THE ECONOMICS OF THE NORTH KIMBERLEY CATTLE INDUSTRY: THE EFFECT OF ROADS, PORTS, AND FREIGHT SUBSIDIES ON SUPERPHOSPHATE AND LIVESTOCK INTRODUCTIONS

by

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A dissertation submitted in partial fulfilment of the requirements for the degree of Master of Economics

University of New England

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SUMMARY

(1) The physical resources of the King Edward-Drysdale area of W.A. are described, and its potential for cattle raising is assessed in the light of currently available technology.

(2) The rate of development of the cattle industry in the area is compared with the rate of development in the areas of the N.T. which have a similar environment.

(3) It is hypothesized that the slow rate of development in the King Edward-Drysdale Country relative to the Top End of the N.T. has been due to deficiencies in the transport infrastructure in the North Kimberley area, and the subsidization of crucial inputs in the N.T.

(4) The effect of regionally differentiated assistance schemes on the pattern of land use and efficiency of resource allocation is discussed.

(5) The hypothesis is tested by building a deterministic budgetary model of a representative cattle enterprise in the area to measure the effect of variations in transport infrastructure and level of subsidization on profitability.

(6) The effect of changes in the price of beef is determined in order to assess the likelihood of the area being developed for cattle raising in the near future.

(7) Arguments in favour of regional assistance schemes are reviewed, and the role of such schemes in Northern Australia are discussed.

CHAPTER 1

THE AREA

1.1 Introduction

The dissertation aims to explain why a cattle industry has not become established in the North Kimberley area of Western Australia as it has in the other high rainfall areas of Northern Australia. It also aims to predict what action (if any) could be taken to stimulate development of the area. The economic implications of development incentives in Northern Australia are also discussed.

1.1.1 Definition of the area

In 1954 the C.S.I.R.O. Land Research and Regional Survey Section conducted a survey of the North Kimberley area. Two zones of "potential cattle country" were described (2). These were named "Mount Synott Country" and "King Edward-Drysdale Country" and are shown in Figure 1.1. The King Edward-Drysdale Country which covers 11,560 square miles is the area studied here.

1.2 Description of the Area

1.2.1 Physical

The 1954 C.S.I.R.O. survey described the geology, geomorphology, soils, vegetation, pastures and land systems of the North Kimberley area.

Speck (39) described twelve soil types and made an assessment of their agricultural potential, but did not map the soils or estimate the area of each

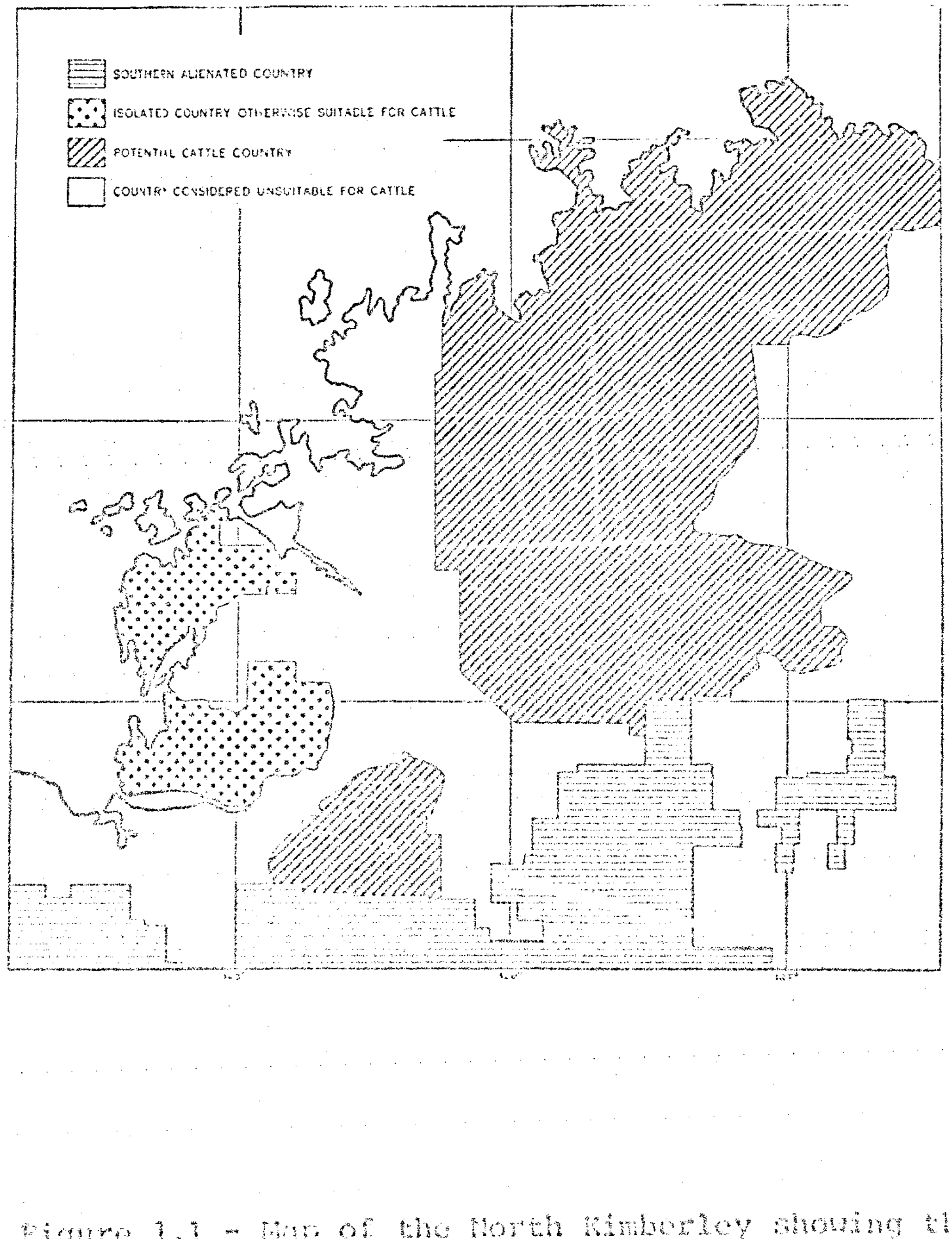

Figure 1.1 - Map of the North Kimberley showing the location of potential cattle country.

soil type present. However, a more recent and comprehensive soil survey of the area provides information which is more useful in assessing its economic potential (3). The mapping and classification system used enables the soils of the area to be compared with similar soils elsewhere in Northern Australia. From these two reports it is clear that in general the soils of the area are only of low to moderate fertility and that there are large areas that are unsuitable for agriculture.

Lazarides (22) has described the native pastures of the area. He noted that they were generally poor with an absence or low densities of the species which dominate the better grazing areas of Northern Australia. The main grass species are tall fast growing perennials which are palatable to stock only in the early stages of growth. As they mature they become coarser and their nutritive value declines rapidly.

Speck (38) collated all the information gathered in the 1954 C.S.I.R.O. reconnaissance in order to classify the area into land systems. He used the land system concept developed by Christian and Stewart (11) who defined it as "...an area or group of areas throughout which can be recognised a recurring pattern of topography, soils and vegetation". Stewart and Speck (40) have discussed the potential land use of the North Kimberley area. They estimated the cattle carrying capacity of each of the land systems, and divided the King Edward-Drysdale Country into three land use groups -

Group 1 Moderate pastoral lands

The area consists of the Barton, Kennedy and Napier land systems. Group 1 lands have high proportions of moderate quality pasture which are relatively accessible to stock. Stewart and Speck (40) considered that the Group 1 lands would be "...the backbone of any development of the cattle industry in the area".

Group 2 Poor pastoral lands

The area consists of the Foster, Pago and Karunjie land systems. The Group 2 lands have a high proportion of poor pastures, and because of the occurrence of steep scarps access by stock is restricted in some areas.

Group 3 Very poor pastoral lands

The group consists of the Buldiva and Carpentaria land systems. They are generally inaccessible and isolated and have very poor pastures. Stewart and Speck (40) considered that the Group 3 lands had very little value for cattle raising.

They concluded that by overall Northern Australian standards the native pastures of the King Edward-Drysdale country are only poor to moderate, and that the rugged nature of much of the country would make livestock control difficult. Stewart and Speck (40) considered that the only practical form of development would be to concentrate on Group 1 lands in conjunction with adjacent areas of Group 2 lands.

A break-down of the King Edward-Drysdale Country into land systems is shown in Table 1.1.

TABLE 1.1

Land Systems and Cattle Carrying Capacity in the King Edward-Drysdale Country [(a)]

Classification	Carrying (b) Capacity	Area	% of Total Area
Group 1 Lands			
Barton system	10	1,300 squ. miles	11.2
Kennedy system	8	430 " "	3.7
Napier system	7	1,700 " "	14.7
Total Group 1 Lands		3,430 " "	29.6
Group 2 Lands			
Foster system	6	800 " "	6.9
Pago system	4	4,300 " "	37.3
Karunjie system	4	210 " "	1.8
Total Group 2 Lands		5,310 " "	46.0
Group 3 Lands			
Buldiva system	0	2,800 " "	24.2
Carpentaria system	0	20 " "	0.2
Total Group 3 Lands		2,820 " "	24.4

(a) From Stewart and Speck (40) Table 25 page 88.

(b) Carrying capacity is measured in Adult Equivalents (AE's) of grazing pressure per square mile.

According to these estimates of carrying capacity the area could carry 51,180 cattle in an unimproved state. However Stewart and Speck (40) also referred to the possibility of using improved pastures, particularly Buffel grass (Cenchrus cilaris) and Townsville Stylo (Stylosanthes humilis). They considered that it would be possible to establish Townsville stylo on the Barton, Kennedy, Napier, Karunjie and Pago land systems. These cover an area of 7,940 square miles.

1.2.2 Climate

Slatyer (36) has described the area as tropical savannah with a distinct dry season in winter. Most of the rain falls between November and March, and the months of August and September are almost rainless. Most of the area lies between the 30" and 40" isohyets, as shown in Figure 1.2.

Slatyer (36) estimates, in the absence of any temperature records, that maximum temperatures are high throughout the year, remaining at over 29°C even in the coldest months, and probably averaging at least 37°C in the hottest period. Slatyer (36) also produced a map showing the average length of growing period for agricultural purposes. This is shown in Figure 1.3.

Apart from a small area immediately to the West, the King Edward-Drysdale Country receives the highest and most reliable rainfall in tropical Western Australia. Slatyer (36) concluded that, "...from the point of view of moisture supply the area as a whole would be very reliable stock country with droughts most unusual".

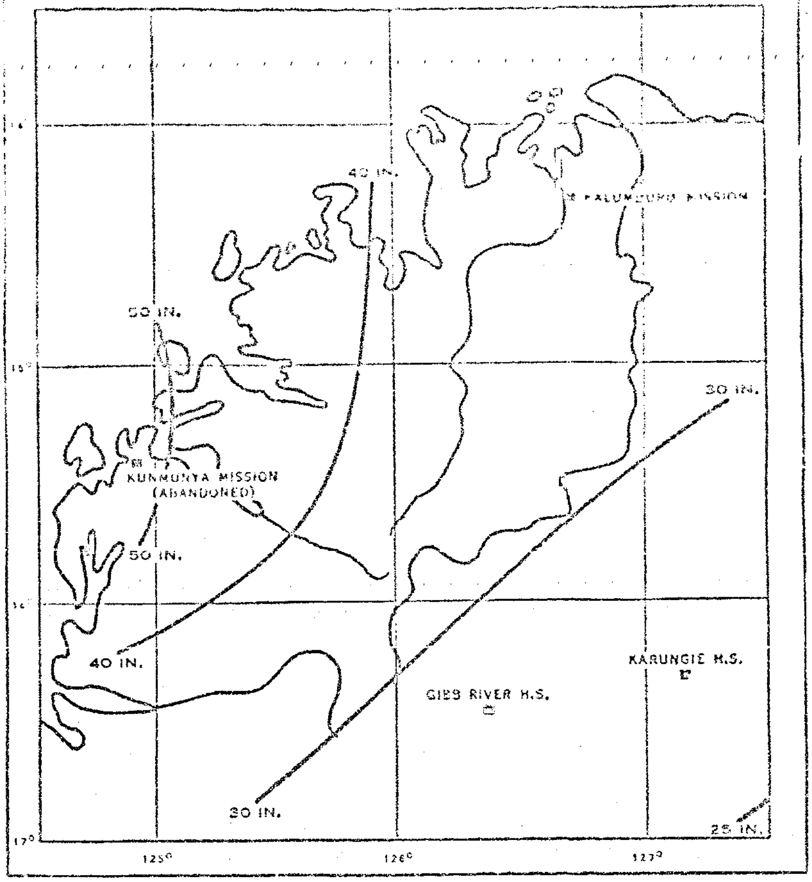

Figure 1.2

Annual rainfall isohyets showing the decreasing rainfall towards the south-east.

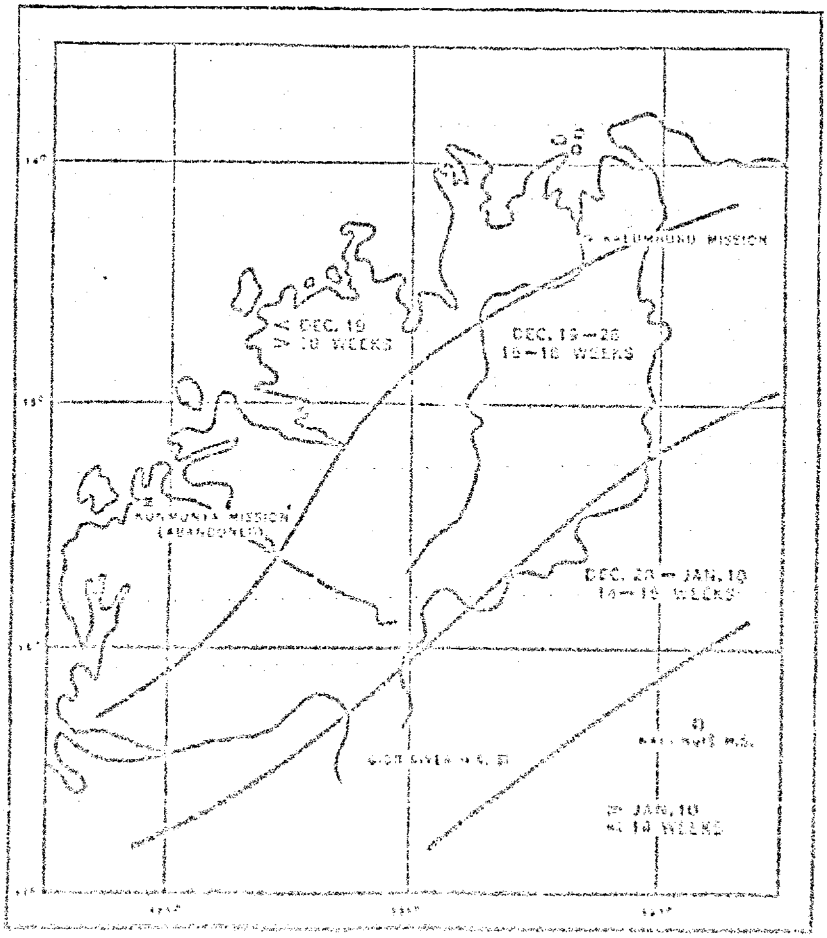

Figure 1.3

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Hence the climate of the area should not constrain the development of cattle enterprises based on the types of improved pastures which have been used successfully in the Top End of the Northern Territory.

1.3 History of the Kimberley Cattle Industry

It is necessary to have an appreciation of the history of the Kimberley area as a whole in order to appraise the prospects for pastoral development in the King Edward-Drysdale Country.

The statistical division of Kimberley is that part of Western Australia lying above about 20^{o} South. Teakle (41) has reviewed the history of the division. Following abortive attempts to settle the area in the 1860's, the explorer Alexander Forrest led an expedition there in 1879. His glowing report of the grazing land in the area led to the first successful settlements in the 1880's by the well known pioneer family, the Duracks. Apart from a short lived gold rush period, population growth has been slow up until the 1960's. Table 1.2 shows that the population of the Kimberley division as a proportion of the state total declined between the 1911 census and the 1954 census. However between 1961 and 1971 the population more than doubled, and the percentage of the state total increased from 0.77% to 1.38%.

TABLE 1.2

Population of the Kimberley Division, 1911-1971[a]

	1911	1921	1933	1947	1954	1961	1966	1971
Population ('000)	2.0	2.2	2.1	2.8	3.5	5.7	11.7	14.1
% of state total	0.70	0.65	0.48	0.55	0.55	0.77	1.50	1.38

(a) From W.A. Yearbook, 1972.

In 1970 the Kimberley division carried 647,196 head of cattle which was 43.2% of the state's beef cattle (5). Figure 1.4 shows the growth of total cattle numbers in the Kimberley division since 1960.

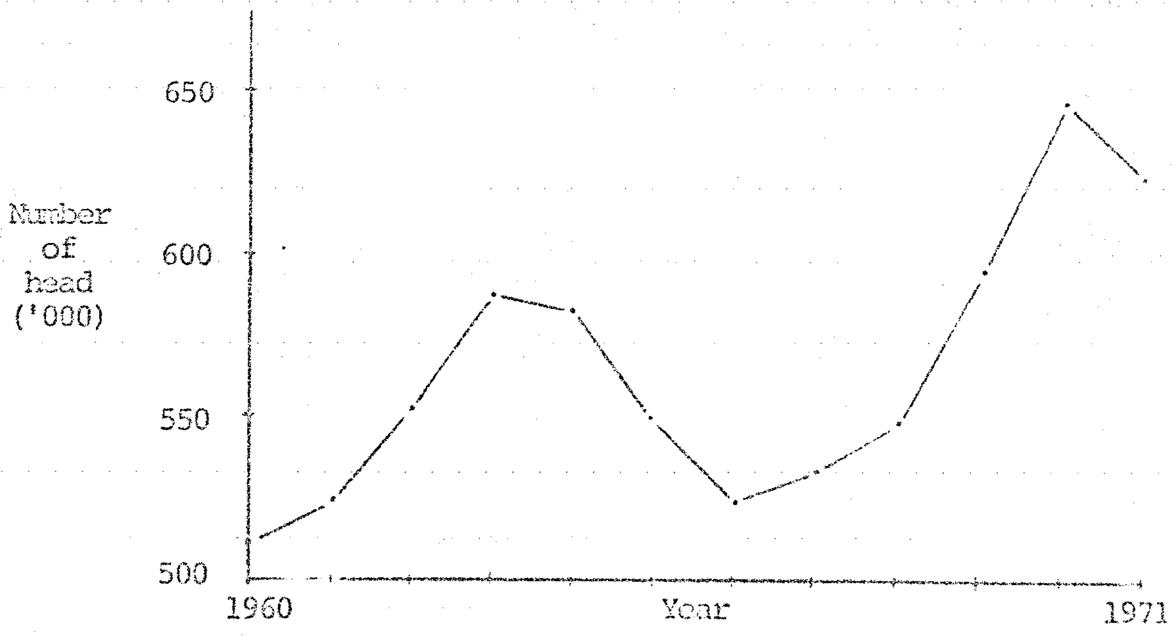

FIGURE 1.4

Growth of Cattle Numbers in the Kimberley Division[a]

(a) From W.A. Yearbooks 1960-1971

Official data on cattle numbers and human population are not available for the King Edward-Drysdale portion of the Kimberley Division. However, estimates made by consultants working in the area indicate that the King Edward-Drysdale Country has not shared in the increases shown for the Kimberley division as a whole.

As recently as 1954 the King Edward-Drysdale Country was practically uninhabited by Europeans*, and there was only one pastoral lease, which was adjacent to the Kalumburu Mission on the North Coast. However, during the 1960's the area was divided into eight pastoral leases. With the gradual improvement of the road from Derby, efforts (sometimes quite minimal) were made to occupy these leases. In June 1970 there were 21 miles of sealed road East from Derby and it was proposed to seal another 25 miles and upgrade the remainder as far as Gibb River to gravel standard, with new bridges in two places (4).

In January 1970 the permanent European population of the King Edward-Drysdale country consisted of five men, two women, and two children, plus those people connected with the Kalumburu Mission. Cattle numbers controlled and uncontrolled probably did not exceed 5,000 and at least three of the leases

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* The following description is taken from (35) Hugh Robinson & Co. Pty. Ltd. "The Impact of the Proposed Bauxite and Alumina Industry on the Beef Potential of the North Kimberleys". Unpublished paper, 1972.

remained unstocked. In 1970 under the stimulus of a proposed regional development plan associated with a major bauxite mining and alumina complex, a start was made on the development of the "Doongan" and "Mitchell River" leases, with a substantial part of the development based on the use of improved pastures. These stations were taken up by a U.S.A. mining company for development in conjunction with a bauxite mining and alumina complex. They are now becoming established as cattle stations, and both have plans for further pasture improvement and herd buildup.

However despite the stimulus of prospective mining developments and the influence of the nearby Ord irrigation area, the King Edward-Drysdale country remains very much "terra incognita". Investors interested in developing the high rainfall area of the North for cattle production have largely passed this area over in favour of similar areas in the N.T.

The road system of the area is shown in Figure 1.5. It can be seen that the King Edward-Drysdale country is only accessible by a single track from the South. At present the area is dependent on the port and township of Derby by way of 232 miles of reasonable road from Derby to Gibb River and thereafter, approximately 180 miles of graded track running up through the middle of the area to Kalumburu Mission. It is possible, but very difficult to gain access from Wyndham over a poorly constructed track which is totally inadequate for conventional freight vehicles and road trains. There is no port on the coast.

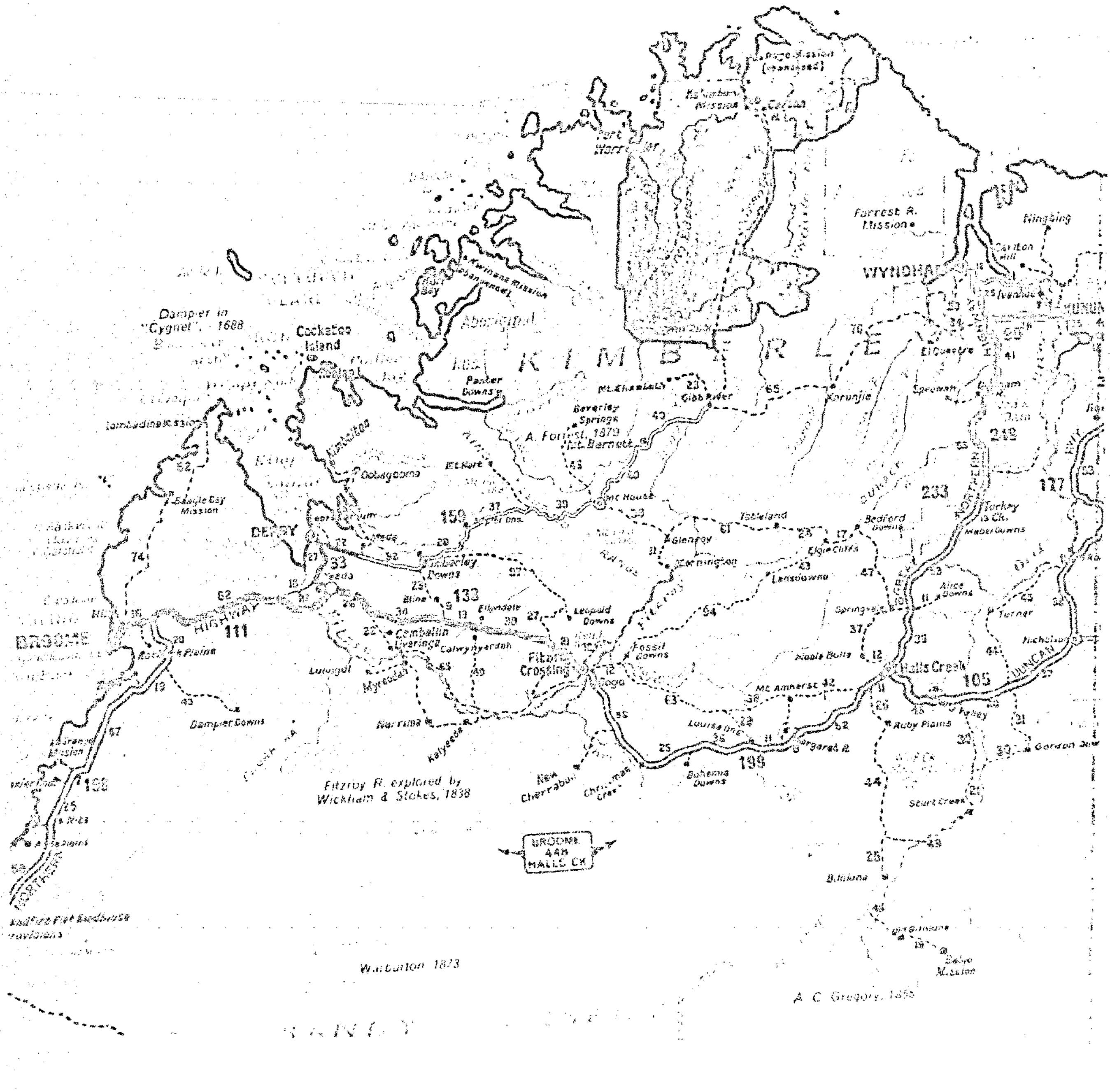

Figure 1.5

Road Map of the Kimberley District.

Hence it is apparent that the transport infrastructure of the area is mediocre, even by Northern Australian standards.

1.4 Development Prospects

Patterson (32) has commented on prospects for development of the King Edward-Drysdale Country. He suggested (in 1960) that the potential of the area for cattle raising was very limited due to poor native pastures, restricted access to markets, social isolation and shortages of skilled stockmen.

Thomas (42) has made estimates of the costs and returns from beef production in the area over the period 1950 to 1958. The analysis assumes a turnoff rate of 11.9% which is rather optimistic given the level of technology at that time. In fact in 1968 it was estimated (42) that the turnoff rate from the Kimberley Division as a whole was only 12.3%. This area includes the better quality grazing country of the Ord-East Kimberley district.

Thomas's rather optimistic analysis of the situation showed that in every year between 1950 and 1958 a positive net margin per head would have been earned, but this margin was decreasing towards the end of the period. Hence in 1960 it seemed that there was little chance that the land resources of the King Edward-Drysdale Country could be used profitably for cattle production. However, since then several technological advances have improved the prospects for the area, along with the rest of the high rainfall cattle zone of Northern Australia. These technological innovations are discussed in sections 1.4.1 to 1.4.3.

1.4.1 Townsville Stylo

The use of phosphate fertilized Townsville Stylo (*Stylosanthes humilis*) pastures to supplement grazing from native pastures in the dry season, has greatly improved the prospects for the cattle industry in the high rainfall zone of Northern Australia. Townsville Stylo is an annual legume which can be established and maintained on uncleared open savannah woodland, provided it receives sufficient phosphate fertilizer and grazing pressure is adequate to limit competition from native grasses. No grazing trials with Townsville Stylo have been carried out in the King Edward-Drysdale Country. However, as the climate and soils are similar to the Katherine area of the N.T. where extensive trials have been done, it is possible to extrapolate from these trials.

Norman (27) has shown that at Katherine there is an approximately inverse linear relation between the period of grazing on Townsville Stylo during the first two years after weaning, and the total period from weaning to slaughter.

Miller and Perry (24) have shown that at Katherine Townsville Stylo can be established on untreated soil surfaces in uncleared annual and perennial pastures.

Commercial experience with Townsville Stylo at Doongan and Mitchell River Stations in the last few years has shown that there is considerable potential for the use of Townsville Stylo in the King Edward-Drysdale Country.

Begg (6) considered that 37% of the North Kimberley area is suitable for Townsville Stylo. This is an area of 12,580 square miles. As the King Edward-Drysdale Country is the best part of the North Kimberley, it is reasonable to assume that a large proportion of this area lies within the King Edward-Drysdale Country.

The author estimates that an area of 5,930 square miles (3,796,500 acres) could be sown to Townsville Stylo. If cattle also had access to some native pasture in the wet season, it is reasonable to expect (from experience to date) that a carrying capacity of one Adult Equivalent per five acres of Townsville Stylo could be achieved. This means that it is technically possible for the area to carry a maximum of about 759,000 Adult Equivalents of cattle.

These facts make it apparent that by using improved pastures the potential of the area for beef production is much greater than Stewart and Speck's original estimate of 51,180 head. However despite the available evidence, and the success of small plantings in the King Edward-Drysdale area, no move had been made to establish significant areas of Townsville Stylo prior to 1969/70. However, in the Top End of the Northern Territory, pasture improvement based on the use of Townsville Stylo has been proceeding much more rapidly. This position is summarized in Table 1.3 below -

TABLE 1.3

Pasture Improvement in W.A. and the N.T.

Year	Area of sown pasture (ac) Wyndham - East Kimberley area[1]	Area of sown pasture (ac) Darwin-Gulf area[2]	Area of Townsville Stylo in the N.T.[3]
1960/61	108	-	-
1961/62	208	-	-
1962/63	300	-	-
1963/64	434	-	36,918
1964/65	512	-	41,236
1965/66	317	-	48,084
1966/67	904	-	66,342
1967/68	810	-	100,678
1968/69	2,160	-	-
1969/70	6,224	-	-
1970/71	7,916	192,865	-
1971/72	16,439	259,712	-
1972/73	27,164	258,763	-

1 Source: Australian Bureau of Statistics. The Wyndham - East Kimberley area is a statistical division encompassing the King Edward-Drysdale Country, plus the Wyndham and Kununurra areas to the East, and includes the Ord irrigation project.

2 Source: Australian Bureau of Statistics. Data by region are not available for years prior to 1970/71. A large proportion of the total area of sown pasture would be Townsville Stylo.

3 Source: Survey carried out by Woods (45) in October 1968. Woods' map (page 93) shows that almost all of the Townsville Stylo established in 1968 was within the Statistical Division known as the Darwin-Gulf area.

Although the data in Table 1.3 are incomplete, the picture is nevertheless clear. Despite the stimulus of the Ord River project, pasture improvement based on Townsville Stylo technology has been adopted much more rapidly in the Northern Territory than in the similar areas of Western Australia. This has occurred despite the estimate by Begg (6) that almost as much land was physically and climatically suitable for Townsville Stylo in the North Kimberley, as in the Top End of the N.T.

Most of the area of sown pasture in the Wyndham-East Kimberley district is on two properties, both within the King Edward-Drysdale Country. Since 1970 Doongan and Mitchell River Stations have established approximately 20,000 acres of Townsville Stylo. This is part of an integrated regional development project being initiated by American Metal Climax Inc., which plans to establish a $350 million bauxite and alumina complex on nearby Mitchell Plateau. It has been done in the expectation that the massive infrastructural development associated with the project would substantially improve the profitability of this form of investment (45).

1.4.2 Zebu cattle

The superior performance of Zebu (Bos indicus) cattle over the traditionally used Shorthorns, has been demonstrated many times under both commercial and experimental conditions, in a number of environments similar to the King Edward-Drysdale Country. The work with most relevance to this area is that of Norman (26) done at Katherine, N.T. From weight gain trials on native pasture Norman concluded that - "The faster growth rate of the tropical crossbred cattle in comparison with local cattle of temperate origin is in accord with previous tests in the tropical and sub-tropical summer rainfall zones of Australia". Young (47) has compared the feasibility of a North Kimberley cattle enterprise with Shorthorn and Brahman cattle. He concluded that Brahmans were economically superior for that area.

Hence the marked superiority both biologically and economically, of Zebu cattle has greatly enhanced the prospects for pastoral development in the high rainfall cattle zone of Northern Australia.

1.4.3 Motor transport of cattle

Prior to the development of road-train cattle transport, the long distance which cattle had to be walked to market was a critical limitation to beef production in the North Kimberleys. Patterson (32), in his assessment of the area's potential, stressed the importance of access to an abattoir. The fact that no stock route to Wyndham could be easily developed meant that cattle would have to be walked 360 miles to Derby. This is a harsh stock route, and aged breeders could not be expected to last the trip. Therefore only mature healthy bullocks could be moved out and the rest would be left to die on the station. In addition, the introduction of breeding cows to the area to establish a herd also presented a problem. Hence prior to the introduction of road-train transport in the early and mid 1960's the development of the area was restricted by poor access to supplies of breeders, and a market. This constraint has since been partially removed.

Moulden and Jenkins (25) point out that between 1962-63 and 1964-65 the average distance travelled by cattle turned off by road in the Kimberleys was 202 miles. Hence the distance of 360 miles which must be travelled under the existing road system means that the King Edward-Drysdale Country still suffers some locational disadvantage with respect to market access

1.4.4 Potential beef production

It was pointed out in section 1.4.1 that if the whole of the King Edward-Drysdale Country was fully developed using present technology, about 759,000 Adult Equivalents of cattle could be carried. The maximum attainable turnoff from the area can be calculated by finding the static herd solution using the assumptions outlined in Appendix A, and the method described in Section 3.3.1.

Static herd solutions have been derived for two different herd management systems - bullock turnoff and yearling turnoff.

A turnoff rate* of 22.0% could be achieved under a bullock turnoff system, and a rate of 32.9% could be achieved where steers are sold as yearlings. Details of the maximum possible herd size, and annual turnoff from the area after full development using present technology are shown in Table 1.4.

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* Turnoff rate is the number of cattle sold in a year expressed as a percentage of the total number in the herd.

TABLE 1.4

Maximum Attainable Herd Size and Turnoff from the King Edward-Drysdale Country under Two Herd Management Systems

	Management System	
	Bullock turnoff	Yearling turnoff
Herd Size (No. of head)	819,889	821,542
Number of bullocks sold	90,093	-
Number of yearlings sold	-	143,527
Number of heifers sold	54,117	77,493
Number of aged cows sold	31,271	44,629
Number of bulls sold	3,415	4,858
Total Cattle Sold	178,896	270,507

It is obvious from Table 1.4 that it is technically possible for the King Edward-Drysdale Country to become a significant beef producing area if it was fully developed. However, the area is moving towards the achievement of this potential much more slowly than the areas of the N.T. where similar technology is applicable. This is illustrated in figure 1.6.

Figure 1.6 shows that in the Wyndham-East Kimberley district, which includes the King Edward-Drysdale Country, cattle numbers actually declined between 1967/68 and 1972/73, a period when herds in most other parts of Australia were increasing steadily. However during the same period cattle numbers in the Darwin Gulf region showed significant growth as a result of the increased area of improved pastures.

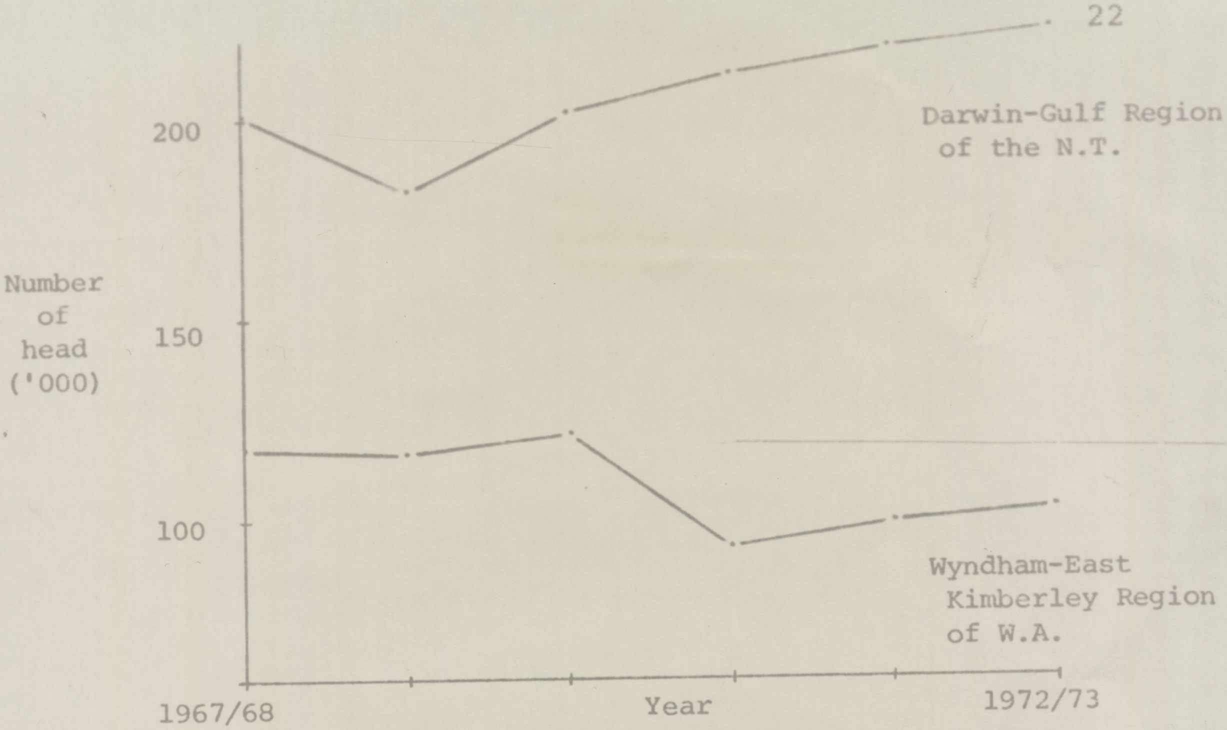

FIGURE 1.6

Cattle numbers in W.A. and the N.T.[(a)]

(a) Source: Australian Bureau of Statistics

1.5 Outline of the Study

Chapter 1 has described the present level of development of the cattle industry in the area, relative to similar areas in the N.T., and outlined the relevant technological advances which have enhanced the possibilities for development in recent years.

Chapter 2 discusses the economic implications of regional assistance schemes, and outlines the hypothesis to explain the relatively slow development of the area.

Chapter 3 explains the rationale of testing the hypothesis, gives a detailed description of the budgetary model, and presents the results of the budgetary analysis.

Chapter 4 presents an analysis of the model output and the hypothesis is tested. The effect of variations in beef prices is assessed. The role of special incentives in Northern Australia is discussed, and conclusions are drawn concerning the reasons for the retarded development of the area, and likely developments in the near future.

CHAPTER 2

THE HYPOTHESIS AND METHODOLOGY

2.1 The Hypothesis

- 2.1.1 Subsidies and concessions available in the N.T.
- 2.1.2 Other assistance to country areas
- 2.1.3 Effect of locational subsidies on resource allocation
- 2.1.4 Effect of locational subsidies on the pattern and intensity of land use

2.2 The Importance of a Road Link with the Wyndham-Kununurra area

2.3 The Importance of a Port on the North Coast of the Area

2.4 The Absence of a Sea Freight Subsidy on Superphosphate

2.5 The Absence of a Subsidy on the Cost of Introducing Breeding Stock

2.1 The Hypothesis

Having described the area and reviewed the prospects for development, the next step is to propose a hypothesis to explain why the cattle industry has not become established in the area.

The hypothesis arises from three observations which were detailed in Chapter 1.

(1) Very little capital has been invested in developing the land resources of the King Edward-Drysdale Country.

(2) The area has similar physical potential for cattle raising to the Top End of the N.T. which has been attracting significant amounts of capital in recent years.

(3) Recent technological advances have enhanced the prospects for the whole of the high rainfall Northern cattle zone, but to date this new technology has not been widely used in the King Edward-Drysdale Country.

This dissertation attempts to explain these observations, and to predict what events (if any) might bring the development of the area more into line with the rest of Northern Australia.

There are two possible explanations for these observations. Firstly, that the observed pattern of land use is due to the fact that capital and labour for any type of land use cannot be applied as profitably as in the areas of the North where development has been rapid in recent years. The alternative explanation is that immobility of capital and labour and imperfect information account for the situation.

If it is found that poor prospects for profit, rather than market imperfections explain the retarded development of the area, then it would seem that the King Edward-Drysdale Country has a comparative disadvantage in cattle production.

Johnson (20) has suggested seven factors which can be the basis for comparative advantage or disadvantage in agriculture. These are -

(1) Physical factors such as climate, soil, topography etc.

(2) Biological factors such as weeds, diseases, availability of suitable varieties etc.

(3) Human factors such as population structure and density, education, aspirations etc.

(4) Capital factors such as availability and cost of funds and the size of the existing fixed capital stock.

(5) Historical factors such as skill and experience, presence of established markets etc.

(6) Location factors with respect to markets and supply of inputs.

(7) Institutional factors such as services, taxes, subsidies etc.

Physical and biological factors do not explain the retarded development of the area. These are similar to the Top End of the N.T. where the land has been used for cattle for many years, and there has been considerable development since the technological breakthroughs of the 1960's.

The same can be said of human factors. Harsh climate and social isolation have never prevented stations from being established wherever cattlemen and investors saw a reasonable chance of profit.

Similarly, capital factors do not provide an explanation. There is no obvious reason why capital for the establishment of a cattle enterprise in this area should be any more expensive or less easily available than for enterprises with similar risk in any other area.

Johnson includes "skill and experience" and "established markets" in the category of historical factors. In many cases land has been settled and developed in Australia without skill and experience in the particular environment, and often before markets for the produce have been established. Although this has often led to extreme hardship for the settlers, it does not seem to have been a barrier to land settlement in other parts of Australia, so there is no reason to suppose that this has been the case for the King Edward-Drysdale Country.

Having eliminated the first five factors as being unlikely to explain the failure of the area to attract capital, it seems that the two remaining ones, (location and institutional factors), could be used to explain the disparity in the rates of development of the King Edward-Drysdale Country and the N.T.

The next step is to look at the range of institutional incentives available in the N.T., and to discuss their role in influencing the pattern and intensity of land use, and the efficiency of resource allocation.

2.1.1 Subsidies and concessions available in the N.T.

Subsidies and other forms of financial assistance which have been available to pastoralists in the N.T. but not pastoralists in other parts of Northern Australia (29) include -

(1) Credit assistance for -

- (i) Water supply works
- (ii) Producers co-operatives
- (iii) Any other expenditure that the N.T. Primary Producers Board sees fit.

(2) Reimbursement of expenditure on -

- (i) Stock route fencing
- (ii) Maintenance of unemployed aborigines
- (iii) Airstrip maintenance.

(3) Subsidies on -

- (i) Drought relief - half the cost of livestock movements and freight on fodder
- (ii) Railway freight of fencing materials
- (iii) Freight charges on imported breeding stock*
- (iv) Superphosphate freight, enabling superphosphate to be landed in Darwin at the same cost as the landed Townsville price**
- (v) The cost of nursing sisters and schools on stations.

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* Discontinued as of 1/7/73.

** Discontinued as of 1/7/73.

(4) Other assistance

(i) Provision and maintenance of roads
(ii) Motor registration benefits
(iii) Education allowances
(iv) Rebate of duty on diesel fuel
(v) Accelerated depreciation allowances above those available in other states.

2.1.2 Other assistance to country areas

Locational subsidies are not unique to the N.T. There are many other examples of positive measures which have been taken to influence the location of industries. Richardson (34) has placed these in six categories -

(1) Publicity and the provision of information

(2) Services, infrastructure and social amenities

(3) Investment in education, retraining and natural resource development

(4) Direct inducements such as grants, loans or investment incentives

(5) Transport incentives

(6) Wage subsidies.

Coombs (13) has discussed the role of these locational measures in Australia. It was said (p.18) - "In addition to the financial assistance provided directly to the rural industries, producers in those industries, like all other residents of the non-urban areas benefit from a range of assistance measures designed to reduce the costs of goods and services in non-urban areas. This assistance takes a variety of forms, much of it by way of differential or reduced rates of charge for services by government or public authority business undertakings".

An example of this type of assistance quoted in the Coombs report is the Petroleum Products Subsidy Scheme. In this scheme subsidies have been paid to oil companies to reduce the wholesale price of motor spirit in rural areas to not more than 3.3 cents per gallon above city prices. According to Hoffman (17) the scheme aims to assist decentralization by reducing transport costs for country industries. The Coombs task force estimated the cost of the scheme in 1972-73 to be $25.8 million.

The Commonwealth Government also provides many other incentives to decentralize. These include losses on country postal and telecommunication services, zone allowances, rural air service subsidies etc. However those which favour a certain region rather than the whole of the non-metropolitan area are the ones of particular interest here. An example of this has been discussed by Van Dugteren (44). This is the Victorian rail freight scheme in which assistance is based on net locational freight disability which reduces freight costs to a nominal figure, thus minimizing the effect of freight charges on decentralized manufacturer's operating costs. Van Dugteren says that this is supposedly justified on the principle that further decentralization operations will cause increased rail traffic eventually showing marginal profitability from the low freight rates being offered.

Hence it is apparent that in the past both state and federal governments have made considerable efforts to influence the spatial distribution of various industries. The next step is to determine what effect the locational subsidies examined in this dissertation might have had on the efficiency of resource allocation in Northern Australia.

2.1.3 Effect of locational subsidies on resource allocation

It must be asked what effect the numerous forms of assistance available in the N.T. might have had on the efficiency of resource allocation in the North?

Heady (16) has discussed this question of the spatial pattern of resource allocation. He says (p.639), "A maximum national product is forthcoming from given resources only as mobile resources (capital and labour) are applied to immobile resources (land) in a geographic pattern which allows the greatest economic product to each unit of mobile resource". This is to say that the marginal value productivity must be equal for each use in which a unit of mobile resource is employed. Hence if by reshuffling resources -

(1) within holdings,

(2) between holdings in the same area,

(3) between areas, or

(4) between agricultural and non-agricultural industries, total economic product can be increased, then we must conclude that resources have been inefficiently allocated.

This is a situation which can easily occur when a particular region is provided with special incentives. Heady (16) has analysed such a situation. He says (pp.640-648) the nature of agricultural production in any area depends on -

(1) The physical production possibilities i.e. the production function, and

(2) the commodity-factor price ratios.

The latter are determined by transportation costs which are mainly a function of distance but can be affected by institutional considerations such as subsidies.

Heady (p.653) compares two situations which have identical production functions, but in one case a crucial factor is subsidized. These are shown in Figure 2.1.

In figure 2.1 (A) we have two situations. Where the input is unsubsidized the average cost and marginal cost curves are represented by AC_a and MC_a respectively. A rational producer would produce Y_a in this case. Where the factor is subsidized the average cost curve falls by the amount of the subsidy to AC_b, and it would be rational to produce Y_b of product. Given identical production functions as shown in figure 2.1 (B) it can be seen that the marginal product of the input will be different at the two locations. By using more of the input at location A, and less at location B, the total product could be increased. Hence it must be concluded that the resource has been inefficiently allocated between the two locations due to the existence of a subsidy on the input at one of the locations.

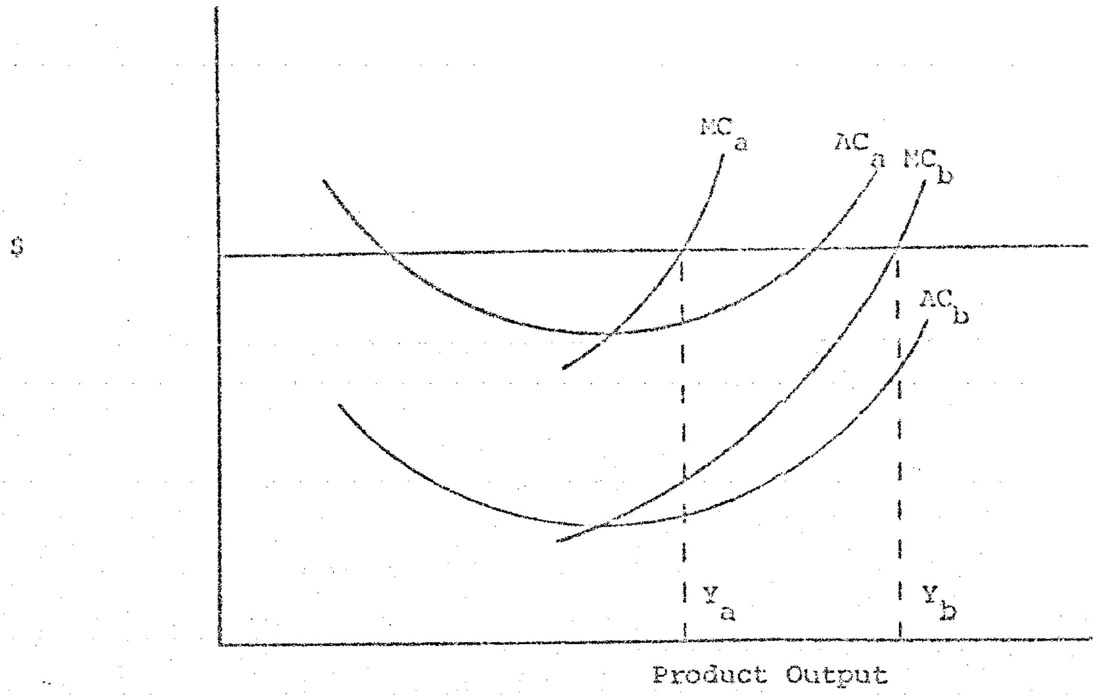

Fig.2.1(A)

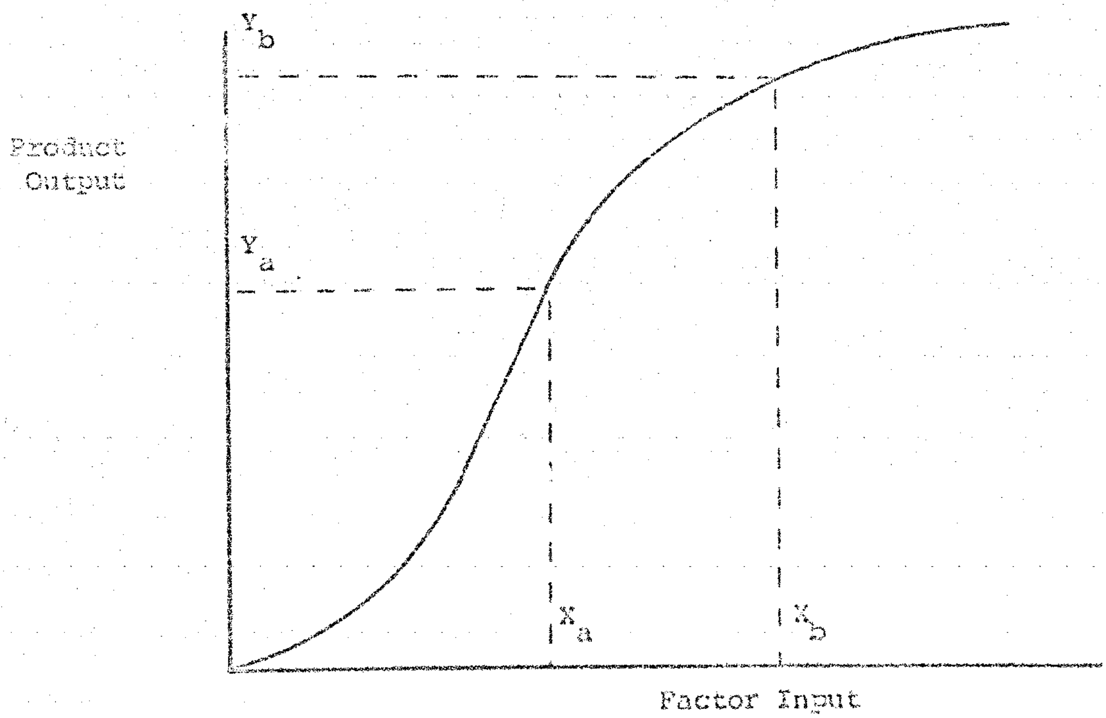

Fig.2.1(B)

FIGURE 2.1

Effect of input subsidization on product output

Davidson (14) has also discussed this matter. He says that return to farmer's capital cannot be used as a measure of the efficiency of resource use in any area. He says, "The efficiency with which resources are used in any region can only be measured by finding the unsubsidized return to all of the resources used, including those provided by the state, after deducting the unimproved value of land from the capital invested in agriculture".

This implies that because rural enterprises in a particular area are profitable, this does not necessarily mean that they are efficient from the national economic viewpoint. Davidson defines the efficiency of farming as the difference between the value of the output obtained and the costs of the variable resources used as a percentage of the capital used, when resources and capital are valued at their opportunity cost. This differs from farm profit because -

(1) farmer's profit includes subsidies and protection from competition,

(2) farmers must count the unimproved value of their land as part of their capital, but the nation need not, as it has no opportunity cost from the nation's point of view, and

(3) any capital supplied by the state to farmers must be included at opportunity cost.

Davidson defines the unimproved value of land as its sale value in the natural state. Provision of transport facilities, improvements in technology, price increases or factor cost decreases all increase unimproved value.

Hence the efficiency of farming is -

$$\frac{\text{Total Revenue} - \text{Price Protection and Subsidies} - \text{Annual Costs} - \text{Production Subsidies}}{\text{Farmer's Capital} + \text{State Capital} - \text{Unimproved value of land}} \times \frac{100}{1}$$

By making interregional comparisons on this basis Davidson concluded that the nation's resources were being used most efficiently in the extensive pastoral zone and least efficiently in the more intensive areas where there was considerable subsidization and provision of large amounts of capital by the state for irrigation works etc.

Looking at the problem in this way, it is apparent that the non-use of land in the King Edward-Drysdale Country in the past may have been a more efficient way of allocating resources than has been the case in the N.T. According to Davidson's analysis the existence of special incentives and a superior transport infrastructure in the N.T. may have increased the profitability of the cattle industry in the N.T. but it could do nothing to improve its efficiency.

Campbell (10) has also discussed the question of input subsidization in the N.T. He criticized the recommendations of the Forster Committee which originally suggested that the superphosphate transport subsidy be introduced. Campbell said that the Forster Committee, in evaluating the prospects for agriculture in the N.T. rejected conventional economic criteria by not considering whether investment in other parts of Australia would not bring greater benefits to the nation. This is to say that the recommendation to introduce the subsidy was made in the light of regional, rather than national economic goals.

Campbell goes on to say, "...why should the price of superphosphate be uniform or nearly so at all the major parts of Australia as the Committee's discussion seems to imply? If the general principle stated is to be applied consistently, why should not farmers in the more remote areas of all parts of the Commonwealth receive subsidies covering their inward and outward freight charges? The whole basis of comparative advantage and of economic production hinges on the existence of "disabilities", some physical in nature, some economic in nature. It is unreasonable to expect that even in the longer run all the economic disabilities will disappear - that the disadvantages relative to other parts of Australia are temporary".

Hence it is apparent that the existence of regional assistance schemes such as those available in the N.T. are likely to have impaired the efficiency of resource allocation in Northern Australia.

2.1.4 Effect of locational subsidies on the pattern and intensity of land use

At any given distance from a source of input supplies and an abattoir more of the subsidized inputs have been used in the N.T. than in W.A. i.e. the land has been used more intensively. If the effect of distance from the abattoir and supply point is also considered it is apparent that the area of profitable production extends further where crucial inputs are subsidized. With increasing distance from the input supply and marketing centre the average cost and marginal cost curves will rise, and the price line will fall, so production will become less and less intensive. Eventually the point is reached where average cost is greater than average revenue for all input levels, and it will not be profitable to engage in this activity at all. This point is known as the extensive margin of production. It is assumed that in Northern Australia costs and revenue are linear functions of distance from the abattoir and supply centre. Costs are lower over the full range of distance in the N.T. due to input subsidization, and figure 2.2 shows the effect of this on the location of the extensive margin of production.

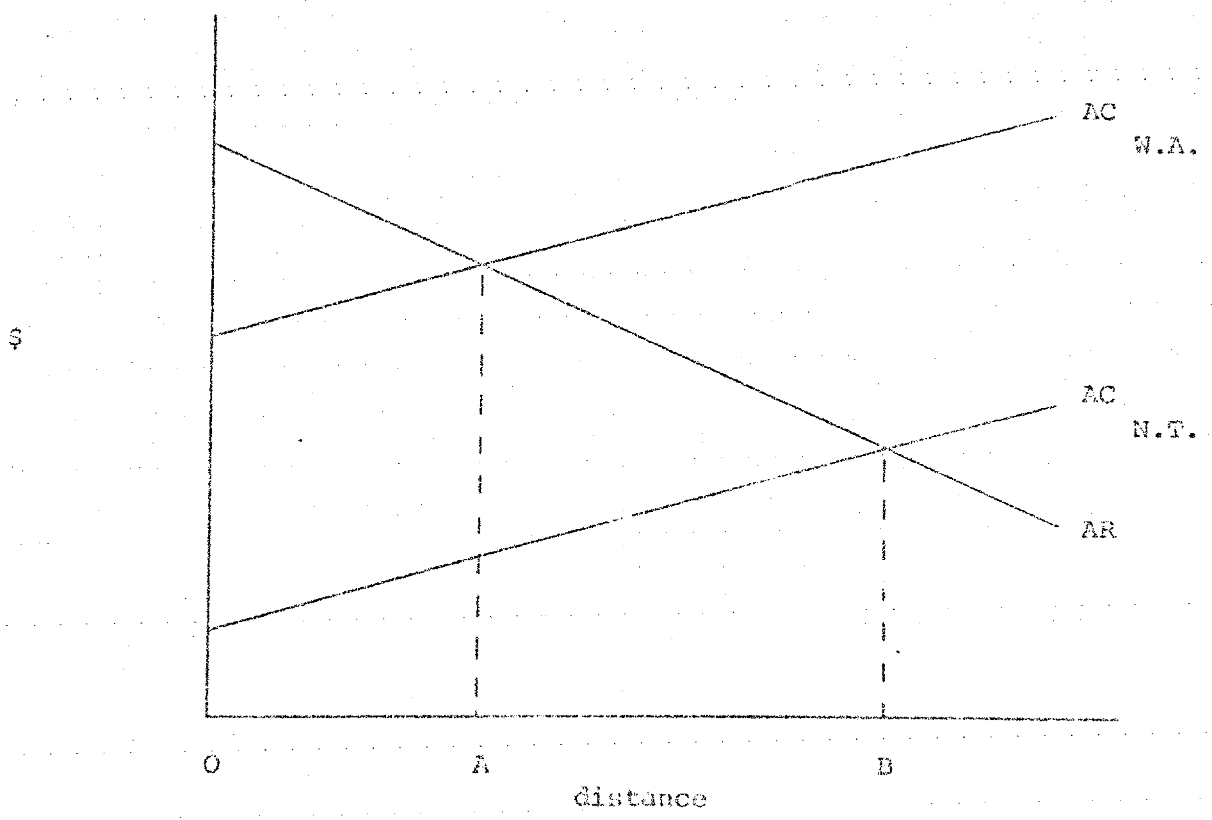

FIGURE 2.2

Effect of input subsidization on the location of the extensive margin of production

It can be seen that in W.A. production is only profitable up to a distance of OA from a supply/abattoir centre, whereas in the presence of input subsidies in the N.T., production is profitable up to a distance of OB.

This analysis explains in economic terms, how the existence of locational subsidies in the N.T. may have influenced the pattern of land use in Northern Australia. It has explained how an area such as the King Edward-Drysdale Country could have remained virtually unused, whereas similar areas in the N.T. have undergone considerable development. It has also been shown that by influencing the spatial pattern in this way the efficiency of resource allocation is theoretically impaired.

It is now appropriate to state the hypothesis to explain why the area has not attracted development capital at a rate comparable with the N.T.

The hypothesis is -

(1) The development of the King Edward-Drysdale Country has been retarded in relation to similar areas of the Northern Territory due to poor prospects for profit in the cattle industry.

(2) The poor prospects for profit have been due to institutional and location factors, particularly -

(i) The absence of a direct road link with the Wyndham-Kununurra area.

(ii) The absence of a port on the North coast of the area.

(iii) The absence of a superphosphate freight subsidy of the type which has been available in the N.T.

(iv) The absence of a subsidy on the cost of introducing breeding stock of the type which has been available in the N.T.

The next four sections (2.2 to 2.5) explain why these four factors have been chosen to account for the apparently poor profitability of cattle raising in the area relative to similar areas in the N.T.

2.2 The Importance of a Road Link with the Wyndham-Kununurra Area

The construction of a road from the King Edward-Drysdale Country to Wyndham would reduce the distance to a port and abattoir from the present 360 miles (to Derby) to 260 miles (to Wyndham). This would reduce the cost of transporting bullocks to the abattoir from $13.50 per head to $9.75, a saving of $3.75 per head.

The vital importance of roads in the Northern Australian cattle industry has been pointed out on a number of occasions. For example, a publication by the Department of National Development (4) states -

"Vast distances and remoteness from the main centres of consumption have made the beef cattle industry in Northern Australia exceptionally reliant on transport for the integration of store cattle production and fattening, and for the delivery of cattle in good condition at the main export meat works and domestic outlets..."

"In the past lack of efficient transport has been one key factor inhibiting the development of cattle properties and delaying the introduction of better management practices".

Similarly, the Forster Committee (15) which reported on prospects for agriculture in the N.T. in 1960 said -

"Any means by which transport costs can be reduced, including public works in the form of roads, railways and airfields should be accepted as one of the major contributions which the Commonwealth Government can make to the development of the N.T."

Kelley (21) has commented directly on the importance of transport facilities in the North Kimberley area. He said, "...areas of zone 10 (the North Kimberley) could be developed for cattle production if, amongst other things suitable facilities were provided for the outward movement of cattle to markets and the inward movement of station supplies".

These comments partially explain why the author has chosen the absence of a road link with the Wyndham-Kununurra area as one of the components of the hypothesis. However, there is another reason unrelated to the simple reduction in distance from a port and abattoir which has caused the author to include this factor. The construction of this link would bring the King Edward-Drysdale Country into the influence of the Ord River Irrigation project centred on Kununurra.

Direct access to the Ord irrigation area has important implications for the North Kimberley cattle industry. The Ord Project Co-ordinating Committee (30) carried out a detailed investigation of the prospects for integrating the Kimberley cattle industry with the Ord project. It star d that -

"Improved roads and vehicles should be a factor in lifting turnoff from all properties whether outlying or adjacent to the irrigation area. They will facilitate turnoff of culled female cattle and young stores, encourage cattle movements between outlying stations and those adjacent to the irrigation area, and facilitate the carriage of feedstuff supplements and stock from the irrigation area to cattle properties".

The Cattle Integration-Sub Committee said that prospects for more intensified cattle production in conjunction with the Ord project were especially good where there were significant areas suitable for pasture improvement. This is the situation in the King Edward-Drysdale Country. The system envisaged by the committee was one where cattle would have access to Townsville Stylo pastures and be turned off to fattening enterprises as yearlings.

Blunt (7) has also discussed the prospects for cattle production on the Ord based on supplies of store cattle from the Kimberley stations. He concluded at at May 1973 prices, beef production on irrigated pastures could be profitable.

Hence with further improvements in pasture technology, and availability of better quality store cattle it seems that cattle fattening could become attractive to Ord farmers in the near future, and a considerable demand for young store cattle could develop. Only stations with good access to the farming area would be able to take advantage of this demand.

2.3 <u>The Importance of a Port on the North Coast of the Area</u>

There are two separate reasons for including this factor in the hypothesis. The first of these is the well known importance of transport facilities in Northern Australia which was discussed in the preceding section. The second reason is that a port is actually proposed for the area, so that including this factor means that the result of testing the hypothesis will have some predictive value.

It is proposed that a township of 3,000 people and port facilities be built at Port Warrender in the Admiralty Gulf to service the proposed development of a bauxite mining and alumina production complex on the Mitchell Plateau. This would mean that the centre of the King Edward-Drysdale Country would be within about 60 miles from a port, an improvement of 300 miles over the present situation. This would greatly reduce the cost of freight on inputs, particularly the large tonnage of superphosphate required for the establishment and maintenance of Townsville Stylo pastures. However it would not reduce cattle marketing costs except for the small numbers supplied directly to the township.

It is unlikely that an export meatworks would be established at Port Warrender. Parsons & Guise (31) in their analysis of the cost of operation of Australian export abattoirs, have shown that costs associated with the capital investment (interest and depreciation) are highly responsive to annual throughput capacity where this is less than 60,000 Cattle Equivalents (CE's) per annum. Beyond this, unit cost savings from establishing abattoirs capable of attaining higher annual throughputs are not very large. This position is summarized in Table 2.1 taken from Parsons & Guise (p.53).

TABLE 2.1

Annual Cost of Total Capital Investment per Cattle Equivalent (CE) Unit: Australian Export Abattoirs: 1964-65

Ave. monthly % Utilization of Capacity	Annual Throughput ('000 CE)						
	20	40	60	80	100	160	220
25	$5.22	$3.20	$2.53	$2.20	-	-	-
45	$4.69	$2.67	$2.00	$1.67	$1.47	$1.16	
65	$4.49	$2.47	$1.80	$1.47	$1.27	$0.96	$0.83

Table 2.1 shows that investment in an abattoir with a slaughter capacity of less than 60,000 CE's per annum is unlikely to be attractive. Maximum attainable turnoff from the King Edward-Drysdale Country under two management systems is shown in Table 1.4. Under yearling turnoff only 49,487 head would be turned off from the whole area, insufficient to justify the construction of an abattoir according to Parsons & Guise's analysis. If the whole of the area was fully developed for bullock production, total turnoff would be 178,896 head, of which 124,779 would be slaughter cattle. This would be sufficient to reduce the capital cost per unit of annual throughput to a level where the establishment of an export abbatoir could be an attractive proposition.

However, as shown in figure 3.4, even if development commenced immediately, it would be more than ten years before this level of turnoff was achieved. In the interim slaughter cattle for an export abattoir would have to be drawn from the established cattle raising areas several hundred miles to the South. This would place it in a poor competitive position in relation to the existing abattoirs at Wyndham and Derby. Thus in the foreseeable future, marketing alternatives for slaughter cattle appear to be limited to these existing plants.

The importance of cheap superphosphate to the development of Townsville Stylo based cattle enterprises in Northern Australia has often been stressed. The report of the Ord Cattle Integration Sub-Committee (30) said that the high cost of superphosphate was a critical limitation to the improvement in productivity of many Kimberley stations. Similarly, the N.T. Phosphate Consultative Group (28) in commenting on the possibilities for pasture improvement in the higher rainfall areas has said, "...little progress has so far been made towards more intensive land use in part because of the extremely high cost of superphosphate".

Thus it seems that the construction of a port to serve the Mitchell Plateau bauxite industry would greatly enhance the prospects for developing a viable cattle industry in the area due to the reduced on-station cost of inputs, especially superphosphate.

2.4 <u>The Absence of a Sea Freight Subsidy on Superphosphate</u>

It has been pointed out that without superphosphate fertilized Townsville Stylo pastures the King Edward-Drysdale Country is only moderate to poor grazing land. It is not likely that a successful cattle project could be run on native pasture alone.

From the preceding section it is apparent that profitability is highly sensitive to the on-station cost of superphosphate. Users of superphosphate in the North of W.A. must pay sea freight of about $40.00 per ton to transport it from Perth to a Northern port. However, until recently, in the N.T. there has been a subsidy paid on the differential between the landed price of superphosphate in Darwin and Townsville. Coombs (13) has discussed the operation of this subsidy. The Coombs report says that the objective has been to encourage the use of superphosphate in the Northern Territory. The rationale of the subsidy was that the price of superphosphate was of critical importance to the development of improved pastures on pastoral properties. The Coombs report also estimated the cost of the subsidy scheme over the period 1968-69 to 1972-73, as shown in Table 2.2.

The Coombs report recommended that the subsidy be abolished. It said that there was no comparable scheme elsewhere in Australia, and that it was doubtful whether it was in the interests of the nation as a whole to provide a subsidy of this kind to producers in a particular area. As a result of the Coombs report recommendations the scheme was abolished from the beginning of the 1973-74 financial year. However, it is likely that during the years of its operation it had a considerable influence on the pattern of land use in Northern Australia. The theoretical basis for this assertion has been described in sections 2.1.3 and 2.1.4. It therefore seems reasonable to hypothesize that the absence of a sea freight subsidy on superphosphate in W.A., and the presence of such a subsidy in the N.T., partially explains the very different rates of pastoral development in the two areas.

TABLE 2.2

Cost of the Superphosphate Transport Subsidy in the Northern Territory

Year	Expenditure
1968-69	$ 23,162
1969-70	$ 60,127
1970-71	$ 55,173
1971-72	$194,243
1972-73 [a]	$156,500
1973-74 [b]	$200,000
Total for 6 years	$689,205

(a) Estimated

(b) Forecast expenditure if the scheme had been continued

2.5 The Absence of a Subsidy on the Cost of Introducing Breeding Stock

In section 1.4.2 the importance of introducing Zebu cattle to the area was stressed. However, to date very few Zebu cattle have been introduced into W.A., whereas in the N.T. there have been large numbers imported from Queensland in the last six or seven years. Not only is the N.T. much closer to the coastal areas of Central Queensland, which is the main source of supply of *Bos indicus* cattle, but the N.T. cattle enterprises have enjoyed substantial freight subsidies on cattle introduced from other states. Until recently a subsidy of up to $70.00 per head has been paid on the cost of introducing bulls, cows, stallions and mares provided they had been purchased for a certain minimum price. This subsidy has not been available in W.A. The Coombs reports estimated the cost of operating the scheme over the period 1968-69 to 1972-73, as shown in Table 2.3.

TABLE 2.3

Cost of the Freight Subsidy on Breeding Stock in the Northern Territory

Year	Expenditure
1968-69	$174,627
1969-70	$244,941
1970-71	$129,481
1971-72	$ 99,822
1972-73 [a]	$100,000
Total for 5 years	$748,871

(a) Estimated

The Coombs report says that the subsidy was introduced in 1949 for the purpose of encouraging the purchase of high quality breeding stock on the assumption that in the absence of this assistance pastoralists would not have considered such purchases worth while. The Coombs task force considered that such a subsidy was no longer necessary and recommended that it be abolished. This was done as of the beginning of the 1973-74 financial year.

Since the main supplies of Zebu cattle are in Eastern Queensland, prospective investors in the North Kimberley cattle industry have suffered a distinct disadvantage when compared with their N.T. counterparts in having to transport suitable stock further, and without a freight subsidy.

Hence it seems reasonable to suggest that the absence of this subsidy partially explains why development of the cattle industry in the King Edward-Drysdale Country has not been as attractive to investors as similar areas in the N.T.

The two subsidies described above have been chosen from the numerous forms of assistance mentioned in section 2.1.1, as those most likely to account for the difference in profitability between the Top End of the N.T. and the King Edward-Drysdale Country. This assessment was based on the opinions of cattlemen and professional agriculturists in the North, who considered that these subsidies were the two most powerful forms of assistance.

The next chapter explains the methodology which is used to test the hypothesis, and gives a detailed description of the model.

CHAPTER 3

THE MODEL

3.1 Methodology

3.1.1 The Rationale

3.1.2 The Model

3.2 The Development Concept

3.3 Construction of the Model

3.3.1 The static herd solutions

3.3.2 The herd projections

3.3.3 Cash flows from cattle trading

3.3.4 Capital and operating budgets

3.3.5 Calculation of freight charges

3.3.6 Calculation of performance criteria

3.1 Methodology

Having given "prima facie" reasons why each of the four elements of the hypothesis have been included, it is now appropriate to explain how the hypothesis is to be tested.

3.1.1 The rationale

The first part of the hypothesis (which states that capital has not been attracted to the area due to poor prospects for profit in the cattle industry) can be tested by building a budgetary model of a hypothetical station, to determine whether the proposition would be attractive to an investor who had the option of allocating his capital to any other project in the Northern cattle industry.

If the model does not generate adequate profit, then this will explain why very little of the capital which has been invested in the Northern cattle industry has been attracted to the King Edward-Drysdale Country. If a reasonable profit is generated, then the first part of the hypothesis will have been disproven, and it will be concluded that the non-development of the area is due to some market imperfection.

If the first part of the hypothesis is upheld, the author will then test the four parts of the hypothesis which explain why cattle raising in the area has presented relatively poor prospects for profit compared with the Top End of the N.T. This will be done by modifying the model to account for every combination of the following situations -

(1) Road or no road

(2) Port or no port

(3) Superphosphate freight subsidy or no subsidy

(4) Livestock freight subsidy or no subsidy.

Two alternative management systems, bullock turnoff and yearling turnoff, will also be considered, so that the benefits of having direct access to the Ord project can be fully realized. Hence there will be 32 different budgetary variations - two management systems x two road situations x two port situations x two livestock freight subsidy situations x two superphosphate freight subsidy situations. These are set out in figure 3.1.

(In addition, the effect of positive and negative deviations of beef prices from the assumed level are assessed by the inclusion of a beef price sensitivity analysis. This is outlined in detail in section 4.4).

If none of the 31 variations of the basic budget lift the level of profitability of beef production to a level comparable with similar areas in the N.T., then the hypothesis that these factors have caused the poor profitability, will have been disproven. However, if any or all of the 31 variations on the original budget cause the establishment of a cattle station in the area to appear attractive to investors, then the hypothesis will be partially or totally upheld. It will then be apparent which of the four factors have been the most powerful constraints on development in the past, and which, if removed, would be the most powerful catalysts to development in the future.

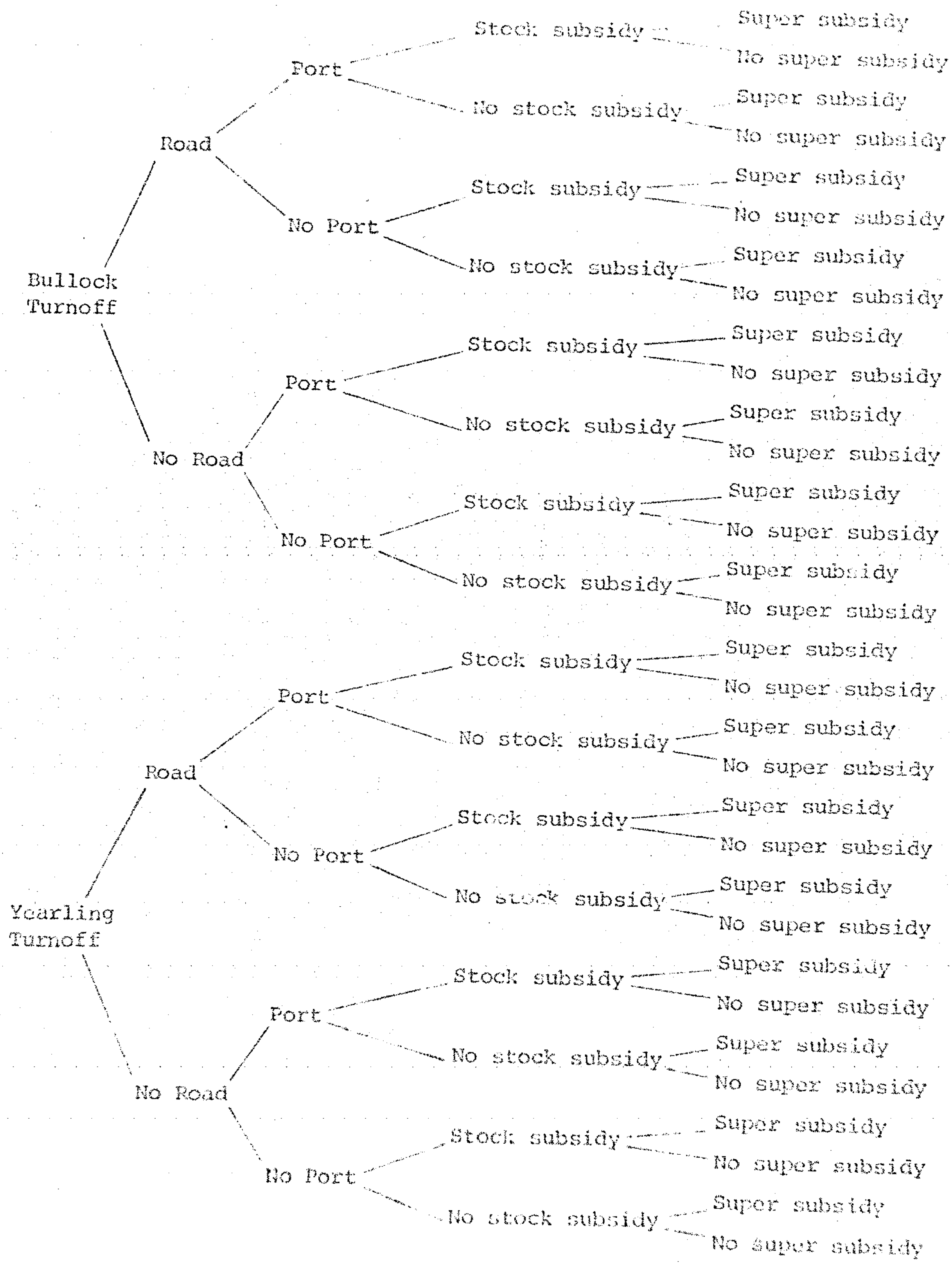

Figure 3.1
Chart of the Thirty-two Different Budgetary Situations

3.1.2 The model

The basic form of the model is a budgetary projection of the pattern of cash flows from the present time to infinity, for what the author considers to be a typical cattle station in the area.

The budgets are for an extensive cattle station based on the use of Zebu cattle with access to Townsville Stylo pastures in the dry season. After the initial livestock purchases, herd buildup is unconstrained until the ceiling carrying capacity of 10,000 Adult Equivalents is reached. After this there is selective culling until the age and sex structure of the herd is such that it can maintain itself in this state perpetually.

Townsville Stylo establishment continues throughout the period of herd buildup, and levels of animal performance improve as pastures become better, and the Zebu proportion increases.

The output of the budgetary analysis is a stream of cash flows for each of the 32 budgetary situations. From these cash flows the following performance criteria are calculated -

(1) Net Present Value (NPV) at 5% and 10% discount rates

(2) Internal Rate of Return (IRR)

(3) Cash Surplus (Deficit) (CS/CD) at 20 years

(4) Payback period (PBP).

These will indicate how attractive each of the 32 situations would be to a prospective investor.

A complete description of the model, the assumptions underlying it, and the output are presented in sections 3.3.1 to 3.3.6.

3.2 The Development Concept

The development concept is based on experience gained from Townsville Stylo based cattle projects in the Top End of the N.T., and from experience to date with the two existing cattle stations in the King Edward-Drysdale Country.

The aims of the study can best be achieved by building a model of a typical development oriented station of the type found in the Top End of the N.T., and resembling the two existing stations in the area.

Information for the construction of the model was gained from several sources, viz -

(1) The author's own experience gained while working on cattle stations in the Kimberley area and the Top End of the N.T.

(2) Budgets, records and reports from Doongan and Mitchell River Stations in the King Edward-Drysdale Country.

(3) Budgets, records and reports from development projects in the Top End of the N.T.

(4) Discussions with agricultural consultants who have been active in the area.

(5) Publications on the economic and managerial aspects of the Northern Australian cattle industry (8), (9).

The project envisaged has the following characteristics when fully developed -

(1) An area of 1,000 square miles (640,000 acres).

(2) A herd of 10,000 Adult Equivalents (A.E.'s) of cattle.

(3) An area of 50,000 acres of Townsville Stylo pasture, fertilized every second year.

(4) Controlled mating and weaning.

(5) All cattle are mustered twice per year.

(6) All cattle are high grade (i.e. greater than one half) Brahman.

(7) Two management strategies are analysed - bullock turnoff and yearling turnoff.

3.3 Construction of the Model

The basic form of the analysis is a deterministic budgetary examination of the flow of costs and returns which are expected to occur during the period of property development and herd buildup to the static state. The budgetary model is built up in a series of steps, each based on a number of assumptions. Each of these steps is described in the following sections 3.3.1 to 3.3.6.

3.3.1 The static herd solutions

Finding the static herd composition is the first step in the economic evaluation of any animal breeding enterprise. The static herd composition is that combination of age and sex categories which is able to perpetuate itself and generate a constant Net Cash Flow. The total net productivity of the herd is sold, and no animals are retained for herd expansion. The grazing pressure exerted by a static herd does not change from year to year, although there are seasonal fluctuations within years. The static herd represents the equilibrium end point of the development programme, although when it is being derived it is not known how long it will take to reach this point.

To derive the static herd, assumptions must be made regarding -

(1) Weaning percentages for the progeny of each age category of cows in the herd.

(2) Mortality rates for each age and sex category.

(3) Mating ratio.

(4) Turnoff and culling rates for each age and sex category.

(5) The maximum carrying capacity of the property.

(6) The grazing pressure in A.E.'s exerted by each age and sex category in the herd.

These assumptions are set out in Appendix A. The procedure followed to determine the static herd composition for each of the management systems is shown in flowchart form in Figure 3.2. and described in the following paragraphs.

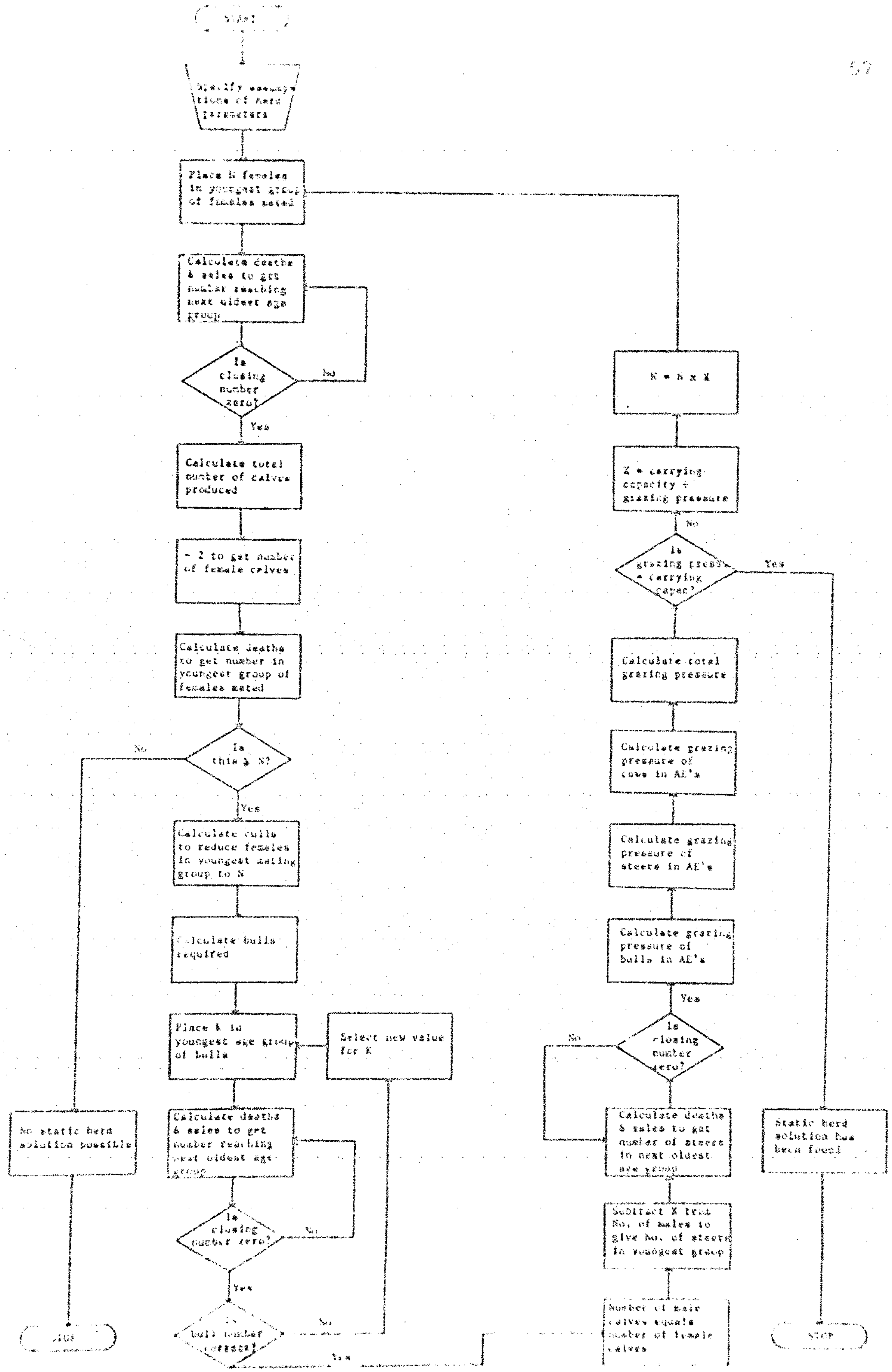

Figure 3.2

Flowchart for Static Herd Solution

The first step is to find the youngest age group of females to be mated and place some arbitary number, N (say 1,000) in this age group. Using the age specific mortality and culling rates, then calculate how many of these females will reach the next oldest age group. This procedure is then repeated for consecutively older age groups, until the age group is reached where all of the surviving cows are culled for age, and the closing number is zero.

Having determined the age structure of the adult female herd, the next step is to calculate the number of calves produced using the age specific weaning percentages. As half of the calves are females, the next step is to calculate the heifer mortalities to get the number reaching the youngest group of females mated. If this is less than N the procedure is terminated as the assumptions of herd parameters chosen cannot possibly give rise to a static situation. If the number is greater than N, the number of culls required to reduce this number to exactly N, is calculated.

Using the mating ratio specified in the assumptions, the number of bulls required is then calculated. The next step is to place an arbitrarily chosen number, K, in the youngest age group of bulls. Using the age specific culling and mortality rates the number of bulls reaching each of the older age groups is then calculated. This procedure is repeated until the age group is reached where all of the surviving bulls are culled for age. The total number of working age bulls is then calculated and compared with the number of bulls required. If the two are not equal, the value of K is adjusted until the actual number of working bulls is equal to the requirement.

The final value of K which is arrived at is then subtracted from the number of male calves to give the number of steers in the youngest age group. Using the age specific mortality and turnoff rates for steers, the number of steers reaching each of the older age groups is then calculated until all of the steers have been turned off. (In the case of the bullock turnoff system this is the 4-5 year old group, and in the case of yearling turnoff this is the 1-2 year old group).

The total grazing pressure exerted by the herd is then calculated by adding together the grazing pressure of each of the sex categories. If this grazing pressure is equal to the specified maximum carrying capacity (which is 10,000 A.E.'s in this case), then the static herd solution has been found. If this is not the case then the carrying capacity is divided by the grazing pressure to give a ratio, X. The number of females in the youngest age group of females to be mated (N), is then multiplied by X, and the whole procedure is repeated until the static herd composition is found.

This has been carried out for two separate herd management systems, bullock turnoff and yearling turnoff. These are identical except for the assumptions regarding turnoff age of steers, but the resultant static herd compositions are markedly different. These are shown in Tables 3.1 and 3.2 on pages 60 and 61.

Notable differences include the much higher proportion of females in the herd, and the greater number of steers sold, in the case of yearling turnoff than for bullock turnoff.

TABLE 3.1

Static Herd Solution for Pure Brahman Herd

of 10,000 A.E.'s with Bullock Turnoff

Age	Open No.	Natural Increase	Deaths	Sales	Close No.	Adult Equivalents
I COWS						
0-1		1425			1425	570
1-2	1425		43	713	669	838
2-3	669		40		629	649
3-4	629		38		591	610
4-5	591		29		562	576
5-6	562		28		534	548
6-7	534		21		513	523
7-8	513		31		482	497
8-9	482		34		448	465
9-10	448		36	412	-	224
	5853	1425	300	1125	5853	5500
II STEERS						
0-1		1362			1362	544
1-2	1362		69		1293	1062
2-3	1293		51		1242	1267
3-4	1242		37	602	603	923
4-5	603		18	585	-	302
	4500	1362	175	1187	4500	4098
III BULLS						
0-1		63			63	31
1-2	63		3		60	55
2-3	60		3		57	70
3-4	57		3	3	51	64
4-5	51		3	2	46	58
5-6	46		2	2	42	53
6-7	42		2	2	38	48
7-8	38		2	36	-	23
	357	63	18	45	357	402
TOTALS	10,710	2,850	493	2,357	10,710	10,000

TABLE 3.2

Static Herd Solution for Pure Brahman Herd
of 10,000 A.E.'s with Yearling Turnoff

Age	Open No.	Natural Increase	Deaths	Sales	Close No.	Adult Equivalent
I COWS						
0-1		2039			2039	815
1-2	2039		61	1021	957	1198
2-3	957		57		900	928
3-4	900		55		845	872
4-5	845		42		803	824
5-6	803		40		763	783
6-7	763		31		732	747
7-8	732		44		688	710
8-9	688		49		639	663
9-10	639		51	588	-	319
	8366	2039	430	1609	8366	7862
II STEERS						
0-1		1949			1949	780
1-2	1949		58	1891	-	780
2-3	-					
3-4						
4-5						
	1949	1949	58	1891	1949	1560
III BULLS						
0-1		90			90	45
1-2	90		5		85	81
2-3	85		4		81	100
3-4	81		4	4	73	92
4-5	73		4	3	66	83
5-6	66		3	3	60	75
6-7	60		3	3	54	68
7-8	54		3	51	-	32
	509	90	26	64	509	578
TOTALS	10,824	4,078	514	3,564	10,824	10,000

3.3.2 The herd projections

Having determined what the end point of herd buildup will be, the next step in the budgetary analysis is to trace out the course of herd buildup to that point.

To do this a number of additional assumptions must be made regarding the herd parameters. In this case the parameters are assumed to change over time as the availability of improved pastures increases, and management techniques become more sophisticated. In addition, the female herd is divided into three breed categories -

(1) Shorthorns. These are local cattle purchased from the Kimberley district.

(2) Low grade Brahmans. These are cattle with less than one half Brahman blood. They are the progeny of Shorthorn cows crossed with seven-eighths or fifteen-sixteenths Brahman bulls.

(3) High grade Brahmans. These are cows with greater than one half Brahman blood. They enter the herd either by direct purchase from Queensland, or as the progeny of low grade Brahman cows crossed with Brahman bulls.

Each of these breed groups has a different set of performance parameters.

In addition, the steer herd is separated into two breed categories. These are -

(1) Shorthorns. These are the progeny of Shorthorn cows and Shorthorn bulls. They enter the herd only in the first year of the project.

(2) Brahmans. These include all steers which are not pure Shorthorn.

The different breed groups of steers have different turnoff and mortality rates.

There is only a single breed category of bulls. Initially all of the bulls purchased from Queensland are seven-eighths or fifteen-sixteenths Brahman. Later in the budget period the system generates its own replacement high grade Brahman bulls.

Hence for each age, breed, sex, year and management category the following parameters must be specified -

(1) Mortality percentage.

(2) Weaning percentage.

(3) Culling percentage.

(4) Turnoff percentage.

In addition, a starting position in terms of the age, breed and sex composition of the herd, as well as a purchasing policy must be specified.

These assumptions are set out in full in Appendix A.

Given this, the course of herd buildup to the static state can be traced out in detail by following the procedure shown in the flowchart in Figure 3.3, and described below.

In the livestock projections operations are performed in the following order -

(1) Year order. year 0, year 1, year 2 ... static year.

(2) Sex order. Females first, then steers, then bulls.

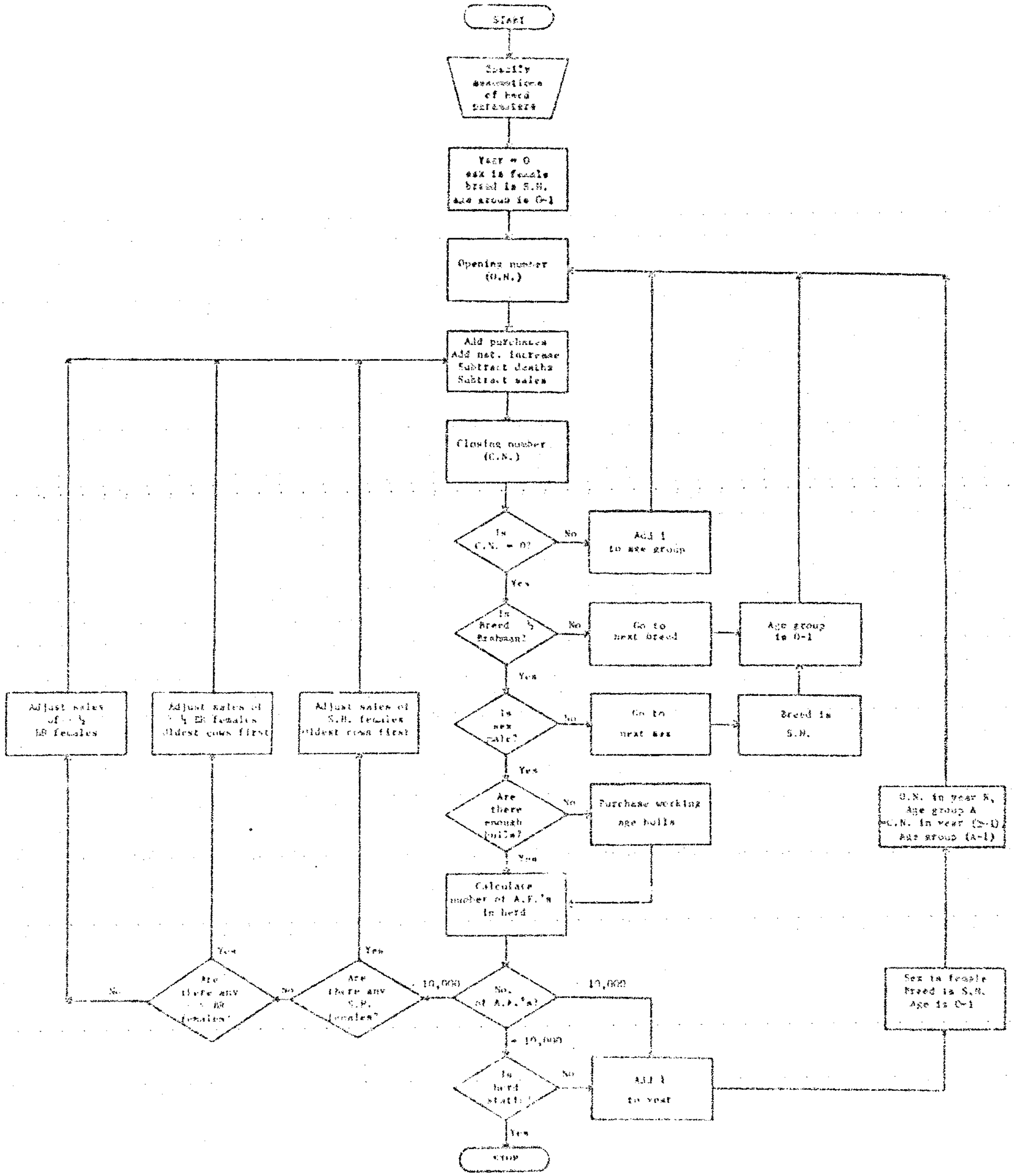

Figure 3.3

Flowchart showing the procedure for herd projections to the static state

(3) Breed order. Shorthorns first, then low grade Brahmans, then high grade Brahmans.

(4) Age order. Youngest age group first, oldest age group last.

Hence the first category which is looked at is the youngest age group of Shorthorn females in year 0. The number present at the start of the year is called the opening number. Purchases and natural increase are added to this, and deaths and sales are subtracted to give the number present at the end of the year which is the closing number. This is then repeated for each of the older age groups until the age group is reached where all of the surviving animals are culled for age, and the closing number is zero.

The next breed group (in accordance with the order specified above) is then chosen, and starting in the youngest age group, the process is repeated until all of the breed categories in that sex have been completed. Then the next sex group is chosen, and starting in the youngest age group and the first of the breed groups, the process of adding purchases and natural increase to the opening number, is repeated until the oldest age group in the last breed group of that sex category is reached. This is then repeated for each of the three sex categories in the order specified above.

A check is then taken to see that there are enough bulls. If more bulls are required, then additional working age bulls must be purchased.

The result so far is a complete description of the opening numbers, purchases, natural increase, deaths, sales and closing numbers of each age, breed and sex category for the year under consideration. The next step is to calculate the grazing pressure exerted by this herd. If this is equal to the maximum carrying capacity of 10,000 A.E.'s, the herd composition should be compared with that of the static herd. If they are identical, or nearly identical, the procedure is terminated and the livestock projection is complete. If they are not identical the whole procedure described so far is repeated for the next year. Similarly if the number of A.E.'s is less than 10,000 the procedure is to go to the next year. The opening number in each herd category in year N, age group A, is equal to the closing number in year (N-1), age group (A-1).

If the grazing pressure of the herd is greater than 10,000 A.E.'s, a selective culling policy must be introduced to reduce it to that level. The culling policy is that the oldest cows in the breed group with the lowest Brahman content are sold first. When all of the Shorthorn and low grade Brahman cows have been sold, high grade Brahman cows are sold from any age group which has greater than the number in the static herd.

Having calculated the number of cows which must be sold to reduce the grazing pressure to 10,000 A.E.'s, the sales and closing number of the appropriate categories are altered and the total grazing pressure again calculated to check that it is close to 10,000 A.E.'s. If the herd has reached its static composition the procedure is terminated. If not it is repeated for as many years as are necessary for the static state to be reached.

The results of herd projections for both bullock and yearling turnoff systems are shown in graphical form in Figures 3.4 and 3.5. Detailed summaries of the livestock projections are also presented in Appendix B. It is clear that the pattern of herd buildup and the final herd composition is quite different for the two management systems. It can be seen from Figures 3.4 and 3.5 that with bullock turnoff -

(1) The buildup of grazing pressure is more rapid than with yearling turnoff.

(2) The static herd composition is reached two years earlier than with yearling turnoff.

(3) The herd becomes purely high grade Brahman (and therefore more productive) two years earlier than with yearling turnoff.

(4) The peak in the number of females occurs two years earlier than with yearling turnoff.

This means that given identical starting positions, the system approaches equilibrium more rapidly under a bullock turnoff system than a yearling turnoff system.

3.3.3 Cash flows from cattle trading

Having derived the static herd composition, and traced out the course of herd buildup to that point, the next step in the budgetary analysis of the "typical" station is to determine the financial consequences in terms of cash flows from cattle purchases and sales.

In the first part of the financial analysis all operating expenditure is omitted. It consists simply of deriving cash flows from livestock trading for each of the management systems, by subtracting the value of stock

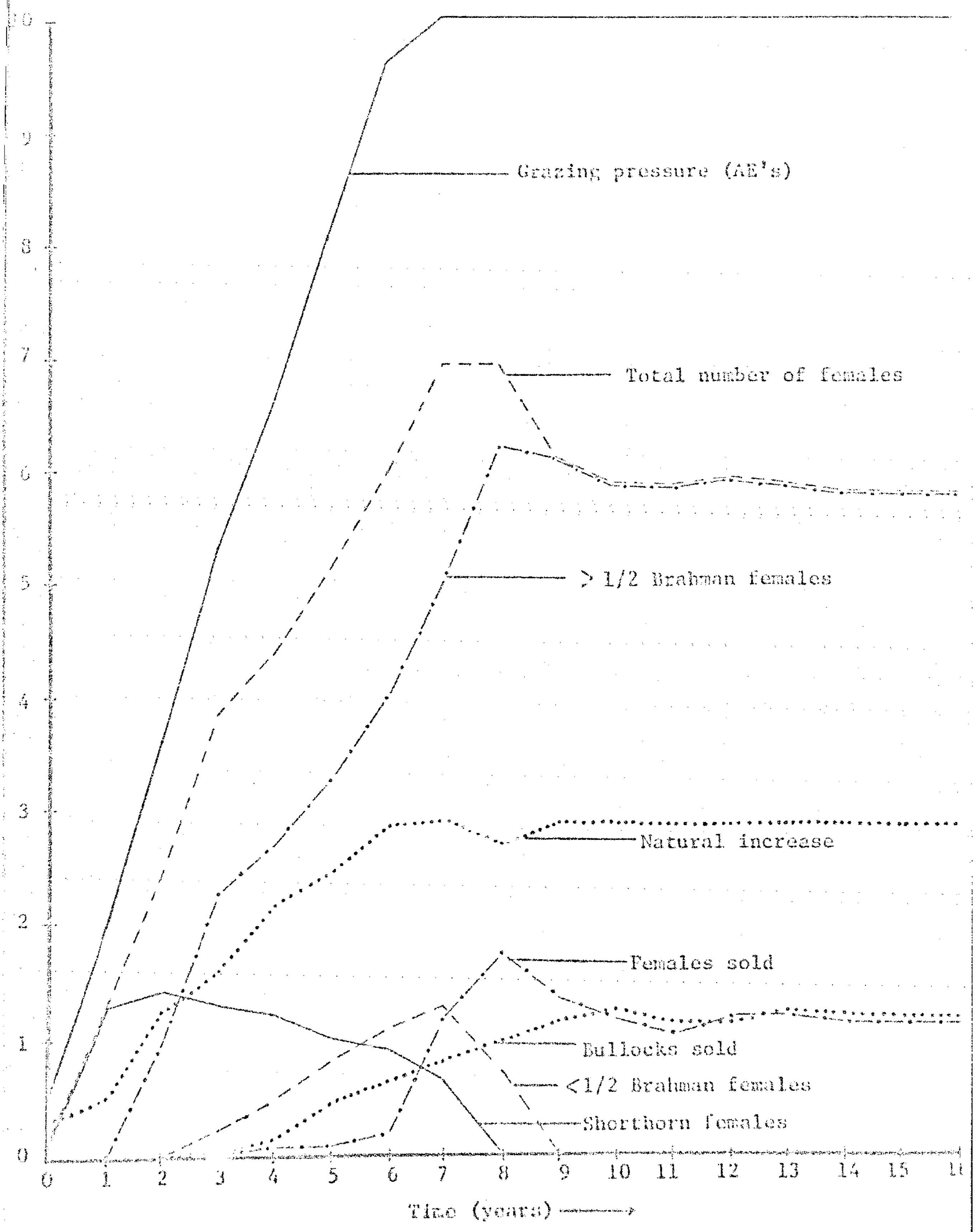

Figure 3.4 Herd Building to Static State - Bullock Turnoff

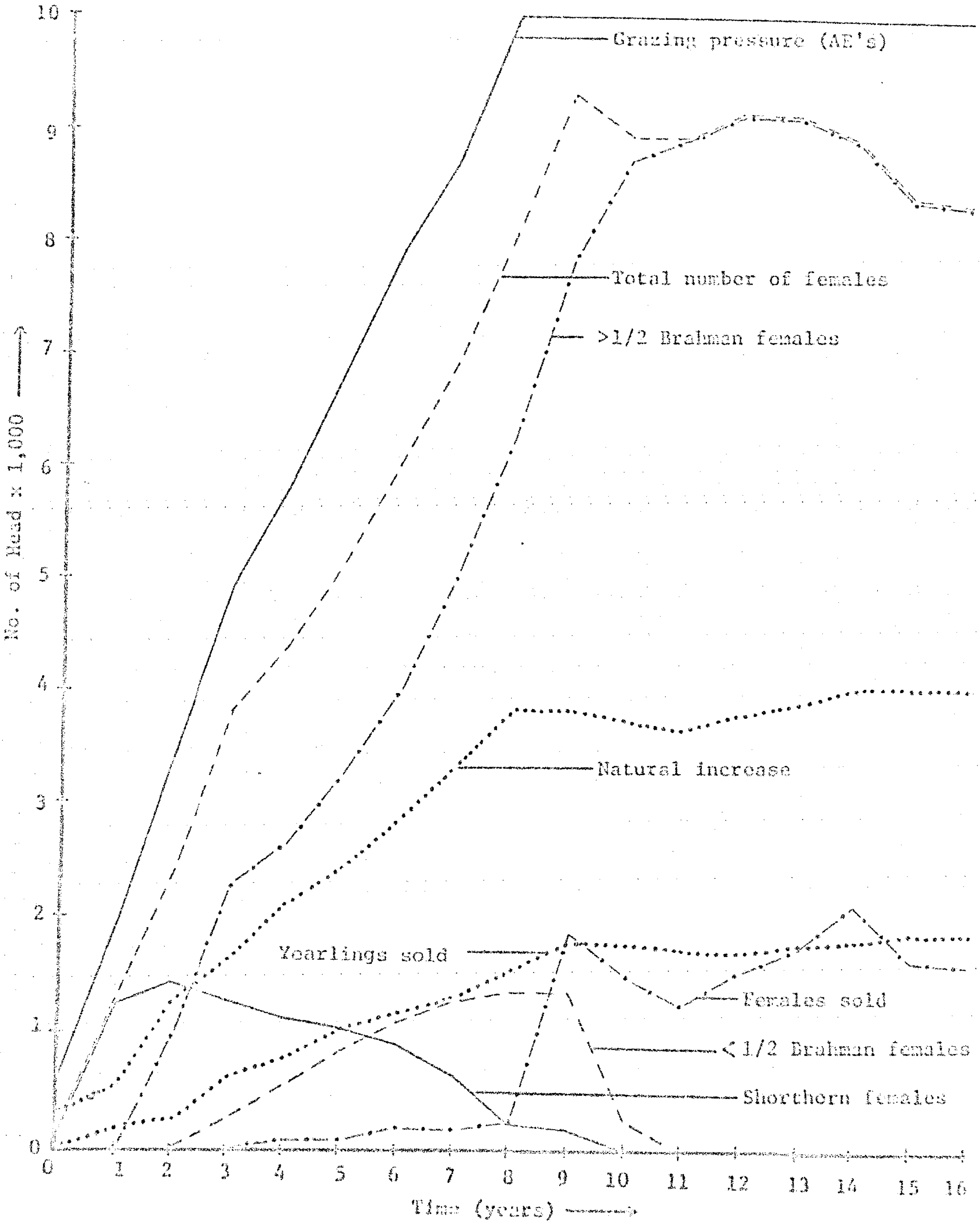

Figure 3.5 Herd Building to Static State - Yearling Turnoff

purchased from the value of stock sold in each year. The prices used are those which were prevailing in May, 1973 and it was assumed that prices remained constant into the future.

The results of the financial analysis, including the assumptions concerning carcase weights are shown in Appendix C. The cash flows from livestock trading are also shown in graphical form in Figures 3.6 and 3.7. Although in the case of yearling turnoff the cash flow in the static state is higher, and a positive cash flow is achieved earlier, the increase in the cash flow between these two points is more gradual than is the case for bullock turnoff. For yearling turnoff the cash flow from livestock trading does not reach the static level until year 13, whereas for bullock turnoff, except for a slight drop in year 11, the cash flow exceeds the static level from year 8 until the static state is reached in year 14.

This difference in the time pattern of cash flows has a strong effect on the relative attractiveness of the two management systems.

3.3.4 Capital and operating budgets

Given the complete physical data on herd buildup to the static composition, and the cash flows from livestock trading, the next step in the budgetary analysis is to build up capital and operating budgets for each of the management systems. Initially freight charges are omitted, since these are specific to each of the 32 budgetary variations. Hence there are only two sets of capital and operating budgets, one for each of the management systems.

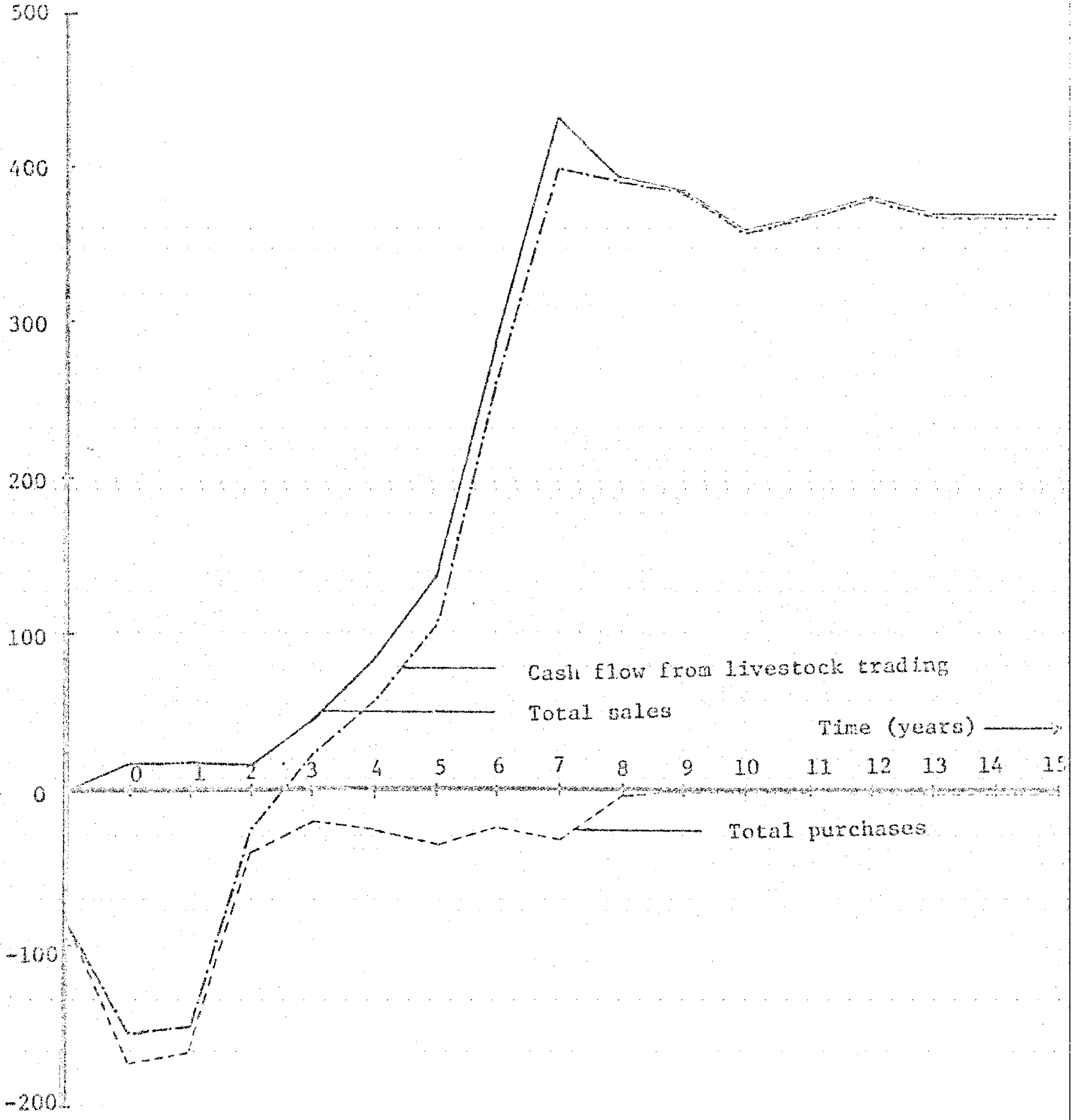

Figure 3.6 Cash Flows from Livestock Trading - Bullock Turnoff

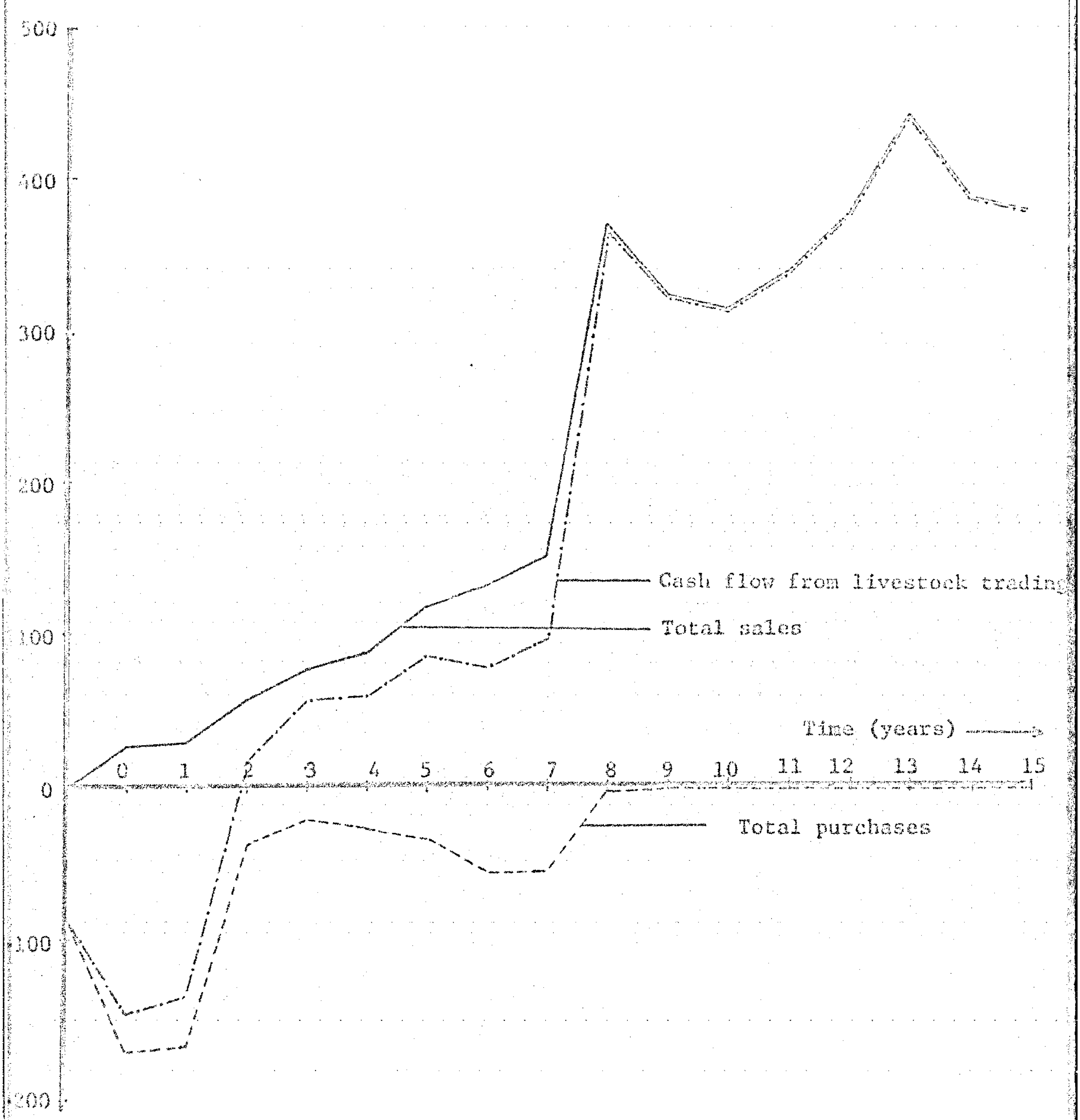

Figure 3.7 Cash Flows from Livestock Trading - Yearling Turnoff

When generating the herd projections (section 3.3.2) it was assumed that herd buildup was constrained only by the ceiling carrying capacity of 10,000 A.E.'s, and the assumptions concerning the herd parameters as set out in Appendix A. Herd buildup was not constrained by the rate of capital expenditure on equipment and structures necessary to achieve the specified levels of herd performance.

Hence the capital budgets were derived by making the capital expenditures as small as possible, and as late as possible in the development period without impeding herd buildup. An example of this is the pasture improvement programme, which is carried out at a slower rate, but over a greater span of years in the case of yearling turnoff, than for bullock turnoff, because the buildup of grazing pressure is more rapid in the latter case.

The operating budgets are also built up around the livestock projections which are the skeleton of the whole budgetary analysis. All operating costs are estimated from budgets and records of similar stations.

Having developed the capital and operating budgets, these are combined with the cash flows from livestock trading to give overall Net Cash Flows (ex. freight) for each of the management systems. These are shown in the spreadsheets in Appendix D. Appendix E shows the assumptions used in the preparation of the capital and operating budgets.

Figures 3.8 and 3.9 show in graphical form the pattern of capital and operating expenditure and Net Cash

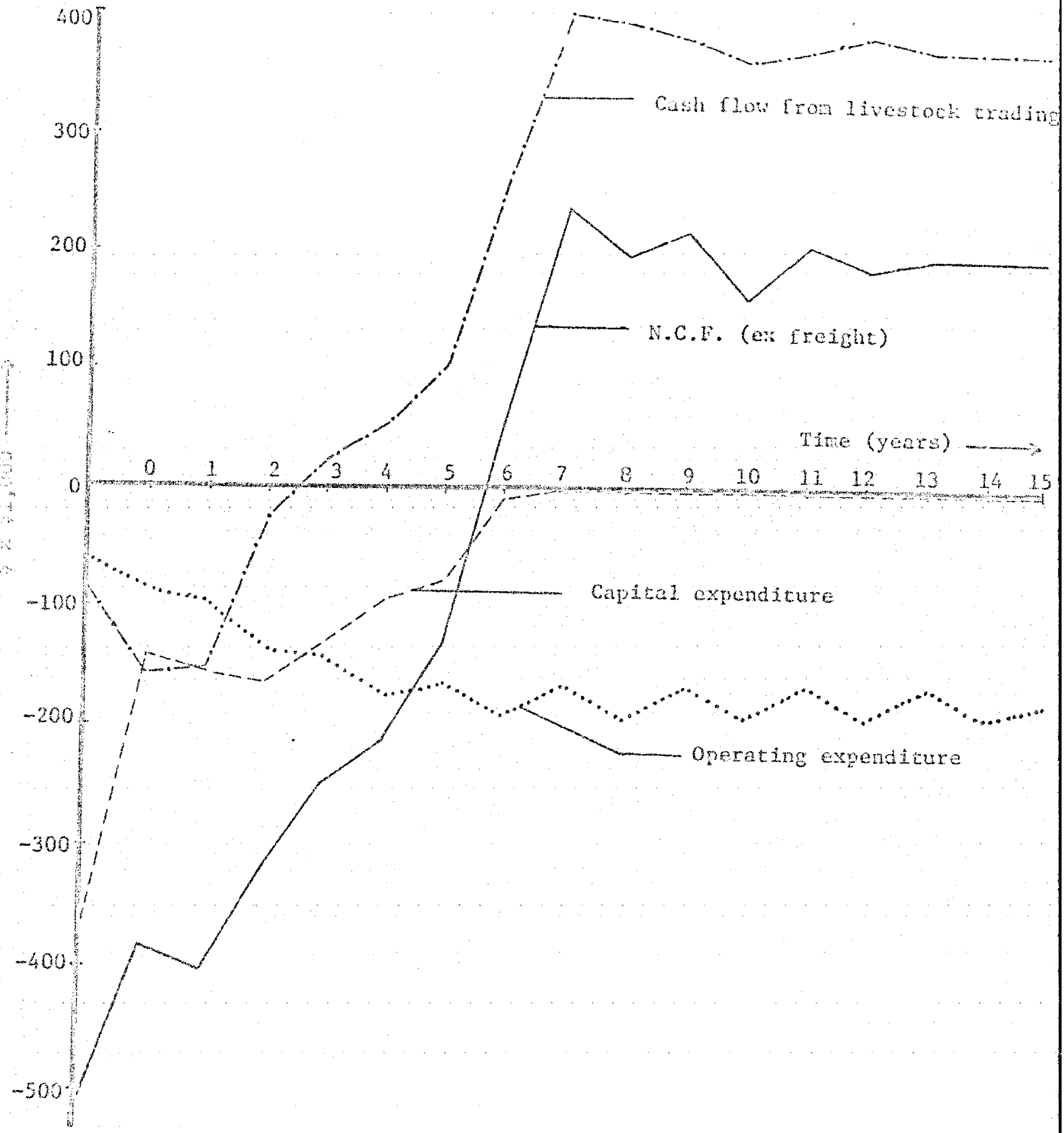

Figure 3.8 Capital & Operating Expenditure and Net Cash Flow (Ex freight) - Bullock Turnoff

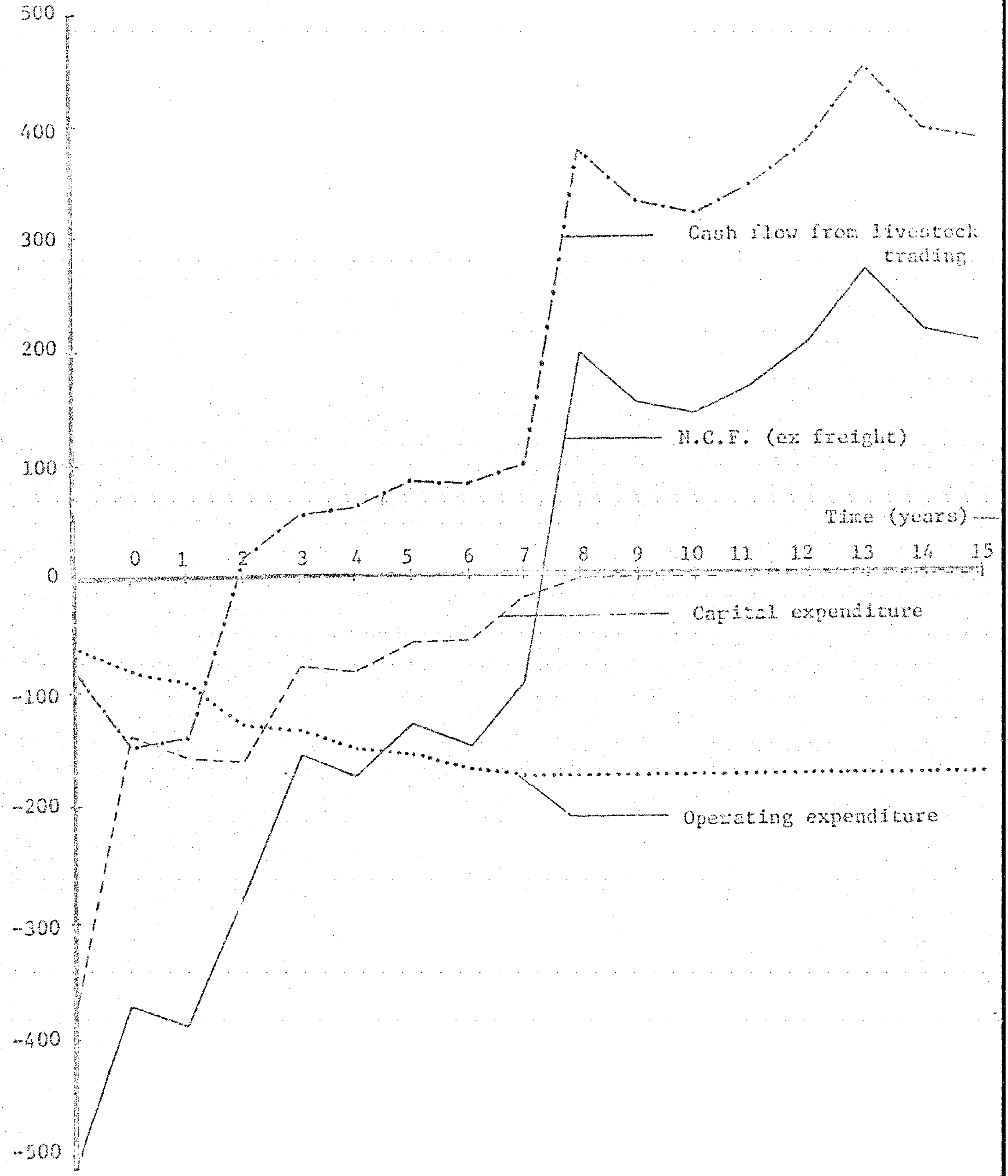

Figure 3.9 Capital and Operating Expenditure and Net Cash Flow (Ex freight) - Yearling Turnoff

Flows (ex. freight) for each of the management systems.

The "zig-zag" form of the operating expenditure line under bullock turnoff is because the Townsville Stylo pastures receive a superphosphate application every second year. The line is not zig-zagged in the case of yearling turnoff because the pattern of pasture establishment is such that the area fertilized is constant from year to year. For bullock turnoff it was assumed that from the static year onwards the annual superphosphate application was constant, giving a flat line for operating expenditure.

3.3.5 <u>Calculation of freight charges</u>

Having derived the Net Cash Flows excluding freight charges for each of the two management systems, the next step is to calculate the freight costs in every year for all of the 16 different budgetary situations under each of the management systems. The freight charges are subtracted from the Net Cash Flows (ex. freight) to give 32 separate streams of Net Cash Flows.

The assumptions used in the calculation of freight charges, are shown in Appendix F, and an example of freight calculations for one of the 32 budgetary situations is shown in Appendix G.

Examples of Net Cash Flows for bullock and yearling turnoff under different budgetary situations are also shown in graphical form in Figures 3.10 and 3.11.

The gap between the lines representing Net Cash Flow in the "best" and the "worst" situations shows the total range in freight charges over all of the 16 budgetary situations for each management system. Figures 3.10 and 3.11 illustrate the strong influence of freight

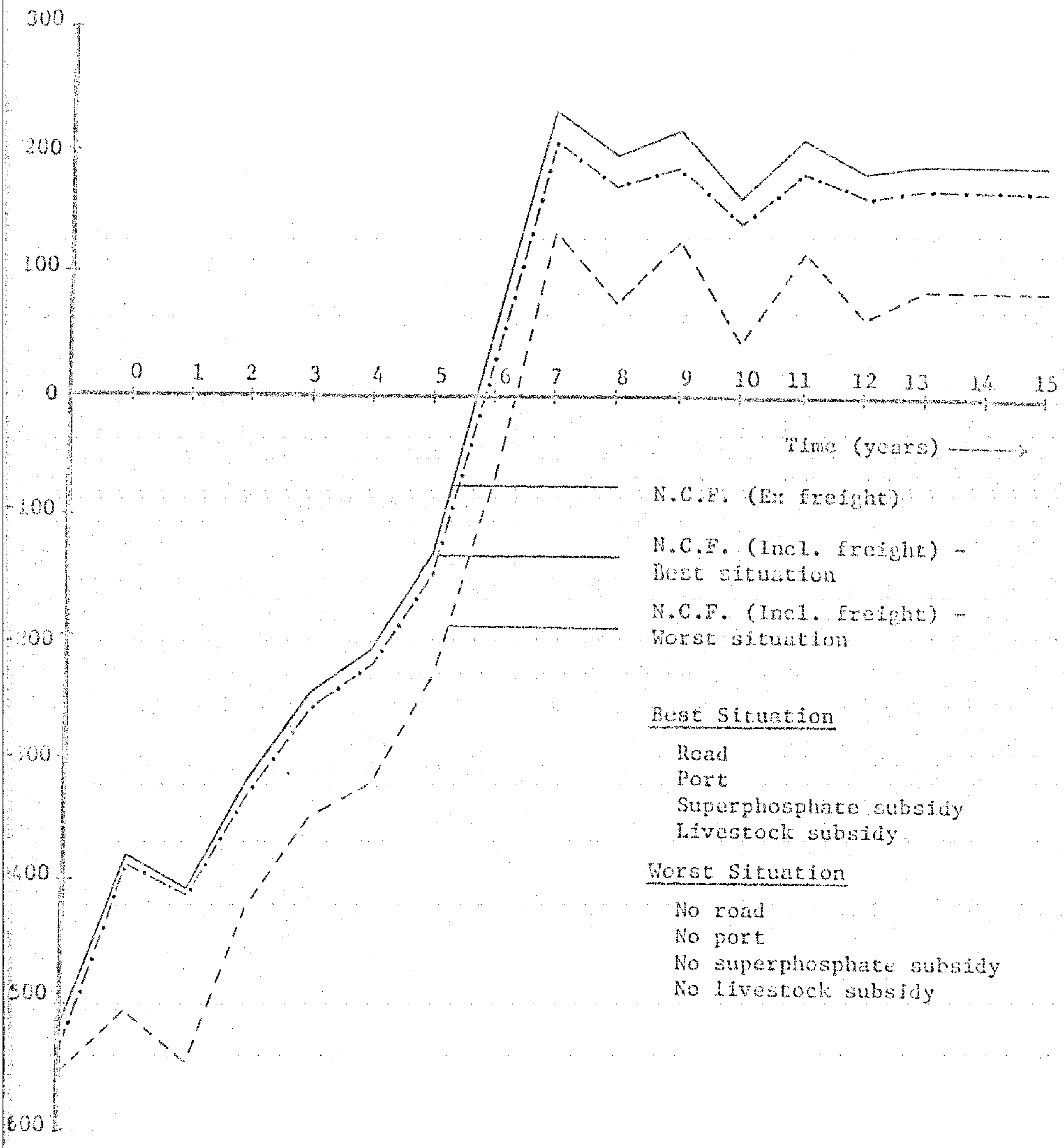

Figure 3.10 Examples of Cash Flows for Bullock Turnoff

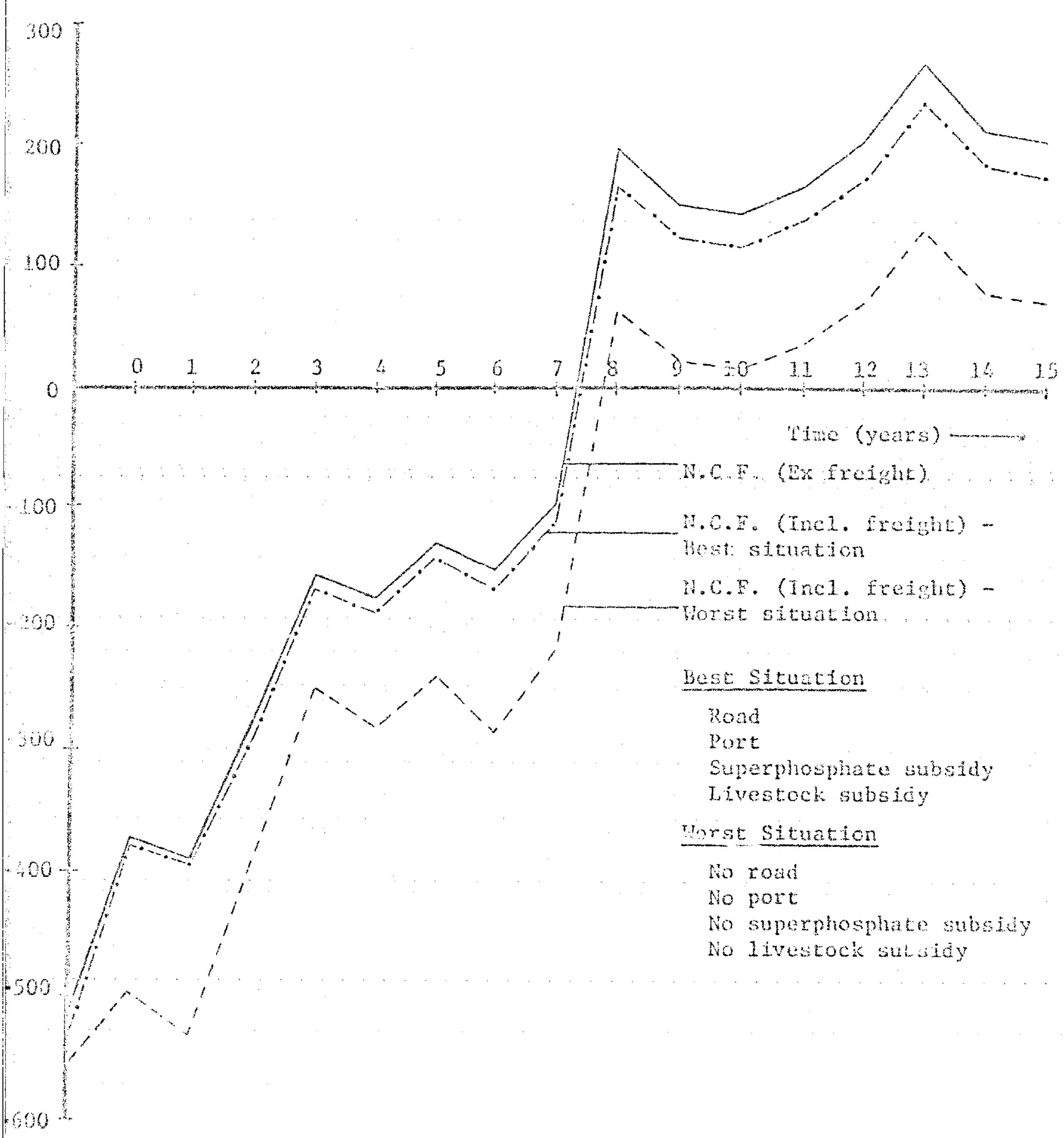

Figure 3.11 Examples of Cash Flows for Yearling Turnoff

costs over the range of situations examined.

3.3.6 Calculation of performance criteria

Having derived streams of Net Cash Flows for each of the 32 situations examined, the next step is to calculate performance criteria for each of them. This enables them to be compared in terms of their relative attractiveness to investors. The performance criteria used are -

(1) Internal Rate of Return, (IRR).

(2) Net Present Value at a discount rate of 5%, (NPV at 5%).

(3) Net Present Value at a discount rate of 10%, (NPV at 10%).

(4) Cash surplus (deficit) at 20 years, (CS/CD).

(5) Payback period, (PBP).

In the calculation of Net Present Values and Internal Rates of Return, it was assumed that the project was continued for an infinite period, i.e. the static Net Cash Flow is considered to be a perpetual annuity.

The values of each of the performance criteria are shown in Figures 3.12 and 3.13.

In the next chapter the hypothesis is tested, and conclusions are drawn.

BULLOCK TURNOFF

Road	Port	Stock subsidy	Super subsidy	Ref. No.	IRR	NPV(5%)	NPV(10%)	CS(CD) at 20 years	PBP
Road	Port	Stock subsidy	Super subsidy	1	5.80%	$411,336	($866,362)	($5,558)	21 yrs.
			No super subsidy	2	4.16%	($447,863)	($1,334,035)	($668,933)	27 yrs.
		No stock subsidy	Super subsidy	3	5.52%	$282,439	($1,077,101)	($488,163)	23 yrs.
			No super subsidy	4	3.97%	($576,597)	($1,501,293)	($1,011,793)	28 yrs.
	No port	Stock subsidy	Super subsidy	5	4.95%	($29,523)	($1,182,458)	($449,289)	24 yrs.
			No super subsidy	6	3.37%	($888,560)	($1,606,651)	($1,312,485)	33 yrs.
		No stock subsidy	Super subsidy	7	4.72%	($158,257)	($1,299,716)	($592,129)	24 yrs.
			No super subsidy	8	3.22%	($1,017,294)	($1,723,908)	($1,455,324)	34 yrs.
No road	Port	Stock subsidy	Super subsidy	9	5.57%	$293,748	($1,015,779)	($123,377)	21 yrs.
			No super subsidy	10	3.95%	($565,288)	($1,439,971)	($986,572)	29 yrs.
		No stock subsidy	Super subsidy	11	5.25%	$136,286	($1,159,851)	($297,117)	22 yrs.
			No super subsidy	12	3.73%	($722,750)	($1,584,042)	($1,160,312)	30 yrs.
	No port	Stock subsidy	Super subsidy	13	4.30%	($377,285)	($1,359,695)	($768,692)	27 yrs.
			No super subsidy	14	2.78%	($1,227,715)	($1,774,885)	($1,653,864)	39 yrs.
		No stock subsidy	Super subsidy	15	4.08%	($524,747)	($1,493,766)	($962,432)	28 yrs.
			No super subsidy	16	2.64%	($1,383,785)	($1,917,959)	($1,825,683)	41 yrs.

Negative figures in brackets

Figure 3.12
Performance Criteria for Bullock Turnoff

Fig. 3.12

YEARLING TURNOFF

Road	Port	Stock subsidy	Super subsidy	Ref. No.	IRR	NPV(5%)	NPV(10%)	CS(CD) at 20 years	PBP
Road	Port	Stock subsidy	Super subsidy	17	5.37%	$201,918	($1,103,476)	($386,768)	23 yrs.
Road	Port	Stock subsidy	No super subsidy	18	3.91%	($621,312)	($1,495,766)	($1,208,736)	30 yrs.
Road	Port	No stock subsidy	Super subsidy	19	5.12%	$68,400	($1,224,129)	($536,469)	24 yrs.
Road	Port	No stock subsidy	No super subsidy	20	3.71%	($776,710)	($1,637,304)	($1,381,398)	32 yrs.
Road	No port	Stock subsidy	Super subsidy	21	4.59%	($232,146)	($1,320,808)	($821,692)	26 yrs.
Road	No port	Stock subsidy	No super subsidy	22	3.17%	($1,077,257)	($1,738,983)	($1,666,623)	36 yrs.
Road	No port	No stock subsidy	Super subsidy	23	4.39%	($365,665)	($1,441,461)	($971,391)	27 yrs.
Road	No port	No stock subsidy	No super subsidy	24	3.03%	($1,205,905)	($1,851,231)	($1,809,244)	37 yrs.
No road	Port	Stock subsidy	Super subsidy	25	4.55%	($248,587)	($1,294,411)	($815,770)	26 yrs.
No road	Port	Stock subsidy	No super subsidy	26	3.08%	($1,094,168)	($1,707,913)	($1,661,421)	37 yrs.
No road	Port	No stock subsidy	Super subsidy	27	4.31%	($404,656)	($1,437,485)	($987,535)	27 years.
No road	Port	No stock subsidy	No super subsidy	28	2.92%	($1,256,432)	($1,855,390)	($1,842,021)	38 yrs.
No road	No port	Stock subsidy	Super subsidy	29	3.45%	($875,724)	($1,601,377)	($1,447,645)	33 yrs.
No road	No port	Stock subsidy	No super subsidy	30	2.05%	($1,743,500)	($2,032,544)	($2,311,360)	53 yrs.
No road	No port	No stock subsidy	Super subsidy	31	3.23%	($1,061,708)	($1,767,522)	($1,648,748)	35 yrs.
No road	No port	No stock subsidy	No super subsidy	32	1.94%	($1,906,819)	($2,180,697)	($2,493,680)	56 yrs.

Negative figures in brackets

Figure 3.13

Performance Criteria for Yearling Turnoff

Fig. 3.13

CHAPTER 4

THE MODEL OUTPUT AND THE EFFECT OF BEEF PRICES

4.1 The Model Output

4.1.1 Analysis of model output

4.1.2 Testing the hypothesis

4.2 Beef price sensitivity analysis

4.2.1 Reasons for conducting a sensitivity analysis

4.2.2 The form of the sensitivity analysis

4.2.3 The results of the sensitivity analysis

4.3 The role of regional assistance programmes in Northern Australia

4.4 The limitations

4.5 Conclusions

4.1 The Model Output

The model output as presented in figures 3.12 and 3.13 consists of five different performance criteria for each of the 32 budgetary situations. There are certain problems associated with the use of some of these criteria. A discussion of these problems is presented in Appendix H.

4.1.1 Analysis of model output

To carry out this analysis the four factors, road, port, livestock freight subsidy and superphosphate freight subsidy are denoted A - D respectively. The letters A, B, C or D indicate the presence of the corresponding factor, while the letters a, b, c and d indicate that it is absent. For example, the situation in which the road and livestock freight subsidies are present, but the port and superphosphate subsidies are absent is represented by (AbCd). The form of the analysis when represented in this way is shown in Table 4.1.

TABLE 4.1

The form of the analysis

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A	A	A	A	A	A	A	A	a	a	a	a	a	a	a	a
B	B	B	B	b	b	b	b	B	B	B	B	b	b	b	b
C	C	c	c	C	C	c	c	C	C	c	c	C	C	c	c
D	d	D	d	D	d	D	d	D	d	D	d	D	d	D	d

Given this representation, the model output can be analysed in a number of different ways. These are -

(1) An assessment of the present situation in the King Edward-Drysdale Country (i.e. estimation of the prospects for profit using the production - management system outlined in section 3.2 in the absence of the four factors A - D). Using the method shown in Table 4.1 this situation is represented by (abcd).

(2) An assessment of the importance of each of the four factors acting alone. This can be done by comparing the performance criteria for the situation where none of these four factors are present, (i.e. (abcd)), with the values of those criteria where a single factor is present, and all others are absent. For example, to determine how much influence the road (factor A) has on the economics of the project, performance criteria for (Abcd) can be compared with performance criteria for (abcd).

(3) The calculation of main effects. The main effect of a factor is a measure of the average influence it exerts over all of the situations in which that factor is present. In this case it is calculated by subtracting the average value of a performance criterion over every situation in which the factor is not present, from the average value of that criterion over every situation in which it is present. For example, the main effect of the road (factor A) is given by substituting the values of a performance criterion into -

1/8((ABCD)+(ABCd)+(ABcD)+(ABcd)+(AbCD)+(AbCd)+(AbcD)+(Abcd))
-1/8((aBCD)+(aBCd)+(aBcD)+(aBcd)+(abCD)+(abCd)+(abcD)+(abcd))

This procedure for calculating main effects has been carried out for each of the performance criteria except the IRR. For reasons explained in Appendix H, it is not possible to add and average IRR's for different projects unless they are of equal scale and timing. This is not the case here.

(4) The calculation of main effects of two-factor interactions. These are derived by calculating the main effect of a particular factor (say A) in every situation in which it is combined with a second factor (say B), and subtracting from this the main effect of A for all the situations where it is not combined with B.

The general example in algebraic terms is -

(¼{(ABCD)+(ABCd)+(ABcD)+(ABcd)} - ¼{(aBCD)+(aBCd)+(aBcD)+(aBcd)})
-(¼{(AbCD)+(AbCd)+(AbcD)+(Abcd)} - ¼{(abCD)+(abCd)+(abcD)+(abcd)})

The main effect of a two-factor interaction is a measure of how the presence of one factor modifies the influence of the other. For reasons outlined in Appendix H, this technique cannot be applied to the IRR criterion.

4.1.2 Testing the hypothesis

The hypothesis is tested by examining the analysis of model output as described in the previous section. The first part of the hypothesis states that -

> "The development of the King Edward-Drysdale Country has been retarded in relation to similar areas in the Northern Territory, due to poor prospects for profit in the cattle industry".

It can be tested by examining the performance criteria for the present situation represented by (abcd). Table 4.2 summarizes the present situation under each of the management systems.

TABLE 4.2

Measures of profitability under the existing situation

Management System	Performance Criteria				
	NPV(5%)	NPV(10%)	IRR	Payback Period	Deficit at 20 yrs.
Bullock turnoff	-$1,383,785	-$1,917,959	2.64%	41 yrs.	$1,825,683
Yearling turnoff	-$1,906,820	-$2,180,698	1.94%	56 yrs.	$2,493,680

These figures clearly demonstrate that in the absence of the four factors A - D, cattle raising in the King Edward-Drysdale Country presents very poor prospects for profit, even when using the improved production-management systems outlined in Chapter 1. The Agricultural Development Advisory Committee of the Department of the N.T. (1) has shown by updating BAE budgets taken from (9), that developers of cattle stations in the Top End of the N.T. can expect to obtain an IRR of greater than 6%. This is considerably better than the levels indicated in Table 4.2[1].

[1] The basic form of the BAE analysis is identical to that used in this study. It is a budgetary examination of the flow of expected costs and returns during a period of property development and buildup of the herd size to a specified maximum. Thus the BAE study uses the same concept of capital as that used in this analysis. However, a small difference exists between the methods of calculating IRR's. In the BAE study cash flows were discounted up to the one hundredth year of the project, whereas in this case the cash flows were assumed to continue for an infinite period. However, this only leads to very small differences in the resultant IRR's.

The technical and economic assumptions used in the BAE budgets are virtually identical to those used in this study. In fact many of the assumptions used here were drawn directly from the BAE work. The authors of the BAE report (9) considered that their findings were applicable over a wide area. They said (page 1) that "....While the analysis relates specifically to the Tipperary Land System, it would have general application to much of the higher rainfall areas of the north". The BAE analysis was carried out using late 1972 beef prices, and was subject to the full level of subsidization available in the N.T. at that time.

The first part of the hypothesis is therefore upheld, and the alternative explanation (that the non development of the area is due to market imperfections), is rejected.

Having accepted the first part of the hypothesis, the remaining four sections can be tested. These suggest why cattle raising in the area has not been profitable in comparison to the more rapidly developing areas of the N.T.

The first step in this process is to assess the effect that each of the four factors has on the performance criteria. Initially the factors are considered separately rather than in combination with each other.

The changes in the performance criteria due to the effect of each factor are shown in Table 4.3.

It can be seen from Table 4.3 that under both of the management systems the existence of a superphosphate sea freight subsidy, in the absence of the other three factors, exerts a strong influence on the profitability of

TABLE 4.3

The Effect of Each Factor on Performance Criteria

(a) Bullock turnoff

Factor	Amount of Change			
	NPV(5%)	NPV(10%)	Payback	Deficit at 20 years
A. Road	$366,491	$194,051	- 7	-$370,359
B. Port	$661,035	$333,917	-11	-$665,371
C. Stock Subsidy	$156,070	$143,074	- 2	-$171,819
D. Super. Subsidy	$859,038	$424,193	-13	-$863,251

(b) Yearling turnoff

Factor	Amount of Change			
	NPV(5%)	NPV(10%)	Payback	Deficit at 20 years
A. Road	$700,914	$329,466	-19	-$684,436
B. Port	$650,387	$325,307	-18	-$651,659
C. Stock Subsidy	$163,319	$148,153	- 3	-$182,320
D. Super. Subsidy	$845,111	$413,175	-21	-$844,932

cattle raising in the area. The presence of this subsidy alone is adequate to increase the NPV (5% discount rate) by over $800,000 under both management systems, thereby making the investment considerably more attractive.

Hence that part of the hypothesis relating to the effect of the freight subsidy on superphosphate is upheld. It is therefore concluded that the absence of this subsidy in W.A. has been a significant factor contributing to the poor prospects for profit relative to the

Top End of the N.T., and the consequent disparity in the rates of development of the two areas.

It can also be seen from Table 4.3 that the presence of a subsidy on the cost of introducing breeding stock, exerts little influence on the economic viability of cattle raising in the King Edward-Drysdale Country, as measured by the performance criteria used. The presence of this subsidy, if all other factors were absent, would increase the IRR by only 0.14 in the case of bullock turnoff, and 0.11 in the case of yearling turnoff. The author therefore considers that the absence of this subsidy has not been a major cause of the relatively poor profitability of the cattle industry in the area, as measured by the performance criteria used.

However this subsidy could well have a significant effect on the financial aspects of the enterprise. As mentioned in Appendix H, conventional investment criteria such as IRR and NPV give no indication of the financial feasibility of projects, something which is undoubtedly relevant when making investment decisions.

Because the cost of introducing breeding stock is a "once only" cost which occurs early in the development period, it has considerable influence on the peak cash deficit. In fact it reduces it by $167,375 in the case of bullock turnoff and $181,180 for yearling turnoff.

Hence the livestock introduction subsidy has a significant influence on the amount of finance required for a cattle enterprise in the King Edward-Drysdale Country. It is therefore concluded that it has been of some imp rtance in making the area less attractive to investors than the Top End of the N.T. However, it has had less influence than the superphosphate freight subsidy.

The relative importance of the road and port factors depends on the management system chosen. Table 4.3 shows that under bullock turnoff the presence of a road exerts less influence on the performance criteria than the port. However, if yearlings are turned off this position is reversed.

It is not difficult to see why this is so. If yearlings are turned off, the presence of a road to Kununurra reduces the distance to market by 700 miles, whereas the reduction is only 100 miles in the case of bullock turnoff.

Given the relative prices of bullocks and yearlings assumed in this study, any cattle station in the area would be more profitable under bullock turnoff than yearling turnoff. Hence the port can be considered to have a more powerful effect on profitability than the road. However, if the relative prices of yearlings and bullocks changed so that yearling turnoff became more profitable than bullock turnoff, then the road would exert a stronger influence on the economics of cattle production in the area than the port.

Hence the general conclusions from examining the effect of each of the four factors individually are that the road, the port and the superphosphate subsidy all exert considerable influence on profitability as measured by the five performance criteria, and the parts of the hypothesis relating to them are upheld.

The livestock subsidy has only a small influence on profitability, but it is worth remembering that it helps to reduce the amount of finance required in the early years and would therefore make cattle raising in the area more attractive to investors.

Having demonstrated the effect of each of the four factors acting alone, it is now appropriate to examine their effects when acting in various combinations with each other. This is done by calculating the main effect of each of the four factors using the method described in section 4.1.1. These are presented in Table 4.4.

TABLE 4.4

Main Effects of Factors

(a) Bullock turnoff

Factor	Amount of change due to Main Effect			
	NPV(5%)	NPV(10%)	Payback	Deficit at 20 years
A. Road	$243,402	$133,402	- 2.9	-$226,797
B. Port	$552,310	$291,325	- 6.1	-$537,259
C. Stock Subsidy	$141,694	$140,975	- 1.1	-$225,523
D. Super. Subsidy	$857,981	$434,752	- 8.9	-$796,026

(b) Yearling turnoff

Factor	Amount of change due to Main Effect			
	NPV(5%)	NPV(10%)	Payback	Deficit at 20 years
A. Road	$572,864	$258,685	- 8.7	-$593,232
B. Port	$542,147	$271,681	- 8.2	-$543,703
C. Stock Subsidy	$152,340	$138,110	- 3.5	-$168,809
D. Super. Subsidy	$845,492	$413,057	-12.3	-$844,[illegible]

The figures in Table 4.4 confirm the conclusions drawn from looking at the effect of each of the factors individually. It can be seen that the effect of the livestock subsidy is small in comparison to the other factors, and that the road is much more important in the case of yearling turnoff than for bullock turnoff.

Further insight into the relative importance of the four factors can be gained by examining two-factor interactions. These are calculated using the method described in section 4.1.1 and are presented in Table 4.5.

TABLE 4.5

Main Effects of Two-factor Interactions on the NPV at 5% Discount Rate

Interaction	Main Effect	
	Bullock turnoff	Yearling turnoff
A X B	-$223,145	-$207,659
A X C	-$ 25,839	-$ 29,138
A X D	$ 2,192	$ 4,138
B X C	$ 2,889	$ 1,055
B X D	$ 2,191	$ 3,135
C X D	$ 2,111	$ 1,235

A high absolute value for the interaction figure signifies a large amount of interdependence between the two factors, i.e. that the effect of one factor depends to a large extent on the simultaneous presence or absence of the other.

A negative sign for the interaction figure means that the presence of one factor diminishes the effect of the other. Conversely a positive sign indicates that the presence of one factor enhances the effect of the other.

The figures in Table 4.5 show that most of the interactions are small. The most significant one is the negative interaction between the road and the port. This means that the effect of the road is diminished by the presence of the port, and vice versa. The effect of the livestock freight subsidy is also diminished somewhat by the presence of the road (A X C interaction).

4.2 Price Sensitivity Analysis

4.2.1 Reasons for conducting a sensitivity analysis

The budgetary analysis was carried out using beef prices prevailing in May 1973. This has enabled the hypothesis regarding the reasons for the retarded development of the area, to be tested. The factors which most strongly influence the economics of the cattle industry in the area have been identified. However in order to comment on likely developments in the future it is necessary to measure the sensitivity of the model to changes in the price of beef.

The beef price in May 1973 was considerably higher than in the 1972 killing season and significantly lower than in the latter half of the 1973 killing season. As it is a fundamental assumption of this study that cost-price relationships remain constant from year zero onwards, the conclusions drawn from manipulation of the model must depend to some degree on when it is assumed the project begins. If it was assumed that the cost-price relationships of 1972 prevailed, the result would obviously be different than if it was assumed that late 1973 prices would continue into the future.

Hence because of the instability in beef prices in recent years, and the uncertainty regarding the future price of manufacturing grade beef, it was considered necessary to measure the sensitivity of the model to changes in the price of beef, in order to predict future developments in the area.

There are no major logical difficulties in using conventional investment criteria to test the hypothesis regarding the relative influence of various factors on the profitability of cattle raising in the area. However a frustrating problem does arise when an assessment is being made of the likelihood of the project being adopted. There is no ready solution to this problem. One cannot define with any reasonable degree of credibility that there is an explicit thresh-hold rate of return above which the project will be accepted, and below which it will not be accepted. Thus conclusions about the future development of the cattle industry in the area cannot be drawn with certainty.

4.2.2 The form of the sensitivity analysis

Two additional price levels are considered. These are a 20% increase in the price of all categories of beef, and an overall 20% decrease. Hence the basic price of 31 cents per pound for a bullock of 550 pounds dressed weight was either reduced to 24.8 cents per pound or increased to 37.2 cents per pound. This is well within the range over which the price of beef at Northern abattoirs has changed between early 1972 and the latter half of the 1973 killing season.

The price sensitivity analysis consists of a complete reworking of the budgetary analysis at the two new price levels. It is assumed that when the beef price is changed by 20% the price of the breeding stock required to establish the herd also changes by 20% in the same direction. All other costs are unchanged.

4.2.3 The results of the sensitivity analysis

Although it was necessary to look at five different performance criteria to get an overall appreciation of the economics of cattle raising in the King Edward-Drysdale Country, the effect of variations in the price of beef can be measured by looking at only one of these - IRR.

As pointed out in Appendix H, it is not possible to use the IRR criterion for comparing projects which differ in scale and timing. However, the criterion can be used by investors to decide whether to accept or reject a particular investment proposal. The different project IRR's presented in Table 4.6 are not being compared with each other. The comparisons are between the IRR for any particular budget alternative, and measures of the cost of capital. The decision rule that a project is accepted if the IRR is greater than the cost of capital, is then applied. The use of IRR in this way does not conflict with the NPV analysis earlier in this chapter.

The results of reworking the analysis at the two new beef price levels are shown in Table 4.6.

If these figures are compared with the results of the analysis at the basic price as presented in figures 3.12 and 3.13, a number of points can be drawn. An assessment is made of the profitability (as measured by IRR) at the three different price levels in three different situations. These situations are -

(1) The existing situation - No road, no port, no superphosphate freight subsidy, and no subsidy on livestock introduction.

(2) The best possible situation - All of the above factors are present.

(3) The best likely situation - Road and port present but neither of the subsidies.

The last of these categories requires some explanation. It is not likely that superphosphate and livestock freight subsidies will be introduced in W.A. These factors were included in the study to explain why the development of the area has been so much slower than the Top End of the N.T., where these subsidies have been available. Hence the best situation which is likely to prevail in the future is one where there is a road and a port but neither of the subsidies.

A number of conclusions can be drawn from inspection of Table 4.6 -

(1) Under the existing situation it is not likely

TABLE 4.6

Internal Rates of Return after 20% Increase and 20% Decrease in the Price of Beef

			Bullock turnoff		Yearling turnoff	
			20% Increase	20% Decrease	20% Increase	20% Decrease
Road	Port	Live-Stock Subsidy — Super Subsidy	7.59	3.65	7.00	3.39
		Live-Stock Subsidy — No Super Subsidy	6.05	1.92	5.58	1.82
		No Live-Stock Subsidy — Super Subsidy	7.25	3.45	6.70	3.22
		No Live-Stock Subsidy — No Super Subsidy	5.77	1.82	5.35	1.73
	No Port	Live-Stock Subsidy — Super Subsidy	6.76	2.75	6.25	2.58
		Live-Stock Subsidy — No Super Subsidy	5.26	1.11	4.89	1.08
		No Live-Stock Subsidy — Super Subsidy	6.47	2.62	5.93	2.45
		No Live-Stock Subsidy — No Super Subsidy	5.04	1.05	4.71	1.03
No Road	Port	Live-Stock Subsidy — Super Subsidy	7.37	3.40	6.25	2.46
		Live-Stock Subsidy — No Super Subsidy	5.82	1.69	4.86	0.92
		No Live-Stock Subsidy — Super Subsidy	6.98	3.19	5.94	2.32
		No Live-Stock Subsidy — No Super Subsidy	5.52	1.59	4.62	0.87
	No Port	Live-Stock Subsidy — Super Subsidy	6.16	2.10	5.20	1.29
		Live-Stock Subsidy — No Super Subsidy	4.69	0.52	3.85	-ve
		No Live-Stock Subsidy — Super Subsidy	5.84	1.96	4.91	1.21
		No Live-Stock Subsidy — No Super Subsidy	4.46	0.47	3.67	-ve

that capital for the development of the cattle industry will be attracted to the King Edward-Drysdale Country even if there is a sustained increase in the price of beef of 20% above the May 1973 level. This would yield an IRR of only 4.46% for bullock turnoff and 3.67% for yearling turnoff. In the present state of the rural economy this would be most unlikely to attract capital to the area. Some measures of average profitability obtainable from mixed farming in Southern states are shown in Table 4.7.

TABLE 4.7

Measures of Before-tax Profit from Farming in Three States for 1972-73[(a)]

	Operating Return/ Average Assets		Operating Return/ Average Equity	
	Average Farm	Best Farms[(b)]	Average Farm	Best Farms
Quirindi, N.S.W.	8.77%	12.50%	10.22%	14.44%
Cootamundra, N.S.W.	13.29%	20.72%	15.05%	25.25%
Blaney, N.S.W.	7.00%	15.41%	7.90%	19.78%
Gulargambone, N.S.W.	2.92%	8.50%	1.17%	8.32%
Hamilton, Vic.	12.58%	19.91%	14.36%	20.22%
Hobart, Tas.	11.82%	17.49%	13.24%	20.03%

(a) These figures have been collated from computerised whole farm business analyses performed by the Agricultural Business Research Institute, University of New England, Armidale, N.S.W.

(b) The category of Best Farms is the most profitable 25% of farms in the group.

The measures of profitability shown in Table 4.7 are not synonymous with Internal Rate of Return. They are measures of the rate of return on the realizable value of assets employed in one year only. If we assume that cost-price relationships remain constant into the future (a basic assumption of this study), then the figures in Table 4.7 indicate the opportunities which would be foregone by investing in the study area, rather than in Southern Australia, i.e. they provide some indication of the opportunity cost of capital to agricultural investors.

It is apparent from Table 4.7 that the opportunity cost of capital invested in agriculture in the South, is generally higher than the IRR generated from cattle raising in the study area under the existing infrastructural situation. On this basis it is therefore unlikely that funds scheduled for investment in Southern agriculture would be diverted to the King Edward-Drysdale Country under the existing situation.

(2) In the best possible situation a 20% increase in beef prices would mean that an IRR of 7.59% could be earned in the case of bullock turnoff, and 7.00% in the case of yearling turnoff. This would be unlikely to divert capital from Southern agriculture, especially when it is considered that much larger quantities of capital are required for the development of Northern stations than for mixed or specialised farming in the South.

An IRR of 7.59% may be adequate to attract some of the capital currently being invested in other parts of the high rainfall Northern cattle zone. No data are available which would enable a rigorous comparison to be made between the level of profitability of the typical King Edward-Drysdale property, and an identical property located in the N.T. However, as mentioned previously, the Agricultural Development Advisory Committee of the Department of the N.T. has provided an estimate of the profitability of cattle development projects in the Top End of the N.T. It was found that an Internal Rate of Return of between 6.40% and 6.90% could be attained from development of a Townsville Stylo based cattle enterprise.

Although this measure of profitability can only be considered an approximate guide to the likely rewards from pastoral development in the Top End of the N.T., it enables the author to conclude that in the best possible situation some of the capital which is currently being invested in other parts of Northern Australia may be attracted to the King Edward-Drysdale Country.

However, a 20% fall in beef prices would cause the IRR to drop to 3.65% for bullock turnoff, and 3.39% for yearling turnoff. This would be inadequate to stimulate development of cattle stations in the area.

(3) In the best likely situation a 20% price increase would generate an IRR of only 5.77% in the case of bullock turnoff and 5.35% for yearling turnoff. Comparison with the figures in Table 4.7 shows that this would be unlikely to bring about a large amount of capital inflow from Southern agriculture, although it could lure some investors from the N.T. However, it must be concluded that the development of the area in

the near future, is not likely to be rapid, even if the road and port are built.

An overall impression of the effect of changes in the price of beef can be gained by comparing the average effect of a price rise with the average effect of a price fall, over all of the 32 budgetary situations. The effect of these changes on NPV are shown in Table 4.8.

TABLE 4.8

Changes in profitability due to changes in the price of beef: NPV at 5% discount rate

	Bullock Turnoff	Yearling Turnoff
Average effect of 20% price rise	+ $1,043,067	+ $ 998,646
Average effect of 20% price fall	- $1,034,909	- $1,004,298

Table 4.8 shows that cattle raising in the King Edward-Drysdale Country is highly sensitive to changes in the beef price. Over all of the budgetary situations examined a 20% change in the price of beef is sufficient to alter the NPV (5%) by an average of approximately $1 million.

4.3 The role of regional assistance programmes in Northern Australia

There are several arguments in favour of governments providing assistance to industries on a regionally differentiated basis, as observed in the Northern Australian cattle industry. These arguments include -

(1) The infant industry argument,

(2) The decentralization argument, and

(3) The factor immobility argument.

The issue discussed here is whether or not any of these arguments could have been used to justify special assistance being given to the Northern Territory cattle industry in relation to -

(1) The North of Western Australia, and

(2) Southern Australia.

The author can see no reason why any assistance given to the cattle industry in Northern Australia should apply only to the N.T. Either there should be no special assistance at all, or it should be available to the whole of the high rainfall Northern cattle zone. As explained in section 2.1.3, where there are two areas with similar production functions, and one of these receives a subsidy on inputs, this will theoretically induce some misallocation of resources, as the marginal value product of a particular input will be different at the two locations. This means that the same product could be forthcoming by altering the spatial pattern in which the input is used, while using less of the input. Alternatively, more could be produced from the same amount of input if the spatial pattern of input use was changed. Hence there appears to be no case in favour of assisting the pastoral industry in the N.T. while leaving the remainder of the high rainfall Northern cattle zone unsubsidized.

The infant industry argument cannot be used to justify special assistance to the Northern cattle industry. Implied in this argument is the assumption that the disabilities of the area are only temporary, and that after a period of assistance they will be overcome. This is not the case in Northern Australia. There are limited possibilities for diversification and little chance of further technological breakthroughs in addition to those described in Chapter 1. The disabilities of the high rainfall Northern cattle zone are not likely to be overcome by increasing profitability by providing special assistance to pastoralists.

Similarly, subsidization of the Northern cattle industry cannot be justified as a means of decentralization. If it is assumed that decentralization is a worth-while goal in Australia, it must be decided which areas should be selected as the new centres of population. There are no good reasons for choosing Northern Australia. Firstly, the Northern cattle industry has a low labour requirement and apart from abattoirs, is unlikely to induce the growth of complementary industries. Hence even if the industry expanded rapidly little labour would be attracted to the area. Secondly, the skills required to work in the cattle industry are such that few city dwellers are suitable, and any labour attracted would be from other rural areas. Also the climate is unpleasant, so the incentives required to attract population to the North are probably much greater than those required for Southern rural areas.

The factor immobility argument cannot be used to justify the provision of special assistance to the N.T. cattle industry. Little labour is required, and most investment is made by companies which tend to have more mobile capital than individual farmers or pastoralists. In any case, the slow rate of development of the King Edward-Drysdale Country can be explained by the relatively poor prospects for profit rather than resource immobility.

4.4 <u>The Limitations</u>

The method used to reach the conclusions outlined in this chapter has several limitations. These should be kept in mind when evaluating the implications of these findings.

The main limitations are -

(1) Much of the technological basis of the model is derived from experiments and commercial production experience from outside the area, as no precise data are available for the King Edward-Drysdale Country. In particular the author has drawn heavily on work done in the Katherine area of the N.T. Extrapolation of technological data was unavoidable in this case, and it is a problem which must be tolerated if economic research is to be carried out for remote areas.

(2) No attempt is made to estimate the costs to the public of each of the sixteen variations in transport infrastructure and subsidies. Only the private benefits which are likely to accrue from them are measured. This

is consistent with the aims of the study, which are to explain the retarded development of the King Edward-Drysdale Country, and to predict what effect future changes in the transport infrastructure might have.

(3) As the situation with respect to infrastructure and subsidies changes, the optimal plan for a cattle station in the area will also change. Since only two alternative management systems are considered some of the budget variations will be further from the optimum than others. This will conceal some of the effect of the variations in the four independent variables. This problem is inherent in the methodology used.

(4) There are a large number of factors influencing the profitability of any business proposition. However, only four are considered here. This should not be taken to mean that they are the only relevant factors. They have been chosen because it is generally thought in Northern Australia that these factors are important determinants of profitability.

(5) The analysis does not account for the effects of taxation on the relative profitability of each of the 32 situations examined. However, this is not a serious limitation, as the potency of each of the four factors being considered can readily be gauged by measuring their effect on "before-tax" income.

(6) The comparison between the profitability of cattle raising in the King Edward-Drysdale Country and the Top End of the N.T. has not been as rigorous as it might have been. Hence further work needs to be done on developing a model of a "typical" station in the Top End

of the N.T. which carries 10,000 Adult Equivalents, and uses the same production technology as was assumed in this study. This would enable the factors influencing the relative profitability of cattle raising in the two areas to be identified and measured with greater precision than has been done here. Further work also needs to be done to measure the influence of other means of assistance which are available in the N.T. so that their effect on the pattern and intensity of land use in the North can be determined.

4.5 Conclusions

(1) The King Edward-Drysdale Country has potential for cattle raising similar to the Top End of the Northern Territory.

(2) The cattle industry in the Top End of the N.T. has undergone much more rapid development in recent years.

(3) The provision of regionally differentiated development incentives can distort the pattern and intensity of land use in a way which is contrary to efficient resource allocation.

(4) The disparity in the rates of development in the two areas has been caused (among other things) by -

(i) The absence of a port on the North Coast of the area.

(ii) The absence of a direct road link with the Wyndham-Kununurra area.

(iii) The existence of a subsidy on the cost of transporting superphosphate into the N.T., and the absence of such a subsidy in W.A.

The existence of a subsidy on the introduction of suitable breeding stock to the N.T. has been of lesser importance.

(5) There are no good reasons for providing special assistance to the N.T. pastoral industries in relation to -

(i) other parts of the high-rainfall Northern cattle zone, and

(ii) the rest of Australia.

(6) The profitability of cattle enterprises in the area is sensitive to changes in the price of beef. However the area will only be attractive to investors if -

(i) the price of beef is maintained at 20% above the May 1973 level,

(ii) the road and port are built, and

(iii) superphosphate and livestock freight subsidies are introduced.

The third of these conditions is unlikely to prevail, and it is therefore concluded that in the absence of events not examined here, it is unlikely that the area will be developed in the near future.

Appendix A Assumptions used in static herd solutions and livestock projections

(1) Purchases

(i) Shorthorn cows: 1,000 local cows are purchased in the middle of year 0. These have 300 calves at foot.

Age distribution of Shorthorn purchases -

Age	Number
0-1	150 males plus 150 females
1-2	200 females
2-3	300 females
3-4	300 females
4-5	100 females
5-6	100 females

150 feral Shorthorn females are mustered from the property in year 0.

Age distribution of mustered Shorthorn cattle -

Age	Number
0-1	25 males plus 25 females
1-2	40 females
2-3	40 females
3-4	30 females
4-5	20 females
5-6	20 females

(ii) High grade (i.e. greater than one-half Brahman) pregnancy tested heifers are imported from Queensland. 1,000 are purchased in the middle of years 1 and 2.

(iii) Bulls: High grade Brahman bulls are purchased from

Queensland, aged 2-3 years. When the maximum grazing pressure (10,000 AE's) is reached, the herd supplies its own replacement bulls.

(2) Sales

(i) Aged cows are sold mid-year after early weaning of calves.

(ii) Other surplus cows (i.e. those sold in order to reduce grazing pressure) are sold at the beginning of the year before calving.

(iii) Surplus heifers are all sold mid-year in the 1-2 years age group, after mating.

(iv) Culled and aged bulls are sold mid-year after mating.

(v) Surplus bulls (i.e. those sold due to an excess of bulls) are sold at the beginning of the year, before use.

(3) Calendar years are used rather than financial years. This corresponds more closely to the seasonal pattern of operations.

(4) Weaning percentage*

(i) Shorthorn cows - Calves are low grade Brahman

Age of cow	Year of Project 0	1	2	3	4	5	6	7	8	9	10	11+
0-1	0	0	-	-	-	-	-	-	-	-	-	-
1-2	0	40	0	-	-	-	-	-	-	-	-	-
2-3	0	40	25	25	-	-	-	-	-	-	-	-
3-4	0	40	45	50	60	-	-	-	-	-	-	-
4-5	0	40	45	50	55	60	-	-	-	-	-	-
5-6	0	40	45	50	55	55	60	-	-	-	-	-
6-7	-	30	45	50	55	55	55	60	-	-	-	-
7-8	-	-	35	50	55	55	55	55	55	-	-	-
8-9	-	-	-	40	55	55	55	55	55	55	-	-
9-10	-	-	-	-	35	50	50	50	50	50	-	-

(ii) Low grade Brahman cows - Calves are high grade Brahman

Age of cow	Year of Project 0	1	2	3	4	5	6	7	8	9	10	11+
0-1	-	-	0	0	0	0	0	0	0	-	-	-
1-2	-	-	-	0	0	0	0	0	0	0	-	-
2-3	-	-	-	-	35	35	35	35	35	35	35	35
3-4	-	-	-	-	-	65	65	65	65	65	65	65
4-5	-	-	-	-	-	-	65	65	65	65	65	65
5-6	-	-	-	-	-	-	-	65	65	65	65	65
6-7	-	-	-	-	-	-	-	-	65	65	65	65
7-8	-	-	-	-	-	-	-	-	-	65	65	65
8-9	-	-	-	-	-	-	-	-	-	-	65	65
9-10	-	-	-	-	-	-	-	-	-	-	-	-

* Weaning percentage is $\frac{\text{No. of calves weaned}}{\text{Opening No. of Cows}} \times \frac{100}{1}$

(iii) High grade Brahman cows - Calves are high grade Brahman

Age of cow	Year of Project 0	1	2	3	4	5	6	7	8	9	10	11+
0-1	-	-	0	0	0	0	0	0	0	0	0	0
1-2	-	0	0	0	0	0	0	0	0	0	0	0
2-3	-	-	80	80	40	40	40	40	40	40	40	40
3-4	-	-	-	70	70	70	70	70	70	70	70	70
4-5	-	-	-	-	70	70	70	70	70	70	70	70
5-6	-	-	-	-	-	70	70	70	70	70	70	70
6-7	-	-	-	-	-	-	70	70	70	70	70	70
7-8	-	-	-	-	-	-	-	70	70	70	70	70
8-9	-	-	-	-	-	-	-	-	65	65	65	70
9-10	-	-	-	-	-	-	-	-	-	65	65	65

The 2-3 year old heifers which produce 80% weaning in years 2-3 of the project are those which were diagnosed pregnant and transported from Queensland in the previous years.

(5) Bull mortalities and culls*

These are the same for every year in the budgetary analysis.

Age	Mortality %	Culling %
0-1	0	0
1-2	5	0
2-3	3/5**	0
3-4	5	5
4-5	5	5
5-6	5	5
6-7	5	5
7-8	5	100

* Expressed as a percentage of opening number

** 3% in transit mortality for purchased bulls, 5% mortality for station bred bulls.

(6) <u>Cow mortalities</u> - percentage of opening numbers

(i) Shorthorn cows

Age of Cow	Year of Project 0	1	2	3	4	5	6	7	8	9	10	11+
0-1	3	0	-	-	-	-	-	-	-	-	-	-
1-2	3	9	5	-	-	-	-	-	-	-	-	-
2-3	3	9	9	5	-	-	-	-	-	-	-	-
3-4	3	13	9	8	7	-	-	-	-	-	-	-
4-5	3	10	9	7	7	6	-	-	-	-	-	-
5-6	4	8	8	7	6	6	6	-	-	-	-	-
6-7	-	8	7	6	5	5	5	5	-	-	-	-
7-8	-	-	9	8	7	7	7	7	7	-	-	-
8-9	-	-	-	9	8	8	8	8	8	8	-	-
9-10	-	-	-	-	10	9	9	9	9	9	-	-

(ii) Low grade Brahman cows

Age of Cow	Year of Project 0	1	2	3	4	5	6	7	8	9	10	11+
0-1	-	-	0	0	0	0	0	0	0	-	-	-
1-2	-	-	-	3	3	3	3	3	3	3	3	3
2-3	-	-	-	-	6	6	6	6	6	6	6	6
3-4	-	-	-	-	-	6	6	6	6	6	6	6
4-5	-	-	-	-	-	-	5	5	5	5	5	5
5-6	-	-	-	-	-	-	-	5	5	5	5	5
6-7	-	-	-	-	-	-	-	-	4	4	4	4
7-8	-	-	-	-	-	-	-	-	-	6	6	6
8-9	-	-	-	-	-	-	-	-	-	-	7	7
9-10	-	-	-	-	-	-	-	-	-	-	-	-

(iii) High grade Brahman cows

Age of cow	Year of Project 0	1	2	3	4	5	6	7	8	9	10	11+
0-1	-	-	0	0	0	0	0	0	0	0	0	0
1-2	-	3	3	3	3	3	3	3	3	3	3	3
2-3	-	-	6	6	6	6	6	6	6	6	6	6
3-4	-	-	-	6	6	6	6	6	6	6	6	6
4-5	-	-	-	-	5	5	5	5	5	5	5	5
5-6	-	-	-	-	-	5	5	5	5	5	5	5
6-7	-	-	-	-	-	-	4	4	4	4	4	4
7-8	-	-	-	-	-	-	-	6	6	6	6	6
8-9	-	-	-	-	-	-	-	-	7	7	7	7
9-10	-	-	-	-	-	-	-	-	-	8	8	8

(7) <u>Steer mortalities</u> - percentage of opening numbers

(i) Bullock turnoff

Age	Breed Group	Year of Project 0	1	2	3	4	5	6	7	8	9	10	11+
0-1	Shorthorn	3	0	-	-	-	-	-	-	-	-	-	-
	Brahman	-	-	0	0	0	0	0	0	0	0	0	0
1-2	Shorthorn	-	5	5	-	-	-	-	-	-	-	-	-
	Brahman	-	-	-	5	5	5	5	5	5	5	5	5
2-3	Shorthorn	-	-	5	5	-	-	-	-	-	-	-	-
	Brahman	-	-	-	-	4	4	4	4	4	4	4	4
3-4	Shorthorn	-	-	-	4	3	-	-	-	-	-	-	-
	Brahman	-	-	-	-	-	3	3	3	3	3	3	3
4-5	Shorthorn	-	-	-	-	3	3	-	-	-	-	-	-
	Brahman	-	-	-	-	-	-	3	3	3	3	3	3

(ii) Yearling turnoff

Age	Breed Group	Year of Project 0	1	2	3	4	5	6	7	8	9	10	11+
0-1	Shorthorn	3	0	-	-	-	-	-	-	-	-	-	-
	Brahman	-	-	0	0	0	0	0	0	0	0	0	0
1-2	Shorthorn	-	3	3	-	-	-	-	-	-	-	-	-
	Brahman	-	-	-	3	3	3	3	3	3	3	3	3

(8) Steer turnoff rates - percentage of opening number sold.

(i) Bullock turnoff

Shorthorns: 20% in 3-4 years age group

100% in 4-5 years age group

Brahmans: 50% in 3-4 years age group

100% in 4-5 years age group

(ii) Yearling turnoff

All steers sold in 1-2 years age group.

(9) Grazing pressure in Adult Equivalents (AE's) exerted by each age and sex category

Age	Sex category Cows	Steers	Bulls
0-1	0.4	0.4	0.5
1-2	0.8	0.8	0.9
2-3	1.0	1.0	1.2
3-4	1.0	1.0	1.2
4-5	1.0	1.0	1.2
5-6	1.0	-	1.2
6-7	1.0	-	1.2
7-8	1.0	-	1.2
8-9	1.0	-	-
9-10	1.0	-	-

APPENDIX I Summary of livestock projections - Bullock turnoff

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
I Reconciliation of Cattle Numbers															
Opening number	250	1,454	2,851	4,933	6,303	7,901	9,476	11,089	11,555	10,947	10,773	10,717	10,803	[illegible]	[illegible]
Purchases - Bulls	0	64	57	79	43	55	66	50	64	4	0	0	0	0	0
- Cows	1,000(SH)	1,000(BR)	1,000(BR)	0	0	0	0	0	0	0	0	0	0	0	0
Natural increase	250	502	1,254	1,604	2,124	2,438	2,866	[illegible]	2,697	[illegible]	2,872	[illegible]	[illegible]	[illegible]	[illegible]
Sub Total	1,500	3,020	5,162	6,616	8,470	10,393	12,408	[illegible]	14,318	13,835	13,645	[illegible]	13,431	13,842	[illegible]
Sales (Excluding scrub bulls)	0	0	3	36	244	533	867	2,027	2,904	2,571	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Losses	46	169	226	277	325	383	452	456	469	491	488	480	481	492	[illegible]
Closing number	1,454	2,851	4,933	6,303	7,901	9,476	11,089	11,555	10,947	10,773	10,717	10,803	[illegible]	[illegible]	[illegible]
Sub Total	1,500	3,020	5,162	6,616	8,470	10,393	12,408	14,038	14,318	13,835	13,645	13,539	[illegible]	13,842	[illegible]
II General Information															
Grazing pressure (A.E.'s)	614	1,589	3,610	5,288	6,640	8,121	9,961	10,000	10,000	10,000	10,000	10,000	10,000	10,000	[illegible]
No. of Shorthorn females	175	1,284	1,406	1,254	1,206	1,047	699	540	0	0	0	0	0	0	0
No. of low grade Brahman females	0	0	0	239	521	826	1,018	1,371	702	0	0	0	0	0	0
No. of high grade Brahman females	0	0	970	2,270	2,658	3,256	4,027	5,025	6,231	6,147	5,909	5,882	5,915	[illegible]	[illegible]
Total No. of females	175	1,284	2,376	3,803	4,385	5,129	6,004	6,936	6,933	6,147	5,909	5,882	5,915	[illegible]	[illegible]
Bulls required	0	64	119	190	219	256	300	[illegible]	296	292	294	290	290	[illegible]	[illegible]
No. of females sold	0	0	0	0	78	77	194	1,169	1,751	1,378	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
No. of bullocks sold	0	0	0	39	158	447	625	[illegible]	995	1,156	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Appendix 8 (Cont.) Summary of livestock projections - Yearling turnoff

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I Reconciliation of Cattle Numbers																	
Opening number	200	1,456	2,689	4,541	5,363	6,392	7,437	8,697	[illegible]	[illegible]	11,323	11,288	11,480	11,515	11,355	10,896	[illegible]
Purchases - Bulls	0	64	57	79	43	33	66	109	[illegible]	[illegible]	0	0	0	0	0	0	[illegible]
- Cows	1,000(ER)	1,000(ER)	1,000(ER)														
Natural increase	300	502	1,254	1,604	2,124	2,439	[illegible]	3,383	[illegible]	[illegible]	3,746	3,722	3,842	3,944	4,080	4,076	[illegible]
Sub Total	1,500	3,020	5,600	6,224	7,530	8,863	10,3[illegible]	12,0[illegible]	[illegible]	[illegible]	15,069	15,010	15,322	15,459	15,435	14,972	[illegible]
Sales (excluding aged bulls)	0	165	246	616	864	1,116	1,424	1,615	[illegible]	[illegible]	3,283	3,054	3,329	3,614	4,022	[illegible]	[illegible]
Deaths	44	166	263	247	274	310	3[illegible]3	413	[illegible]	506	498	476	478	490	512	[illegible]	[illegible]
Closing number	1,456	2,689	4,541	5,363	6,392	7,437	[illegible]	[illegible]	[illegible]	11,323	11,288	11,480	11,515	11,355	10,896	10,823	[illegible]
Sub Total	1,500	3,020	5,600	6,224	7,530	8,863	10,3[illegible]	12,0[illegible]	[illegible]	[illegible]	15,069	15,010	15,322	15,459	15,435	14,972	[illegible]
II General Information																	
Grazing pressure (A.E.'s)	614	1,989	3,454	4,525	5,993	6,853	7,5[illegible]	8,453	[illegible]	[illegible]	10,000	10,000	10,000	10,000	10,000	10,000	[illegible]
No. of shorthorn females	173	1,284	1,406	1,2[illegible]	1,206	1,047	899	840	[illegible]	[illegible]	0	0	0	0	0	0	[illegible]
No. of low grade Brahman females	0	0	0	[illegible]	521	826	1,078	1,271	[illegible]	[illegible]	244	0	0	0	0	0	[illegible]
No. of high grade Brahman females	0	0	970	2,2[illegible]	2,658	3,[illegible]54	4,027	5,045	[illegible]	7,923	8,732	8,968	9,172	9,157	8,961	[illegible]	[illegible]
Total No. of females	173	1,284	2,376	3,871	4,385	[illegible]	6,0[illegible]	6,[illegible]36	[illegible]	9,361	8,976	8,968	9,172	9,157	8,961	[illegible]	[illegible]
Bulls required	0	64	119	[illegible]	219	[illegible]56	30[illegible]	347	[illegible]	464	405	397	397	402	417	[illegible]	[illegible]
No. of females sold	0	0	0	0	78	77	194	180	[illegible]	1,876	1,462	1,259	1,535	1,756	2,135	[illegible]	[illegible]
No. of yearlings sold	0	165	243	[illegible]	778	1,030	1,182	1,396	[illegible]	1,773	1,772	1,730	1,718	1,776	1,824	[illegible]	[illegible]

Appendix C Cash Flows from livestock trading - Bullock turnoff (May 1973 prices)

Year			0	1	2	3	4	5	6	7	8	9	10	11	12	13	TAIL
I Purchases	Cost per head																
Shorthorn breeders (with calves)	$ 85.00	No	1,000														
		Value	85,000														
Brahman heifers (pregnancy tested)	$140.00	No		1,000	1,0[illegible]												
		Value		140,000	140,[illegible]												
Brahman bulls	$500.00	No		64	57	79	43	[illegible]	[illegible]	50	64	4					
		Value		32,000	28,500	39,500	21,500	[illegible]	[illegible]	25,000	32,000	2,000					
Total Purchases		Value	85,000	172,000	168,500	39,500	21,500	[illegible]	[illegible]	25,000	32,000	2,000					
II Sales	Price per head																
Shorthorn bullocks (500 lbs @ $0.31/lb)	$155.00	No				30	[illegible]	[illegible]									[illegible]
		Value				4,650	[illegible]	[illegible]									
Brahman bullocks (550 lbs @ $0.31/lb)	$170.50	No						[illegible]	[illegible]	814	995	1,158	1,228	1,164	1,162	1,199	1,18[illegible]
		Value						[illegible]	[illegible]	138,787	169,647	197,439	209,374	198,462	198,121	204,429	2[illegible]
Aged Shorthorn cows (425 lbs @ $0.26/lb)	$110.50	No					[illegible]	[illegible]	[illegible]	198							
		Value					[illegible]	[illegible]	[illegible]	21,879							
Aged low grade Brahman cows (450 lbs @ $0.26/lb)	$117.00	No															
		Value															
Aged high grade Brahman cows (475 lbs @ $0.26/lb)	$123.50	No										412	412	231	306	[illegible]	[illegible]
		Value										50,882	50,882	26,528	37,791	5[illegible]	[illegible]
Surplus Shorthorn cows (450 lbs @ $0.26/lb)	$117.00	No								442							
		Value								51,714							
Surplus low grade Brahman cows (475 lbs @ $0.26/lb)	$123.50	No								529	702						
		Value								65,331	86,697						
Surplus high grade Brahman cows (500 lbs @ $0.26/lb)	$130.00	No									400	327	25	85	166	[illegible]	
		Value									52,000	42,510	3,250	11,050	21,580	5,5[illegible]	
Surplus high grade Brahman heifers (breeders)	$150.00	No									749	639	730	724	700	703	[illegible]
		Value									112,350	95,850	109,500	108,600	105,000	105,450	[illegible]
Aged bulls (600 lbs @ $0.30/lb)	$180.00	No							[illegible]	35	48	26	35	42	31	41	[illegible]
		Value							7,[illegible]	6,300	8,640	4,680	6,300	7,560	5,580	7,380	[illegible]
Cull bulls (600 lbs @ $0.30/lb)	$180.00	No			3	6	8	5	9	9	8	9	10	10	9	9	[illegible]
		Value			540	1,080	1,440	[illegible]	1,62[illegible]	1,620	1,440	1,620	1,800	1,800	1,620	1,620	[illegible]
Scrub bulls (550 lbs @ $0.30/lb)	$165.00	No		100	100	50	50										
		Value		16,500	16,500	8,250	8,250										
Total Sales		Value	0	16,500	17,040	13,[illegible]	42,7[illegible]	[illegible]	[illegible]	285,631	430,774	392,981	381,106	356,000	369,692	376,809	[illegible]
CASH FLOW FROM CATTLE TRADING			(85,000)	(155,500)	(151,460)	(23,5[illegible])	21,2[illegible]	[illegible]	[illegible]	260,631	398,774	390,981	381,106	356,000	369,692	376,809	[illegible]

Appendix C (Cont.) Cash flows from livestock trading - Yearling turnoff (May 1973 prices)

Year	Cost per head		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	STATIC 16
I Purchases																			
Shorthorn breeders (with calves)	$ 85.00	No	1,000																
		Value	85,000																
Brahman heifers (pregnancy tested)	$140.00	No		1,000	1,000														
		Value		140,000	140,000														
Brahman bulls	$500.00	No	0	64	57	79	43	55	66	108	[illegible]	2							
		Value		32,000	28,500	39,500	21,500	27,500	33,000	54,000	53,500	1,000							
Total Purchases		Value	85,000	172,000	168,500	39,500	21,500	27,500	33,000	54,000	53,500	1,000							
II Sales																			
Shorthorn yearlings	$ 50.00	No		165	243														
		Value		8,250	12,150														
Brahman yearlings	$ 75.00	No				608	778	1,030	1,182	1,390	1,483	[illegible]	1,772	1,730	1,718	1,776	1,826	[illegible]	[illegible]
		Value				45,600	58,350	77,250	88,650	104,250	111,225	[illegible]	132,900	129,750	128,850	133,200	136,950	[illegible]	[illegible]
Aged shorthorn cows (425 lbs @ $0.26/lb)	$110.50	No					26	78	194	[illegible]	[illegible]	9							
		Value					2,873	8,[illegible]	21,437	[illegible]	[illegible]	[illegible]							
Aged low grade Brahman cows (450 lbs @ $0.26/lb)	$117.00	No																	
		Value																	
Aged high grade Brahman cows (475 lbs @ $0.26/lb)	$123.50	No										[illegible]	[illegible]	331	306	438	554	588	588
		Value										[illegible]	[illegible]	40,878	37,791	54,093	68,419	72,618	[illegible]
Surplus Shorthorn cows (450 lbs @ $0.26/lb)	$117.00	No									[illegible]	[illegible]							
		Value									14,5[illegible]	[illegible]							
Surplus low grade Brahman cows (475 lbs @ $0.26/lb)	$123.50	No										[illegible]	244						
		Value										[illegible]	30,134						
Surplus high grade Brahman cows (500 lb @ $0.26/lb)	$130.00	No											[illegible]	1,028	1,229	1,113	625	69	
		Value											[illegible]	133,640	159,770	144,690	81,250	8,970	
Surplus high grade Brahman heifers (breeders)	$150.00	No														207	956	1,022	[illegible]
		Value														31,050	143,400	153,300	[illegible]
Aged bulls (600 lbs @ $0.30/lb)	$180.00	No							39	[illegible]	[illegible]	[illegible]	35	43	62	66	53	51	[illegible]
		Value							7,020	[illegible]	[illegible]	[illegible]	6,300	7,740	11,160	11,880	9,540	9,180	[illegible]
Cull bulls (600 lbs @ $0.30/lb)	$180.00	No			[illegible]	6	8	9	9	[illegible]	[illegible]	[illegible]	14	22	14	14	13	13	[illegible]
		Value			[illegible]	1,080	1,440	1,620	1,620	[illegible]	[illegible]	[illegible]	2,520	3,960	2,520	2,520	2,340	2,340	[illegible]
Scrub bulls (550 lbs @ $0.30/lb)	$165.00	No		100	100	50	50												
		Value		16,500	16,500	8,250	8,250												
Total Sales		Value	0	24,750	29,190	54,930	76,859	87,3[illegible]	118,727	[illegible]	[illegible]	[illegible]	326,319	315,968	340,091	377,433	441,899	388,308	379,[illegible]
CASH FLOW FROM CATTLE TRADING			(85,000)	(147,250)	(139,310)	15,430	55,159	59,879	85,727	[illegible]	[illegible]	[illegible]	326,319	315,968	340,091	377,433	441,899	388,308	379,[illegible]

Appendix D Capital and operating expenditure, income and net cash flows [illegible]

Year	Ref. No.	0	1	2	3	4	5	6
I Physical								
Townsville Stylo sown (acres)	1	5,000	5,000	10,000	10,000	15,000	[illegible]	[illegible]
Carrying capacity of Townsville Stylo (AE's)	2	323	823	2,154	3,645	5,245	[illegible]	[illegible]
Stock numbers carried	3	827	2,332	3,892	5,618	7,102	[illegible]	[illegible]
Stock numbers purchased	4	1,000	1,664	1,057	79	63	[illegible]	[illegible]
Stock numbers sold (including scrub bulls)	5	-	100	163	88	244	[illegible]	[illegible]
II Financial								
(1) Cash flow from cattle trading	6	(85,000)	(153,000)	(151,668)	(23,520)	21,239	[illegible]	[illegible]
(2) Expenditure								
(1) Capital expenditure								
Purchase of horses	7	3,000	8,300	3,000	1,500			
Land purchase	8	128,000						
Land development	9	36,900	10,500	61,800	61,800	61,800	[illegible]	[illegible]
Buildings and structures	10	107,900	25,700	4,200	17,766	[illegible]	[illegible]	[illegible]
Fencing	11	25,632	43,254	53,254	53,254	[illegible]	[illegible]	[illegible]
Watering points	12	20,000	30,000	30,000	30,000	30,000	[illegible]	[illegible]
Plant and equipment	13	49,260	4,360	8,360	1,116	[illegible]		
TOTAL CAPITAL EXPENDITURE (Ex. cattle purchases)	14	394,692	162,534	158,674	143,446	[illegible]	[illegible]	[illegible]
(2) Operating expenditure								
Wages, salaries and payroll tax	15	23,6[illegible]	27,728	31,645	31,804	[illegible]	[illegible]	[illegible]
Rations and fares	16	8,320	7,840	9,340	[illegible]	[illegible]	[illegible]	[illegible]
Top dressing	17	-	13,935	13,925	41,775	43,775	[illegible]	[illegible]
Fuel and lubricants	18	3,055	3,236	4,325	4,315	4,315	[illegible]	[illegible]
A.A.R.M. & R.	19	13,450	18,325	24,136	24,749	[illegible]	[illegible]	[illegible]
Fees and expenses	20	11,572	11,572	11,998	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL OPERATING EXPENDITURE	21	60,606	84,745	95,759	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL EXPENDITURE (Ex. cattle purchases)	22	425,258	227,259	254,433	[illegible]	[illegible]	[illegible]	[illegible]
NET CASH FLOW (Ex. freight costs)	23	(520,298)	(382,759)	(403,873)	[illegible]	[illegible]	[illegible]	[illegible]

Year	Ref. No.	7	8	9	10	11	12	13	14
I Physical									
Townsville Stylo sown (acres)	1								
Carrying capacity of Townsville Stylo (AE's)	2	9,500	10,000	10,000	10,000	10,000	10,000	10,000	[illegible]
Stock numbers carried	3	11,322	11,251	10,860	10,745	10,760	10,787	10,7[illegible]	[illegible]
Stock numbers purchased	4	50	64	4					
Stock numbers sold (including scrub bulls)	5	2,027	2,902	2,571	2,440	2,256	2,37[illegible]	2,435	[illegible]
II Financial									
(1) Cash flow from cattle trading	6	266,631	396,774	390,981	381,106	356,006	369,892	378,609	[illegible]
(2) Expenditure									
(1) Capital expenditure									
Purchase of horses	7								
Land purchase	8								
Land development	9								
Buildings and structures	10								
Fencing	11								
Watering points	12	10,000							
Plant and equipment	13								
TOTAL CAPITAL EXPENDITURE (Ex. cattle purchases)	14	10,000	-	-	-	-	-	-	-
(2) Operating expenditure									
Wages, salaries and payroll tax	15	44,200	44,200	44,200	44,200	44,200	44,200	44,200	[illegible]
Rations and fares	16	11,720	11,720	11,720	11,720	11,720	11,720	11,720	[illegible]
Top dressing	17	83,550	55,700	83,550	55,700	83,550	55,700	83,550	[illegible]
Fuel and lubricants	18	4,325	4,325	4,325	4,325	4,325	4,325	4,325	4,325
A.A.R.M. & R.	19	36,001	36,301	36,301	36,301	36,301	36,301	36,301	[illegible]
Fees and expenses	20	12,329	12,329	12,329	12,329	12,329	12,329	12,329	[illegible]
TOTAL OPERATING EXPENDITURE	21	192,125	164,575	192,425	164,575	192,425	164,575	192,425	[illegible]
TOTAL EXPENDITURE (Ex. cattle purchases)	22	202,125	164,575	192,425	164,575	192,425	164,575	192,425	[illegible]
NET CASH FLOW (Ex. freight costs)	23	38,506	234,199	198,556	216,531	163,575	205,117	186,384	[illegible]

Appendix 2 (Cont.) [illegible] Capital and operating expenditure, income and net cash flows [illegible]

Year	Ref. No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	STATIC 16
1 Physical																		
Townsville Stylo sown (acres)	1	5,000	5,000	10,000	10,000	5,[illegible]	5,[illegible]	[illegible]	3,000									
Carrying capacity of Townsville Stylo (AU's)	2	329	923	2,345	3,443	5,174	[illegible]	[illegible]	8,323	9,300	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Stock numbers carried	3	827	2,671	3,415	4,527													
Stock numbers purchased	4	1,000	1,574	1,603	79	45	[illegible]	34	109	108	2							
Stock numbers sold	5	-	165	248	615	914	[illegible]	[illegible]	2,415	2,822	3,663	3,283	3,054	3,329	3,616	4,027	3,635	3,564
2 Financial																		
(1) Cash flow from cattle trading	6	(85,668)	(141,350)	(139,316)	15,470	5,159	[illegible]	[illegible]	78,260	94,413	169,494	326,319	315,968	340,091	377,433	441,899	388,308	379,[illegible]
(2) Expenditure																		
(1) Capital expenditure																		
Purchase of horses	7	3,000	8,400	2,500	3,000													
Land purchase	8	128,000																
Land development	9	30,900	30,000	61,[illegible]	61,800	[illegible]	[illegible]	[illegible]	10,879									
Buildings and structures	10	107,920	15,700	6,[illegible]	17,300	3,[illegible]	[illegible]	[illegible]										
Fencing	11	25,412	24,234	31,[illegible]	[illegible]	25,[illegible]	[illegible]	[illegible]	4,5[illegible]									
Watering points	12	20,000	30,000	32,613	20,000	[illegible]	[illegible]	[illegible]	24,[illegible]	26,[illegible]								
Plant and equipment	13	44,240	4,360	8,763	1,158	1,980												
TOTAL CAPITAL EXPENDITURE (Ex. cattle purchases)	14	384,532	147,918	[illegible]	[illegible]	81,[illegible]	[illegible]	[illegible]	13,5[illegible]	1[illegible],000	-	-	-	-	-	-	-	-
(2) Operating expenditure																		
Wages, salaries and payroll tax	15	21,637	27,326	25,[illegible]	33,[illegible]	[illegible]	[illegible]	[illegible]	42,741	44,200	44,200	44,200	44,200	44,200	44,200	44,200	44,200	44,[illegible]
Rations and Stores	16	8,120	9,840	9,[illegible]	9,[illegible]	[illegible]	[illegible]	[illegible]	11,160	11,720	11,720	11,720	11,720	11,720	11,720	11,720	11,720	11,720
Top dressing	17	-	11,623	13,[illegible]	60,229	60,[illegible]	[illegible]	[illegible]	67,125	67,125	67,125	67,125	67,125	67,125	67,125	67,125	67,125	67,[illegible]
Fuel and lubricants	18	3,850	3,954	4,323	4,325	4,325	[illegible]	[illegible]	4,325	4,325	4,325	4,325	4,325	4,325	4,325	4,325	4,325	4,325
A.R & M. & B.	19	13,450	18,244	24,[illegible]	27,759	31,[illegible]	[illegible]	[illegible]	35,702	35,301	36,301	36,301	36,301	36,301	36,301	36,301	36,301	[illegible]
Fees and expenses	20	11,372	11,932	11,093	12,157	12,[illegible]	[illegible]	[illegible]	12,329	12,329	12,329	12,329	12,329	12,329	12,329	12,329	12,329	12,329
TOTAL OPERATING EXPENDITURE	21	80,408	86,185	91,810	118,360	124,[illegible]	[illegible]	[illegible]	173,5[illegible]	176,000	176,000	176,000	176,000	176,000	176,000	176,000	176,000	176,[illegible]
TOTAL EXPENDITURE (Ex. cattle purchases)	22	425,299	234,330	245,924	235,[illegible]	205,[illegible]	[illegible]	[illegible]	213,892	190,000	176,000	176,000	176,000	176,000	176,000	176,000	176,000	176,[illegible]
NET CASH FLOW (Ex freight costs)	23	(510,237)	(371,859)	(385,304)	(218,926)	(185,[illegible])	[illegible]	[illegible]	(135,532)	(97,587)	193,494	150,319	139,886	164,091	201,433	265,899	212,308	[illegible]

Appendix E Assumptions used in preparation of capital and operating budgets

The reference numbers correspond to those in the capital and operating budgets in Appendix D.

I Bullock turnoff

1. Townsville Stylo sown (acres). This includes fencing of the area, provision of watering points etc.

2. Carrying capacity of Townsville Stylo (AE's)

Age of pasture	Carrying capacity
less than 1 year	15.5 acres per A.E.
1-2 years	10.0 acres per A.E.
2-3 years onwards	5.0 acres per A.E.

Total Carrying Capacity in A.E.'s

	Year 0	1	2	3	4	5	6	7	8	9	10	11+
Acres Sown	5000	5000	10000	10000	10000	5000	5000	-	-	-	-	
Age of pasture 0-1	323	323	645	645	645	323	323					
1-2		500	500	1000	1000	1000	500	500				
2-3			1000	1000	2000	2000	2000	1000	1000			
3-4				1000	1000	2000	2000	2000	1000	1000		
4-5					1000	1000	2000	2000	2000	1000	1000	
5-6						1000	1000	2000	2000	2000	1000	
6-7							1000	1000	2000	2000	2000	
7-8								1000	1000	2000	2000	
8-9									1000	1000	2000	
9-10										1000	1000	
10-11											1000	
Total	323	823	2145	3645	5645	7323	8823	9500	10000	10000	10000	10000

3. Stock numbers carried. This is the average of opening and closing number taken from Appendix B - Summary of livestock projections.

4. Stock numbers purchased. From Appendix B - Summary of livestock projections.

5. Stock numbers sold. From Appendix B - Summary of livestock projections. Includes scrub bulls.

6. Cash flow from cattle trading. From Appendix C - Cash flow from cattle trading.

7. Purchase of horses. It is assumed that 15 working horses per stockman are required. To supply this number -

30 workers are bought in years 0, 1 and 2, and 15 are bought in year 3.

30 brood mares are bought in year 1.

1 stallion is bought in year 1.

Workers cost $100 per head

Brood mares cost $110 per head

Stallion costs $2,000.

8. Land purchase. It is assumed that land is bought at $0.20 per acre, giving a cost of $128,000 for land purchase.

9. Land development i.e. The cost of Townsville Stylo establishment.

Seed:	6 lbs. per acre @ $0.65/lb ...	$3.90
Superphosphate:	1 cwt. per acre @ $43.70/ton ...	$2.68
Application:	$0.60 per acre	$0.60
	Total cost per acre	$6.18

10. Buildings and structures

(i) Yards - main homestead yard built in year 1 at a cost of $10,000

- three drafting yards built in years 1, 3 and 5 at a cost of $6,000 each

- 15 tailing yards built by year 6, at a cost of $1,000 each.

(ii) Roads and tracks - Built up roads @ $100/mile - 20 miles built in year 0

- Graded tracks @ $25/mile - 20 miles per year for the first five years.

(iii) Airstrips - Station all-weather strip build in year 0 at a cost of $3,000

- Agricultural strips (one for each 10,000 acres of Townsville Stylo) built in years 0, 2, 3, 4 and 6 at a cost of $700 each.

(iv) Houses and men's quarters - First stage of men's quarters ($12,000), manager's house ($35,000) and two other houses ($25,000 each) are built in year 0.

(v) Sundry buildings - Workshop ($1,500), pump shed ($300), power plant shed ($500), and meat house ($400) are built in year 0

- Large machinery shed ($2,000), small general purpose shed ($1,200) and office and store ($3,000) are built in year 1. Saddle shed ($500) built in year 3.

Total Expenditure on Buildings and Structures

	Year						
	0	1	2	3	4	5	6
Yards	2,000	19,000	3,000	8,000	2,000	8,000	1,000
Roads and tracks	2,500	500	500	500	500		
Airstrips	3,700		700	700	700		700
Houses and quarters	97,000			8,000			
Sundry buildings	2,700	6,200		500			
Total Expenditure	107,900	25,700	4,200	17,700	3,200	8,000	1,700

11. Fencing.

Cost per mile for pegging, grading, materials and erection is $534. This does not include freight on materials.

100 miles of boundary fencing is erected

200 miles of internal fencing is erected

This is enough to split the whole area into paddocks of less than 50 square miles.

For every 1,000 acres of Townsville Stylo sown three extra miles of fencing are erected.

Hence the total mileage of fencing is -

	Year						
	0	1	2	3	4	5	6
Boundary miles		33	33	33			
Internal miles	33	33	33	33	33	33	
Townsville Stylo miles	15	15	30	30	30	15	15
Total mileage	48	81	96	96	63	48	15

12. Watering points.

Maximum use is made of the abundant natural waters. One homestead bore is sunk in year 0, plus one other bore per 500 A.E.'s.

Each bore costs $10,000 to sink and equip.

	Year 0	1	2	3	4	5	6	7
Number of bores sunk	2	3	3	3	3	3	3	1
Total cost ($)	20,000	30,000	30,000	30,000	30,000	30,000	30,000	10,000

13. Plant and equipment

Item	Number	Cost ($)
<u>Year 0</u>		
Second hand grader	1	10,000
Seven ton diesel truck	1	9,000
Four wheel drive vehicles	2	7,000
70 horsepower tractor	1	7,000
Power plant and switchboard	1	5,000
Front end loader	1	1,000
Superphosphate bucket	1	1,000
P.T.O. welder	1	1,700
Posthole digger	1	500
Trailer	1	800
Chain saw	1	300
Fire plant	1	600
Tools and workshop gear		1,000
Saddles and horse gear		360
Camp gear		1,000
Sundry gear		3,000
	Total year 0	49,260
<u>Year 1</u>		
Tools and workshop equipment		1,000
Saddles and horse gear		360
Sundry gear		3,000
	Total year 1	4,360

Item	Number	Cost ($)
Year 2		
Stock crate and loading ramp	1	2,000
Four wheel drive vehicle	1	3,500
Camp gear		500
Saddlery and horse gear		360
Sundry gear		2,000
	Total Year 2	8,360
Year 3		
Saddlery and horse gear		180
Sundry gear		1,000
	Total Year 3	1,180
Year 4		
Saddlery and horse gear		360
Camp gear		500
Sundry gear		500
	Total Year 4	1,360

Year 5 onwards - no capital expenditure on new plant and equipment

15. Wages, salaries and payroll tax.

Manager ($6,500), overseer ($5,000), mechanic ($5,000), cook ($3,500) and three station hands ($3,000 each) employed from year 0 onwards.

One stockman is employed for 36 weeks at $55 per week for every 1,000 A.E.'s in the herd.

Payroll tax is 4% of the total wage bill in excess of $20,800.

16. Rations and fares.

Food, accommodation and an annual return air fare to a southern city is provided for all permanent married men (i.e. overseer, manager and mechanic).

Rations cost $1,000 per year and air fares cost $720.

Single men (i.e. station hands and cook) receive rations worth $500 per year and air fares of $240.

Stockmen - no air fare paid and rations cost $360 per year.

17. Top dressing.

All Townsville Stylo is top dressed with single superphosphate at the rate of one cwt. per acre in the year of establishment (included in (10) - Land Development), one cwt. the next year, and 1 cwt. every second year thereafter.

	Year									
	0	1	2	3	4	5	6	7	8	9
2nd year T.S.		5,000	5,000	10,000	10,000	10,000	5,000	5,000		
4th year T.S.				5,000	5,000	10,000	10,000	10,000	5,000	5,000
6th year T.S.						5,000	5,000	10,000	10,000	10,000
8th year T.S.								5,000	5,000	10,000
10th year T.S.										5,000
12th year T.S.										
Total Acreage	0	5,000	5,000	15,000	15,000	25,000	20,000	30,000	20,000	30,000
Total Tonnage	0	250	250	750	750	1,250	1,000	1,500	1,000	1,500
Value @ $43.70/ton	0	10,925	10,925	32,775	32,775	54,625	43,700	65,550	43,700	65,550
Appln. @ $0.50/acre	0	2,500	2,500	7,500	7,500	12,500	10,000	15,000	10,000	15,000
Total Cost ($)	0	13,425	13,425	40,275	40,275	67,125	53,700	80,550	53,700	80,550

From the static year onwards it is assumed that the area top dressed is a constant 25,000 acres per annum, at a total cost of $67,125.

18. Fuel and lubricants.

	Amount used in gallons/year		
	Diesel Fuel	Petrol	Oil
Power plant	6825	-	155
Grader	3000	-	45
Truck (7 ton)	700	-	7
Tractor (70 HP)	100	-	12
Vehicles	-	833	7
Small engines	-	100	10

19. A.A.R.M. and R.

Annual average repairs maintenance and replacement.

This item is designed to include an annual allowance for the repair, maintenance and replacement of all assets in the projection, and can be calculated for each asset as indicated by this example -

Fences -

Original cost per mile	$534.00
Full life	30 years
Salvage value	$0
Annual average replacement cost per mile ($534 ÷ 30)	$17.80
Average annual repairs and maintenance	$12.00
A.A.R.M. & R.	$29.80

This method was used to calculate A.A.R.M. & R. for all assets on the station to give the totals shown below -

	Year 0	1	2	3	4	5	6	7	8	9+
Fences	1,430	3,844	6,705	9,565	11,443	12,874	13,321	13,321	13,321	13,321
Watering points	600	1,500	2,400	3,300	4,200	5,100	6,000	6,300	6,300	6,300
Bldgs.	2,991	3,177	2,177	3,432	3,432	3,432	3,432	3,432	3,432	3,432
Yards	120	1,260	1,440	1,920	2,040	2,520	2,580	2,580	2,580	2,580
Plant & equip.	7,809	8,245	9,914	10,032	10,168	10,168	10,168	10,168	10,168	10,168
Stallion	500	500	500	500	500	500	500	500	500	500
Total AARM&R	13,450	13,526	24,136	28,749	31,783	34,594	36,001	36,301	36,301	36,301

20. Fees and expenses.

This consists of administrative overheads of $10,000 per annum plus insurance at 1% of the total investment in buildings and structures, plant and equipment.

	Year 0	1	2	3	4	5	6	7	8+
Administrative overheads	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Ins. on bldgs. & structs.	1,079	1,336	1,378	1,555	1,587	1,667	1,684	1,684	1,684
Ins. on plant & equipment	493	536	620	632	645	645	645	645	645
Total fees & Expenses	11,572	11,872	11,998	12,187	12,232	12,312	12,329	12,329	12,329

II <u>Yearling turnoff</u>

1. Townsville Stylo sown (acres) - As for bullock turnoff.

2. Carrying capacity of Townsville Stylo (AE's)

	Year											
	0	1	2	3	4	5	6	7	8	9	10	11+
Acres Sown	5000	5000	10000	10000	5000	5000	5000	5000				
Age of Pasture												
< 1	323	323	645	645	323	323	323	323				
0-1		500	500	1000	1000	500	500	500	500			
1-2			1000	1000	2000	2000	1000	1000	1000	1000		
2-3				1000	1000	2000	2000	1000	1000	1000	1000	
3-4					1000	1000	2000	2000	1000	1000	1000	
4-5						1000	1000	2000	2000	1000	1000	
5-6							1000	1000	2000	2000	1000	
6-7								1000	1000	2000	2000	
7-8									1000	1000	2000	
8-9										1000	1000	
9-10											1000	
Total	323	823	2145	3645	5323	6823	7823	8823	9500	10000	10000	10000

3. Stock numbers carried)
4. Stock numbers purchased.) As for bullock turnoff.
5. Stock numbers sold.)
6. Cash flow from cattle trading.)

7. Purchases of horses. Fifteen horses per stockman are required. To supply this number -

30 workers are bought in years 0, 1 and 3, and 15 are bought in year 2.

30 brood mares are bought in year 1.

One stallion is bought in year 1.

8. Land purchase.)
9. Land development.) As for bullock turnoff
10. Buildings and structures.)

11. Fencing

Boundary and internal fencing as for bullock turnoff.

Fencing of Townsville Stylo paddocks is different due to the different time pattern of pasture establishment.

	Year								
	0	1	2	3	4	5	6	7	8+
Boundary miles		33	33	33					
Internal miles	33	33	33	33	33	33			
T. Stylo miles	15	15	30	30	15	15	15	15	
Total mileage	48	81	96	48	48	15	15		
Total Cost($)	25,632	43,254	51,264	51,264	25,632	25,632	8,010	8,010	-

12. Watering points.

One homestead bore is sunk in year 0, plus one other bore per 500 A.E.'s. Each bore costs $10,000 to sink and equip.

	Year								
	0	1	2	3	4	5	6	7	8
Number of bores sunk	2	3	3	3	2	2	2	2	2
Total cost ($)	20,000	30,000	30,000	30,000	20,000	20,000	20,000	20,000	20,000

13. Plant and equipment. As for bullock turnoff.

15. Wages, salaries and payroll tax. As for bullock turnoff, but the increase is more gradual, as the number of stockmen required does not increase as rapidly.

16. Rations and fares. As for bullock turnoff.

17. Top dressing. Same rates and cost as for bullock turnoff.

	Year									
	0	1	2	3	4	5	6	7	8	9+
2nd year T.S.		5,000	5,000	10,000	10,000	5,000	5,000	5,000	5,000	
4th year T.S.				5,000	5,000	10,000	10,000	5,000	5,000	5,000
6th year T.S.						5,000	5,000	10,000	10,000	5,000
8th year T.S.								5,000	5,000	10,000
10th year T.S.										5,000
12th year T.S.										
Total Acreage	0	5,000	5,000	15,000	15,000	20,000	20,000	25,000	25,000	25,000
Total Tonnage	0	250	250	750	750	1,000	1,000	1,250	1,250	1,250
Value @ \$43.70/ton	0	10,925	10,925	32,775	32,775	43,700	43,700	54,625	54,625	54,625
Appln. @ \$0.50/ac.	0	2,500	2,500	7,500	7,500	10,000	10,000	12,500	12,500	12,500
Total Cost	0	13,425	13,425	40,275	40,275	53,700	53,700	67,125	67,125	67,125

18. Fuel and lubricants. As for bullock turnoff.

19. A.A.R. M. & R.

Method used to calculate this is the same as for bullock turnoff.

	Year									
	0	1	2	3	4	5	[illegible]	7	8	9+
Fences	1,430	3,844	6,705	9,565	10,996	12,427	12,874	13,321	13,321	13,321
Watering Points	600	1,500	2,400	3,300	3,900	4,500	5,100	5,700	6,300	6,300
Bldgs.	2,991	3,177	3,177	3,432	3,432	3,432	3,432	3,432	3,432	3,432
Yards	120	1,260	1,440	1,920	2,040	2,520	2,580	2,580	2,580	2,580
Plant & Equip.	7,809	8,245	9,914	10,032	10,168	10,168	10,168	10,168	10,168	10,168
Stallion	500	500	500	500	500	500	500	500	500	500
Total AARM&R ($)	13,450	18,526	24,136	28,749	31,036	33,547	34,654	35,701	36,301	36,301

20. Fees and expenses. As for bullock turnoff.

Appendix F Assumptions used in the calculation of freight charges

The reference numbers correspond to those shown in Appendix G.

(1) Bulls purchased

All bulls are purchased in the central Queensland coast area. They are sent by rail to Cloncurry and by road train from there to the King Edward-Drysdale Country.

Freight charges are calculated on the basis of -

(i) Queensland coast to Cloncurry @ $200 per K waggon, with 18 bulls per K. i.e. $11.10 per bull.

(ii) Cloncurry to the King Edward-Drysdale area by road train @ $0.65 per K per mile. i.e. 3.61 cents per bull per mile.

(iii) Veterinary charges @ $2.00 per bull.

(iv) Hay to be used on the trip @ $3.70 per bull.

(v) Freight subsidy of $70.00 per bull available (where appropriate).

(2) Heifers purchased

These are purchased from the same area as the bulls and transported by the same route.

Freight charges are calculated on the basis of -

(i) Queensland coast to Cloncurry @ $200 per K waggon, with 24 heifers per K.

(ii) Cloncurry to the King Edward-Drysdale area by road train @ $0.65 per K per mile. i.e. 2.71 cents per heifer per mile.

(iii) Veterinary expenses of $1.00 per heifer.

(iv) Hay to be used on the trip @ $3.70 per heifer.

(v) Freight subsidy of up to $70.00 per heifer available (where appropriate).

(3) Cows purchased

Shorthorn cows are purchased locally and transported to the station by a 500 mile road-train journey @ $0.75 per K per mile with 22 cows per K. Hence freight cost per cow is $17.00

The cost of introducing local Shorthorns is not affected by the presence or absence of a road link with Kununurra or a livestock freight subsidy.

(4) Buildings and Structures	All transported from the nearest port at the general freight rate of 9 cents per ton per mile.
(5) Superphosphate (Capital)	
(6) Fencing materials	
(7) Tanks and Windmills	
(8) Plant and Equipment	
(10) Rations	
(11) Superphosphate (Operating)*	
(12) Fuel and Lubricants	
(13) Sundries	

(15) Abattoir animals

This includes all cattle sold except yearling steers and surplus heifers,

The general rate for livestock cartage is $0.75 per K per

* This includes sea freight from Perth. Freight and handling costs decrease by 10% from year 5 onwards due to improved handling facilities.

mile for single decked road trains, and $0.50 for double decked road trains.

In the case of bullock turnoff abattoir animals are trucked by single deck at 20 per K.

In the case of yearling turnoff abattoir animals are trucked by single deck at 23 per K, because most of the abattoir animals are cows.

(16) Store animals i.e. yearlings

These are taken by double decked road train to Kununurra.

There is no freight charge for surplus heifers as these are sold as breeders, and the buyer pays the freight bill.

(19) Net Cash Flow (Excluding freight)

From Appendix D.

Appendix C An example of freight calculations for one of the 32 budgeted situations

[illegible] port, livestock subsidy, superphosphate subsidy, [illegible] tariff

Year	Ref. No.	0	1	2	3	4	[illegible]	[illegible]	[illegible]	8	9	10	11	12	13	Stable
Freight on Capital Goods																
Bulls purchased	1		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]					
Heifers purchased	2															
Cows purchased	3	17,000														
Buildings and structures	4	776	[illegible]	[illegible]	[illegible]											
Superphosphate	5	1,350	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]								
Fencing materials	6	130	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]								
Tanks and windmills	7	[illegible]	113	[illegible]	113	[illegible]		[illegible]	[illegible]							
Plant and equipment	8	[illegible]	[illegible]	16	[illegible]	[illegible]										
Total freight on capital goods	9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Freight on Operating Goods																
Rations	10	54	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Superphosphate	11		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fuel and lubricants	12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sundries	13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total freight on operating goods	14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Freight on Cattle Turned Off																
Abattoir animals	15	-	975	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Store animals	16															
Total freight on cattle turned off	17	-	975	1,304	838	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total freight cost	18	19,871	4,724	5,794	6,622	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Net cash flow (Ex. freight)	19	(510,298)	(382,759)	(405,873)	(319,824)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NET CASH FLOW	20	(530,169)	(387,483)	(411,667)	(328,446)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Appendix H The Performance Criteria

Accountants and economists have developed numerous criteria for evaluating proposed investments. These investment criteria vary considerably in their levels of sophistication, and in the nature of the information they reveal about different investments. This appendix discusses problems associated with the investment criteria used in this study. Four criteria have been used -

1. Payback period
2. Cash surplus (deficit) at 20 years
3. Net present value (NPV)
4. Internal rate of return (IRR)

There are certain problems associated with the use of each of these criteria. This appendix discusses those problems, and explains the manner in which the criteria have been used in testing the hypothesis.

1. Payback period: This is simply the number of years required for the accumulated net cash flow from a project to become positive. It is a crude tool for evaluating investments, can be highly misleading when used alone. Investments with identical payback periods can differ widely with respect to scale, and the time pattern of cash flows. All cash flows occurring after the payback period has been reached are completely ignored. Despite these shortcomings, payback period has been used in this study because it reveals a characteristic of investments which is not apparent from the other criteria used.

2. Cash surplus (deficit) at 20 years: As with payback period, this criterion is virtually meaningless on its own, but used in conjunction with the more rigorous techniques of investment appraisal it does reveal some useful information.

3. Discounting procedures: There are a number of investment criteria

which use the concept of discounting, in which the values of future benefits and costs are adjusted at discount rates dependent on their remoteness from the present, and the decision maker's preference for future dollars, relative to present dollars. The most commonly used discounting procedures are Net Present Value (NPV) and Internal Rate of Return (IRR).

A number of problems associated with the use of these criteria have been pointed out. The remainder of this Appendix discusses these problems and their relevance to this study. The following symbols and definitions are used -

$b_1, b_2 \ldots\ldots b_j \ldots\ldots b_n$ represents a series of anticipated benefits in years $1, 2 \ldots\ldots j \ldots\ldots n$.

$c_1, c_2 \ldots\ldots c_j \ldots\ldots c_n$ represents a series of anticipated costs in years $1, 2 \ldots\ldots j \ldots\ldots n$.

PV_b and PV_c represent the present value of anticipated benefits and costs respectively.

i represents the discount rate.

NPV, $(PV_b - PV_c)$ represents Net Present Value.

$$NPV = \sum_{j=1}^{n} \frac{b_j - c_j}{(1 + i)^j} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The Internal Rate of Return, IRR, is that value of i for which NPV = 0.

Perhaps the most widely recognized difficulty with the use of discounted cash flow procedures, is the problem of multiple solutions. Attention was first drawn to this problem by Lorie & Savage (23). They concluded (page 237) that the phenomenon of multiple solutions made the IRR technique for evaluating investment proposals "...ambiguous or anomalous". However, Jean (18) in a more rigorous analysis showed that the multiple solutions problem does not automatically invalidate the use of the technique. To solve equation (1) the transformations $(b_j - c_j) = V_j$ and $\frac{1}{(1 + i)} = X$ are made. If only positive values of i are considered, then $0 < X < 1$. By inserting the above transformations in equation (1) -

$$NPV = \sum_{j=1}^{n} V_j X^j \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

When expanded, equation (2) is an nth degree polynamial in X -

$$NPV = V_1 X + V_2 X^2 + \ldots\ldots + V_j X^j = \ldots\ldots + V_n X^n \ldots\ldots (3)$$

- which must be solved for X to determine the IRR. However, because only positive values of i are considered, meaningful roots of this equation are limited to $0 < X < 1$. Jean used Budan's theorem to show that multiple positive roots of equation (3) are only possible where negative cash inflows occur in the middle of a project's life, not when the negative inflows come at the beginning or end of the project life. It is therefore a simple matter to recognize situations where there may not be a unique positive value for IRR.

In these situations, the problem cannot be avoided by using NPV in place of IRR. Figure 5.1 explains why this is so.

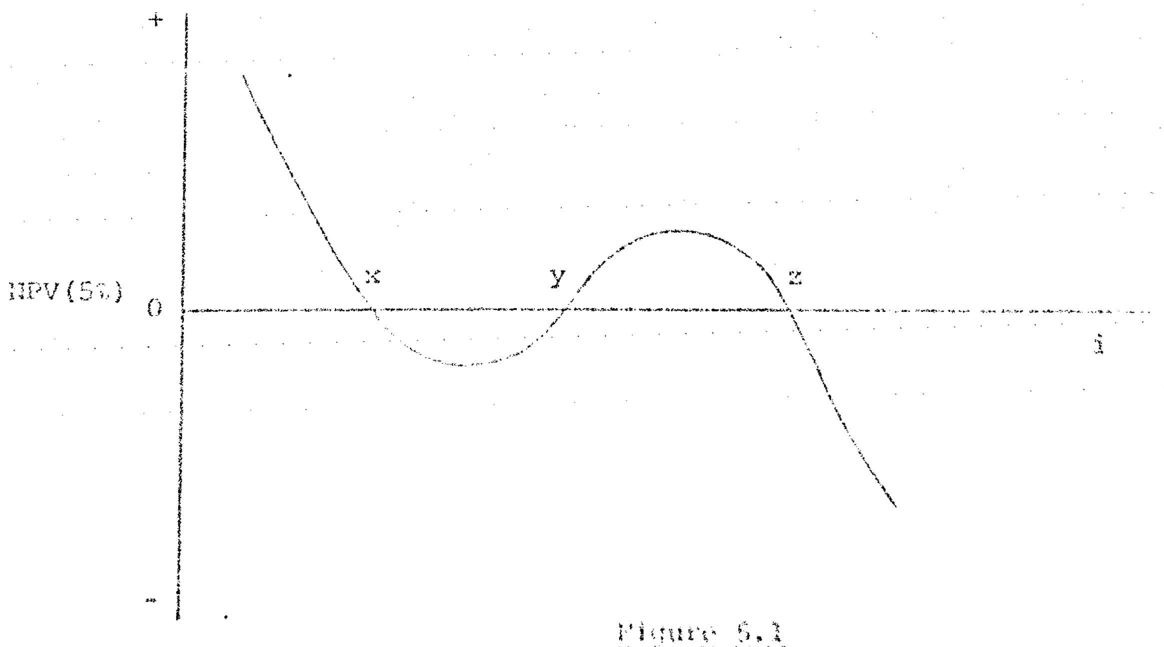

Figure 5.1

The problem of multiple solutions

IRR cannot be used to evaluate the investment shown in figure 5.1 because there are three positive solutions, a, b and c. Using the rule that a project should be adopted if NPV is positive, an investor would adopt if $i < x$ or $y < i < z$, but reject if $x < i < y$. However, since $y > x$ we have a problem of intransitivity which renders the NPV criterian useless in this particular situation. This means that in cases where negative cash flows occur in the middle of a project's life we are left without a simple technique for evaluation.

Investment analysts should therefore inspect cash flow streams before applying discounting procedures to ensure that the necessary condition for multiple positive solutions mentioned by Jean does not exist. The problem does not arise in this study since all cash flows, on becoming positive, remain so to infinity. Figures 3.10 and 3.11 illustrate this.

Another problem with the use of discounting procedures is that of possible inconsistency between the IRR and NPV techniques when ranking groups of mutually exclusive alternatives. Two sets of rules can be used when ranking projects -

Rule 1: Project A is preferred to project B if $IRR_{(A)} > IRR_{(B)}$

Rule 2: Project A is preferred to project B if $NPV_{(A)} > NPV_{(B)}$ using the firm's cost of capital as the discount rate.

It is possible for rule 1 to rank projects in a different order than rule 2. Lorie & Savage (23) drew attention to this problem but considered (page 238) that it was, ".....of small practical significance". Later authors to comment on the problem have included Solomon (37) and Renshaw (33).

Solomon provided the following example to illustrate the conflict -

Cash flows

	t_0	t_1	t_2	t_3	t_4	IRR	NPV(i=10%)
Project X	-100	+120	-	-	-	20.0%	$109.09
Project Y	-100	-	-	-	+174.90	15.0%	$119.46

Solomon (page 126) says that the apparent conflict between the two methods is due to different assumptions regarding the reinvestment of cash surpluses. In relation to the example shown above, Solomon said -

> "According to the data given, proposal Y will provide the investor with $174.90 at time t_4. All we know about proposal X is that it provides $120.00 at time t_1. What happens to these funds between time t_1 and t_4 is obviously an important piece of necessary information. Neither the rate-of-return approach nor the present-value approach answers this question explicitly. But they both answer it implicitly, and in different ways. This is the source of the conflicting results that they yield".

The IRR approach generally assumes that the cash surpluses generated during the life of the project are reinvested at the IRR, whereas the NPV approach implies reinvestment at a rate equal to the firm's cost of capital (i.e. the discount rate). Solomon concluded that if a common reinvestment assumption is used, both approaches will rank projects identically.

This principle has been used by International Computers Ltd. (ICL) in the design of their investment analysis package, "Profit Rating of Projects", (PROP). Here the user has the option of using the usual implicit assumptions regarding reinvestment rates and risking conflict between NPV and IRR rankings, or nominating reinvestment rates to ensure consistent rankings. Hence the problem is surmountable provided the user is aware of it.

Further problems associated with the use of discounting techniques, particularly the IRR, have been pointed out by Jensen (19). Jensen examined three different investment criteria under assumptions of varying scale, timing and rate of investment. The criteria examined were NPV, PV_b/PV_c (benefit-cost ratio), and IRR. Jensen's conclusions are summarized in the following discussion.

(i) Scale of investment: Consider an investment, A, which can be carried out in multiples, A, 2A....nA. Provided additional units of investment can be added without altering the unit net cash flows, the following will hold -

$NPV_{(1\ unit)} = \sum_{j=1}^{n} (b_j - c_j)\, a^j$, where a is the discount factor, $1 / (1 + i)$.

$$NPV_{(x\ units)} = \sum_{j=1}^{n} x(b_j - c_j)\, a^j = x \sum_{j=1}^{n} (b_j - c_j)\, a^j$$

Thus NPV is directly proportional to the scale of investment.

Since $\sum_{j=1}^{n} (b_j - c_j)\, a^j = 0$ where $i = r$ (the IRR),

Then $x \sum_{j=1}^{n} (b_j - c_j)\, a^j = 0$ at the same r.

Thus IRR is independent of the scale of the investment. Hence IRR is not an appropriate method for comparing projects with different scales of operation.

(ii) Timing of investment: Let NPV_t = NPV (in year 0) of an investment undertaken in year t. The calculation of NPV_t explicitly includes the opportunity cost of deferring investment through the discount factor, a. Equations for calculating the NPV of a project initiated at time periods 1, 2.....6 are shown below -

$$NPV_1 = (b_1 - c_1)a + (b_2 - c_2)a^2 + \ldots + (b_n - c_n)a^n = \sum_{j=1}^{n} (b_j - c_j)a^j$$

$$NPV_2 = (b_1 - c_1)a^2 + (b_2 - c_2)a^3 + \ldots + (b_n - c_n)a^{n+1} = \sum_{j=1}^{n} (b_j - c_j)a^{j+1}$$

.

.

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$$NPV_n = (b_1 - c_1)a^t + (b_2 - c_2)a^{t+1} + \ldots + (b_n - c_n)a^{n+t+1} = \sum_{j+1}^{n} (b_j - c_j)a^{j+t+1}$$

Clearly $NPV_t = a(NPV_{t-1})$ i.e. the NPV of an investment is reduced by the factor a, for each time period it is delayed. NPV can therefore be used as a basis for comparison of investments with different timing. This is not true of the IRR -

$$NPV_{b(t)} - NPV_{c(t)} = 0 \text{ where } i = r.$$

$\therefore$ $a(NPV_{b(t)} - NPV_{c(t)})$ is also zero at $i = r$ i.e. the IRR is independent of the timing of the investment. Thus, if there are two investments, one of which begins in year 1, and the other in year 2, but are otherwise identical, the IRR criterion would rank them equally. The example below illustrates this point -

	t_0	t_1	t_2	IRR
NCF (Investment A)	-\$100	+\$120		20%
NCF (Investment B)	-	-\$100	+\$120	20%

Jensen's conclusion from this is that the IRR criterion cannot be used to make valid comparisons between projects which differ in their time patterns of investment.

(iii) Rate of investment: Jensen (page 260) distinguishes between constant and variable rates of investment. A constant rate consists of say x units of investment per year for y years, e.g.

a farmer increasing stock numbers at a constant rate. A variable rate of investment occurs when the number of units of investment applied in each time period varies, perhaps according to the funds available.

The NPV of an investment which is composed of several sub-units of investment can be represented as follows -

$$NPV_{(N\ units)} = f_1V_1 + f_2V_2 + \ldots + f_tV_t + \ldots + f_nV_n \quad (t = 1, 2 \ldots n),$$

where f_t represents the number of units of investment applied in period t, and $\Sigma f_t = N$. The rate of investment is constant if $f_1 = f_2 = \ldots f_n$. The above equation is a linear combination of f_t (representing scale), and V_t (representing timing). Therefore if the rate is constant in the manner described above, NPV will vary directly with the magnitude of f_t, i.e. will be dependent on the rate of investment. However, the IRR will be independent of the rate of investment. The following example illustrates this point -

	t_0	t_1	t_2
Investment A:			
Costs (c)	$100	$100	$100
Benefits (b)	$20	$20	$320
(b-c)	-$80	-$80	$220
Investment B:			
Costs (c)	$200	$200	$200
Benefits (b)	$40	$40	$640
(b-c)	-$160	-$160	$440

Investments A and B shown above both have an IRR of 23%, but it is difficult to imagine that an investor would be indifferent between them. However, the NPV of the two investments will be different at all discount rates other than 23%. Thus Jensen concluded that if the rate of investment is constant IRR cannot be used as a criterion for ranking projects with different rates of investment.

Jensen has also shown that if the rate of investment is variable, i.e. $f_1 = f_2 = ... = f_n$; NPV will vary with the distribution (rate and timing) of investment, but the IRR will be independent of these factors.

The overall conclusion which can be drawn from Jensen's paper is that the IRR is not a valid means of ranking or comparing projects unless they are identical (or very nearly so) with respect to scale, timing and rate of investment. Projects which differ greatly in these characteristics can be ranked equally by the IRR method simply because their NPV's equal zero at the same discount rate. The NPV versus i curves may exhibit widely different characteristics with important implications for the investor. These implications are concealed by the IRR method of ranking.

In each of the 32 different budgetary situations examined in this study, there are variations in scale and timing of investment. For example, the timing of investment in pasture improvement is different for each of the two turnoff strategies. IRR's have been calculated for each budgetary situation, but it is only possible to make IRR comparisons between situations which only show small variations in the pattern of cash flows.

A number of other points regarding the use of discounting procedures have been raised in the literature. Although these do not appear to be problems in this study they are nevertheless worth noting.

Turvey (43) has pointed out that when making investment decisions, conventional investment criteria must be used within a framework of other constraints. Thus the nature of the constraints is just as important as the criteria themselves. The choice of constraints is a value judgement, and since they influence the final selection, there is no way of making investment decisions that is completely rigorous.

A common constraint encountered by investors is capital availability. Thus the aim is not just to maximize NPV or IRR, but to do this subject to the constraint that capital requirements should not exceed certain levels at certain times. Renshaw (33) has pointed out that the capital constraint has a particularly strong influence when we are dealing with indivisible investments. In these cases when faced with a range of alternatives, it may be desirable to adopt a project ranked lower by whatever investment criterion is used, either because a larger but more profitable project would exceed the budget constraint, or a smaller one would leave some capital unemployed. In reality investment decisions are therefore as much a problem of financial feasibility as of economic optimality.

The overall conclusion is that the IRR criterion is of limited value as an investment criterion, and can be quite misleading if not used with great care. It is not generally a suitable criterion for ranking of alternative projects but can be used validly for simple accept - reject decisions. However, in this case there seems to be little reason for going to the trouble of carrying out additional computations, as accept - reject decisions are just as easily made using the NPV criterion. It is most desirable that one of the discounting procedures is used in investment analysis, since these are the only procedures which recognize the time value of money. However, the user should be aware of problems which can arise, and be prepared to use different criteria for different investment decisions.

The overall conclusion is that the IRR criterion should be used with considerable care, and if there is any doubt as to its validity, an alternative criterion such as NPV should be used.

BIBLIOGRAPHY

(1) Agricultural Development Advisory Committee. "Closer Settlement in the Northern Territory". Department of the Northern Territory. Australian Government Publishing Service. Canberra, 1973.

(2) Anon. "Lands and Pastoral Resources of the North Kimberley Area of W.A." C.S.I.R.O. Land Research Series, No. 4, 7, 1960.

(3) Anon. "Atlas of Australian Soils". Division of National Mapping, Department of National Development, Canberra 1967.

(4) Anon. "Beef Roads - a Review of Progress". Department of National Development, Canberra, 1970.

(5) Anon. "Western Australian State Yearbook" 1972.

(6) Begg, J.E. "Probable Distribution of Townsville Stylo as a Naturalized Legume in Tropical Australia". J. Aust. Inst. Agric. Sci. 38, (3), 1972.

(7) Blunt, C.G. "Cattle Research on the Ord" Unpublished bulletin from the Kimberley Research Station, Kununurra, W.A. 1973.

(8) Bureau of Agricultural Economics. "Economics of Land Development. Aboriginal Pastoral Properties in Arnhem Land, N.T." Australian Government Publishing Service, Canberra. 1971.

(9) Bureau of Agricultural Economics. "Economics of Land Development. Tipperary Region of the N.T." Australian Government Publishing Service, Canberra, 1972.

(10) Campbell, K.O. "The Rural Development of Northern Australia" Aust. J. Agric. Econ. 6, (1), 21-30, 1962.

(11) Christian, C.S. and Stewart, G.A. "General Report on a Survey of the Katherine - Darwin Region". C.S.I.R.O. Land Research Series, No.1, 1953.

(12) C.S.I.R.O. "More Beef from the Kimberleys" Rural Research in C.S.I.R.O., No. 63, 28, 1968.

(13) Coombs, H.C. "Review of the continuing expenditure policies of the previous Government". Australian Government Publishing Service, Canberra, 1973.

(14) Davidson, B.R. "The Comparative Profitability and Efficiency of Agriculture in Different Regions of Australia". Rev. Mktg. Agric. Econ. 35, (4), 1967.

(15) Forster Committee. "Prospects for Agriculture in the Northern Territory". Department of Territories. Australian Government Publishing Service, Canberra, 1960.

(16) Heady, E.O. "Economics of Agricultural Production and Resource Use" Prentice Hall, 1952.

(17) Hoffman, E.S. "Agricultural Development Projects" Chapter 12 in "Agriculture in the Australian Economy" D.B. Williams ed.

(18) Jean, W.H. "On Multiple Rates of Return" J. Finance, 187-191, March 1968.

(19) Jensen, R.C. "Some Characteristics of Investment Criteria" J. Agric. Econ. 20, (2), 251-268, 1969.

(20) Johnson, S.E. "Interregional Competition and Comparative Advantage in Agriculture" J. Fm. Econ. 19, 224, 1937.

(21) Kelley, J.H. "Movement of Cattle in Northern Australia: Possibility of Water Transport" Quarterly Review of Agricultural Economics 14, (1), 17, 1961

(22) Lazarides, M. "Pastures of the North Kimberley area, W.A." C.S.I.R.O. Land Research Series, No. 4, 64-70, 1960.

(23) Lorie, J.H. and Savage, L.J. "Three Problems in Rationing Capital" J. Bus. 30, 193-201, 1957.

(24) Miller, H.P. and Perry, R.A. "Preliminary Studies on the Establishment of Townsville Stylo (Stylosanthes humilis) in Uncleared Native Pasture at Katherine, N.T." Australian Journal of Experimental Agriculture & Animal Husbandry 8, (36), 26-32, 1968

(25) Moulden, J.O. and Jenkins, E.L. "Road Transport of Beef Cattle in Northern Australia" Quarterly Review of Agricultural Economics, 21, (2), 1968.

(26) Norman, M.J.T. "The Comparative Performance of Tropical Crossbred and Local Shorthorn Cattle on Native Pasture at Katherine, N.T." Australian Journal of Experimental Agriculture and Animal Husbandry, 7, 26, 1967.

(27) Norman, M.J.T. "The Performance of Beef Cattle on Different sequences of Townsville Stylo and Native Pastures at Katherine, N.T." Australian Journal of Experimental Agriculture and Animal Husbandry, 8, 36 1968.

(28) Northern Territory Phosphate Consultative Group "Phosphatic Fertilizers in the N.T." Department of the Interior. Australian Government Publishing Service , 1969.

(29) Northern Territory Legislative Council. Question Paper, 1973.

(30) Ord Project Co-ordinating Committee "Report of the Cattle Integration Sub-committee" Australian Government Publishing Service, 1970.

(31) Parsons, S.A. and Guise, J.W.B. "An Analysis of the Costs of Operation of Export Abattoirs in Australia". Quarterly Review of Agricultural Economics 24, (1), 45-56, 1971.

(32) Patterson, R.A. "Economic Aspects of the Cattle Industry of the North Kimberley area, W.A." C.S.I.R.O. Land Research Series, No. 4, 99-107, 1960.

(33) Renshaw, E. "A Note on the Arithmetic of Capital Budgeting Decisions" J. Bus. 30, 193-201, 1957.

(34) Richardson, H.W. "Regional Economics Location Theory, Urban Structure and Regional Change" Weidenfeld and Nicolson, 1969.

(35) Robinson, Hugh & Co. Pty. Ltd. "The Impact of the Proposed Bauxite and Alumina Industry on the Beef Potential of the North Kimberleys" Unpublished paper, 1972. Not available for general circulation.

(36) Slatyer, R.O. "Climate of the North Kimberley Area, W.A." C.S.I.R.O. Land Research Series, No. 4, 12-19, 1960.

(37) Solomon, E. "The Arithmetic of Capital Budgeting Decisions" J. Bus., 29, 124-129, 1956

(38) Speck, N.H. "Land Systems of the North Kimberley Area, W.A." C.S.I.R.O. Land Research Series, No.4, 71-85, 1960.

(39) Speck, N.H. "Soils of the North Kimberley Area, W.A." C.S.I.R.O. Land Research Series, No.4, 33-62, 1960.

(40) Stewart, G.H. and Speck, N.H. "Present and Potential Land Use of the North Kimberley Area, W.A." C.S.I.R.O. Land Research Series, No.4, 86-98, 1960.

(41) Teakle, L.J.H. "The Kimberley Project" W.A. Department of Agriculture, Technical paper No. 2147, 1954.

(42) Thomas, F. "Estimated Costs of Beef Production in the North Kimberley Area, W.A." C.S.I.R.O. Land Research Series, No.4, 107-109, 1960.

(43) Turvey, R. "Present Value Versus Internal Rate of Return - an Essay in the Theory of the Third Best" J. Econ. 73, 93-98, 1963.

(44) Van Dugteren, T. "A Time to Decentralize" Current Affairs Bulletin, 48, (7), 210-223, 1971.

(45) Woods, L.E. "A Survey of Townsville Stylo (Townsville Lucerne) Pastures Established in the Northern Territory up to 1969". Tropical Grasslands, 3, (2), 91-98, 1969.

(46) Young, P.J. Personal communication (Mr. Young is an agricultural consultant with the firm Hugh Robinson & Co. Pty. Ltd. which has been active in the study area).

(47) Young, P.M. "An Economic Comparison of Brahman and Shorthorn Cattle: A Case Study in the North Kimberleys" Unpublished M.Ec. dissertation, University of New England, 1971.