, vaccinations against trypanosomiasis and official marked paths in the southern regions will contribute greatly to the reduction of losses which are the main costs. Another element of technological efficiency is the exploitation of

economics of scale. Traders should operate in the range of scales which yield the lowest marketing costs.

The second component of low cost delivery objective includes the concept of normal profit margins. Under such a system, long run profits will approximate the going rate of return for capital. In addition, traders will be rewarded with incomes that represent the opportunity costs of their managerial skills.

2. Responsiveness to Production and Demand Conditions

In areas like West Africa, efficient livestock marketing systems must be capable of gathering the production of a multitude of small producers in widely varying quantities and qualities, processing and, redistributing the commodities so they reach consumers in quantity and quality demanded. The achievement of this objective is, to a large degree, dependent upon an efficient physical marketing infrastructure which generally is outside the control of marketing agents. The transportation and information networks are examples, among others. Major infrastructure improvements require government interventions. And any system of livestock marketing in West African conditions may be constrained until these major improvements are made.

3. Pricing Efficiency

An efficient marketing system enables prices to serve their economic function of allocating resources in an efficient manner, directing inputs to their most productive use and ouputs aligned with consumer demand. On the production side, when prices reflect consumers' willingness to pay for commodities, they serve

as incentives to production. An increase in demand which results in the price of a commodity rising, calls additional resources into the production of that commodity. Contrarily, decreases in demand and commodity prices should signal producers to decrease output and move resources into the production of other commodities that consumers value more.

To achieve the objectives of low cost distribution, responsiveness to production and demand conditions, and pricing efficiency in West African livestock marketing system, several basic conditions should be met. These conditions are:

a) Improved infrastructure and central marketing facilities (roads, railroads, slaughter houses, feed and water facilities, public markets).

b) Adequate institutions (credit institutions, producer cooperatives, trucking and rail industries).

c) Comprehensive central supporting services (grading and market information).

d) Efficient price policies (live animals and retail meat).

e) Adequate regulations and controls in marketing (animal health, handling in transit and consumer protection).

f) Effective research, training and extension actions.

4. Cost and Benefit Assessment of the Different Actions

Calculation of the relationships between benefits and costs of any investment requires several initial decisions and assumptions with respect to: a) the type of benefits to be included, b) the assignment of values to the resources used and benefits produced, c) the adjustment of costs and benefits for different periods of time to the values prevailing during a reference period of time, and d) the length of time to be considered.

The most common practice in defining the type of benefits to be included in a benefit-cost study is to consider only those quantifiable benefits directly attributable to the investment. Although seldom considered because of the difficulty in identifying or quantifying effects, two additional benefits can be included: a) quantifiable economic effects indirectly induced by the operation of the investment and b) social benefits generated by the project or program including changes in attitudes and expectations of the individuals who participate in the project, change in nation's productive capacity, change in organization-management, and gains in knowledge through learning by doing in the use of new technology and in arranging for institutions or services and policies.

Costs of the investments can be classified as (a) operational costs, the value of the goods and services used to establish and operate the project; and (b) associated costs, the value of the goods and services that are necessary to perform the activites.

In both benefit and cost cases, the type of assessment used in this study is simply an attempt to evaluate the impact of the outputs given some categories of

inputs required in the improvement of the infrastructure, institutions, price policies, regulation, research, and extension in the West African beef subsector.

4.1 Infrastructure and Contribution to Marketing Facilities

A government's contribution to marketing development begins with the provision of services such as law and order, currency, railraods, roads, postal services and communications. While the creation of these basic services is a function of development in general, it clearly determines the potential efficiency of any marketing arrangements.

Beyond these provisions of general infrastructure, authorities also accept responsibilities for central marketing facilities such as markets and abattoirs

4.1.1 Central Marketing Facilities

The first problem in the livestock marketing in West Africa is the lack of adequate markets. It is argued that in the case of livestock markets the establishment of improved market facilities is necessary before improved pricing policies, standardized grades, supervised weighing, and sales and transfer operations can be introduced. The same remarks apply in principle to slaughterhouses which have become obsolete and inadequate in terms of services, hygiene and operational efficiency.

One reason for the unsatisfactory situation may be the result of poor management of the facilities. Unless adequate fees for utilizing the facilities are fixed at a level that covers the full costs of maintaining the assets in a good state

of repair and operational efficiency while, at the same time, providing sufficient funds for its extension, there will be no opportunity of providing for the continuous maintenance of the facilities in a condition to satisfy changing and increased demand and needs. The basic needs are the provision of water to animals, fences, pens, and grazing areas near the market for keeping cattle before sale and after slaughter.

4.2 Institutions

Institutions in the framework of African livestock marketing comprise the railraod industry, the trucking industry, the producers, the traders, the butchers, the middlemen and the boards or government's agencies.

4.2.1 Transportation

Chapter III and Chapter V have discussed the situation of the industries of transport and the economic costs involved in cattle transportation. Chapter VI discussed technical recommendations for reducing shipment losses. This section's objective is to deal with some economic costs and benefits of the improvements in cattle transportation.

4.2.1.1 Trekking

Trekking is an efficient and inexpensive method of moving cattle. The main problems are lack of water points in northern areas and occasional conflicts with farmers over crop damages in southern areas. Any investment which provides water points on the route and marked trails will induce drovers to follow the trail

and thus lessen conflicts with agriculturalists and facilitate monitoring of market activity. Moreover, providing grazing reserve for short term regain near major markets helps stabilize the flow of cattle and alleviate problems with surrounding farmers. However, expectations of lower weight losses from establishing trails may not be real since the claim of significant weight loss on treks has never been proven as indicated in Chapter V (page 83). Nevertheless, any investement dealing with watering points, cattle trails and grazing reserves would be profitable and the costs should be shared by the users through payment of usage fees. However following a single frequently used trail may divert herds from longer but more favorable routes. Moreover, traders may refuse to pay fees leading to the boycottage of new infrastructures.

4.2.1.2 Rail Transport

Improved rail transport of cattle presents real possibilities for cost reduction. Reducing the time animals spend in transit, by reducing the long delays at the beginning and at the end of the journey, and by increasing the number of trains for livestock; providing better ventilated cattle cars, reomoval of mechanical problems and providing better grazing at railheads and terminal markets could help reduce travel time, costs of shipping cattle by reducing shrinkage losses, mortality, bruising, crippling and forced sales.

Improved rail transport represents the method of choice for the transportation of cattle over long distance. To amortize the investment in such a rail transport improvement rental rates could be adjusted to reflect the marginal social opportunity cost of users particularly during the peak season. The major adverse effect here is the high capital that this investment requires. But, as said

earlier, those capital intensive investments (railroad and trucking) may be considered only in the framework of general development program and not for the special purpose of livestock marketing.

4.2.1.3 Trucking

Truck transport of cattle, especially to export markets, will gain acceptance as roads are paved and trucking costs decrease and become a more economical means of transport. Roads give traders direct access to the pastoral zones. Export traders are given the possibility to penetrate easily into the pastoral zone to assemble their herds. Similarly the roads make possible greater penetration of trucked-in consumer goods into the pastoral zones. The combination of more buyers for their output and greater availability of goods for their consumption may attract herders to markets along the roads and increase the offtake. The penetration of export traders into the pastoral zone may cause changes in the marketing system by making possible direct transactions from herder to export traders. This shortening of the chain may also have impact on the prices received by the producers for their animals. An additional benefit from the improved road transportation may be in the communication of price and other demand information from coastal markets. This can allow a quicker response to price changes which should act to smooth fluctuations as high prices can be quickly met by increased supply and low prices by a holding back of animals. But here again important capital investment is needed.

In ranking the priorities of investment in cattle transportation, trekking will probably remain the most interesting in the immediate future because of the lesser investment needed for its improvement and also because of the nature of the

current cattle marketing system. However, in the long run the improved road transport might be the most favorable means of transport for cattle particularly export cattle because of its flexibility and convenience as to the time and place of marketing. But still improved railroad will remain the best means in long distances because of its lower freight rates due to the economies of scale. However, it should be emphasized that all these benefits from the improvements of cattle transportation may be overshadowed if technical recommendations for reducing shipment losses discussed in Chapter VI are neglected. These recommendations except those for the protection against disease in trekking and monetary rewards do not require direct monetary costs. All that is needed for them is a good management: good handling, good organization, good timing, and caretaking. Those recommendations involving direct monetary costs do not have high costs. But in both cases the benefits to be received outweigh largely the costs involved.

4.2.2 Producers

The creation of livestock producers' cooperatives is a popular proposal often made. It should be appreciated, however, that in producing countries, in particular in Mali, hardly any livestock cooperatives have succeeded in operating as fullly viable concerns either financially or institutionally. It must be recognized that the livestock industry produces a commodity with characteristics that make it less acceptable to cooperative marketing than other commodities. First, the commodity is highly perishable; second, it is difficult to standardize; third, the market supply situation fluctuates strongly from day to day and from week to week, and fourth the competitive nature of the market.

From practical experience therefore, it can be seen that there are numerous constraints on the development of effective livestock producers' cooperatives in

West Africa and that these prevent the cooperatives from becoming competitive with established private traders. This has to be taken into account when discussing strategies for livestock marketing development. Meanwhile finding a sufficient number of qualified, honest and reliable managers to operate in a marketing system dealing with such a difficult commodity might be a temporary solution.

4.2.3 Credit Institutions

If rich traders and butchers can usually obtain finance through the commercial banking system, small traders and butchers with less security to offer are more often dependent on loans from relatives, individual lenders or their trading partners. The lack of working capital needed to cover the stages between the purchase of livestock and the eventual payment for sales constitutes a major barrier to entry into market and butchering and is also a major factor of the diseconomies of scale in the industry. And all these are factors which limit the efficiency of the marketing system in West Africa. Thus large credits provided or guaranteed by government sources are needed and may be a key factor in promoting a more competitive market and a more efficient marketing system. However, there are some serious problems such as the level of interest rates and the guarantee of credit reimbursement to be solved first.

4.3 Central Supporting Services

4.3.1 Grading Systems

In agricultural marketing, the immediate purpose of grading is to help describe and compare units of a commodity more accurately. A grade cannot

describe the commodity completely or exactly; it deals only with selected characteristics within certain limits.

It is known that market participants themselves have evolved a classification system that aids in the transmittal of market information, and pastoralists in West Africa have a broad vocabulary to describe different characteristics of cattle. The vocabulary may be standardized and incorporated in the system of market intelligence. Since the system must be meaningful to both producers and consumers, it should develop standards and grades that reflect perceived differences in the types and values of animals marketed. In any case, it would be inappropriate to import Western grades that put high emphasis on different degrees of marketing in the carcass or on the degree of finish of an animal. An effective system of livestock grading is likely to be more difficult to organize especially in those Sahelian areas where trading is widely dispersed. Thus the grade definitions should be simple to facilitate the work of the graders and to minimize disputes.

A system of grades and standards coupled with adequate diffusion of market information could lead to improved operational and pricing efficiency in West African cattle markets. Negotiations will then focus mainly on the price per kg of the animal as the grade and live weight of the animal would be determined before negotiation began. As the familiarity with the system increases, purchases could also be made later on the basis of contracts with description rather than depending on the inspection of each animal sold. This may lead to the reduction of losses and other costs involved in the attendency of animals at many markets. Pricing efficiency with which signals about what consumer's desire are transmitted back to producers through the price system, could be facilitated because the meaningfulness of price information through the system would be greater under a

uniform system of grades and standards. Such a system might, therefore, reduce the marketing chain, increase competition in the subsector or leading to lower abnormal margins and hopefully, better returns to producers.

Thus even though there is no universal grades because of types of livestock and other production factors vary from one country to another, the establishment of common grades for West African countries may possibly be worked out to put more harmony in the terminology of trade. Obtaining the adhesion of policy makers, producers and traders to the system is the most difficult task.

4.3.2 Market Information

The function of a market information service is to supply producers, traders, consumers and government agencies with information to help them in making decisions. Price information is the most important, and news of quantities reaching the markets and of signficant changes in production or consumption prospects also may be given.

In fact, better information for all concerned should allow the marketing system as a whole to operate more economically. Uncertainty in production and trading involves risks, and risks involve costs particularly cost of misallocation of scarce resources. On the other hand, greater certainty reduces the frequency of wrong decisions involving cost and waste, and also reduces the need to take expensive precautions.

In many ways, a better knowledge of the market allows for more rational planning, decision-making and allocation of resources, and thus reduces costs and

improves services. The function of market information services is to add to the knowledge available for decision making and resource allocation. Market information services must justify themselves by the extent to which they cause people to make better decisions in marketing. Only when producers become more business-minded and produce more for cash sales are they likely to make effective use of market news and advice.

In circumstances where a market information service cannot be adequately used by producers, the collection and analysis of price and market data may still be useful to government agencies. Insufficient information, especially lack of up-to-date statistics is a serious handicap for many governments in forming and implementing livestock industry policies concerning production programs, prices, import or export and taxation.

The effectiveness of service will depend heavily upon the competence of those who collect and report the primary data. They must be adequately trained, willing to use initiative in finding the facts, and able to judge and evaluate the information they are given. That is not easy.

4.4 Training and Extension Services

Since the development of livestock and meat marketing call for new techniques and skills, the availability of sufficient trained personnel is a serious problem. The evolution of new enterprises for trading, processing, distribution or export marketing depends as much upon qualified managers and entrepreneurs as upon capital resources. Similarly, the success of government policies, services and interventions in the marketing system relies on the experience and competence of

the responsible public officers. This is especially true where marketing board or other public organizations (e.g. Mali) have been set up for trading, processing or export marketing. Quite often, a lack of sufficient trained personnel at various levels has been a primary reason for failure.

There is a growing awareness of the need for more comprehensive training programs to meet the changing needs of the livestock industries. For that reason the CEAO organized in 1977 short term livestock marketing training for market inspectors. In the past, the subject did not receive attention in curricula on agriculture and economics, and students were unlikely to go into such topics as storage, transport, grading, distribution or price policies.

It is particularly important for officers of livestock extension services to have a sound understanding of marketing and prices, because in many ways they may help livestock producers to understand the needs of the market and guide them in their production and selling.

4.5 Regulations and Controls

The main purposes of these controls are to prevent exploitation or cheating in the course of buying and selling and to protect the public from health risks in consuming meat.

In most West African marketing systems, the buyer can physically inspect an animal or a piece of meat to his satifaction before buying. He may still be cheated, but at least he knows who is to blame. However, when marketing becomes more highly organized, personal relationships in buying and selling (particularly in

contract markets) may give place to purely commercial relationships which require more enforced rules. The public authorities will bear increasing responsibility for the introduction and enforcement of the regulations and controls needed to support efficient marketing.

It is obvious that regulations cannot always be enacted solely inthe interest of public health and marketing efficiency. Nor is there a clear decision between good regulations and bad ones. Measures that are introduced to ensure fair trading or the protection of public health have often been used to protect special interests. For example, licensing may be needed to give adequate control over trader's activities, but it can also be used to restrict the right to enter the trade and reduce competition. Thus while regulations are needed, they also imply some trade offs. The final choice depends on decision makers' goals.

In the transport industry there are no regulations regarding livestock transport. And it seems that even in the near future, regulations will not be required. Any attempt in this sense may discourage potential movement of this industry toward cattle transportation. However, some practices such as the use of good foot, shock absorbers or the respect of loading capacity should be advised in cattle transport to reduce losses.

4.6 Price Policies

The general aim of official price policies is to promote economic development and welfare of producers and consumers. According to the classical theory of economics, these aims tend to be served by the working of the price mechanism in the open market. But the conditions required by the theory are never

exactly reproduced in real life: the price mechanism never works perfectly, and under some circumstances it may work so imperfectly that its results are unacceptable.

The full working of supply and demand factors may be impaired by an inadequacy of the marketing system. This may be due to a lack of basic facilities or a shortage of organized enterprises. In either case it will mean that changes in market requirements are not transmitted to all producers. Especially in remote areas lacking good market outlets, traders may not pass on the benefit of higher market prices to producers, but may absorb the increase in the form of excess profit margins. Governments try always to avoid market failures by influencing the pricing system. In livestock and meat marketing two main lines of price policy can be distinguished:

1) Control of meat prices for the benefit of consumers.

2) Support of producer prices for livestock in order to stimulate output and increase farm incomes.

These two kinds of intervention may not be fully compatible with each other. The overall policy has to be a compromise between the interests of consumers and the interests of producers. But the relative priorities differ from one country to another.

4.6.1 Meat Price Controls

The main objective of meat price control is to restrain increases in the cost of living and to benefit urban consumers in particular. A second goal may be to reduce the profit margins of butchers.

In West Africa official controls are usually applied at the retail level since this is the only stage of the marketing channel at which prices can be verified. But the enforcement of retail price controls is extremely difficult, especially if the official prices are seriously out of line with open market trends. Enforcing statutory prices reliably at every meat retailing market is a formidable task that is often beyond the administrative resources of these countries. Moreover, it is difficult to set official prices that are appropriate for seasonal changes and long term trends.

The general experience of meat price controls has not been encouraging. Such controls may have their use as a political act demonstrating a government's good intentions toward consumers, but as a serious part of economic policy they have usually been of doubtful value.

In general, improving the production side, or transportation infrastructure and encouraging competition in the cattle and meat trades are more effective than price controls in holding down retail meat price.

4.6.2 Support of Producer Prices

Practical experience has confirmed the difficulty of effectively guaranteeing producer prices.

There is no means of compelling independent traders to buy, even at floor prices, cattle they do not want. Nor is it economic to maintain an official buying organization which only buys the animals that are not profitable for the traders.

Any effective form of price policy depends ultimately on the actual whereby producers market their output. The administration of pricing policies is difficult and costly if it is necessary to work through a traditional marketing system. The problem can be much easier if the authorities can work through modern and well organized enterprises. The improvement and modernizing of marketing arrangements can therefore be of basic importance for the implementation of livestock price policy.

At the same time, marketing improvements and new marketing services described earlier may themselves bring substantial benefits to producers.

4.7 Setting Priorities

Choice is the name of the game (Allan Schmid). In principle, government must decide the size of the public budget, which project to invest in and which transfers and regulations to implement according to its politically chosen objectives both on the size and content of production and its distribution in short and long runs. Thus the choice of priorities is a matter for decision makers.

In the absence of stated political objectives such as in this study the choices made may be inconsistent with those implied by the officials of the West African countries considered in this study. Nevertheless, the author believes that the

priorities in the improvement of West African livestock marketing system could be grouped into short run and long run priorities.

4.7.1 Short Run Priorities: Marketing Facilities

The first priority in short run is the establishment of improved market facilities. Adequate markets are a prerequisite to improved buying and selling functions in producing countries and deficit countries as well.

The second is the improvement of the means of transport to reduce the costs and facilitate the trade (mainly trekking with water points and trails).

The third priority is the official credit arrangements for livestock and meat marketing.

The fourth priority is the improvement of meat storage capacity for better hygiene of the consumers and marketing operational efficiency.

The fifth priority is the improvement of livestock trade between Sahelian and Coastal countries by removing all policies that obstruct the movement of cattle within the ECOWAS countries in order to satisfy both the demand and supply.

4.7.2. Long Run Priorities: Market Organization; Price Policies; Marketing Facilitating Services

The establishment of grading standards and accurate and timely market information services should be the first priorities in long run to make the marketing

system more competitive and more efficient. Once grades and standards and information services are established it is easier for a government to determine its price policies, whatever they are, producer price support or consumer's benefit policies. The third priority is the training in marketing of livestock specialists at policy and technical levels for developing more skills in the field through the universities, training centers and special short term seminars. The fourth priority is research in order to reveal the real scope for improvements in economic terms particularly on specific key issues such as:

1) The accurate assessment of the costs and benefits involved in the marketing of cattle and meat and the use of this as a barometer of efficiency from producer to consumer.

2) What is the real economic role of middlemen in the marketing system: are they price stabilizers or cost increasers?

3) Can producer's access to buyers make the system more efficient?

4) What specific opportunities are there for central supporting services to meet needs for information, training, grades and standards?

5) What types of grades and standards are more appropriate for the region?

6) What economic scope is there for the development of meat processing and canning and by products for domestic or export markets?

The fifth is the improvement of extension services and the creation of producer's cooperatives to give producers more bargaining power for the defense of their own interests in a more orderly marketing system instead of relying on governmental questionable producer price support policy. And to coordinate their production activities and reduce marketing costs through the economies of scale.

5. Conclusions

The implementation of such improved livestock marketing system is beyond the possibilities of private enterprises and even the possibilities of one single country. Because of the magnitude of the investment needed for that purpose, the interdependency of the economies of the eight countries considered in this study and also because of the public good nature of most of the investment outlets, it is necessary to make a joint investment funded by all West African countries or by a regional organization such as CEAO or ECOWAS.

PART II

CHAPTER IX

A. REGAIN

Definition and Concept

Regain, sometimes (not always) called compensatory growth, is a period of growth on unrestricted feeding after a period of restricted feeding (Lamond, 1963). Growth being defined here as an increase in weight (Hammond, 1952). According to Prescott (1974), variation in nutrition, principally associated with level of energy intake has marked effects on the rate of growth in cattle. However, following a period of restricted nutrition at any stage, cattle display a remarkable capacity for recovery and there is no evidence from reported experiments that they would not eventually attain their potential mature size (Gilbert, 1944; Hogan, 1929; Winchester, 1955; Carroll, 1963). The effects of restriction and the nature of their recovery growth is affected by:

1) The stage of maturity of the animal at restriction.
2) The severity and duration of adverse condition.
3) The conditions prevailing during the recovery period.

Because of the variety of these effects and the factors fostering them in the context of West Africa, this chapter deals with two patterns of restriction and therefore, two types of regain:

- Short time feed restriction and fatigue effects and short term regain
- Long time restriction and long term regain

1. Short time feed restriction and fatigue effects and short term regain.

a) Short time feed restriction and fatigue effects. Almost all marketing cattle coming from markets or slaughter are subject more or less to the effects of transport, fatigue and starvation. Therefore, it is a tradition in many countries to not kill cattle for meat if they are in a fatigued or heated condition. Four broad reasons have been suggested (Ingram, 1964) to explain that:

- Intestinal bacteria tend to leak from the gut into the tissue if an animal is fatigued.
- With an animal in a state of stress, bleeding tends to be imperfect, and such retention of blood in the muscles is believed to promote putrefection.
- Animals killed when fatigued produce meat which is more liable to putrefy because it is less acid, and has higher pH and low glycogen.
- Animals which are fatigued in transport may suffer severe losses in carcass weight particularly when the time of starvation is relatively long (e.g., more than 72 hours).

However, in up to 72 hours of transport and starvation, there is no effect in body composition and carcass yield (Kirton, 1972; Carr, 1969; Raikes, 1979).

b) Short term regain. An obvious solution to the short time restriction effects is to try to restore cattle by resting and feeding them before market or slaughter. In West Africa the length of regain depends more on the state of the demand and supply and market prices than other recovery consideration. That implies that cattle can be sold upon arrival at the market or slaughtered without restoration in case of beef shortage. When regain is practiced, it consists simply of resting, grazing and watering cattle around the consumption center for one or two days before the sale or the slaughter day and no special diet is given to them.

In an improved marketing system especially when cattle are sold on live weight basis traders should take advantage of regain since loss of stomach fill can be partially, if not completely, regained under conditions that insure fill-back. It takes a longer time than a day or two at the market to regain tissue shrink (Harston, 1959). Fill-back depends upon the environment at the market as well as the quality of feed and water. Restful and relaxing conditions are of primary importance as soon as cattle are unloaded. Only after cattle have had a chance to lie down and rest, will they take on a good fill. Feed and water should be added slowly with rest periods in between, before cattle have full access to both feed and water. Managing the fill-back in this manner may be most important for cattle completing long hauls. But fill-back does not pay off for cattle in transit less than ten hours (Brownson, 1976) because they won't be hungry enough. According to Harston (1959), cattle arriving at sale yards during

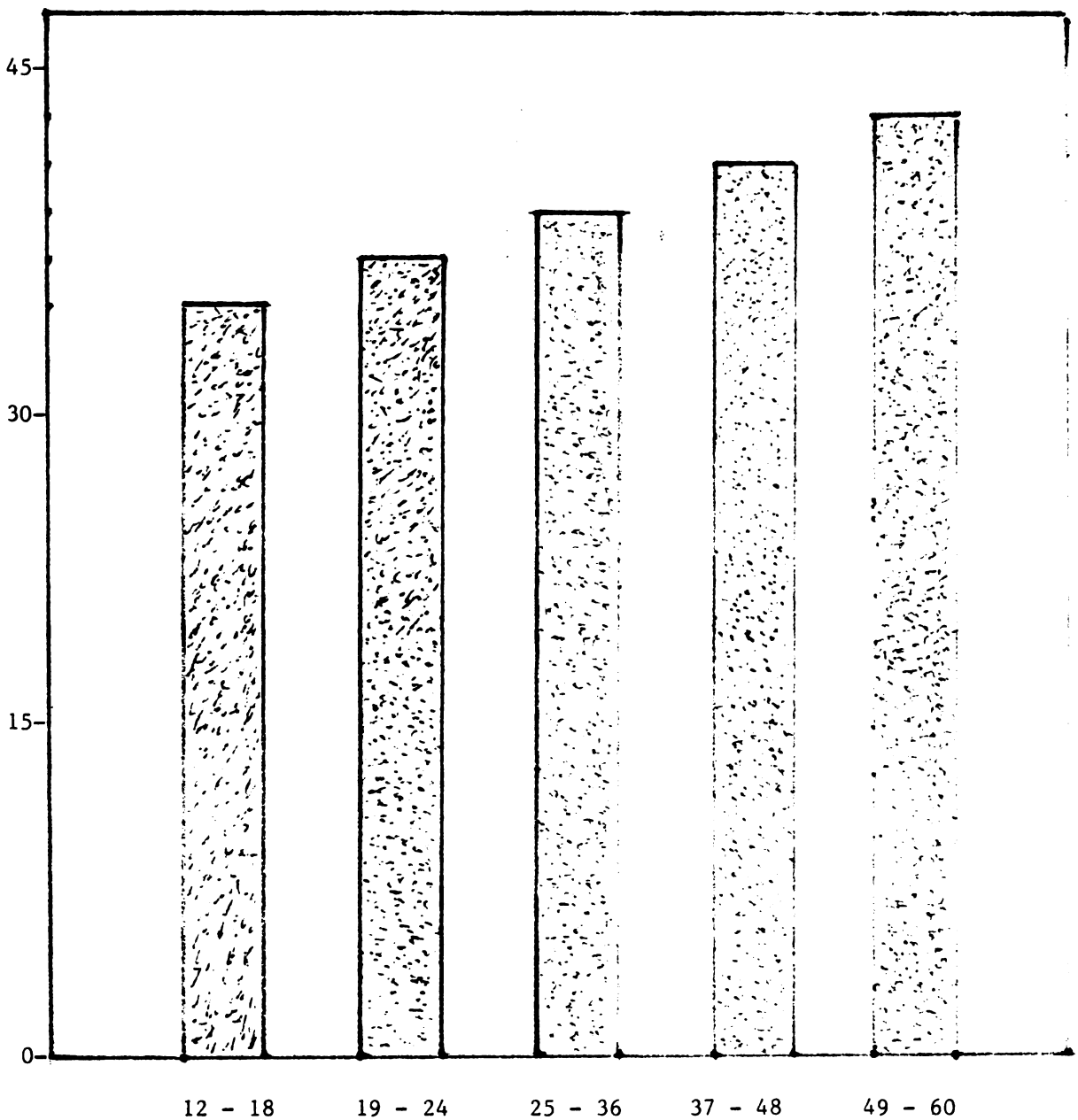
the night are slow to adjust themselves and settle down to eating and drinking. If hay and water at the yards are the same quality as they have been accustomed to, cattle regain stomach fill rapidly. Net shrink decreases as the hours of fill-back increase. The greatest gain per hour of fill-back comes, as shown in Figure III, during the first 18 hours of regain for fat cattle shipped long distances. It is a few hours longer for feeder cattle (Harston, 1959) because of its greater stomach volume. But the average percentage of lost weight recovered up to a 48 hour fill-back period is about the same for both feeder and fat cattle since as the time is lengthened, feeder cattle regain a greater percentage of their lost weight. Fat cattle tend to respond more rapidly and uniformly to fill-back than feeder cattle.

The time required to regain the in transit weight loss will vary considerably. Some reports (Brownson, 1976; Harston, 1959) claimed a variation of from 2 to 3 days upto 12 to 14 days as the time required for cattle to regain weight lost during shipment and get back on a normal gain. The variation may be due to marketing conditions and shrinkage experienced as well as conditions surrounding the regain period.

It might be worthwhile to mention certain disadvantages of regain or more particularly, of the pre-slaughter feeding. Arguments advanced against pre-slaughter feeding (Ingram, 1964) are that:

- It diminishes the dressing percentage because food is retained in the gut.
- It engorges the capillary circulation, making bleeding difficult.
- The decomposition of food in the gut is likely to taint the carcass.

FIGURE III. PROPORTIONS OF LOSSES REGAINED DURING FEEDBACK PERIODS.



Source: Harston, 1959.

- It has undesirable effects in that it too, promotes escape of bacteria from the gut into the tissue at large.

2. Long time feed restriction and long term regain.

Restricted nutrition at any age from the late foetal stage to maturity not only retards growth in general, but also affects the tissues differentially (Mailton, and Haigh, 1918)*, (Dickinson, 1960; Everitt, 1968)**, (Hogan, 1929).

Hammond (1932) stated that: "During starvation it would appear that the organs with an early period of maximum growth can draw on or have prior claim on, the nutrition of those having a later period of growth." According to Butterfield (1963) there is ample evidence of the selective depletion of body tissues during starvation. As the latest-developing tissue are the first to be affected, it should be possible by starvation of sufficient severity and duration to partially reverse the changes in the musculature which occur during normal growth.

When very young cattle are restricted, the affects of nutrition may well be confounded with disease, however, even when this does not appear to be the case, there is evidence now that the sensitivity of cattle to nutrient restriction is greatest in the neonatal period. A number of experiments have shown that quite moderate restriction of calf growth from birth to 3 to 4 months of life

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**Prescott, 1974; p. 71.

*R. M. Butterfield, 1963; p. 7-6.

result in at the least, a proportional extension of the growth period to slaughter and mature size that may be attained (Logan, 1929; Prescott, 1974).

This persistent influence of restriction on young calves constrasts with the response of older steers that generally make more rapid compensation gains following restriction (Wilson and Osbourn, 1960: Lawrence and Pearce, 1964)*. When restriction of older cattle has been followed by continuous liberal feeding, the cattle usually have fully compensated by showing more rapid and efficient growth during realimentation (Winchester, 1955 and 1957) (but this is not in all cases). This phenomenon may be related to the effects of what Lamond (1963) calls the factors which control growth (plane of nutrition, impetus to growth, size of an animal and age) in general, and more particularly the growth hormone (GH) production increases which presumably stimulate growth at a rapid rate because it is always ahead of the tissues (Lamond, 1963). In grazing situations declining forage quality or availability commonly limits the extent of more rapid compensatory growth (Lawrence and Pearce, 1964; Jourbert, 1954)**. Recovery from a period of restricted growth after four months of age generally depends upon a prolongation of the growth period moderated by more rapid compensatory gains that those made by heavier cattle of the same age.

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*Prescott, 1974; p. 71.

**Prescott, 1974; p. 71.

In part, the very rapid weight gains in the early stages of realimentation may reflect increased gut fill, and also some tissue gains.

In West African situation, the limitations of natural grasses are well documented (Boudet, 1961, 1970, 1972, 1978; Audru, 1966; Bremaud et Pagot, 1960, 1962; Breman, 1977). Their quantity and quality exceed maintenance allowance of cattle during the first 3, 4 or 5 months of the rainy season (June to September or October) when their crude protein content may be high. But protein content declines rapidly towards the beginning of the dry season as the grasses mature, and it may decline to three percent or less (Sleeper, 1978) in the late dry season (March to May). Digestibility also declines as the grasses liquify over the hot dry season.

Cattle on natural grasses without supplemental feeding in West Africa may lose ten to thirty-three percent of their weight by the end of the dry season (Mittendorf, 1963). Within four to six weeks on the young grass of the rainy season, cattle may regain their weight during a period considered as of compensatory growth. Protein is the most deficient nutrient in dry season pasture causing seasonal weight loss. The following is an example of compensatory growth and loss of weight over a two year period observed in Northern Nigeria.

Live weight of animal at end of:	(Kgs)
first dry season	250
following rainy season	350
end of second dry season	255
following rainy season	382
end of third dry season	307

Source: Mittendorf (1963).

The magnitude of growth and loss may differ from an area to another but the cyclical patterns are identical. It has been estimated by A. Ongoiba (1975 personal conversation) that in Sahelian environment at least one hectare is required to support each tropical livestock unit (or beef of 250 kg of weight) for each month of dry season to cover maintenance needs.

EFFECTS OF LONG TERM FEED RESTRICTION AND REGAIN IN BODY COMPOSITION

When feed restricted cattle are slaughtered after a period of realimentation and at the same weight as unrestricted cattle, there have generally not been significant differences in body composition. However, the effect of continuous differences in plane of nutrition have been reflected in differences in fatness (Winchester, 1955; Guilbert, 1944; Carroll, 1963). According to Guilbert et al. (1944) a high plane of nutrition early in life followed by a lower plane results in carcasses higher in lean and lower in fat then when the reverse occurs, even though the same final weight at the same age is obtained. They claimed that high planes of nutrition speed up the development of thickness growth generally, specially in later-maturing parts such as loin and hind quarter. Carroll et al. (1963) found in their experiment that supplemented steers appeared to have increased in carcass bone and lean, but not in fat while unsupplemented steers appeared to have increased in carcass bone only and decreased in carcass fat. A high plane of nutrition may advance the stage of growth at which rapid fattening occurs to a lighter weight (Guenther et al., 1965)*.

*Prescott, 1974; p. 72.

3. Conclusion

For practical implication there is a need to identify cattle of different growth potential and to match them to appropriate feeding systems. Thus, potentially large and late maturing cattle are likely to be exploited on consistently high planes of nutrition in systems based on high quality forage in assured supply or highly digestible crop by-products.

Under circumstances in which the quality and quantity of feed available cannot be assured, early maturing cattle may have an advantage. They may have greater resilience in condition of fluctuating feed supply and their ability to lay down fat at a lighter weight and on a lower plane of feeding, permits greater flexibility in market weight. Such cattle should also survive more readily under severely restricted feeding conditions. However, in many areas such as in West Africa adaptation to the specific climate and environment conditions is much greater significance than size as such. Therefore, patterns of feeding for beef cattle and the extent to which compensatory growth may be exploited requires critical examination. It is likely that in most practical situations compensatory growth will be affected by such a complex of factors that it is desirable to not generalize but to establish for any particular production system and environment the appropriate limits to restriction with consideration of the opportunity for recovery. This should take into account the potential of the cattle and seasonal variations with respect to disease and feed and water supply.

B. HONDURAS PROJECT

Analysis

I. BACKGROUND

The project was designed to conduct research on patterns of reconstitution in 89 stressed market cattle in tropical and subtropical areas of Puerto Castilla, Honduras in the summer of 1976.

The project consisted of two phases.

Phase I studies the patterns of transport stress occurrence and their effect on body composition changes in cattle of various ages and sizes as they pass into distribution channels from primary points of production.

Phase II studies the effect of regain in body composition of stressed animals emphasizing methods of enhancing empty body mass and observing such effects upon meat character and yield.

Description

All cattle were grouped subjectively into two sex types, bulls and steers, and were allotted into these groups by stratified randomization. A total of five groups were constituted.

A second variable involved the supplemental feeding of molasses x urea mixtures.

Cattle were grazed and all groups except control group were rotated between the pasture areas on a maximum two week period.

Molasses consumption has been measured. Lick tank devices have been utilized to minimize loss in feeding and in rain contamination.

Individual live weights were made and all cattle individually identified.

All cattle were transported by truck from the ranch at Tumbador to the abbattoir at Puerto Castilla (17 miles).

Slaughter data included viscera (intestine, rumen), paunch fill, pluck, chilled carcass weight. Estimates of lean composition were made by weighing round muscle.

The following schematic Table describes the experiment plan.

TABLE XXI

Treatments	Characteristics
	Control Group
0	19 animals (16 bulls; 3 steers) slaughtered straight
1	16 animals (13 bulls; 3 steers) 30 day pasture, no molasses
2	16 animals (13 bulls; 3 steers) 30 day pasture, plus molasses
3	16 animals (13 bulls; 3 steers) 75 day pasture, plus molasses
4	14 animals (11 bulls; 3 steers) 75 day pasture, no molasses

II. ANALYSIS

1. Objective

The specific objectives of this analysis of data from the Honduras Project was as follows:

a) To determine the effect of regain period in animal weight regain.

b) To determine the relative change on body composition which has occurred from the supplemental feeding of molasses.

c) To observe comparative effects in estimated muscle yield of steers and bulls on regain.

2. Method

All data are taken from individual record sheet (model is attached).

INDIVIDUAL ANIMAL - RECORD
REGAIN PROJECT - HONDURAS - MSU,ENO

GROUP = TREATMENT

Animal No.

Ranch Data

	Date	Time	Date
Live weight			
Live weight			

Slaughter Data

Abbatoir Wt.

Carcass Wt.

Carcass Wt.

Int. Full

Rumen Full

Rumen MT

Pluck

Hides

Pasture Allocation

No. Date

Composition Date

Carcass Wt.

Carcass Wt.

Round

A SPSS computer model was designed and implemented with the following data:

a) Input Variables

Variable Name	Code
Animal Number	Anim.
Sex	Sex
Treatment	TRT
Age	Age
In Farm Weight	FARM IN
Out Farm Weight	FARM OUT
In Plant Weight	PLNT IN
Hot Carcass WEight	HOT
Cold Carcass Weight	COLD
Intestine Full and Rumen Full	INTRMT
Pluck	Pluck
Hides	Hides
Difference INTRMT and Empty	Diff.
Trim	Trim
Round	Round
Outside Muscle	Outside
Inside Muscle	Inside
Tip Muscle	Tip

b) Independent Variables

Three types of independent variables were used: treatment, sex, interaction.

- Treatment: Five treatments were used as shown in schematic Table XXI.
- Sex: Bulls code O; steers code 1.
- Interaction Sex-Treatment.
- The age is not considered since all animals are young.

c) Dependent Variables. Three types of dependent variables were used regain, change, round.

- Regain was defined as the differential between plant in weight and farm in weight.

  R = PLNTIN - FRMIN.
- Change: was defined as the percentage of change increase in muscle composition which occurred during a regain period. Muscle composition percentage is estimated by:

$$2\,\frac{(\text{Outside} + \text{Inside} + \text{Tip})}{\text{Cold Carcass}} \times 100$$

- Round or round yield was used as the measure of relative effect on round muscle change from the effect of treatments, sex and sex-treatment interaction.

III. RESULTS AND DISCUSSION

1. Statistical Analysis

Statistical analysis of variance (Manova) was performed using all independent variables to determine the effect of each independent variable on every dependent variable.

The level of significance considered in this study is 95 percent confidence and higher ($P \leq .05$).

1.1 Regain

1.1.1. Effects of Treatments

The five treatment effects were found significant at more than 99 percent level ($P \leq .01$). This was not a surprise it is known that higher plane of nutrition increases growth rate. The analysis of results obtained on the basis of average weight per animal is described below.

Treatment O (control) mean was found negative (-12 kg) probably due to shrinkage during the transport of cattle.

- Regain in all other treatment was greater than the control. Within the 75 day pair, the group fed pasture plus molasses produced significantly ($P \leq .01$) greater regain compared to the group fed pasture only. Within the 30 day pair, the group fed pasture plus molasses produced greater regain but not significantly compared to the group fed pasture only. But in all cases it was found that the higher the length of feeding period is, the greater the regain.

In conclusion, the following observations can be made from the analysis of the effects of treatments on weight gain.

- All treatments represent improvement over the straight slaughtered group.
- The addition of molasses to the pasture results in significantly greater regain provided sufficient time is allowed for the effects to become apparent. It was found that 30 days were not sufficient for the effect of additional molasses to become significant; 75 days on additional molasses were found sufficient.

1.1.2 Effects of Sex

There was no significant effect of sex on regain ($P \geq .05$). The lack of significance may be attributed to the fact that few individuals were included in the steer group making comparison not possible.

1.1.3 Interaction Treatment-Sex Effects

There was no significant interaction of treatment on sex for regain.

Again, this fact may be attributable to the few individuals in the steers' category.

Table XXII shows the various data obtained in regain.

1.2 Percentage Change in Muscle Composition

Treatments, sex and interaction of treatment-sex were found not significant. This means that change did not differ in any treatment. Moreover, addition of molasses or lengthening of the time on pasture also did not result in a significant effect on muscle composition percentage change. Therefore, if one is interested in changing muscle composition, these treatments should not be selected.

1.3 Round

1.3.1 Treatment Effects

Treatment effects were found significant ($P \leq .01$) for round muscle yield. Means of control treatment and treatments 1 and 2 were not different but means of treatments 3 and 4 were greater than the others. Thus, it seems that yield in round compared to the control was found only in the 75 day regain

TABLE XXII - REGAIN (WEIGHT GAIN MEANS IN KG)

Treatment.	Average Weight Before Experiment Kg	Average Weight After Experiment Kg	Weight Gain/Loss Kg	STD DEV
0 (Control)	261		-13	8.52
1	252	275	+23	15.03
2	262	291	+29	10.81
3	245	315	+70	13.43
4	253	303	+50	18.68

TABLE XXII. REGAIN (WEIGHT GAIN MEANS IN KG). (Continued)

Sex[NS]	Treatment**				
	0	1	2	3	4
Bull Gain	-13.60	24.75	27.91	66.99	52.78
No. of Animals	15	12	13	13	11
Steers Gain	-11.34	17.01	36.29	66.52	43.09
No. of Animals	4	4	3	3	3
Pool Data Gain	-13.13[a]	22.82[b]	29.48[b]	69.90[c]	50.70[b]
No. of Animals	19	16	16	16	14

**P $\leq$.01

NS = Not significant - P $\leq$.10

TXS Treatment sex interaction = NS

Changes not significantly different across one line carry similar superscripts.

period. This implies that the round muscle yield is affected by longer feeding period and not by short time feeding.

The effects of molasses on round yield were not found at either the 30 or 75 day regain period. Values are shown in Table XXXIV.

1.3.2 Sex and Interaction Sex-Treatment

Sex and interaction sex treatment were not found significant.

IV. CONCLUSION

The duration of regain period affected the regain and round muscle weight but not the percentage of muscle composition.

The consumption of molasses did affect weight gain especially in the longer regain period. However, muscle composition was not affected.

Although, round yield was affected in terms of weight, it was not affected in terms of percentage of carcass. This may be explained by the report of Zinn (1977) that pointed out the fact that muscle and bone of young cattle develop at a near proportional rate during the first 150 days of its 250 day feeding experiment. From 180 to 270 days bone increased less than muscle, indicating that bone growth rate declined, causing substantial change of proportions of muscle in the carcass composition.

Sex and interaction treatment-sex were not found to affect the results of this experiment at any measure. This may be attributed to the fewer number of steers (not allowing comparison).

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LITERATURE CITED

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APPENDIX

TABLE XXIII. TRANSPORT COSTS OF TREKKING CATTLE WITHIN UPPER VOLTA, 1976-1977
(PRICES IN F CFA)

Herd size = 50 head
Average price = 30,000F CFA

Market of origin:	Djibo		Markoye		Pouytenga	
Destination:	Ouagadougou		Ouagadougou		Ouagadougou	
Distance:	210 km		325 km		140 km	
Transit time:	18-12 days		15-20 days		3-7 days	
Distance traveled per day:	18-26 km		16-22 km		20-47 km	
Costs*	Per Head	Herd	Head	Herd	Head	Herd
Food and salary of drovers	240	12,000	360	18,000	180	9,000
Mortality, lost animals, forced sales	675 (72%)**	33,750	675 (63%)**	33,750	675 (78%)**	33,750
Return transport for selling agent	24	1,200	40	2,000	12	600
Total transport cost	939	46,950	1,075	53,750	867	43,350

Source: Larry Herman, 1983

*Shrinkage costs are not included.

**Percentage of loss costs from total transport costs.

TABLE XXIV. TIME AND LABOR REQUIREMENTS FOR EXPORTING FIFTY HEAD OF CATTLE FROM NIONO TO ABIDJAN - (In Man-Days)

	Truck to Abidjan
Time Required for Malian Formalities after Purchase	7 owner-days
Time Required for Trekking	- 0 -
Time Required for Shipping	3 days x 2 drovers
Time Required for Marketing in Abidjan[a]	11 owner-days 5 days x 2 drovers
Number of Days Capital is Tied up[b]	21 days
Number of Owner-Days Required	18 days
Number of Drover-Days Required	16 drover-days

Sources: Times taken from Staatz,1979 (Chapter Six), based on interviews with owners and drovers. Where data is missing (such as from Niono to Koutiala), trekking times are calculated assuming that a herd covers 16 km per day. Cited by CRED Volume III, 1980.

[a]Includes unloading, marketing, roundtrip travel for owner, and return travel to Mali for drovers.

[b]The capital involved is greater for trucking.

TABLE XXV. COST OF EXPORTING FIFTY HEAD OF CATTLE FROM NIONO TO ABIDJAN IN 1977 (In FM)

Transportation Costs*	Trek to Bouake, then Rail to Abidjan	
Salary and expenses of drovers	176,000	
Ivorian health certificate	8,000	
Indemnities for damaged fields	2,000	
Salt for animals	1,000	
Loss of animals	100,000	(26%)**
Forced sales of animals	32,000	
Rail transport charges	191,000	
TOTAL	510,000	

Source: CRED Volume III, 1980.

*Shrinkage cost is not included.

**Percentage of loss from total transport costs.

TABLE XXVI. TIME AND LABOR REQUIREMENTS FOR EXPORTING FIFTY HEAD OF CATTLE FROM NIONO TO ABIDJAN - (In Man-Days)

	Trek to Bouake, then Rail to Abidjan
Time Required for Malian Formalities after Purchase	7 owner-days
Time Required for Trekking	57 days x 3 drovers
Time Required for Rail Shipping	2 days x 2 drovers
Time Required for Marketing in Abidjan[a]	11 owner-days 5 days x 2 drovers
Number of Days Capital is Tied up[b]	77 days
Number of Owner-Days Required	18 days
Number of Drover-Days Required	185 drover-days

Sources: Times taken from Staatz, 1979 (Chapter Six), based on interviews with owners and drovers. Where data is missing (such as Niono to Koutiala), trekking times are calculated assuming that a herd covers 16 km per day. Cited by CRED Volume III, 1980.

[a]Includes unloading, marketing, roundtrip travel for owner, and return travel to Mali for drovers.

[b]The capital involved is greater for trucking.

TABLE XXVII. COST OF EXPORTING FIFTY HEAD OF CATTLE FROM NIONO TO ABIDJAN IN 1977 - (In FM)

Transportation Costs*	Trek to Ferkessedougou, then Rail to Abidjan	
Salary and expenses of drovers	110,000	
Ivorian health certificate	8,000	
Indemnities for damaged fields	1,000	
Salt for animals	1,000	
Loss of animals	125,000	(32%)**
Forced sales of animals	60,000	
Rail transport charges	262,000	
TOTAL	576,000	

Source: CRED, Volume III, 1980.

*Shrinkage cost is not included.

**Percentage of loss from total transport costs.

TABLE XXVIII. COSTS OF ALTERNATIVE MEANS OF TRANSPORTING LIVE CATTLE FROM NIGER PRIMARY MARKET TO FOREIGN TERMINAL MARKETS (1972).

	(CFA FRANCS PER HEAD)				
	1	2	3	4	5
Mean	Markoye to Abidjan	Markoye to Lome	Aybrou to Cotonou	Tahoua to Lagos	Gotheye to Lome
Trekking	350	1,300	700	600	1,300
Railing	2,650	-	1,400	2,850	-
Loss and Shrink	1,500 (24%)*	1,900 (29%)*	1,200 (28%)*	1,500 (25%)*	1,900 (32%)*
Taxes En Route	1,620	3,240	1,000	1,000	2,800
Total	6,120	6,440	4,300	5,950	6,000

Source: Bishop, 1972.

1. Markoye to Ouagadougou by foot, and Ouagadougou to Abidjan by rail 1,600 km.
2. Markoye to Lome entire distance by foot 1,250 km.
3. Ayerou to Parakou by foot; Parakou to Cotonou by rail, 1,400 km.
4. Tahoua to Kano by foot; Kano to Lagos by rail, 1,500 km.
5. Gotheye to Lome, entire distances by foot, 1,400 km.

*Percentage of loss costs from total costs of transport.

TABLE XXIX. COSTS OF ALTERNATIVE MEANS OF TRANSPORTING LIVE CATTLE IN MALI* (MALIAN FRANC PER TON OF CARCASS AND OFFALS PER KILOMETER)

Transport Mode	Cost of Transport	General Cost	Cost due to weight loss	Total Cost
Trek	12-20	20-38	18-38 (36-39%)**	50-96
Truck	40-74	10-24	10-20 (17%)**	60-118
Rail	20-26	16-34	10-20 (22-25%)**	46-80

*From Sedes cited by Stryker in The Marketing of Malian Cattle, p. 23, table 5.

**Percentage of cost due to weight loss from total cost.

Mortality and forced sale costs are not included.

TABLE XXX. COST OF EXPORTING FIFTY HEAD OF CATTLE FROM NIONO TO ABIDJAN IN 1977
(in FM)

Transportation Costs	Trek to Bouake, then Rail to Abidjan		Trek to Ferkessedougou, then Rail to Abidjan		Truck to Abidjan	
	(FM)	% of Total	(FM)	% of Total	(FM)	% of Total
Salary and expenses of drovers	176,000	12%	110,000	8%	48,000	2%
Ivorian health certificate	8,000	1%	8,000	1%	8,000	-
Indemnities for damaged fields	2,000	-	1,000	-	-0-	-
Salt for animals	1,000	-	1,000	-	-0-	-
Loss of animals	100,000	7%	125,000	8%	150,000	6%
Forced sales of animals	32,000	2%	60,000	4%	60,000	2%
Truck or rail transport charges	191,000	13%	262,000	17%	1,400,000	56%
TOTAL	510,000	(100%)	(576,000)	(100%)	(1,666,000)	(100%)

Source: Staatz, 1979.

TABLE XXXI. COSTS OF TRANSPORTING CATTLE FROM SOKOTO TO THE WEST.

Truck			Rail			Foot		
Category	Cost /cow	% of Total	Category	Cost /cow	% of Total	Category	Cost /cow	% of Total
Mortality cost	.54	4.3	Mortality cost	.15	1.8	Mortality cost	.44	5.5
						Salvage cost	.89	11.2
Shrinkage cost	4.25	34.2	Shrinkage cost	4.00	47.9	Shrinkage cost	3.76	47.2
Other expenses	.40	3.2	Other expenses	.40	4.8	Other expenses	.40	5.0
Freight costs	7.25	58.3	Freight costs	3.20	38.3	Drover's fees	1.00	12.6
			Attendant cost	.60	7.2	Food money	.17	2.1
						Interest cost	.37	4.6
						Water and Feed cost	.93	11.8
TOTAL	12.44	100.0		8.35	100.0		7.96	100.0

COSTS OF TRANSPORTING CATTLE FROM KANO TO THE WEST.

Truck			Rail			Foot		
Category	Cost /cow	% of Total	Category	Cost /cow	% of Total	Category	Cost /cow	% of Total
Mortality cost	.63	4.54	Mortality cost	.12	1.6	Mortality cost	.57	6.1
						Salvage cost	1.14	12.0
Shrinkage cost	4.46	32.20	Shrinkage cost	3.34	44.5	Shrinkage cost	4.43	46.9
Other expenses	.40	2.90	Other expenses	.40	5.3	Other expenses	.40	4.2
Freight costs	8.37	60.36	Freight costs	3.05	40.7	Drover's fee	1.19	12.6
			Attendant cost	.59	7.9	Food money	.20	2.1
						Interest costs	.40	4.2
						Water and Feed cost	1.12	11.9
TOTAL	13.86	100.0		7.50	100.0		9.45	100.0

Source: Kellogg, 1971.

TABLE XXXII. COSTS OF TRANSPORTING CATTLE FROM BORNU TO THE WEST.

Truck			Rail			Foot		
Category	Cost /cow	% of Total	Category	Cost /cow	% of Total	Category	Cost /cow	% of Total
Mortality cost	.98	5.0	Mortality cost	.25	2.7	Mortality cost	.78	5.2
						Salvage cost	1.51	10.0
Shrinkage cost	5.09	26.1	Shrinkage cost	4.84	42.0	Shrinkage cost	7.35	48.5
Other expenses	.40	2.0	Other expenses	.40	3.5	Other expenses	.40	2.6
Freight costs	13.06	66.9	Freight costs	5.10	44.2	Drover's fee	1.98	13.1
			Attendant costs	.94	8.1	Food money	.34	2.2
						Interest cost	.65	4.3
						Water and Feed cost	2.14	14.1
TOTAL	19.53	100.0		11.53	100.0		15.14	100.0

COSTS OF TRANSPORTING CATTLE FROM BORNU TO THE EAST.

Truck			Rail			Foot		
Category	Cost /cow	% of Total	Category	Cost /cow	% of Total	Category	Cost /cow	% of Total
Mortality cost	.81	4.9	Mortality cost	.21	2.1	Mortality cost	.72	6.1
						Salvage cost	1.45	12.2
Shrinkage cost	5.05	30.6	Shrinkage cost	4.83	48.2	Shrinkage cost	5.55	46.8
Other expenses	.40	2.4	Other expenses	.40	4.0	Other expenses	.40	3.4
Freight costs	10.25	62.1	Freight costs	3.83	38.3	Drover's fee	1.40	11.8
			Attendant costs	.74	7.4	Food money	.24	2.0
						Interest cost	.50	4.2
						Water and Feed cost	1.60	13.5
TOTAL	16.51	100.0		10.01	100.0		11.86	100.0

Source: Kellogg, 1971.

TABLE XXXIII. TRANSPORT COSTS OF TREKKING CATTLE TO FOREIGN MARKETS, 1976-1977
(PRICE IN F CFA)

Herd size = 50 head
Average price = 30,000F CFA

Market origin:	Pouytenga		Kaya		Ouagadougou	
Destination:	Lome (Togo)		Tera (Niger)		Paga (Ghana)	
Distance:	860 km		215 km		170 km	
Time in transit:	45-75 days		9-18 days		8-12 days	
Distance traveled per day:	12-20 km		24-25 km		14-21 km	
Costs*	Per head	Herd	Head	Herd	Head	Herd
Vaccination against Trypanosomiasis	50	2,500	-	-	50	2,500
Food on salary,	1,650	82,000	330	16,500	200	10,000
mortality, lost animals, forced sales	675 (24%)**	33,750	675 (67%)**	33,750	675 (67%)**	33,750
Return transport for drovers and round trip for seller	400	20,000	-	-	80	4,000
Total transport cost	2,775	138,250	1,005	50,250	1,005	50,250

Source: Larry Herman, 1983.

*Shrinkage costs are not included. **Percentage of loss costs from total transport costs.

The analysis of the percentage of vaccination against trypanosomiasis (shipment to Lome vs. shipment to Tera) and the effect of walking speed of cattle (shipment of Lome 12-20 km/day vs. shipment to Paga 14-21 per day).

TABLE XXXIV

AVERAGE WEIGHT OF COLD CARCASS AND ROUND MUSCLE PER TREATMENT (KG)

TREATMENT	CARCASS	ROUND
0 (control)	127.36	12.97
1	131.89	12.82
2	134.93	12.85
3	155.78	15.17
4	143.30	14.93