CHAPTER 1: INTRODUCTION

1.1 MOTIVATION AND OBJECTIVES OF THE STUDY

Livestock husbandry and the production of food and by-products from animal origin, is an important part of the highly diverse agricultural sector of the South African economy. The country has the potential to be self-sufficient in milk production, but it currently exports and imports fluid milk and processed dairy products. If the dairy sector strives to attain a larger world market share, it has to be competitive. A proper understanding of the structure of the underlying dairy production technology is the key to improving the sector's competitiveness. Thus, analysis of the supply of fluid milk (the focus of this study) will provide useful information to managers and policy makers for predicting how the dairy sector would respond to shifts in world and local market prices of production inputs and fluid milk. Appropriate and timeous adjustment mechanisms can hence be designed to improve the dairy sector's local and international competitiveness.

Analysis of milk supply response continues to be an important part of the international agricultural economics literature. However, the same cannot be said for South Africa. During the 1960's, published work focused on consumer demand and price trends for dairy products and efficiency comparisons between different technological options in the 1960's [Maree, 1962; Du Plessis and Nel, 1963; National Marketing Council, 1964; Viljoen, 1967; and Graham and Groenewald, 1968 and 1969]. The focus of the 1970's was on dairy forage valuation [Comrie and Behrmann, 1977]. Published research in the 1980's focussed on the impact of government intervention in the sector, optimum feed planning models, efficient resource allocation, and analysis of the economic impact of the fresh milk scheme [Backeberg, 1982; Durham and Nieuwoudt, 1982; McKenzie and Nieuwoudt, 1985a and 1985b; and Gordijn and Ortmann, 1988]. The 1990's research pertained to purchasing power of emerging consumers, the impact of uncertain labour legislation changes prior to democratisation, adoption of modern computer technology on dairy farms and the political economy of the dairy sector before market liberalisation in 1995 [Campbell, Jobo and Phakisi, 1990; Antrobus

and Donkin, 1991; Wright and Nieuwoudt, 1993; and Hildebrand and Ortmann, 1994]. Contemporary estimation of supply and demand elasticities, structure and efficiency of production and input substitutability in dairy farming is lacking. Such analysis for the industry as a whole and for different production groups within the industry is imperative for a better understanding of the impacts of changes in the business environment and for developing effective policy measures.

1.1.1 OBJECTIVES OF THE STUDY

The main objective of this study is to analyse the underlying structure of milk production technology in South Africa.

Under this main objective the following three specific objectives were pursued, namely:

a) Use available cross-sectional farm survey data to analyse the supply response to policy changes;

b) Evaluate whether the dual approach to supply response analysis, as applied to cross-sectional production cost data, is appropriate for analysis and testing of the properties of South African milk production technology, in order to model meaningful milk supply response behaviour; and

c) Based on the results, show that production cost surveys provide a valuable basis from which to improve upon the type of information collected.

Duality theory is applied to available cross-sectional farm survey data. An econometric approach is followed in which the Iterative Seemingly Unrelated Regression method is used to estimate the restricted profit system parameters that describe the underlying production technology.

This is a positive, rather than a normative approach, which should ideally form the basis for further, more expanded studies.

A brief background to the South African dairy sector and its contribution to the South African economy follows in section 1.2.

1.2 OVERVIEW OF THE SOUTH AFRICAN DAIRY SECTOR

An industry's absolute size, as well as the size and dispersion of the enterprises of which it is comprised, is influenced by environmental factors (substantial variation in climate and topography); quality of infrastructure; social and economic trends (availability of labour, wage rates, population density and resulting service provision, and interest rates) and government policy (labour legislation, import- and export regulations, health policies).

The milk industry in South Africa is characterised by a wide range of farm sizes (measured in terms of production of milk per annum) and substantial geographic diversity [Dairy Development Initiative, 1999]. Some farms invest in expensive capital equipment with emphasis on mechanisation, whilst other farms are more labour intensive and rely on manual operations. At the lower end of the size scale, one finds a decrease in farm size and in sophistication of the production systems. Typically, a frequency distribution of average daily production shows a distribution that is highly skew to the lower tail indicating a very large number of low output farms in South Africa.

1.2.1 ORGANISATIONAL STRUCTURES IN THE INDUSTRY

Recently, the industry saw the disappearance of production support measures as administered by the former Milk Marketing Board. After abolition of the marketing board (1995), the industry reorganised itself through the formation of various substitute bodies that address the needs of specific groups of milk producers and processors. The milk buyers and producer-distributors are organised into two organisations. Larger companies, representing approximately 78% of all milk processed, are represented by the South African Milk Organisation (SAMO). Smaller processors are organised under the National Milk Distributors Association (NMDA). SAMO and NMDA, together with the Milk Producer Organisation (MPO), consumer groups and organised labour form the overarching South African Milk Federation (SAMFED). Numerous small processors are not directly affiliated to any of the mentioned organisations [Dairy Development Initiative, 1999].

A few characteristics of the industry are outlined. This is necessary for an understanding of the size and contribution of the sector to the national economy, and the consequent importance of analyses pertaining to this specific industry.

1.2.2 RELATIVE SIZE AND DISPERSION IN THE SECTOR

Approximately 6 200 to 6 500 commercial[5] enterprises produce milk in South Africa. These figures vary with the state of the economy. Data on the number of emerging[6] farms is incomplete. The white commercial farmers are mostly located in the traditional farming areas, whilst the bulk of small-scale and commercial dairy farmers are located in and around towns as well as in traditional farming areas [Dairy Development Initiative, 1999].

Table 1 (below) shows the relative contribution of the nine administrative provinces to the total national milk production. The coastal regions (KwaZulu-Natal, Western- and Eastern Cape) are clearly the major contributors, as their collective production constitutes 53% of the country's milk output. Based on climate and natural resources, these coastal regions are more suitable for low-cost milk production systems on natural and irrigated pastures.

The non-coastal production areas are climatically less favourable for milk production. The harsh dry winters in these regions necessitate more intensive feedlot production systems for dairy farming. Despite this, market concentration in the interior combined with the long road distances from the coastal regions, create enough incentives for the cost intensive systems in the interior to play an

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[5] In South Africa, the definitions of commercial and small-scale farms are the subject of a contentious and controversial debate. For the purpose of this study, "commercial" refers to those farms that have been actively producing and selling milk to processors, dairies or directly to the consumer. Small-scale farms are regarded as those that produce milk for home consumption, and occasionally sell small quantities to consumers, but who make use of limited technology inputs.

[6] Emerging farms are those that were previously excluded from the mainstream of the economy but who are now gaining access to input and product markets through agricultural policy and market reforms.

important role in South Africa's dairy industry. These non-coastal regions supply 47% of the national output.

Table 1: Number of milk producers per province (1997) and milk production per province (1994) in South Africa[7].

	Producers		Production	
Province	Number	%	Milk output (Million litres)	%
Western Cape	1437	23	354	23
Eastern Cape	622	10	215	14
Northern Cape	100	2	15	1
KwaZulu-Natal	479	8	246	16
Free State	1505	24	277	18
North West	1144	18	185	12
Gauteng	236	4	62	4
Mpumalanga	634	10	169	11
Northern Province	63	1	15	1
Total	6220	100	1 538	100

1.2.3 COLLECTION COST AND PRODUCTION DENSITY

The economic effect of widely dispersed, low volume of milk production per producer is reflected in the collection cost of milk. In the interior of the country, the cost of collecting milk is high where the milk production per square kilometre is low. The stark reality of South Africa's low litres/ km² /day in comparison with other countries stands out in Table 2. In the coastal areas, the milk density (volume of production per area) is higher. Dairy, together with maize, beef and mutton production, form the main agricultural enterprises in the interior regions.

The low density of milk production per square kilometre in South Africa should be viewed against the general trends in international dairy farming: numbers of herds decrease; herd sizes increase; production yield per cow increases; and the fat and protein contents of milk improve. All these tendencies are conducive to low collection and transaction cost per unit milk collected. Table 2

[7] All tables in this chapter are modified versions of those found in the Dairy Development Initiative [1999].

compares the daily production per square kilometre for the leading international dairy countries with that of South Africa in total, and the more optimal production zones in the country [Dairy Development Initiative, 1999].

Table 2: International comparison of milk production per km² per day

Country	Litres / km² / day
France	125
Germany	308
Netherlands	892
UK	257
New Zealand	94
South Africa: Total area	5
: Production areas	25
: Coastal area 1	103
: Coastal area 2	96

1.2.4 DOMESTIC PRODUCTION

In 1996 South Africa produced 2.22 million tons of milk (equivalent to 2 150.49 million litres) by approximately 6 220 commercial farmers. With a gross value of production (1997/1998) of R2 620 million, fresh milk and dairy products represents the fourth largest agricultural sector in South Africa (7,4% of gross value of all agricultural products). If the value of slaughtered dairy cattle is included, the producer of primary dairy products' share of the gross value of all agricultural products is an additional R 388 million.

The basic nature of the dairy industry is varying production and consumption patterns. There is some predictability in, for example, weekly and seasonal consumption patterns. Predicting the variability in production of raw milk is more difficult [Dairy Development Initiative, 1999]. A significant proportion of South Africa' s milk is produced partially or wholly from natural or artificial pastures with resulting seasonality in supply. Farmers generally view these systems as the least costly production options. However, the inherent variability in climatic conditions across years destabilises farmers' milk supplies, milk prices and cash flows. In addition, unstable inter- and intra-seasonal milk flows

have a cost increasing effect on the dairy processing industry. The market is drastically destabilised due to periodic surpluses and shortages, making it difficult to balance production and demand. This is aggravated by low priced subsidised imports [Dairy Development Initiative, 1999].

1.2.5 LINKAGES WITH OTHER SECTORS OF THE ECONOMY

Of great importance is that the industry has highly positive and advantageous gross domestic product (GDP)-, labour- and household income multipliers. The total GDP multiplier of the primary and secondary dairy industry is 9,66 with a total effect of R28 195 million. This multiplier gives an indication of the additional GDP created throughout the economy, due to an increase in demand for raw milk [Dairy Development Initiative, 1999]. The first round and indirect employment multipliers have the same meaning than that of the GDP multipliers. The total employment multiplier for the primary dairy industry (41.7) is less than that of the rest of agriculture (42.9) - indicating extensive use of capital equipment on dairy farms. The primary dairy industry is very friendly towards the balance of payments. Its direct import propensity is low (0.04) - that is to supply in R 1.00 increase in final demand the sector imports to the value of less than five cents. For this industry, the total import multiplier (0.14) is marginally lower than that of the rest of agriculture (0.16) [Dairy Development Initiative, 1999]. The household income multipliers are indicative of the change in household income with a R 1.00 change in final demand. The primary dairy industry multiplier (0.54) is slightly higher than that of the rest of agriculture (0.47). If the total direct and indirect effects on household income are calculated, the primary dairy industry has a substantially higher figure (8.64 compared with 3.91) than for the rest of agriculture.

The direct purchase of inputs is a first or direct indicator of the size and importance of a sector's backward linkages in the economy. Inputs such as fertiliser, seed, irrigation, etc are not listed separately, but are included in items such as cost of producing roughage. The most important variable inputs at 1998 prices are presented in Table 3 and the value of fixed investments in Table 4.

Table 3: Value of inputs purchased by dairy farmers in 1998.

Type of Input	Rand (Millions)	%
Self produced feed cost	540	25
Purchased feed cost	807	37
Milk supplements and minerals	118	5
Total Feed Cost	1 465	67
Veterinary and medicine cost	62	3
Artificial insemination	36	2
Wash and sterilisation	33	2
Other variable cost	82	4
Labour: Farm workers	263	12
Labour: Hired management	24	1
Fixed Cost	229	10
Total Cost	2 194	100

Table 4: Estimated values of fixed investments on dairy farms, at 1998 prices.

Item	Rand (Millions)	%
Fixed improvements	1 052	14
Equipment	730	10
Machinery and implements	749	10
Land	2 205	30
Livestock	2 469	34
Other	155	2
Total	7 360	100

It is clear that purchased- and self-produced feed cost constitute the largest share of farm expenditure on variable inputs. The most substantial capital investments are in livestock, followed by land.

The nature of milk (as a commodity), characteristics of milk production and the geographical dispersion of dairy farms are critical to organisation of the dairy sector. Milk for drinking purposes is a highly perishable product and thus requires continuous inspection. The dairy farm goes through a three (3) to four (4) year cycle as heifers are bred between 15 and 21 months after birth (to be 24 to 30 months old when freshened) [Dairy Subsector of American Agriculture, 1978]. From a national viewpoint, few primary products are substitutes for raw milk. Yet, many non-food goods are

economic substitutes for milk and dairy products (such as cool drinks, fruit juice, coffee, tea, etc.). Milk supply response is known to be price inelastic in the short run (due to large fixed investments on dairy farms and due to the long production cycle of cows) and only slightly more elastic in the longer run.

There exists an obvious relationship between the size of dairy farms and the scale of milk production that it can achieve [CAS Report 4, July 1978]. However, two sources of variation exist for this general idea. Firstly, many farmers operate other enterprises besides dairying – from which the dairy enterprise might benefit, although it probably places an expansion limitation on the dairy enterprise; and secondly, nearly all farms utilise some level of bought feed, thereby effectively increasing the size of their dairy enterprise [Burton, 1984].

1.3 AVAILABLE DATA

A sub sample of the South African Milk Organisation' s (SAMO) annual milk production cost survey (1996/1997) was initially made available to the University of Pretoria for analytical purposes. The survey included data on 394 farms that delivered milk to on of the major South African milk processors. The survey results indicated that the primary sector is composed of three broad groups. Firstly, small producers, delivering less than 250 litres per producer per day, account for 9% of total deliveries to dairies. They represent 17,76% of the total number of milk producers. Secondly, producers delivering less than 1 000 litres per day constitute 71,32% of all dairy producers. They deliver 33,06% of the total milk production. Thirdly, only 1% of milk producers deliver more than 5000 litres per producer per day, and they produce 11% of the milk.

In addition to the cross-sectional problems inherent in the data, limited detail was given on either prices or quantities of inputs. Subsequently, more detailed data was obtained from the Milk Producer Organisation (MPO). This set was substantially smaller (49 observations), but contained a more detailed record of input use and corresponding prices. This set was comprised of cross-sectional

observations on milk producing farms, for the 1997/1998-production year. The MPO dataset was chosen for the analysis as it contained more detail to support better analysis of supply response and substitution possibilities in milk production on a more disaggregated level.

1.4 OUTLINE OF THE STUDY

The study is organised into five chapters with a reference section and appendices. The second chapter contains a literature survey on supply response analysis, particularly pertaining to milk production. Chapter 3 describes the theory, hypotheses, methods of analysis and tests applied in the analysis. Chapter 4: represents the results and Chapter 5: concludes the discussion with a summary of the chapters and recommendations for further studies. The list of references contain those references specifically cited in the document as well as those that were read to broaden the author's understanding of specific topics.

A summary of the data is provided in Appendix A, and brief explanations of different system estimation techniques are given in Appendix B.