DETERMINANTS OF HERD PRODUCTVITY IN BOTSWANA: A FOCUS ON LAND TENURE AND LAND POLICY

BY

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ABSTRACT

This study attempts to identify factors responsible for determining differences in the productivity of cattle managed by communal and private livestock farmers in the southern region of Botswana during 1999/2000. It is hypothesised that herd productivity and investment in southern Botswana are higher on private ranches than on open access communal grazing land.

This study is important because livestock, especially cattle, contribute significantly to the livelihood of farmers in Botswana. Cattle are a major source of meat, milk and draught power, and provide a store of wealth that protects against inflation and which can easily be converted into cash. Cattle production is also an important source of employment in the rural economy of Botswana. Furthermore, the export of beef is a major source of foreign exchange earnings, and cattle account for 80 percent of agriculture's contribution to Botswana's gross domestic product.

A stratified random sample survey of communal and private livestock farmers was conducted in the southern region of Botswana from August 1999 to May 2000 with the assistance of four enumerators. The sample survey data were used to compute descriptive statistics and to estimate the parameters of a block recursive regression model. The model postulated relationships between agricultural credit, investment in fixed improvement, investment in operating inputs and herd productivity. Some of the equations are estimated with Ordinary Least Squares (OLS) and some with Two-Stage Least Squares (2SLS) to account for likely correlation between endogenous explanatory variables and the error term.

Descriptive statistics show that levels of investment and herd productivity are higher on private farms than on open-access communal grazing. Private farmers are also better educated, more liquid, and have larger herd sizes, but do not differ from their communal counterparts in terms of age, gender, race or household size. The regression results show that (a) respondents with secure tenure and larger herds use more agricultural credit than those who rely on open access communal grazing land to raise cattle; (b) secure land tenure, higher levels of liquidity and use of long-term credit promote investment in fixed improvements to land; (c) liquidity from short-term credit and wage remittances supports expenditure on operating inputs; and (d) herd productivity increases with greater investment in fixed improvement and operating inputs. Herd productivity is therefore positively (but indirectly) influenced by secure land tenure.

It can therefore be inferred that government should (a) uphold private property rights to land where they already exists; (b) privatise open access grazing to individual owner-operators where this is politically, socially, and economically feasible; and (c) where privatisation to individuals is not feasible, government should encourage users to convert the grazing into common property by subsidising the costs of defining user groups and the boundaries of their resources, and enforcing rules limiting individual use of common property. This first-step in a gradual shift towards more secure tenure should be followed by the conversion of user groups to non-user groups organized along the lines of investor-owned firms where members exchange use rights for benefit and voting rights in a joint venture managed by an expert.

DECLARATION

The study described in this thesis was carried out in the school of Agricultural Sciences and Agribusiness, University of KwaZulu-Natal, Pietermaritzburg, under the supervision of Professor Michael Lyne and Professor Anthony Panin as co-supervisor.

This study represents original work by the author and has not otherwise been submitted in any form for any degree or diploma to any University. Where use has been made of the work of others it is duly acknowledged in the text.

Signed:
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DEDICATION

This thesis is dedicated to my wife, daughter and son.

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God bless them all!

LIST OF SYMBOLS AND ABBREVIATIONS

ACP	African Caribbean and Pacific
AGOA	African Growth and Opportunities Act
AI	Artificial Insemination
ALDEP	Arable Land Development Programme
BLS	Botswana Lesotho and Swaziland
BMC	Botswana Meat Commission
CBPP	Contagious Bovine Pleuro- Pneumonia
CEDA	Citizen Entrepreneurial Development Agency
CDM	Cold Dress Mass
CSO	Central Statistics Office
CV	Coefficient of Variation
EU	European Union
FAP	Financial Assistance Policy
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GM/LU	Gross Margin per Livestock Unit
IOF	Investor-Owned Firm
IT	Information Technology
LITS	Livestock Identification and Trace Back System
LSD	Lumpy Skin Disease
LU	Livestock Unit
NDB	National Development Bank
NIE	New Institutional Economics
OLS	Ordinary Least Squares
PCA	Principal Component Analysis
Px	Private costs

LIST OF SYMBOLS AND ABBREVIATIONS CONTINUED

RSA	Republic of South Africa
SLOCA	Services to Livestock Owners in Communal Areas
SPSS	Statistical Package for Social Science
2SLS	Two- Stage Least Squares
USA	United States of America
VAP	Value of Average Product
VMP	Value of Marginal Product

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

" *Wa e tlhoka wa tlhoka boroko, wa nna nayo wa nna wa bo tlhoka*" is a Setswana proverb claiming that a farmer who does not have cattle faces problems such as lack of wealth and income; but when he or she does own cattle, problems of managing them prevail. This summarises the dilemma of cattle ownership in most African countries.

Livestock, especially cattle, make a significant contribution to the livelihood of rural households in Botswana. Cattle are an important source of food and employment creation. The Bank of Botswana (1999: 68) attributes about 16 percent of rural employment in 1999/2000 to the agriculture sector but slowed down to 13.4 percent in 2002 (Ministry of Finance and Development Planning, 2003). Over 80 percent of the 1.7 million people in Botswana reside in rural areas and strive to earn a living directly or indirectly from agriculture, and the majority of them raise cattle (Behnke, 1985; Malope, 1999; Ministry of Agriculture, 1989). Cattle generate a large share of rural household income (Fidzani, 1993), provide milk during the rainy season and meat as a source of protein during the dry season. Rural households in Botswana use ox-drawn ploughs to cultivate extensive areas of arable land. Therefore cattle provide an important link with arable production. Other cattle products used by rural households in Botswana include hides for mats and leather ropes. Importantly, cattle reproduce and provide a store of wealth (Crotty, 1980: 46; Hubbard, 1986: 31; Ministry of Agriculture, 1996) that protects against inflation and which can easily be converted into cash (liquidated) in times of need (Ministry of Agriculture, 1991). For example, cattle are often sold to finance dowry (bogadi), funeral expenses and school fees (Fidzani, 1993). Cattle perform the function of a 'bank' in rural areas in Botswana.

Beef cattle contribute significantly to the foreign exchange earned by the agriculture sector in Botswana because arable agriculture is severely constrained by erratic and unreliable rainfall (Behnke, 1987; Ministry of Agriculture, 1991; Panin *et al.,* 1993; Abel, 1997; Panin & Mahabile, 1997; Mahabile *et al.,* 2002). At macroeconomic level, cattle account

for about three percent of Botswana's gross domestic product (GDP) and 80 percent of agriculture's share of the GDP (Central Statistics Office, 1995; Ministry of Agriculture, 1996). The contribution of agriculture, mining and manufacturing to GDP from 1966 to 2003 is presented in Figure 1.1. The contribution of the agriculture sector declined sharply from about 45 percent in 1966 to about three percent in 2001/2003.

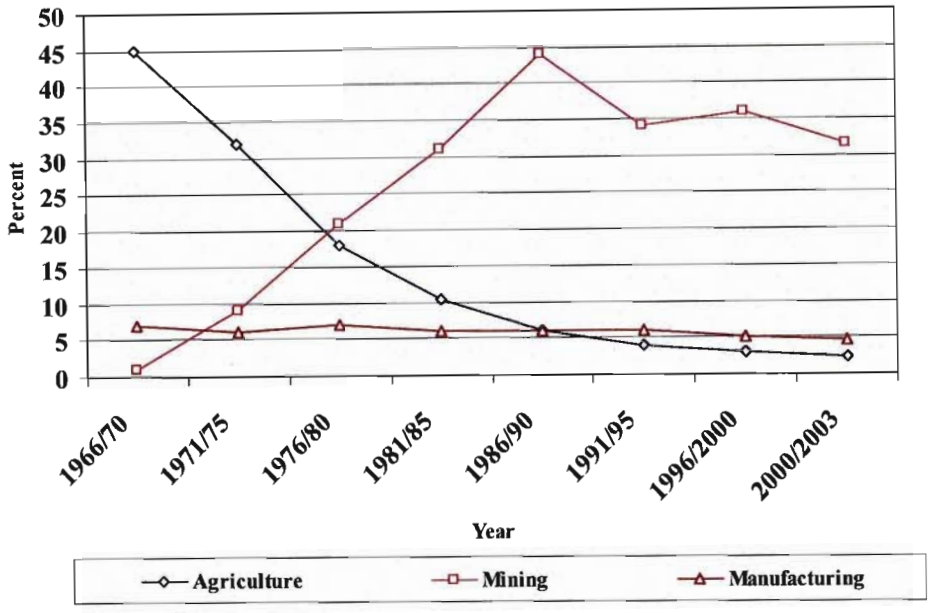

Figure 1.1: Percentage contribution of selected sectors to Botswana's gross domestic product

Source: Adapted from Central Statistics Office, 1995 and Ministry of Finance and Development Planning, 2003.

The mining industry however increased its contribution to GDP from zero percent in 1966 to about 33 percent in 2001/2003. The increase in the contribution of mining was due to the discovery of diamonds, copper and nickel in the early 1970's. The development of the mining sector has been a major source of Botswana's economic growth and development. Agriculture is expected to add 0.8 percent to real annual growth in Botswana's GDP whereas the mining sector is expected to contribute 5.8 percent (Ministry of Finance and Development Planning, 2003). Growth in these sectors has increased the country's real economic growth rate to 6.4 percent per annum from 1997 to 2003 (Ministry of Finance and Development Planning, 2003). The occurrence of drought caused high cattle

mortalities, which constrained agriculture's contribution to GDP in 2000 and 2003. GDP computation does not include, at the farm level, the value of products such as manure, hides and skins that the cattle sector contributes to the rural sector. This measure of agriculture's performance is therefore understated (Abel, 1997).

Despite its current dominance, the mining sector does not generate significant employment because it is highly capital intensive. Agriculture, on the other hand, with its relatively small share of Botswana's GDP, has strong linkages to the rest of the economy (Ministry of Finance and Development Planning, 1997: 227), the most important of which is employment creation particularly livestock production. Although cattle ownership is highly skewed (section 1.5), it is the only sector where the majority of farmers are Batswana[1] (Ministry of Agriculture, 1996).

1.2 LAND RIGHTS AND USE OF GRAZING RESOURCES IN BOTSWANA

Botswana's grazing land is characterised by open access or common property conditions in the communal areas, private property in the country's freehold and leasehold areas, and zones reserved mainly for wildlife and tourism (Lawry, 1983). The communal grazing area accounts for 86 percent of Botswana's cattle population and 71 percent of its rural area. This land is officially owned and administered by statutory Land Boards, and its grazing is mostly an open access resource. Open access implies that rules limiting individual use of communal land are either missing or are not enforced. Common property implies that users make and enforce such rules. The less stringent are these rules, or the more lax is their enforcement, the more similar are the economic outcomes of open access and common property regimes. In Botswana, common property is usually associated with "syndicate" farms, which account for a very small share (less than one percent) of the country's communal grazing land (Ministry of Agriculture, 1991). Sections 2.1 and 2.2 explain why property rights to communal grazing land are not secure in the economic sense.

Private ranches account for only a small fraction (14 percent) of the national herd and a smaller share (five percent) of the land (Ministry of Agriculture, 1991). Private farms refer to farms where the operators have exclusive and marketable property rights to land.

1 People of Botswana are called Batswana.

Freehold farms were acquired during the colonial era. Leasehold farms were allocated to their "owners" by the Land Boards. For the purpose of this study, leasehold farms are regarded as privately-owned ranches (even though their "owners" do not possess freehold title to the land) because their lease is long-term (50 years renewable), fully transferable, can be sold or pledged as collateral, permits subletting and assigns exclusive rights to an individual holder. In short, private ranches, both freehold and leasehold, are characterised by secure land tenure. Private farmers often rest their own grazing land by driving their cattle into communal areas for part of the year (usually during the spring months).

Although the Ministry of Agriculture specifies maximum stocking rates for all types of land, these limitations are not easily enforced by Land Boards (Carl Bro International, 1982). Water rights assigned to farmers in communal areas do not impose any quantitative restriction on the volume of water used or the number of animals kept (stocking rate) by stockowners (Carl Bro International, 1982). National parks and game reserves, which are on state land managed by the Ministry of Wild life and Tourism, make up the remaining 24 percent of the grazing area.

1.3 BOTSWANA'S BEEF TRADE AND EXPORTS

1.3.1 Internal Marketing System

There are three types of slaughtering facilities in the livestock marketing chain in Botswana. The Botswana Meat Commission (BMC) is a monopolistic state enterprise with two operating abattoirs; one at Lobatse established in 1954 and the other at Francistown, which was opened in 1989. These two abattoirs are European Union (EU) export approved and therefore maintain high standards of hygiene and quality control supervised by the Government Department of Animal Health and Production.

Council abattoirs are the second slaughtering facility. These abattoirs provide a slaughter service to local butchers. There are currently a total of six council abattoirs located in each of the Gaborone, Francistown, Lobatse, Jwaneng, Selibe Phikwe and Serowe. Employees of the local council carry out meat inspection and general hygiene and quality control. Some council abattoirs have been found to be inadequate. In 2003, for example, it was

recommended that the Gaborone Council abattoir should be closed for serious renovation.

Private butcheries are found in some of the smaller urban centres where there are no council abattoirs. Most of these facilities consist of slaughtering slabs or a simple slaughterhouse, which are often sub-standard (Ministry of Agriculture, 1996). Some slaughtering occurs on farms and at cattle posts[2] and the meat is subsequently sold at a local butchery.

The Botswana Meat Commission slaughters an average of 114,000 cattle per annum while municipal abattoirs and local butcheries slaughter 67 000 and 50 000 cattle per annum respectively (Central Statistics Office, 2002). The Central Statistics Office (CSO) (1995) reports that 124 000 cattle were slaughtered annually for home consumption from 1992 to 1994, while the Ministry of Agriculture (1996) reports about 120 000 cattle per annum slaughtered for home consumption during the same period.

1.3.2 External Beef Trade

Botswana's economy is heavily dependent on foreign trade. The beef industry accounted for about 20 percent of Botswana's exports in 1999/2000 and remains the country's largest contributor to agricultural exports. Exports of meat and its products are expected to grow at 6.8 per cent after a reduction in 2000 due to drought and diseases (Ministry of Finance and Development Planning, 2003). According to the External Trade Statistics Digest (2001), P[3]240 million was earned through the sale of beef in 2000.

The Cotonou Agreement offers Botswana and other African, Caribbean and Pacific (ACP) countries reduced import tariffs in the beef trade, and a specified quota to the EU. Botswana has, however, managed to supply only 70 percent of its quota (Ministry of Agriculture, 1996). Meat and meat products, as shown in Figure 1.2, are the major export earners followed by hides and skins.

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2 Cattle posts are places where communal farmers keep their livestock.
3 Pula 1 = 0.1865 US$ in year 2000.

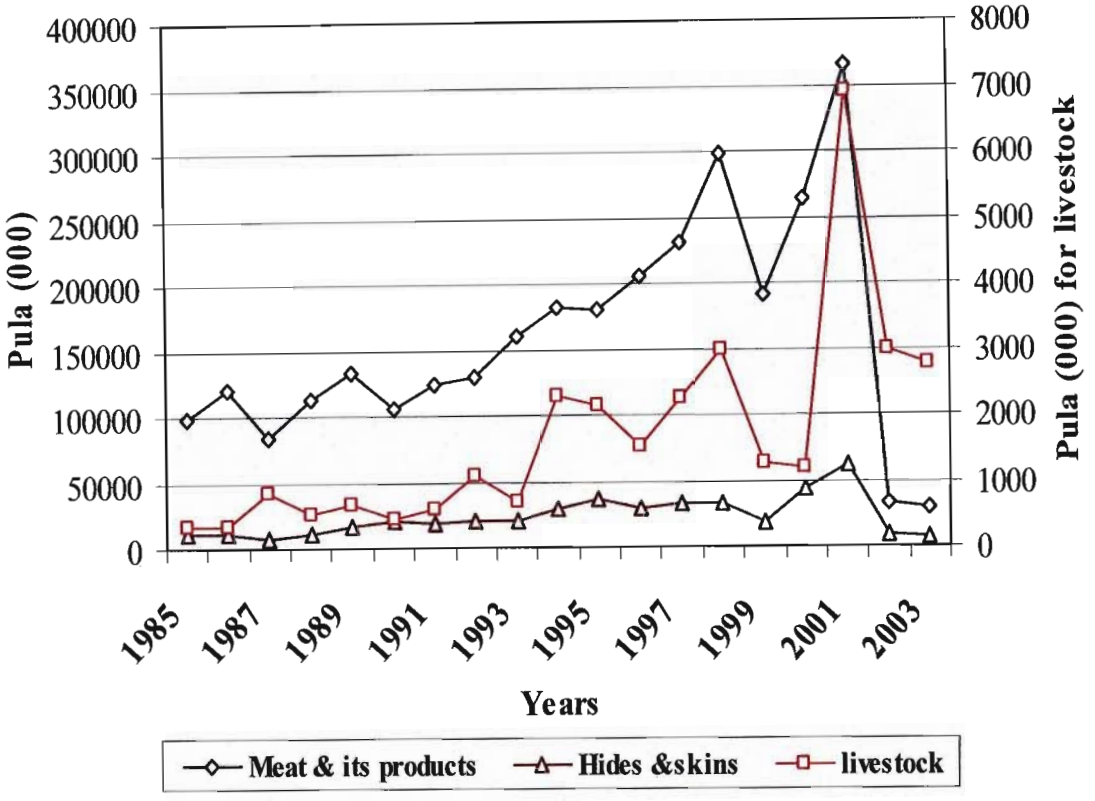

Figure 1.2: Real export earnings of Botswana's livestock and its products (2000 =100)

Source: Central Statistics office, 2003.

Trade in live cattle (measured on the second vertical axis) contributed the least to export earnings from 1980 to 2002. Exports of beef are mainly to the (EU), North America, Japan and South Africa (SA). A closer examination of Figure 1.2 reveals that the value of beef exports has been increasing steadily since 1980. There was, however a significant drop in beef exports during 2002-2003. This was caused by, *inter alia*, the outbreak of foot and mouth disease in the north of the country. The BMC had to close its abattoir in Francistown for a considerable time in order to control the spread of the disease. Beef's contribution to agricultural exports is expected to grow as long as Botswana continues to benefit from protocols such as the Cotonou Agreement and observes EU Trade requirements.

Botswana has invested large sums of money in the Livestock Identification and Trace Back System (LITS). The objective of this project is to be able to identify where cattle originate

from for purposes of controlling diseases. This is one of the EU requirements. Cattle are identified by insertion through the mouth, boluses[4], which are bar coded with detailed information about the farmer (Ministry of Finance and Development Planning, 2003).

The introduction of the African Growth and Opportunities Act (AGOA) by the United States of America (USA) Congress in 2000 is expected to further expand economic opportunities and cooperation for Botswana to export beef, its by products and raw material such as leather for shoes and blood for shoe polish. The AGOA allows duty and quota free access for most of the products (including beef) from sub-Saharan countries to the USA.

1.4 CATTLE POPULATION

The cattle population in Botswana has followed an upward trend since the eradication of the rinderpest disease in the 1960's. Cattle numbers reached the one million mark in the early 1950's and thereafter two million in the 1970's (Harvey & Lewis, 1990: 73). Growth in the national herd was caused in part by investment in water resources, particularly boreholes, and the establishment of a government department in 1905 to control animal diseases. Cordon fences were constructed to control the spread of diseases such as foot and mouth. Cattle were not allowed to pass from one cordon zone to another without being quarantined. The suitability of Botswana's range and climate to cattle production also contributed to the increase in cattle population. Cattle numbers, as shown in Figure 1.3, peaked just above three million in 1991 and later declined to about 2.7 million in the late 1990's due to high mortality caused by drought, diseases and poor management (Ministry of Agriculture, 1991).

4 A bolus is a bar coded instrument for cattle identification.

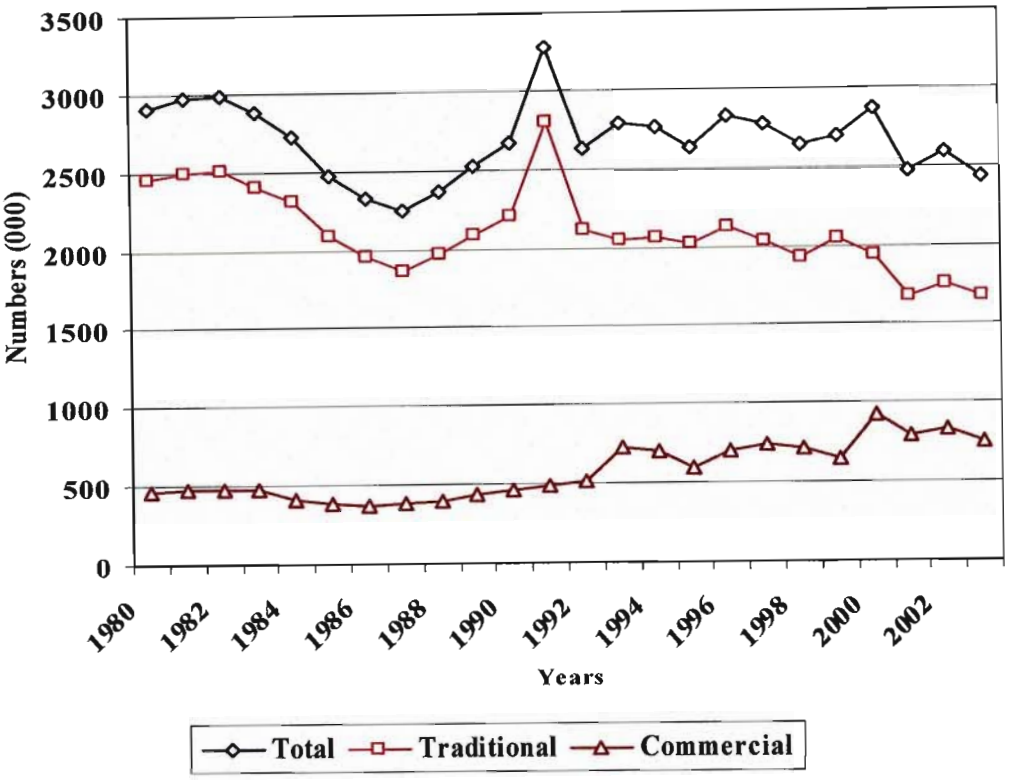

Figure 1.3: Cattle numbers in Botswana from 1980 to 2002

Source: Ministry of Finance and Development Planning, 2003.

Droughts in 1980 and 1992, and frequent outbreaks of diseases such as foot and mouth and lumpy skin disease (LSD) caused dramatic stock losses. The Department of Animal Health and Production responded swiftly to disease outbreaks and managed to control them (Colclough & McCathy, 1980: 114).

The introduction of borehole technology as a source of water supply extended grazing into the Kgalagadi sandveld. This development significantly increased cattle numbers in areas more susceptible to drought (Hubbard, 1986: 31). Government subsidised the cost of constructing dip tanks (through the Service to Livestock Farmers in Communal Areas (SLOCA) programme) and provided free vaccination for some diseases of economic importance, such as foot and mouth disease and botulism (Ministry of Agriculture, 1991). The Government also subsidised supplementary feeds and vitamin A during periods of drought (Ministry of Agriculture, 1991). These subsidies reduced cattle mortalities and

consequently increased the cattle population (Fidzani, 1993: 13). Extensive overgrazing occurred on communal land, especially in areas around boreholes (Harvey & Lewis, 1990:73). Figure 1.3 shows that the majority (86 percent) of cattle are found in communal areas compared to (14 percent) on private farms.

1.5 DISTRIBUTION OF CATTLE OWNERSHIP

Cattle ownership has become progressively skewed with increasing numbers (45 percent) of rural households possessing no cattle (Colclough & McCarthy, 1980: 111–112; Picard, 1987: 233). The group that owns no cattle are generally poor, female-headed households. Forty percent of rural households own less than 50 head each, and account for 25 percent of the national herd. The remaining 15 percent, who are large cattle farmers, own 75 percent of the national herd (Colclough & McCarthy, 1980: 112). Chiefs and political leaders are often amongst the largest cattle owners (Colclough & McCarthy, 1980: 112). Before (and even after) independence, chiefs made their subjects pay levies for certain public works such as building dams or kgotla[5]. In some cases subjects were made to pay the personal debts of the chief and his household (Colclough & McCarthy, 1980: 113). Poor households had to sell cattle to meet these obligations and to pay taxes, and consequently became poorer.

The inequitable distribution of cattle wealth has been debated for many years in Botswana. Literature reveals that the share of cattle owned by larger farmers continued to grow during the 1980's (Ministry of Agriculture, 1991). This trend may indicate intensification of rural poverty if cattle ownership is used as a proxy for welfare. The *mafisa* system is widely practised in Botswana; absentee farmers lend cattle to households that have few or no livestock for caretaking. The caretaker benefits by using the cattle for draught power and consuming milk, and is occasionally given a calf.

5 A place where tribal issues are discussed.

1.6 VARIATION IN BOTSWANA'S CLIMATIC CONDITIONS AND HERD SIZE

Botswana is arid and semi-arid with annual rainfall ranging from over 650 millimetres in the extreme north east (Chobe area) to about 250 millimetres in the south west of the Kgalagadi area (Ministry of Finance and Development Planning, 1997: 3). There are few occasions when rainfall exceeds these averages. There is therefore high variability of rainfall and drought is a recurring phenomenon in Botswana. Drought adversely affects the fragile agricultural situation in the country and negatively impacts the rural economy. Almost all rainfall occurs in the summer months from mid-October to late April (Ministry of Finance and Development Planning, 2003: 5). The maximum daily temperature ranges from about 33°C in December to about 22°C in July. Annual evaporation rates range from 1.8 metres to over 2.5 metres annually (Ministry of Finance and Development Planning, 1997: 6). There are generally hot days and cool nights.

Rainfall is clearly an important determinant of Botswana's herd size. The amount of forage produced on which cattle graze is directly related to the amount and distribution of rainfall. There are, for example, dense indigenous forests and bushes in the Chobe district where rainfall is relatively high. More than 50 percent of the country supports shrub, tree savannah and the mopane tree found in the North East District. In the south and west, the land supports low shrub savannah trees. Low rainfall and poor soils favour animal production rather than crop production. Cattle are raised in all parts of the country (even in areas where average rainfall is less than 200 millimetres per annum). Figure 1.4 shows the annual rainfall from 1992 to 2003. A comparison of Figures 1.4 and 1.3 highlights the relationship between rainfall and livestock numbers in Botswana. Cattle numbers increased in 2000 following good rains in 1999. However, the increase in cattle numbers occurred on private farms and not communal grazing land. One reason for this was the outbreak of contagious bovine pleuro-pnemonia (CBPP) in Ngamiland in 1995 where more than 300 000 cattle were destroyed in an effort to eradicate the disease.

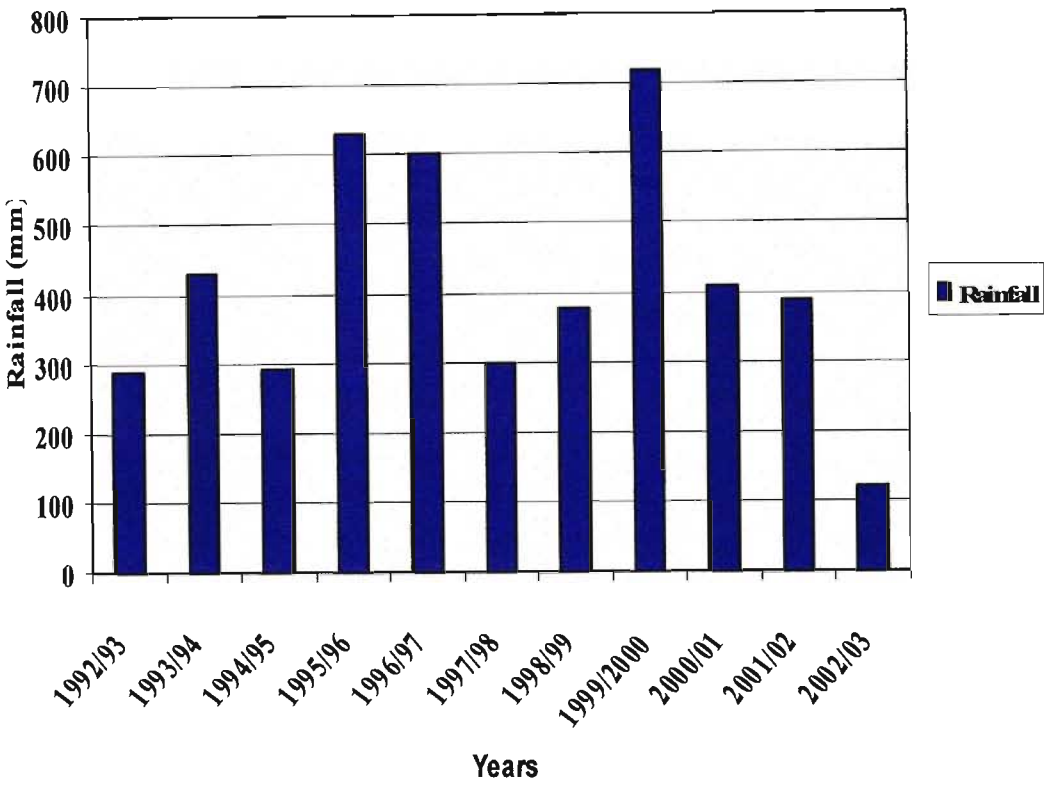

Figure 1.4: Annual rainfall in Botswana from 1992 to 2003
Source: Central Statistics Office, 2003.

Cattle numbers are less variable on private farms than communal grazing land (Figure 1.3) suggesting that private farmers stock cattle at lower rates, invest more in boreholes and purchase supplementary feed. Occasional showers during the rainy season provide sufficient grazing to maintain the herd throughout the summer season in many parts of Botswana (Harvey & Lewis, 1990: 73). Harvey and Lewis (1990) argue that successive years of below average rainfall can be withstood in terms of cattle numbers, even though cattle might lose economic value due to losses in cold dress weight.

1.7 STATEMENT OF THE PROBLEM

The livestock sector in Botswana is characterised by two distinct systems of land tenure;

namely communal land and private land. Grazing on communal land is mostly an open access resource that accounts for 86 percent of the cattle and 71 percent of farmers in Botswana. Private grazing is characterised by more secure land tenure and accounts for 14 percent of the national herd and five percent of the land area (Ministry of Agriculture, 1991). There is a strong view that herd productivity in communal areas is lower than on private ranches (Ministry of Agriculture, 1991).

As reported by Behnke (1987) and Scoones (1992), calving and off-take rates are low amongst communal farmers. The average calving rate on private farms is about 60 percent compared to 50 percent in communal areas (Table 1.1). Mortality rate, on the other hand, is five percent on private farms compared to 12 percent in communal areas. Annual off-take on private farms is 17 percent compared to just eight percent in communal areas (Ministry of Finance and Development Planning, 2003: 181). Carcass weight for cattle sold to the BMC is low and averages about 200 kilograms in communal areas compared to 220 kilograms on private farms (Table 1.1).

Table 1.1: Performance indicators in Botswana in 2000

Cattle	Private	Communal
Cattle number (%)	14	86
Annual off-take (%)	17	8
Annual calving rate (%)	60	50
Annual mortality (%)	5	12
Cold Dress Mass (CDM) (kg)	220	200

Source: Ministry of Finance and Development Planning, 2003.

High stocking rates in the communal areas have been linked to insecure land tenure, land degradation and a general decline in Botswana's communal herd from over 2.5 million in the early 1980's to about 2.0 million in the 1990's (Figure 1.3). The Agricultural Development Policy of 1991 (Ministry of Agriculture, 1991) was introduced to try and encourage communal farmers to adopt new technology and reduce stocking rates. One prominent recommendation of this policy was to convert open access grazing into common or private property by fencing the communal areas where feasible. Commercialisation in

communal areas is low compared to that on private farms. It is argued that herd productivity and hence commercialisation of the livestock sector in Botswana is influenced by many factors, especially land tenure.

Insecure land tenure and absentee farmers lead to poor farm management practices and overstocking in communal areas (Ministry of Agriculture, 1989). Overstocking in communal areas has resulted in overgrazing and range degradation (Gryseels, 1988:1-2; Ministry of Agriculture, 1989). Worse still, farmers in communal areas do not invest in improvements to the range quality because the benefits cannot be fully internalised as other farmers (free-riders) also have access to the range (Kille & Lyne, 1993).

Researchers, however, have not adequately identified factors that contribute significantly to herd productivity differences between farmers in communal areas and their counterparts on private farms. Empirical identification of these factors is very important to the implementation of the Botswana Agricultural Development Policy of 1991 on land reform.

This study aims to identify factors thought to explain differences in the productivity of cattle managed by farmers in southern Botswana. Land tenure is just one of several independent variables that might explain variation in herd productivity, the dependent variable. The study was motivated by the claims of poor herd performance, especially in herds on communal grazing land (Ministry of Agriculture, 1991; Ministry of Finance and Development Planning, 1997; Mahabile *et al.*, 2005). The study also attempts to assess whether government's proposed land reform has merit, and also highlights some of the factors that constrain the implementation of this policy.

1.8 OBJECTIVES OF THE STUDY

The overall objective of this study is to provide decision-makers with economic insights to factors that cause differences in herd productivity between cattle farmers in communal areas and those on private farms in Botswana. The attainment of this objective is

contingent upon the fulfilment of the following specific objectives:

1. To describe and compare the socio-economic characteristics of private and communal cattle farmers in the study region.

2. To measure productivity indicators and investment levels of cattle farmers in southern Botswana.

3. To empirically identify factors that explain differences in productivity of cattle managed by private and communal farmers in southern Botswana.

4. To determine whether the policy focus on land reform of 1991 is justified and to make policy recommendations.

This study hypothesises that investment and herd productivity are higher on private farms than on open access communal grazing land in Botswana. The study differs from previous studies (Ministry of Agriculture, 1989; Ministry of Agriculture, 1996) because it tries to empirically identify factors that are responsible for differences in herd productivity between communal farmers and private farmers. The study uses the southern region of Botswana as a representative area of study.

1.9 PROCEDURE

The rest of the thesis is organised as follows: Chapter 2 reviews relevant literature on determinants of herd productivity and proposes a conceptual recursive model of determinants of herd productivity. Chapter 3 describes the sampling technique used to gather data and presents descriptive sample statistics computed for farmer, farm household and herd characteristics. Chapter 4 postulates and estimates the recursive model, and discusses the findings. Chapter 5 concludes the study and makes specific policy recommendations.

CHAPTER 2 REVIEW OF LITERATURE

2.1 INTRODUCTION

Much has been written about constraints to productivity in sub-Saharan Africa. Some of the constraints most cited include indigenous land tenure systems, access to product and factor markets, small farm sizes, lack of technology adoption and lack of capital (Groenewald, 1993). Clearly these impediments are interrelated. Groenewald (1993) argues that literature proposing that land tenure is not a constraint to agricultural production is out-dated. Indigenous tenure systems are recognised as constraints that provide insufficient incentive to make land improvements or to induce lenders to finance such investments (Place & Hazell, 1993).

There is a widely-held view that the productivity of the livestock sector in Botswana is primarily influenced by insecure land tenure (Ministry of Agriculture, 1991; Fidzani, 1993). Place *et al.* (1994: 19) define tenure security as a function of three components, namely, breadth, duration and assurance of property rights, with both legal and economic dimensions. The breadth or robustness of rights defines the legal quantity or bundle of rights held over land (use, transfer and exclusion rights). Duration refers to the length of time during which the bundle of rights is legally valid. An investment on the land would require that the time period be sufficiently long to enable the land holder to recoup the full economic returns generated by the investment (Place *et al.,* 1994: 19). Assurance defines the certainty with which legal definitions of breadth and duration are held. Tenure is therefore considered to be insecure if legal procedures to settle disputes are not clear or their outcome is uncertain. Communal livestock farmers in Botswana do not have secure tenure in the economic sense because the breadth of their land rights is constrained; they cannot exclude other users, nor can they transact any grazing land (Mahabile *et al.,* 2002).

A theoretical remedy to increase productivity and efficiency is to transform communal land into individualised land rights with title-deeds that are backed by an effective legal system (Van den Brink *et al.*, 1994; Kille & Lyne, 1993). However, a title-deed does not necessarily confer secure property rights, even if it is backed by an efficient legal system, unless it confers a broad bundle of property rights including unfettered rights to exclude

other users and to bequeath, rent, sell and pledge the property as collateral.

Farmers, including those in developing countries, are rational in their decision-making. To understand the apparent lack of profit maximising behaviour displayed by livestock farmers in the communal areas of sub-Saharan Africa, it is first necessary to understand the institutional environment in which they operate. Property rights to land are fundamental institutions that guide decisions to conserve and improve the land, and to adopt farming practices and technologies that make profitable use of land in the long-run.

The first sub-section of this chapter reviews economic theories about relationships between land rights, stocking rates, levels of investment and herd productivity. This is followed by a sub-section dealing with measures of herd productivity in Botswana. This sub-section is followed by a sub-section covering estimation of a conceptual recursive regression model of the determinants of herd productivity. A section discussing institutional reform to improve herd productivity concludes this chapter.

2.2 DETERMINANTS OF HERD PRODUCTVITY

2.2.1 Land tenure and herd productivity

In the communal areas of Botswana, property rights to grazing land are characterised by open access or common property and are not secure in the economic sense. Economic theory suggests that land tenure institutions influence decisions about stocking rates (Gordon, 1954) and investments in improvements and operating inputs (Place *et al.*, 1994: 16–17). Gordon (1954) shows that an open access resource will be used at equilibrium rate when the private cost (Px) of exploiting the resource is equal to the value of the herd's average product (VAP). According to the hypothetical value product curves in figure 2.1, the open access equilibrium occurs when 12 cows are stocked per hectare. At this point the resource is over-utilised in the economic sense (and possibly in the biological sense) because rents are zero. This is a departure from the profit maximising neoclassical model where property rights are presumed to be exclusive. In this case, the profit maximising equilibrium is reached when Px is equal to the value of the herd's marginal product (VMP).

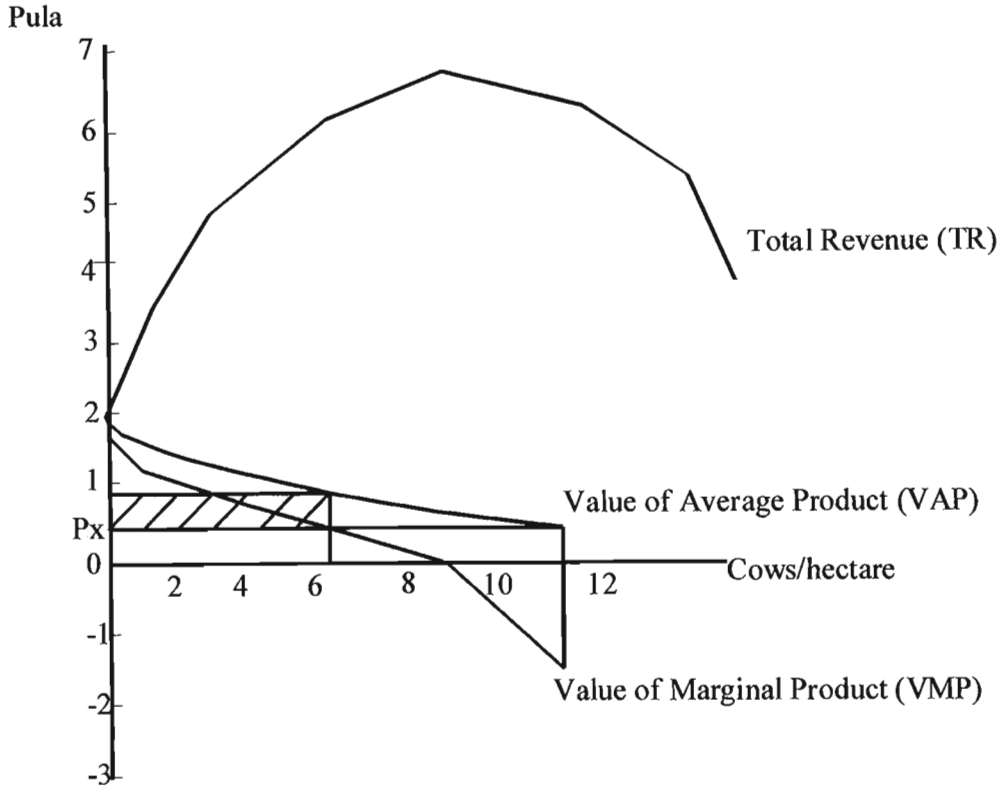

Figure 2.1: Hyphothetical total, average and marginal value product curves

Source: Adapted from Lyne and Nieuwoudt, 1990.

From the hypothetical value product curves in Figure 2.1, if cows and grazing land are owned privately, six cows would be stocked as the sixth cow reduces the value of the marginal product (VMP) to Px, the cost of keeping the additional cow on the range. Rents indicated by the shaded area are maximised at this equilibrium point. Stocking rates between the open access and private property equilibria are the outcome of horizontal coordination (collective action [6]) that defines common property.

Stocking rates are therefore expected to be higher on communal grazing lands than on farms privately owned by individuals, *ceteris paribus*-especially when communal grazing

6 Here collective action is defined as action taken by a collaborating group, involving some degree of collective decision making in pursuit of members' perceived shared interest.

is predominantly an open access resource. Consequently, herd productivity is expected to be lower on communal grazing land. In KwaZulu-Natal where tenure conditions follow a pattern similar to those observed in southern Botswana, Lyne and Nieuwoudt (1990) report much lower calving rates and much higher herd mortality rates in communal areas than on private farms.

There is no incentive for a communal farmer to reduce the size of his own herd, or to finance fixed improvements (such as boreholes to water livestock), on open access grazing land because the benefits would accrue largely to free-riders. Lyne and Nieuwoudt (1990) refer to the low investment problem as the "real tragedy of the commons". Under-investment in fixed improvements leads to under-investment in complementary operating inputs (Place & Hazell, 1993). Kille and Lyne (1993) also anticipate lower investment in operating inputs applied to open access resources owing to allocative inefficiency. This problem arises because there is no market for open access land owing to prohibitively high transaction costs. By contrast, the market for privately-owned farmland creates an opportunity cost for under-utilised land that encourages the owner to sell or rent the land out to more effective farmers (Place *et al.*, 1994:17; Nieuwoudt, 1990). The land market also strengthens incentives to conserve and improve land as the benefits can be realised at any time by selling or leasing the land out (Pasour, 1990: 200-201). In Botswana, private farmers also find it easier to finance improvements because there is a market for privately owned land. Banks do not accept land as collateral for loans unless it has market value (Place *et al.*, 1994: 17; Kille & Lyne, 1993; Migot-Adholla *et al.*, 1991). Improvements to land and livestock tend to raise the productivity of operating inputs, encouraging more intensive use of supplementary feed and medications that prevent disease and injury and hence improve herd productivity.

2.2.2 Measures of herd productivity

This study takes the accepted view that herd productivity improves with a higher calving rate (Hubbard, 1986:46) and with a lower mortality rate. By implication, a higher off-take rate (sales and slaughter) is also an objective measure of better herd productivity. Scoones (1992), Upton (1993); Lange *et al.* (1998) and the Ministry of Agriculture (1996) measure herd productivity in terms of birth, death and off-take rates (sales and slaughter) of cattle.

Upton (1993) expresses herd productivity as a function of calving, mortality, off-take rates and other production traits (such as milk yield and draught power) in his herd growth model. James and Charles (1996) argue that herd productivity measures the efficiency of a livestock production system. Herd productivity measures tend to be less favourable in communal areas because of higher stocking rates and under-investment in improved pastures, supplementary feed, vaccinations and dipping materials (Thirtle, *et al.*, 2000).

The herd off-take rate is often defined as the number of cattle sold and slaughtered less livestock purchased during the period divided by the opening stock:

$$\text{Off-take rate}_t = \frac{N_t + S_t - R_t}{H_{t-1}} \qquad 2.1$$

where;

N_t = number of cattle sold in $year_t$,

S_t = number of cattle slaughtered in $year_t$,

R_t = number of cattle purchased in $year_t$, and

H_{t-1} = number of stock at the beginning of $year_t$.

Source: Fidzani, 1993.

Herd off-take should also account for removals through gifts of cattle, but social exchanges are thought to neutralize between exchanges in and out of the herd and therefore cancel out (Metzel *et al.*, 1998). Off-take is often concentrated on livestock of particular sex and age groups. Since fewer male cattle are needed in the breeding herd, there is generally larger off-take of castrated males on private farms. In communal areas, oxen are often retained to provide draught power. Moreover, the overall rate of off-take is distorted if animals in very poor condition and unlikely to survive the winter are slaughtered for own consumption. Official measures of off-take rate in Botswana exclude herd mortality. Although Hubbard (1986: 46) advocates this approach to avoid interpretation problems, it does not address concerns that off-take rates observed in Botswana may be overstated, and mortality rates understated (Fidzani, 1993: 188-189).

Mortality rate is defined as the number of cattle that die during the current period divided

by the opening stock. Mortality rate can be expressed as in equation 2.2. Mortality rates vary between age groups with young stock more vulnerable than older animals. Mortality rate is influenced by deaths caused by disease and drought.

$$\text{Mortality rate}_t = D_t \div H_{t-1} \qquad 2.2$$

where;

D_t = number of deaths in $year_t$

H_t = number of stock at the beginning of the $year_t$

Source: Metzel, *et al.*, 1998.

Farmers tend to sell or slaughter cattle to avoid mortalities when they anticipate drought or the spread of disease such as Foot and Mouth Disease (FMD). Observed mortality rates are understated in these circumstances.

The calving rate presented in equation 2.3, is computed as the number of calves born over a specified period divided by the breeding cows and heifers in $year_t$:

$$\text{Calving rate}_t = \frac{C_t}{Bc_t + Bh_t} \qquad 2.3$$

where;

C_t = number of calves born in $year_t$

Bc_t = breeding cows in $year_t$

Bh_t = breeding heifers in $year_t$

Source: Metzel, *et al.*, 1998.

Calving rate is influenced by factors such as the availability of a bull and condition of the grazing range. If the range is in poor condition, few cows conceive even if there is a good bull. Investing in improvement of the range, supplementary feeding, minerals salts and good quality bulls can improve the calving rate (Metzel *et al.*, 1998; Mahabile *et al.*, 2002). Lange *et al.* (1998) argue that significant improvements in herd management and

nutrition have increased calving rate to 80 per cent in Namibia. Higher calving rates would result in higher levels of beef production in Botswana, *ceteris paribus*.

2.2.3 Conceptual recursive regression model of the determinants of herd productivity

Following the economic arguments presented in section 2.2.1 postulating that farmers with secure land tenure are both more willing and able to invest in agriculture, a block recursive regression model was developed along the lines proposed by Place *et al.* (1994:28-30) to identify and quantify the determinants of herd productivity observed in the study site. The object of this empirical analysis is to appraise Botswana government policy on communal grazing resources and to make informed policy recommendation.

The regression model was specified as follows:

(a) $c = f(X^a, T, H)$

(b) $l = f(X^a, T, C_L)$

(c) $i = f(X^a, C_S, l)$

(d) $h = f(l, i)$

where c represents the present value of agricultural credit (expressed in 2000 prices) used to finance past fixed improvements and current operating expenses, l measures past investment in fixed improvements to land, i is the current investment in operating inputs per livestock unit, and h represent herd productivity. The vector X^a represents household and farmer characteristics, T is land tenure status, H the herd size, and C_L and C_S are separate measures of the present value of credit used to finance past fixed improvements and current operating expenses respectively. An important and realistic assumption underlying this model is that tenure is predetermined, i.e. farmers cannot change their initial property rights at will.

Equation (a) argues that the present value of (long plus short-term) agricultural credit is positively influenced by private ownership of land, higher liquidity and a larger herd size (wealth). Positive relationships are expected because farmers with greater wealth and liquidity are creditworthy as they have more collateral and better repayment ability (Stanton, 1997). Private ownership of land not only strengthens the incentive to invest but

also adds to the owner's stock of wealth and collateral as argued earlier. The household and farmer characteristics include family size, off-farm income, marital status, the farmer's age, education and gender (a dummy variable scoring one for male farmers and zero for females). This variable is included to capture gender difference in the use of credit. Off-farm wage income is a relatively important and reliable source of liquidity for many rural households and is therefore expected to impact positively on access to credit owing to better debt-servicing ability. Age could also carry a positive sign as it measures accumulated farming experience and social standing. A high social standing can reduce transaction costs (Goetz, 1992). On the other hand, age could carry a negative sign as older farmers may be risk averse and less inclined to innovate than younger farmers (Basabrain, 1983). Education is expected to impact positively on the use of credit because it reduces transaction costs in formal markets and enhances allocative efficiency so improving a farmer's creditworthiness (Fidzani, 1993: 118). Gender, on the other hand, is expected to carry a negative sign if females face higher transaction costs than males. Fenwick and Lyne (1999) argue that this is true in rural KwaZulu-Natal where women married under customary law create greater legal uncertainty for lenders. In Botswana too, a women married in community of property (including women married under customary law) cannot borrow without legal consent from their husbands.

Equation (b) postulates that investment in fixed improvements is positively influenced by private ownership and better access to long-term credit. Secure land tenure strengthens the farmer's incentive to invest. Few improvements are expected where land tenure is insecure as future returns are discounted at a high rate owing to uncertainty (Kille & Lyne, 1993). In this case, uncertainty stems largely from future returns lost to other stockowners (free-riders) who share inclusive rights to communal grazing. Access to long-term credit improves farmer's ability to finance fixed improvements. Positive collinearity between tenure and the present value of long-term credit is likely in view of the arguments presented earlier in section 2.2. Household and farmer characteristics are included largely as control variables although education is expected to carry a positive sign as it serves as a proxy for permanent income (Graham & Darroch, 2001) and family size is expected to carry a negative sign owing to a trade-off between consumption and investment. Age on the other hand is expected to carry a positive sign as it proxies experience and exposure to

investment opportunities.

Equation (c) states that current investment in operating inputs per livestock unit is positively influenced by fixed improvements to land and better access to short-term credit. Again, the ability to finance operating inputs is expected to improve with better access to short-term credit, while investment in fixed improvements is expected to increase the productivity of these inputs thus strengthening the incentive to purchase them (Place & Hazell, 1993). Hayes *et al.* (1997) show that investment in wells positively influenced expenditure in commercial inputs in Gambia. Household and farmer characteristics are included largely as control variables with expected signs similar to those postulated for equation (b). Pudasaini (1983) found that better education raised agricultural productivity in Nepal.

Equation (d) expresses herd productivity as a positive function of past investment in fixed improvements and current investment in operating inputs per livestock unit. Fidzani's (1993: 187-190) study of cattle off-take rates in Botswana supports Place *et al.'* s (1994: 28-29) argument that investment in fixed improvements (like boreholes and fences) and operating inputs (such as feed supplements and vaccines) will increase herd productivity. Investment in boreholes, supplementary feed and vaccines is expected to reduce mortality rates and improve calving and off-take rates. Positive collinearity between past investment in fixed improvements and expenditure on operating inputs per livestock unit is likely following the logic of equation (c).

Factors that do not vary across respondents in a cross-sectional study cannot be considered when estimating the model. For this reason, variables such as weather, interest rate and diseases that determine herd productivity were excluded from the model.

2.3 INSTITUTIONAL REFORM TO IMPROVE HERD PRODUCTIVITY

Following the economic arguments presented in section 2.2, the obvious (but often impractical) policy option to improve herd productivity is to privatise communal land to individual owner-operators. The exclusion of other users would encourage farmers to stock their land at the rent-maximising equilibrium (where VMP = Px) resulting in stocking rates

below the maximum sustainable level (where VMP = 0) given Px > 0 and that farmers discount future income at a rate consistent with the time preferences of society.

Privatisation of grazing land with fully transferable land rights also promotes allocative efficiency because transaction costs are relatively low when a sale or lease agreement can be negotiated with just one owner (Kille & Lyne, 1993; Swallow & Kamara, 2000). Land transfers to the most effective users as the market imposes an opportunity cost on under-utilised land (Kille & Lyne, 1993). An opportunity cost is imposed on the owner in the form of forgone sale or rental income for land that is under-utilised. If the owner is unable to use the land himself, he/she can sell the land or rent it out to someone who can use it more profitably. There is an incentive to maintain and improve the resource because the benefits can be fully internalised through higher profits and capital gains (Place & Hazell, 1993). In theory, privatisation of grazing land to individuals could solve both the overstocking and low herd productivity problems but this policy option may not be politically or economically feasible in areas where communal grazing has many poor users; achieving farm sizes large enough to warrant the cost of fencing will inevitably involve distress sales that dispossess the poorest users. While privatisation may be feasible in a small part of Botswana, a "second-best" strategy built on common property may be more appropriate if land tenure is a significant determinant of low herd productivity in the country's communal areas.

A common property resource, like an open access resource, is shared by multiple users, but the group is well-defined and enforces rules that limit the rate at which the resource is exploited (Stevenson, 1991; Runge, 1981; Lyne & Nieuwoudt (1990). In theory, participants in common property have 'coequal rights' to the resource. Rules that govern users' responsibilities in resource extraction may be formal or informal. Common property groups can exist as user or non-user groups. Members of a user group make independent decisions within the limits established by the group. The group may, for example, agree on maximum stocking rates for members but each member manages his or her own herd. Rents, in a user-group are positive but allocative efficiency is unlikely as use rights seldom transfer to more efficient users outside the group owing to high transaction costs (Lyne, 1995). Investment in improvements is also unlikely because rules encouraging collective

investment by sharing benefits in proportion to the contributions made by each member are difficult to negotiate and apply (Lyne, 1995) in all but very small groups.

Costs of a collective action increase with the size of the group. Consequently, user groups that succeed in making and enforcing rules that prevent unsustainable use of common pool resources tend to be relatively small and those that succeed in making and enforcing more complex rules that encourage members to invest in shared improvements tend to be even smaller. Olson (1971) suggests that significant investment would require user groups with no more than six members. However, if members of the group delegate control to a manager and define members' property rights in terms of voting and benefit rights rather than use rights, a larger group size may promote rather than constrain collective investment.

In this (non-user group) case, members hire or elect experts to manage their joint enterprise. Such ventures require accountable management for financial performance (Knight *et al.,* (2003). Accountability is facilitated by transparency (e.g. in reporting audited financial statements) and sound electoral process, but is best assured by the ability of members to sanction management by withdrawing their investment.

A member's initial investment in the joint enterprise could be financed by exchanging cattle for equity capital (i.e. shares) in the operating entity. Ideally the operating entity would be organised as an investor-owned firm (IOF) such as a private company. Knight *et al.* (2003) argue that a private company offers well-defined property rights that create strong incentives for investment and financial performance because (a) there is direct proportionality between a shareholder's investment and his or her voting and benefit (dividends and capital gains) rights, and (b) shares can be traded at their market value. This eliminates free-rider problems that manifest as 'horizon', 'portfolio', 'control', and 'influence' problems that discourage members from investing in other types of business organization (Sykuta & Cook, 2001; Cook & Illiopoulus, 1999 & 2000). If, for example, the non-user group were organized as a conventional cooperative, there would be very little incentive for members to finance the enterprise because a conventional cooperative does not assign benefits and voting rights in proportion to equity contributions, nor can

members sell shares at their market value. The 'horizon' problem results from residual claims that do not extend as far as the economic life of the underlying asset (Porter & Scully, 1987). Under these circumstances traditional cooperative members tend to under-invest in long-term and intangible assets (such as product promotion) because they are prevented from realising any capital gains by retiring shares at their market value. New members become free-riders as they benefit from investments without paying fully for them in the form of higher share prices.

A portfolio problem also arises when members cannot trade shares at market prices, as they are unable to diversify or concentrate their own asset portfolios to fully reflect personal risk preferences and therefore tend to under invest in the joint enterprise (Jensen & Meckling, 1976). The control problem refers to the cost that members face in monitoring managers to ensure that they make prudent investment decisions and do not cheat. Although this principal-agent problem is not unique to institutions like traditional cooperatives, it is less severe in private companies where (a) larger investors are able to internalise the benefits of their policing effort (because the dividends are proportional to the investment), (b) the agents performance is signalled by the audited value of members' equity shares and (c) the agents are shareholders themselves and therefore have incentive-compliant employment contracts (Knight *et al.*, 2003).

These problems tend to starve traditional cooperatives of equity capital, reducing their ability to finance investments needed to maintain a competitive edge. Hendrikse and Veerman (2001) further argue that traditional cooperatives are at a disadvantage relative to private companies when seeking capital from external sources to finance assets that have specific uses. Specific assets increase the financer's exposure to risks, and lenders find it difficult to influence the managerial decisions to reduce the exposure when many small investors hold a majority of equal or near equal voting rights. This "influence problem" tends to raise the cost of external equity and debt capital to finance assets that have specific uses (Knight *et al.*, 2003).

Non-user groups represent Horizontal Integration, an extreme form of Horizontal Coordination and analogous to Vertical Integration. The success of a horizontally

integrated group depends fundamentally on its institutional arrangement, particularly those which provide for direct proportionality between investment and voting and benefit rights and for exit by selling shares at market value - as in IOFs. Many successful commercial farming operators in southern Africa are organised as private or public companies.

A shift from open access to a traditional common property user group and then on to a non-user group structured as an IOF like a private company represents a shift from open access towards private ownership by an individual, with expected improvements in stocking rates, investment and hence herd productivity while avoiding problems associated with size economies and distress sales.

CHAPTER 3 DATA COLLECTION AND DESCRIPTIVE STATISTICS

3.1 SURVEY DESIGN AND DATA COLLECTION

A sample survey of private and communal farmers in Botswana was conducted from August 1999 to May 2000 to elicit information about herd productivity, investment, use of credit and farmer and household characteristics. These data were used to estimate an empirical model of determinants of herd productivity. The first part of this chapter outlines the sampling technique and the second part provides a descriptive summary of the data.

3.1.1 Sample Survey Design

Collection of primary field data usually involves a trade-off between concentrating the study, or spreading it over a larger region. The former enables the researcher to estimate more precise statistics for a study population (e.g. cattle farmers in southern Botswana) that is less representative of the target population (e.g. cattle farmers in Botswana). The latter improves accuracy at the expense of sampling precision. Precision refers to variance in the sample statistics; the trade-off is between accuracy and precision when the research budget is limited (Barnett, 1991: 17).

A stratified random sample design was used to sample the study population. The strata comprised of private and communal cattle farmers respectively (as the object was to explore differences between these groups) and a random sample of cattle farmers was drawn from a list of all cattle farmers (i.e. a list frame) constructed for each stratum. The study population, however, did not cover all of rural Botswana; given the extensive nature of livestock farming in Botswana and limited amounts of both time and money, the study was confined to the country's southern region (Figure 3.1) where there is a good mix of communal and private grazing land and, within this region, to four representative villages: Sekoma, Samane, Keng and Maokane.

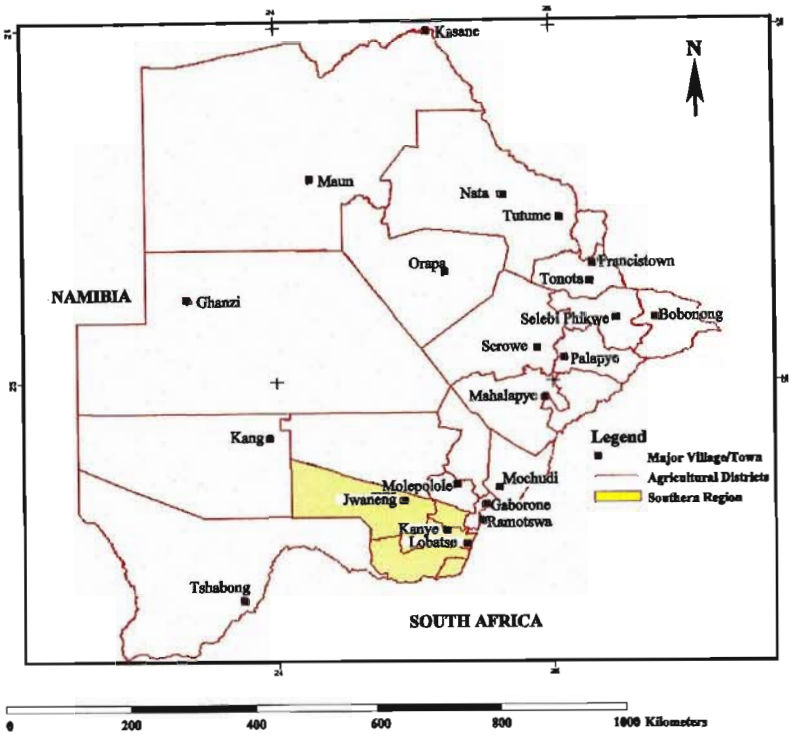

Figure 3.1: Map of Botswana indicating the study area

Source: Prepared by Ministry of Agriculture, 2000a.

Communal and private cattle farmers residing in these villages were identified and listed with the assistance of extension staff employed by the Department of Animal Health and Production. The study population comprised of 517 communal (open access) farmers and 54 private farmers.

A sample of 80 communal and 40 private farmers was drawn randomly from these lists. Unfortunately, several of the selected farmers had left the study area and some were unwilling to participate in the survey. This attrition left 65 communal and 31 private farmers as respondents. The drop outs were not replaced owing to the high cost of travelling long distances between farmers, especially those on private ranches. The ultimate sampling rates were therefore 12.6 percent and 57 percent respectively for the study populations of communal and private (Table 3.1). Private farmers were sampled more heavily as they tend to be relatively less homogenous than communal farmers (Fidzani, 1993) and to ensure sufficient cases for analysis.

Table 3.1: Study population and sampling rates

Stratum	No. of farmers	No. of farmers sampled	Sampling rate (%)
Communal	517	65	12.6
Private	54	31	57.4
Total	571	96	16.8

The descriptive statistics reported in this chapter relate only to (unbiased) sample estimates computed for each stratum. The intention was to contrast the strata and not to compute unbiased estimators for the study population of communal and private farmers.

Although there is variation in climate and the quality of grazing within the southern region, ranging from the wetter and more fertile 'Limpopo unit' in the east to dry sandveld in the west, grazing conditions in the study region are similar to those in other regions of Botswana where cattle are kept (Gulbradnsen, 1980: 1). The southern region has an area of 26, 776 km^2, a population of 146,000 people and aggregate herd of some 180,000 cattle (Central Statistics Office, 1995). It therefore accounts for about ten percent of the county's rural population and seven percent of its national herd.

3.1.2 The Survey Instrument

A structured questionnaire that consisted of pre-coded and open- ended questions was designed and administered to the sampled households. Communal and private farmers were asked the same questions. Interviews were conducted from August 1999 to May 2000 with the assistance of four enumerators who spoke both Setswana and English. Each respondent was visited monthly over a period of nine months. This time lag enabled the author to monitor pregnant cows and so estimate the calving percentage for each respondent's herd. Enumerators were given in-depth orientation on the objectives of the survey and training in the use of the survey instrument. Questions were addressed to the

head of the household in all cases. Field work was closely supervised by the author. Monthly data were collected on variables such as biological production, livestock sales and milk production. In cases where respondents were not available, a second visit was scheduled during the same month. The data were captured in a computerised spreadsheet and analysed using the Statistical Package for Social Science, Version 10 (SPSS, 1999). Inventories of cattle, assets owned and agricultural credit used were taken at the beginning of the study in August 1999 and at the end of May 2000. Estimates of mean herd size, herd composition, off-take, calving and mortality rates compared favourably with national and regional statistics obtained from the Ministry of Agriculture, (2000b), Central Statistics Office (1999) and Botswana Meat Commission (2000).

3.2 CONTENTS OF THE QUESTIONNAIRE

The following sub-sections provide an overview of key information elicited by the survey instrument.

3.2.1 Household and Farmer Characteristics

This section of the questionnaire (Appendix 1) gathered demographic information about the household and its head as primary decision-maker on matters relating to the use of agricultural resources. Questions about household needs, occupation, location of employment, wage income, educational status and farming experience were included as possible determinants of efficiency and the adoption of new technology. Education and accumulated experience in farming are thought to improve allocative efficiency and to reduce information and transaction costs that constrain the adoption of technology (Welch, 1978).

3.2.2 Sources of Household Cash Income

The questionnaire elicited information about household income earned from sources other than cattle. This question is pertinent because cash remittances, especially those which are reliable, influence the liquidity and creditworthiness of the farmer. Other sources of income often determine whether the farmer can invest in cattle production activities such as buying improved bulls and other conventional inputs such as supplementary feed, drugs

and vaccines. Other sources of income also influence herd size, as any savings made by the households in Botswana are usually invested in additional cattle (Harvey & Lewis, 1990: 72).

3.2.3 Agricultural Assets

This section asked questions about farming machinery and equipment owned by the farmer. This was to enable the author to assess the equity position of the farmer. These assets also influence access to markets. Farmers who do not have adequate agricultural assets such as trucks and tractors face problems when, for example, transporting cattle to markets or when transporting livestock feed. Fodder production would also be limited without adequate agricultural equipment and implements.

3.2.4 Cattle Inventory

This section assessed the beginning and end of year inventories of cattle. These data are needed to measure herd productivity indicators. The number of *Mafisa-in* (cattle which the household is keeping and managing but which belong to someone else) and *mafisa-out* (cattle which the farmer owns but are loaned to another farmer) were recorded. This information was required to distinguish herd size from the farmer's own wealth. The reasons for keeping *mafisa* cattle were also established. For example, some farmers keep *mafisa* cattle because they do not have enough cattle for draught power and some *mafisa-in* to provide milk to the household. Some farmers *mafisa-in* because they want to increase their own herd size because calves that are born from *mafisa* cattle are shared proportionally; for every two calves born of *mafisa,* the herder is usually given one calf. The principle of *mafisa-out* cattle is alleged to have been used when a farmer did not want to declare the total number of cattle he owned to avoid taxes and death duties (Harvey & Lewis, 1990: 75). Some *mafisa-out* cattle for children born out of wedlock. Presumably most people who *mafisa*-out work off-farm and do not have the time to manage cattle.

3.2.5 Biological Production

This section collected disaggregated data on the number of cattle at the beginning of the study, the number of calves born each month and the breed of the mother. The age of the cow at calving, calf and cow mortalities and causes of their death were also recorded. The

number of cattle purchased during the study period was also established. These data are needed to calculate calving and mortality rates. This section played an important role in testing the hypothesis that herd productivity of private farmers is higher than that of communal farmers. Some open-ended questions were asked on some of the factors that affected calving and mortality rates.

3.2.6 Livestock Sales

Disaggregated data on livestock sales were collected. Data on the number and type of animals (bulls, cows, oxen, etc.) sold, where they were sold and reasons for sale were established. Direct sales of cattle, either as live or slaughtered, provided a very important statistic to measure off-take rate. This information was also crucial to establish the most common type of cattle sold. It is alleged that most communal farmers sell young steers and heifers rather than oxen because oxen are kept for draught power (Scoones, 1992). It is also common for communal farmers to sell cattle to meet societal needs such as paying school fees for children, paying dowry (bride price) and meeting funeral expenses (Behnke, 1987). The questions regarding the factors that motivate the sale of cattle were included to ascertain the extent to which farmers sell cattle to meet societal responsibilities. Questions on the exchange of cattle were also asked. Farmers often exchange cattle (cow for an ox) to meet societal needs such as providing meat during funerals. Cows are rarely slaughtered for providing meat because they are kept for breeding purposes.

3.2.7 Milk Production

The amounts of milk produced, consumed and sold were recorded, as were the place(s) where milk was sold. It was established whether milk was sold fresh or sour (*madila*). It was also established whether there was any processing of milk before it was sold. This section was also to provide information to assess the economic value of milk produced. The farm gate price was used to assess the value of milk that was sold or consumed.

3.2.8 Draught Power and Other Livestock By-products

Cattle provide draught power and transportation. In this section the author investigated the kind of services cattle provide to farmers. Many communal farmers in developing

countries use cattle manure as a partial substitute for commercial fertilisers (Scoones, 1992). Respondents were also asked if they used cattle manure as fertiliser, and how much cattle manure was used or sold. Information on the number of hides and skins from slaughtered cattle was collected. Respondents were asked the type of curing used. The value of the hides was computed using the local market price.

3.2.9 Herd Management Practice

Questions were asked to assess the quality of herd management. Respondents indicated whether or not they treated their cattle against tick-borne diseases and internal worms, and whether or not they dehorned and castrated calves because these management practices have been shown to improve the growth of calves (Ministry of Agriculture, 1989). Data were collected on whether farmers provided any supplementary feeding to their cattle. The type of feed, cost of feed and where it was bought were established. Watering sources were established and whether the household owned any watering sources. If the livestock farmer did not own the water source, the amount of watering fees paid was established. Respondents were asked whether they vaccinated cattle against diseases other than those vaccinated free by Government. If they did, the cost of vaccination was established. Livestock farmers were asked whether they used artificial insemination (AI) in their herd. Artificial insemination is a very effective way of improving herd quality when farmers do not have sufficient liquidity to purchase improved bulls (Ministry of Agriculture, 1991). For example, the total cost for insemination and feed for a cow on a government farm is about P6.00 (US$1.12) while the cost of a bull ranges from P5 000–P30 000 per bull.

3.2.10 Property Rights to Grazing Land

This section established the land tenure status for each respondent. Place and Hazell (1993) argue that farmers are less willing and less able to improve land when their tenure is insecure in the economic sense (section 2.2.1). If grazing was leased in, length of the lease was established. Respondents were asked whether rules restricting access to communal grazing had been negotiated and enforced, and whether penalties were imposed on those who exceeded the limits. Some open-ended questions on the farmers' perception on some problems facing the cattle industry were also asked.

3.2.11 Cost of Cattle Production

In this section of the questionnaire, farmers were asked about the costs they incurred in cattle production, including the opportunity cost of household labour used in herding and other ranching activities. Family labour costs are crucial in livestock farming owing to the relative scarcity of hired labour for herding cattle. Other costs included costs of fodder production, drugs and vaccines, and feed supplements. The cost of fencing the farm and cost of drilling a borehole were also determined. These costs indicate levels of investment and hence the respondent's incentive and ability to finance a productive enterprise.

3.2.12 Use of Credit

Efforts were made to establish the amount of long-term and short-term credit used and its sources. The purpose and repayment levels of loans were established. The aim was to determine what share of investment made in fixed improvements and expenditure on operating inputs was financed with credit. Amounts borrowed historically to finance long-term investments were adjusted for inflation and expressed in constant 2000 prices. These long-term investments included improvements made to grazing land such as drilling boreholes and constructing fences.

3.3 CHALLENGES FACED DURING DATA COLLECTION

The general tendency of Botswana cattle farmers is to avoid disclosing (especially to a stranger), the correct number of cattle they own and the value of loans borrowed from banks. Many farmers are said to be heavily indebted to financial institutions such as the National Development Bank (Bank of Botswana, 2000). Researchers asking questions on cattle ownership are usually viewed with suspicion. This apprehension of farmers' dates back to the colonial era when taxes were based on the number of cattle the farmer owned. Farmers therefore refused to disclose the number of cattle the households owned to avoid paying taxes. Some farmers lent out cattle as *mafisa* to avoid taxes.

Mis-reporting of data is therefore likely to be a problem. The following measures were taken to ensure that this problem was minimised. Firstly, the officer from the Department of Animal Health and Production accompanied the researchers to introduce us and explain

the purpose of the study, and assured the farmers that the information collected would not be used for anything other than to meet the objectives of the study. Secondly, during the data collection, questions that were asked had follow-up questions so that if a farmer provided incorrect information, a subsequent question would help to reveal the inconsistency. For example, the question on the number of calves born would be followed later by another asking how many calves were male and how many were female. Follow-up visits to farmers were made to rectify inconsistencies that were identified. Enumerators occasionally made visits to the cattle kraals to make physical counts of cattle. Government cattle crush[7] reports from the Southern region were examined to check the data.

The other major challenge was that of absentee farmers, especially private farmers. In some cases, researchers followed farmers to their work places (for those working in Botswana) to collect data. In many occasions visits were rescheduled because the farmers preferred responding to the questionnaire at the farm. Another problem was poor record keeping by many farmers. Most of the information was obtained from the farmers through recall and physical observation.

3.4 DESCRIPTIVE STATISTICS

This section summarises the key results of the survey. It also identifies the behaviour of some of the variables that are used to test the research hypothesis in chapter 4. Independent, t-tests were calculated to check for significant univariate differences between group means computed for private and communal farmers.

3.4.1 Farmer Characteristics

Table 3.2 summarises key attributes of sample farmers and their households. No significant differences were detected between the mean age, gender, family size or residential status (where heads residing on their farms scored a one, and zero otherwise) of private and communal livestock farmers.

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7 A holding pen for vaccination and cattle counting.

Racial differences were not considered because all but one of the respondents were black. These findings are consistent with results from an earlier study in Botswana by Panin (1999). Most herds are managed by older, married men who reside on-farm with their (large) rural families, and who regard livestock farming as their main occupation.

Table 3.2: Descriptive statistics for demographic characteristics of 96 livestock owners in the southern region of Botswana, 2000

Variable	Unit	Private ranches (n=31)	Open access communal grazing (n=65)	t-value	
Average age	Years	55 (36.25)	52 (32.20)	1.37	
Gender	% male	94 (1.44)	95 (2.55)	0.40	
Average size of household	#	6 (19.46)	7 (19.54)	-1.12	
Married	%	97 (30.00)	63 (10.45)	4.62	**
Residential status	% on-farm	88 (10.00)	92 (14.00)	0.61	
Average years of schooling	Years	10 (14.66)	2 (9.52)	8.32	**
Average years of farming	Years	31 (70.23)	20 (30.34)	4.85	**
Main source of income:					
Farming	%	55	55		
Wage work		10	23		
Other		35	22		
Mean monthly income remitted by wage workers	Pula	2308 (2.47)	715 (2.62)	-2.74	**
Wage (Pula) per month:					
0-2000	%	61	85		
2001-4000		21	12		
>6000		18	3		
Gross annual livestock income	Pula	98363 (1.27)	3049 (6.41)	1.23	

Note: ** shows statistical significance at the one percent level of probability.
estimates in parenthesis represent the percentage coefficient of variation.

Despite these similarities, private and communal farmers in the sample differed on some important household variables. Private farmers appear to have accumulated a much greater stock of human capital through both formal education and farming experience. In addition, private farmers have much larger cash inflows from wage remittances and livestock sales, and are therefore more liquid than communal farmers.

3.4.2 Livestock Ownership and Herd Productivity Indicators

Herd size and composition on private and communal grazing land are presented in Table 3.3. Average herd size is substantially larger on private farms.

Table 3.3: Mean herd size, composition and distribution on private and communal grazing land in a sample of 96 farmers in the southern region of Botswana, 2000

Variable	Private ranches (n=31)	Open access communal grazing (n=65)	t-value
Number of cattle	495 (5.32)	55 (12.09)	2.26 *
Number of cows and heifers	273 (7.57)	26 (14.87)	4.05 ***
Number of calves	141 (3.58)	8 (5.53)	3.36 ***
Number of weaners	20 (1.83)	15 (7.38)	1.65 +
Number of bulls	5 (3.99)	1 (5.51)	3.43 *
Number of oxen	56 (1.53)	5 (3.71)	1.39
Mafisa -in	12 (1.14)	1 (2.54)	1.07
Mafisa -out	1 (1.09)	1.4 (2.78)	-1.05
Distribution of herd size (%)			
1 - 40	9.4	52.9	
41 - 80	6.3	27.9	
81 - 120	3.1	4.4	
121 - 160	0.0	4.5	
161 - 200	3.1	1.5	
201 - 240	9.4	2.9	
241 - 280	9.4	0.0	
281 - 320	15.6	0.0	
> 320	43.7	5.9	

Notes: and ** show statistical significance at the five and one percent level of probability respectively.
+ shows significance at ten percent level of probability.
estimates in parenthesis represent the percentage coefficient of variation.

Almost 60 percent of herds kept by private farmers exceeded 280 head of cattle, while 80 percent of those kept by communal farmers numbered less than 80 head. Communal farmers tend to have fewer calves per cow than private farms. The higher proportion of bulls may indicate that private farmers invest in improving their stock by buying bulls for their herd while communal farmers value cattle primarily as a store of wealth because they cannot maximise profit under conditions of open access. This would explain why the off-take rate (Table 3.4) is much lower amongst communal farmers.

Sample means and proportions for indicators of herd productivity and investments made by private and communal farmers are presented in Table 3.4.

Table 3.4: Mean productivity and investment indicators for open access and private livestock owners in a sample of 96 farmers in the southern region of Botswana, 2000

Variable	Unit	Private ranches (n=31)	Open access communal grazing (n=65)	t-value
Aggregate herd size	LU[1]	262 (2.94)	30 (7.31)	2.59 *
Calving rate	%	66 (33.49)	35 (10.10)	7.75 **
Off-take rate	%	20 (6.66)	129 (7.78)	2.46 *
Mortality rate	%	2 (2.91)	5 (4.22)	2.15 *
De-worm	%	87 (11.18)	37 (18.76)	5.64 **
De-horn	%	86 (12.49)	84 (6.12)	3.00 **
Practice supplementary feeding	%	80 (16.21).	63 (7.37)	2.91 **
Vaccinate	%	87 (14.22)	38 (6.19)	5.74 **
Treat cattle against ticks	%	71 (8.56)	44 (7.18)	3.21 **
Financed own borehole	%	77 (9.32)	7 (10.04)	8.20 **
Fencing	%	100	0	
Annual gross margin per LU	Pula	1336 (1.39)	211 (8.82)	1.23
Annual operating inputs per LU	Pula/LU	139 (1.82)	1.7 (3.31)	1.67 +

Notes: [1] LU = Livestock Unit defined as a mature animal with a live weight of 500 kg.
[2] 1 Pula= 0.1865 US$ (in 2000).
*and ** show statistical significance at the five and one percent level of probability respectively.
+ shows significance at ten percent level of probability.

estimates in parenthesis represent the percentage coefficient of variation.

With regard to herd productivity, the calving rate and off-take (i.e. sales plus slaughtering) rates are much higher on private farms than amongst communal farmers.

This is consistent with findings reported by Behnke (1987); Scoones (1992) and the Central Statistics Office (1995). On the other hand, the mortality rate is lower on private farms where the incidence of de-worming, dehorning, supplementary feeding, vaccination and dipping against tick-borne diseases is much higher (Table 3.4). The incidence of fencing and borehole ownership is substantially higher on private farms. These findings are consistent with the arguments in chapter 2 that decisions about stocking rates and investment (in operating inputs and improvements to land and herds) are adversely affected by insecure property rights to open access grazing. Unable to internalise benefits, maximise profits, or raise loan finance, communal farmers tend to keep cattle as a store of wealth rather than as a commercial enterprise (Jarvis, 1980).

3.4.3 Zero-Order Correlation Coefficients

Zero-order correlation coefficient (r) indicates the extent to which quantifiable pairs of variables are linearly associated. If there is collinearity between variables in a regression model that assumes them to be independent the parameters of the model become indeterminate and it is impossible to obtain numerical values for each parameter separately (Koutsoyiannis, 1977: 233). Multicollinearity can also lead to model mis-specification when a relevant variable is rejected because its standard error is too high (Gujarati, 1995: 341). Zero-order correlation coefficients were computed to assess the degree of linear association between pairs of variables relevant to this study. Variables that are strongly correlated were subjected to Principal Component Analysis (PCA) to reduce the multicollinearity problem.

Table 3.5 presents zero-order correlation coefficients for productivity indicators and some possible explanatory variables. Within the set of productivity measures, off-take rate is significantly and positively correlated with gross margin per livestock unit (GM/LU), and calving rate is significantly and negatively correlated with herd mortality rate. These relationships suggest a role for Principal Components Analysis (PCA) in constructing a "productivity index" (Nieuwoudt, 1977). Welch (1978) postulates a positive relationship between farm scale, education and the adoption of technology. The data are consistent with

this view as variable costs (associated with de-worming and treatment for tick-borne diseases) and investment in fencing are positively correlated with education and herd size (LU). As anticipated, private land tenure (private land = 1 and open access = 0) is positively correlated with investment in technology and fixed improvements, and hence with productivity measures such as the calving and off-take rate.

However, private ownership is also positively correlated with education, experience, wage remittances and herd size. This suggests that a multivariate, recursive model is required to untangle the causes of observed differences in herd productivity and investment. While land tenure appears to be an important determinant of investment and herd productivity, it is clearly not the only variable of policy interest. A more rigorous analysis of the survey data is required to isolate and quantify the partial contribution of land tenure to herd productivity. This is the purpose of the next chapter.

Table 3.5: Correlation coefficients for important livestock variables in a sample of 96 farmers in the southern region of Botswana, 2000

	Variable	Units	1	2	3	4	5	6	7	8	9	10	11	12
1	Present value of agric credit	Pula	1.00											
2	Present value of investment in boreholes	Pula	.110	1.00										
3	Expenditure on operating inputs	Pula	.210	.250*	1.00									
4	Calving rate	%	.016	.646**	.102	1.00								
5	Off take rate	%	.096	.061	.076	-.064	1.00							
6	Mortality rate	%	.658**	-.219*	.110	-.314**	.012	1.00						
7	Tenure		.202*	.719**	.326**	.523**	.239*	-.168	1.00					
8	Gross margin	Pula/LU	.183	.126	.127	.143	.308**	-.033	.187	1.00				
9	Herd size	No	.193	.271**	.035	.291**	.269**	-.101	.376**	.914**	1.00			
10	Experience	Years	.084	.138	.165	.211*	-.014	.043	.173	.030	.084	1.00		
11	Education	Years	.208*	.558**	.351**	.395**	.142	-.137	.713**	.065	.266**	.127	1.00	
12	Income	Pula	.247*	.443**	.053	.312*	-.014	-.188	.396**	.260*	.368**	-.142	.371**	1.00

Note: * and ** show statistical significance at five and one percent level of probability respectively.

CHAPTER 4 ESTIMATING THE DETERMINANTS OF HERD PRODUCTIVITY

4.1 ESTIMATED RECURSIVE REGRESSION MODEL

This chapter presents an estimated recursive regression model and empirical results of determinants of herd productivity.

For estimation purposes, equations (a) through (d) in section 2.2.3 were specified as follows:

$$c = B_{01} + B_{11}\text{AGE} + B_{21}\text{GENDER} + B_{31}\text{MARRIED} + B_{41}\text{EDUCATION} + B_{51}\text{LIQUIDITY}_1 + B_{61}\text{FAMILY} + B_{71}\text{HERD} + B_{81}\text{TENURE} \quad \ldots. (4.1)$$

where;

c = present value of agricultural credit used to finance past fixed improvements and current operating expenses measured in Pula,
AGE = age of the household head measured in years,
GENDER = a dummy variable scoring one for male heads and zero for females,

MARRIED = a dummy variable scoring one for married heads and zero otherwise,
EDUCATION = years of formal schooling completed by the household head,

LIQUIDITY_1 = monthly income remitted by household wage workers measured in Pula,
FAMILY = household size,
HERD = herd size, and
TENURE = a dummy variable scoring one if land is privately owned and zero if it is an open access communal resource.

$$\text{LN}(l) = B_{02} + B_{12}\text{AGE} + B_{22}\text{GENDER} + B_{32}\text{MARRIED} + B_{42}\text{EDUCATION} + B_{52}\text{LIQUIDITY}_1 + B_{62}\text{FAMILY} + B_{72}C_L + B_{82}\text{TENURE} \quad \ldots (4.2)$$

where;

LN (l) = natural log of one plus the present value of investment in boreholes measured in Pula, and

C_L = present value of long-term credit used to finance boreholes, the most frequently observed improvement and the only one for which reliable data could be gathered.

$$\text{LN}(i) = B_{03} + B_{13}\text{AGE} + B_{23}\text{GENDER} + B_{33}\text{MARRIED} + B_{43}\text{EDUCATION} + B_{53}\text{FAMILY} + B_{63}\text{LN}(l) + B_{73}(\text{LIQUIDITY}_2) \quad \ldots (4.3)$$

where;

LN (i) = natural log of one plus current expenditure on operating inputs per livestock unit measured in Pula, and

C_S = value of seasonal credit used to finance current operating inputs.

Positive collinearity anticipated between C_S and LIQUIDITY_1 was addressed by summing the two variables (i.e. $C_S + \text{LIQUIDITY}_1$) to create an index called LIQUIDITY_2

$$h = B_{04} + B_{14}\text{LN}(l+i) \quad \ldots(4.4)$$

where;

h = herd productivity measured as the calving rate.

The calving rate was computed as the number of calves born divided by number of breeding cows and heifers. Off-take and mortality rates were not used as measures of productivity because animals in poor condition are sold or slaughtered for own consumption. This tends to understate mortality rates and to overstate off-take rates (Fidzani, 1993: 188-189).

Positive collinearity anticipated between investment in boreholes and expenditure on operating inputs per livestock unit was addressed by summing these two variables (i.e. LN ($l+i$)).

The variables *c*, *l*, *i* and *h* are endogenous. For this reason, only equations 4.1 and 4.2 were estimated using Ordinary Least Squares (OLS) regression. In equations 4.3 and 4.4 the endogenous explanatory variables were replaced with instrumental variables to eliminate possible correlation with the error term. These equations were estimated using Two Stage Least Squares (2SLS) regression with the instrumental variables predicted from all of the exogenous variables in the model.

4.2 PRINCIPAL COMPONENT ANALYSIS

Estimation of equations 4.1-4.4 revealed multicollinearity problems. Principal Component Analysis (PCA) was applied to try and reduce multicollinearity. The main aim of PCA is to convert the original set of variables, X_j's (j = 1, 2,...,p) into a new set of variables or principal components (Y_i) which are linear combinations of the old variables (X_j's):

$$Y_1 = a_{1\,1}X_1 + a_{1\,2}X_2 + \ldots + a_{1P}X_P$$

$$Y_2 = a_{2\,1}X_1 + a_{2\,2}X_2 + \ldots + a_{2\,P}X_P$$

$$\vdots$$

$$Y_P = a_{P1}X_1 + a_{P\,2}X_2 + \ldots + a_{P\,P}X_P$$

where a_{iip} are loading coefficients chosen such that the principal components are (a) uncorrelated (orthogonal) and (b) the first principal component accounts for the maximum share of the total variation in the original set of variables, the second principal component accounts for the maximum share of the remaining variation in the X_J's and so on (Koutsoyiannis, 1977: 425). Principal Component Analysis is a mathematical maximization procedure where each successive component accounts for the maximum amount of the variance that is left (Maddala, 1977: 193; Stevens, 1992: 375-376). PCA can be used to economise on variables, to analyse relationships between variables or as in this study, to address the problem of multicollinearity by transforming collinear original variables into new orthogonal (uncorrelated) variables (Koutsoyiannis, 1977: 424-436). Multicollinearity impairs the estimates of the variables due to lack of sufficient

independent variation in the sample.

4.3 THE RECURSIVE REGRESSION RESULTS

The regression results presented in the following sub-sections show that all four of the equations estimated for the recursive model are statistically significant. Their R^2 values range from 40 to 58 percent and compare favourably with other similar cross-section studies (Place & Hazell, 1993; Hayes *et al.,* 1997; Matangul *et al.*, 2001).

4.3.1 The Present Value of Agricultural Credit (c)

The regression results for equation 4.1 explaining value of agricultural credit are presented in Table 4.1. The coefficient estimated for the variable GENDER is positive and has a t-value larger than unity suggesting that the present value of long–term and short-term credit used by respondents is higher for farmers who are male.

The variables HERD and TENURE are not independent (r=0.376) and it was not possible to estimate their separate contributions to the level of agricultural credit. Principal Components Analysis (PCA) was therefore used to construct an index from these two variables. The first principal component was estimated as:

PC_1= 0.829 (standardised HERD)+0 .829 (standardised TENURE)

with an eigen value of 1.4. This index accounted for 69 percent of variation in HERD and TENURE and was included in equation 4.1 as a positive measure of the original variables. The regression coefficient estimated for this index is positive and highly significant and carries the largest beta value. TENURE therefore appears to be the underlying determinant of agricultural credit used by respondents because current herd size is more likely to be influenced by tenure status than vice versa. Respondents with private farms and larger herds are both willing and able to access more agricultural credit. This finding supports the arguments presented in sub section 2.2.3.

Table 4.1: OLS regression results for agricultural credit (c)

Dependent variable: Present value of agricultural credit used to finance past fixed improvements and current operating expenses measured in Pula (c)

	Coefficient	Beta	t-value
Intercept	28165		0.40
AGE	674	0.01	0.05
GENDER	65727	0.12	1.10
MARRIED	35986	0.10	0.78
FAMILY	3124	0.05	0.43
EDUCATION	5123	0.12	0.79
$LIQUIDITY_1$	-1.23	-0.02	-0.02
TENURE & HERD index[a]	71233	0.51	3.14 ***
R^2		0.40	
Adj. R^2		0.32	
F		5.21***	
Observations		64	

Notes:

[a] first Principal Component.

*** significant at one percent level of probability.

** significant at five per cent level of probability.

* significant at ten percent level of probability.

Contrary to expectations, $LIQUIDITY_1$ is not statistically significant when proxied by wage income. To some extent this might reflect Botswana's Financial Assistance Policy (FAP) and the generous terms of government lending agencies (such as the National Development Bank (NDB)) and grant schemes such as that administered by the Citizen Entrepreneurial Development Agency (CEDA).

The Arable Lands Development Programme (ALDEP) and Services to Livestock Owners in Communal Areas (SLOCA) provided financial support to many cattle producers including farmers who may not have been considered creditworthy by commercial banks

(Bank of Botswana, 2000: 60-61). The NDB disbursed P98 million in agricultural loans, mostly to livestock farmers (Bank of Botswana, 2000:51).

4.3.2 Past Investment in Fixed Improvement to Land (I)

Table 4.2 presents results for equation 4.2 explaining past investment in fixed improvement to land. The regression coefficient estimated for $LIQUIDITY_1$ is positive and significant. Investment in fixed improvements is higher amongst respondents who get more off-farm wage income.

Credit used to finance fixed improvements (C_L) is positively correlated with TENURE (r = 0.719) and it was not possible to estimate the separate contributions of these variables to investment in fixed improvements. Again Principal Component Analysis was used to construct an index of the correlated variables.

Table 4.2: OLS regression results for investment in fixed improvements (LN(*I*))

Dependent variable: Natural Logarithm of one plus present value of investment in boreholes measured in Pula (LN (*I*)

	Coefficient	Beta	t-value	
Intercept	4.81		1.92	*
AGE	0.003	0.00	0.01	
GENDER	0.12	0.01	0.06	
MARRIED	1.65	0.11	1.02	
FAMILY	-0.27	-0.12	-1.11	
EDUCATION	0.16	0.10	0.75	
$LIQUIDITY_1$	0.00047	0.21	2.03	**
C_L & TENURE index[a]	3.14	0.52	3.82	***
R^2		0.58		
Adj. R^2		0.52		
F		10.01***		
Observations		45		

Notes:

[a] first Principal Component.
*** significant at one percent level of probability.
** significant at five per cent level of probability.
* significant at ten percent level of probability.

The first principal component was estimated as;

$PC_1 = 0.765$ (standardized C_L) + 0.765 (standardized tenure)

with an eigen value of 1.2. This index accounted for 59 percent of the variation in C_L and TENURE and was included in equation 4.2 as a positive measure of these variables. The regression coefficient estimated for this index is positive, highly significant and carries the largest beta value. Since TENURE is predetermined and not influenced by the amount of credit used to finance fixed improvements, it could again be viewed as the underlying determinant of such investment followed by C_L, and the independent determinants $LIQUIDITY_1$, FAMILY, and MARRIED - all of which have absolute t-values greater than unity.

FAMILY has a negative coefficient suggesting that there is indeed a trade-off between consumption and investment. Respondents with private farms use more long-term credit to finance fixed improvements and invest more in these improvements than do communal farmers who rely on open access grazing land-especially if they get more off-farm wage income, are MARRIED and have smaller families.

4.3.3 Current Investment in Operating Inputs Per Livestock Unit (*i*)

In equation 4.3 the regression coefficient estimated for $LIQUIDITY_2$ is positive and statistically significant. This is consistent with the arguments made in sub section 2.2.3. Contrary to some arguments, the results in Table 4.3 indicate that older, married, male respondents are less inclined to invest in operating inputs.

Table 4.3: 2SLS regression results for investment in operating inputs per livestock (LN (*i*))

Dependent variable: Natural Logarithm of one plus expenditure on current operating inputs per livestock unit measured in Pula (LN(*i*))

	Coefficient	Beta	t-value
Intercept	4.50		5.29 ***
AGE	-0.390	-0.27	-2.02 **
GENDER	-0.930	-0.15	-1.25
MARRIED	-0.790	-0.18	-1.29
FAMILY	0.00	0.001	0.008
EDUCATION	0.050	0.09	0.62
$LIQUIDITY_2$	0.000060	0.40	2.91 ***
LN(*l*)	0.037	0.12	0.82
R^2		0.40	
Adj. R^2		0.31	
F		4.42***	
Observations		46	

Notes:

*** significant at one percent level of probability.
** significant at five per cent level of probability.
* significant at ten percent level of probability.

According to its beta value, $LIQUIDITY_2$ (from short-term credit and off-farm wage income) is the most important, and the only positive, direct determinant of expenditure on operating inputs per livestock unit.

4.3.4 Herd Productivity (*h*)

In equation 4.4 the regression coefficient for the present value of investments in fixed improvement plus current expenditure on operating inputs per livestock unit is positive and highly significant with a t-value greater than unity (Table 4.4). The result is consistent with the arguments and postulations made in sub section 2.2.3.

Table 4.4: 2SLS regression results for herd productivity *(h)*

Dependent variable: Herd productivity measured in Calving rate *(h)*

	Coefficient	Beta	t-value
Intercept	16.89		2.85***
LN(*l+i*)	3.91	0.66	5.92***
R^2		0.40	
Adj. R^2		0.39	
F		35.02***	
Observations		52	

Notes:

*** significant at one percent level of probability.
** significant at five per cent level of probability.
* significant at ten percent level of probability.

Secure land tenure has an indirect effect on herd productivity through its direct impact on agricultural credit and fixed improvements. The Ministry of Agriculture (1991) and Behnke (1987) also found that farmers who owned boreholes and who purchased supplementary feed had higher calving rates than those who did not.

CHAPTER 5 MAJOR FINDINGS AND POLICY IMPLICATIONS

5.1 MAJOR FINDINGS

This study uses the descriptive statistics and a recursive block regression model to identify factors that explain productivity differences of cattle managed by farmers in southern Botswana. Results of the regression analysis suggest that secure land tenure is a fundamental determinant of agricultural credit use. Respondents with private farms and larger herds are both willing and able to access more agricultural credit than those who rely on open access communal grazing to raise cattle. Secure tenure is also a fundamental determinant of investment in fixed improvements. Respondents with private farms and higher levels of long-term credit and liquidity from off-farm wage remittances tend to invest more in fixed improvements than do communal farmers who rely on open access grazing land–especially if they are married and have smaller families. Liquidity from short-term credit and wage remittances is the most important direct determinant of expenditure on operating inputs. Herd productivity, in turn, increases with greater investment in operating inputs and fixed improvements, and is therefore positively (but indirectly) influenced by secure land tenure.

5.2 CONCLUSIONS AND POLICY IMPLICATIONS

From the regression results it could be inferred that government should (a) uphold private property rights to land where they already exist; (b) privatise open access grazing to individual owner-operators where this is politically, socially and economically feasible; and (c) where privatization to individuals is not feasible, government should encourage users to convert open access grazing into common property by subsidising the costs of defining user groups and the boundaries of their resources, and of negotiating and enforcing rules limiting individual use of the common property. This would help to arrest over-exploitation of the grazing resource but is unlikely to promote investment in fixed improvements in all but the smallest of user groups. Penalties applied to members who break the rules limiting individual use of the common property must be consistent with national law. The government, through the Attorney General Chambers, should draft guidelines for user groups to consider in the design and enforcement of their rules. This

first-step in a gradual shift towards more secure tenure should be followed by conversion of user groups to non-user groups organised along the lines of investor-owned firms where members exchange use rights for benefit and voting rights in a joint venture managed by an expert.

In the case of a non user-group, members surrender their use rights to a management team in exchange for other property rights such as voting and benefit rights. The management team is given power to make decisions without interference from users. Non-user group arrangements can create strong incentives for members to invest in a joint enterprise if the institutional arrangements eliminate free and forced-rider problems in collective action. This requires a non-user group to be operated as (or like) a private company with well-defined and fully tradable benefit and voting rights (i.e. shares) that are proportional to the investment made by each shareholder. The initial investment could be financed by exchanging cattle for equity capital (i.e. shares) in the company.

Good corporate governance should be entrenched through accountability. For the Directors, accountability is facilitated by reporting minutes of Board meetings and independently audited financial statements, and through sound electoral process and marketable shares. The government should also empower share holders with basic literacy skills to be able to interpret financial statements correctly and to participate effectively in general meetings.

5.3 SUGGESTION FOR FUTURE RESEARCH

In this study, the empirical model identified determinants of herd productivity in Botswana. Policy recommendations (i.e. privatising open access grazing to individual owner operators and converting user groups into non-user groups) have been suggested to improve herd productivity in Botswana. Further research should be undertaken to compare the productivity between individual owner operator farms and non-user groups organised along the lines of investor owned firms. This study would also apply the New Institutional Economics (NIE) theory to assist in identifying institutional and organisational factors that would constrain the success of a non-user group organised along the lines of investor

owned firm. The NIE would shed more light on, for example, the best type of governance institutions to promote the efficient use of co-owned resources. This study will provide more information to make shared enterprises work better and improve their efficiency.

SUMMARY

This study compares socio-economic, productivity and investment indicators and identifies factors thought to explain differences in the productivity of cattle managed by farmers in southern Botswana. The study was prompted by claims of poor herd performance, especially in herds on communal grazing land in Botswana. The livestock sector in Botswana is characterised by two distinct systems of land tenure, namely; communal grazing-an open access resource that accounts for 86 percent of the cattle and 71 percent of farmers in Botswana. Private grazing is characterised by secure land rights and accounts for 14 percent of the national cattle herd and five percent of the land area.

An open access resource means that users have unrestricted use of the resource. High stocking rates in the communal areas have been linked to high soil erosion, land degradation and a general decline in the national herd because Land Boards do not enforce maximum stocking rates in communal areas. In addition, water rights assigned to farmers in communal areas do not impose any restrictions on the volume of water used or the number of animals kept by stockowners.

The study is important because livestock make a significant contribution to the livelihood of farmers in Botswana. Livestock, especially cattle, are a major source of meat and milk, and provide a store of wealth. As producer goods, cattle supply draught power. Cattle offer a hedge against inflation and can be readily converted into cash in times of need. Beef exports account for most of the foreign exchange earned by agriculture because crop farming is severely constrained by erratic and unreliable rainfall. Cattle account for about three percent of Botswana's gross domestic product (GDP) and for most of agriculture's share of GDP. Moreover, ranching is an important source of employment in rural Botswana where the majority of households live in communal areas and depend largely on cattle as a source of income.

There is a strong view that the productivity of the livestock sector in Botswana is primarily influenced by land tenure status. Economic theory suggests that land tenure institutions influence decisions about stocking rates and investments in improvements and operating

inputs. There is no incentive for a communal farmer to reduce the size of his own herd, or to finance fixed improvements (such as boreholes to water livestock), on open access grazing land because the benefits would accrue largely to free-riders. Under-investment in fixed improvements leads to under-investment in operating inputs and allocative inefficiency. This problem arises because there is no market for open access land owing to prohibitively high transaction costs. By contrast, the market for privately-owned farmland creates an opportunity cost for under-utilised land that encourages the owner to sell or rent the land out to more effective farmers. Private farmers whose land tenure is secure (in the economic sense of possessing fully exclusive and transferable property rights) have a stronger incentive to invest in fixed improvements as they have a much higher probability of internalizing the benefits of their investment. In Botswana, these farmers also find it easier to finance improvement because there is a market for privately owned land. Banks do not accept land as collateral for loans unless it has a market value. An active land market strengthens incentives to improve land because capital gains can be realized at any time by selling or leasing out. Improvements to land and livestock tend to raise the productivity of operating inputs, encouraging more intensive use of supplementary feed and medications that prevent disease and injury.

For these reasons, it is postulated that herd productivity and investment indicators in southern Botswana will be higher on private ranches than on (open access) communal grazing land. This hypothesis is consistent with the 1991 policy objective of converting open access grazing into common and private property and with the view that common property user-groups should be converted into non-user groups resembling company operations. In this case, members of the group surrender their use rights for benefit rights by exchanging livestock for equity (shares) in the operating entity, they hire or elect experts to manage the farm, and share profits in proportion to their own equity contributions.

To test the hypothesis, this study develops and estimates a block-recursive regression model of the relationships anticipated between secure land tenure, agricultural credit, investment in fixed improvements to land, investment in operating inputs, herd productivity and relevant household and farmer characteristics.

Data used in this study were gathered in a stratified random sample of 96 livestock owners in the southern region of Botswana during 1999/2000. The southern is representative of most other cattle-farming regions in terms of terrain, rainfall patterns and population characteristics. Rainfall is typically low, averaging about 550mm per annum. The study comprised of two strata, one for communal farmers and the other for private farmers to ensure variation in land tenure arrangements. Households with cattle were identified and listed and a random sample was drawn from each list. A total of 65 (black) communal farmers and 31 (30 black and one white) private farmers were interviewed using a pre-tested and structured questionnaire. Land tenure status was measured as a dummy variable scoring one for private farmers and zero for communal farmers.

Independent, t-tests were calculated to check for significant differences between group means for private and communal farmers. Zero-order correlation coefficients were also computed to assess the degree of linear association between pairs of variables relevant to the study. Variables that were strongly correlated were subjected to Principal Component Analysis (PCA) to reduce multicollinearity between explanatory variables that were included in the block-recursive regression model. The model was estimated using OLS and 2SLS regression techniques.

The regression model was postulated as follows:

$$
\begin{aligned}
&(a) \quad c = f(X^a, T, H)\\
&(b) \quad l = f(X^a, T, C_L)\\
&(c) \quad i = f(X^a, C_S, l)\\
&(d) \quad h = f(l, i)
\end{aligned}
$$

Equation (a) argues that the present value of (long plus short) agricultural credit is positively influenced by secure land tenure (private ownership), higher liquidity and a larger herd size (wealth). Positive relationships are expected because farmers with greater wealth and liquidity are more creditworthy as they have more collateral and better repayment ability. Private ownership of land not only strengthens the incentive to invest but also adds to the owner's stock of wealth and collateral. The household and farmer characteristics include family size, off-farm income, marital status and the farmer's age, education and gender (a dummy variable scoring one for male farmers and zero for

females). Off-farm wage income is a relatively important and reliable source of liquidity for many rural households and is therefore expected to impact positively on access to credit owing to better debt-servicing ability. Age could also carry a positive sign as it measures accumulated farming experience and social standing. A high social standing can reduce transaction costs. On the other hand, age could carry a negative sign as older farmers may be more risk averse and less inclined to innovate than younger farmers. Education is expected to impact positively on the use of credit because it reduces transaction costs in formal markets and enhances allocative efficiency, so improving a farmer's creditworthiness. Gender may also influence transaction costs and creditworthiness. In Botswana, women married in community of property (including women married under customary law) cannot borrow without legal consent from their husbands.

Equation (b) postulates that investment in fixed improvements is positively influenced by private ownership and better access to long-term credit. Secure land tenure strengthens the farmer's incentive to invest. Few improvements are expected where land tenure is insecure as future returns are discounted at a high rate owing to uncertainty. In this case, uncertainty stems largely from future returns lost to other stockowners (free-riders) who share inclusive rights to communal grazing. Access to long-term credit improves a farmer's ability to finance fixed improvements. Positive collinearity between secure tenure and the present value of long-term credit is likely in view of the arguments presented in chapter 2. Household and farmer characteristics are included largely as control variables although education is expected to carry a positive sign as it serves as a proxy for permanent income and family size is expected to carry a negative sign owing to a trade-off between consumption and investment. Age on the other hand is expected to carry a positive sign as it proxies experience and exposure to investment opportunities.

Equation (c) states that current investment in operating inputs per livestock unit is positively influenced by private ownership and better access to short-term credit. Again, the ability to finance operating inputs is expected to improve with better access to short-term credit, while investment in fixed improvements is expected to increase the productivity of these inputs so strengthening the incentive to purchase them. Household

and farmer characteristics are included largely as control variables with expected signs similar to those postulated for equation (b).

Equation (d) expresses herd productivity as a positive function of past investment in fixed improvements and current investment in operating inputs per livestock unit. A study of cattle off-take rates in Botswana supports the argument that investment in fixed improvements (like boreholes and fences) and operating inputs (such as feed supplements and vaccines) will increase herd productivity. Investment in boreholes, supplementary feed and vaccines is expected to reduce mortality rates and improve calving and off-take rates. Positive collinearity between investment in fixed improvements and expenditure on operating inputs per livestock unit is likely following the logic of equation (c).

The major findings for this study indicate that:

1. Respondents with private farms and larger herds are both willing and able to access more agricultural credit.
2. Respondents with private farms, more long-term credit and liquidity from wage remittances invest more in fixed improvements than do communal farmers who rely on open access grazing land- especially if they are married and have smaller families.
3. Farmers, especially younger males are more inclined to invest in operating inputs if they are liquid.
4. Herd productivity increases with greater investment in operating inputs and fixed improvements and is therefore positively (but indirectly) influenced by secure land tenure.

It can be concluded that government should (a) uphold private property rights to land where they already exist; (b) privatise open access grazing to individual owner-operators where it is politically, socially and economically feasible; (c) where privatisation to individuals is not feasible, government should encourage users to convert the grazing into common property by subsidizing the costs of defining user groups and the boundaries of their resources, and of enforcing rules limiting individual use of common property. This

first step in a gradual shift towards more secure tenure should be followed by the conversion of user groups to non-user groups organised along the lines of investor-owned firms where members exchange use rights for tradable benefit and voting rights that are proportional to the investment made by each shareholder. The initial investment could be financed by exchanging cattle for equity capital (shares) in the company.

Good corporate governance should be entrenched through accountability. For Directors, accountability is facilitated by reporting minutes in a Board meeting and independently audited financial statements, and through sound electoral process and marketable shares.

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APPENDIX 1: QUESTIONNAIRE

COMMERCIALISATION OF THE TRADITIONAL CATTLE INDUSTRY IN BOTSWANA: PROSPECTS, PROBLEMS AND POSSIBLE SOLUTIONS

SURVEY INFORMATION

Introduction Statement

My name is ..... I am working for the Botswana College of Agriculture. I would like to ask you a few questions about the productivity of cattle and some of the problems you face in keeping your cattle. The information I collect will assist government in planning and properly targeting any future subsidies for the livestock sector. Anything you tell me will be confidential and the report will not have names but will summarise your views together with other farmers we will interview.

I thank you for your time.

DATE OF INTERVIEW.....

1. Interviewer's name.....
2. Respondent Number.....
3. Name of village .....
4. Name of household head.....
5. District .....
6. Region .....

Farm type: A. FREEHOLD:..... B.COMMUNAL.....

1. Owner Operator.....
2. Leasehold .....
3. Common Property (syndicate).....
4. Open access.....

7. Do the household own or manage any cattle including *mafisa* (cattle that are being cared for by someone else).

   Yes No

   Respondent's herd size group .....

   If yes, continue with questionnaire

   If no, make parting comments and depart.

DOC 1

Household No:/farm code _____

Code of village: _____

Interviewer's name: _____

A 1.11 HOUSEHOLD DEMOGRAPHY

Serial No.	Name	1 Age 1.111	2 Gender 1.112	3 Marital Status 1.113	4 Relation 1.114	5 Occupation 1.115	6 Wage per month 1.116	7 Years of Schooling 1.117	8 Residential Status 1.118	9 Location of employment 1.119	10 Years of farming 1.120
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											

CODES: HOUSEHOLD DEMOGRAPHY

(1) Age

1.	Less than 30	2.	31-40
3.	41-50	4.	51-60
5.	61-70	6.	More than 70

(2) Gender

1.	Male	2.	Female

(3) Marital Status

1.	Single	2.	Married
3.	Widowed	4.	Separated/Divorced

(4) Relationship to Household Head

1.	Household Head	2.	Spouse of head
3.	Child of head/spouse	4.	Parent of head/spouse
5.	Sibling of head/spouse	6.	Spouse of child of head/spouse
7.	Grandchild of head/spouse	8.	Full-time hired worker
9.	Other person not related to head/spouse		

(5) Occupation - employment

1.	Farmer	2.	Housewife
3.	Student	4.	Domestic worker (include housekeeping and gardening
5.	Local shop owner or business owner	6.	Shop/business employee
7.	Migrant worker – mines	8.	Migrant worker – farms
9.	Government employee	10.	Herd boy/Shepard
11.	Unemployed	12.	Child

(6) Wage per month

(7) Years of schooling

1.	None	2.	Two
3.	Four	4.	Six
5.	Eight	6.	Ten
7.	Twelve	8.	Fourteen
9.	Sixteen	10.	Eighteen
11.	Twenty	12.	Twenty-two

(8) Residential satus

1.	Resident	2.	Absent, outside Botswana – work
3.	Absent, in Botswana – work	4.	Absent, in Botswana – school

(9) Location of employment

1.	Botswana, Town	2.	Botswana, District
3.	Other – specify		

(10) Years of training

1.	None	2.	5 years
3.	6-10 years	4.	More than 10 years

DOC 2

B1.12 SOURCES OF HOUSEHOLD CASH INCOME

(Except cattle, and their products)

Average Monthly Cash Income received after last visit (Pula)

TYPES OF WORK/INCOME SOURCE **AMOUNT (PULA)**

Work of men elsewhere .....

Work of women elsewhere.....

Work of men within Botswana.....

Work of women within Botswana.....

Sale of chicken, eggs, pigs or pork.....

Sale of Bojalwa or beer.....

Sale of produce from fields.....

Sale of vegetables.....

Rental of house or room.....

Profit from shop/taxi.....

Sales of HH produced handicrafts.....

Sale of other things, Specify.....

.....

Gifts or help from relatives.....

Payment of building, thatching, etc.....

Other cash resources, specify.....

.....

.....

1.13 Please tell us you household's main sources of income, in order of importance from above list

1. .....
2. .....
3. .....

4. .....

DOC 3

C AGRICULTURAL ASSETS

1.14 Total farm land (in ha)

Type of ownership: A. PRIVATE: _____ B. COMMUNAL _____
1. Owner operator_____ 3.Common property_____
2. Leasehold _____ 4. Open access _____

List equipment you own below

Animal Drawn					Tractor drawn			
	Number	**Value**	**Year of Purchase**			**Number**	**Value**	**Year of Purchase**
Plough					Tractor			
Cultivator					Plough			
Planter					Cultivator			
Cart					Planter			
Harrow					Cart			
Baler					Harrow			
Harvester					Baler			
Other – specify					Harvester			
					Other			

DOC 4

DATE RECORDING _____ **HOUSEHOLD NO.** _____

D **LIVESTOCK INVENTORY** **CODE OF VILLAGE** _____

2.0 Of animals that you own, please provide the following information about each species

BREED	Cows	Oxen	Bulls	Heifers	Weaners	Calves	Total
Brahman							
Simmentaler							
Tswana							
Tuli							
Tswana cross							
Other – specify							
TOTAL							

2.10 If the cattle you keep belong to somebody else (*mafsa* –out) or if your cattle are kept and taken care of by someone (*mafias*- in) fill the following table

	Mafisa-in	*Mafisa*-out	Reason for *mafisa* in or out[(1)]
Cows			
Bulls			
Heifers			
Weaners			
Calves			
Other – specify			
TOTAL			

CODE

(1)

1	Helping others	_____
2	Gain access to grazing	_____
3	Gain access to better management	_____
4	Gain access to herding	_____
5	Gain access to cattle post	_____

DOC 5

DATE OF RECORDING _____ **HOUSEHOLD NUMBER** _____

E 2.20 BIOLOGICAL PRODUCTION **CODE OF VILLAGE** _____

(Monthly recordings) **Month** _____

Month	Cattle start of month	Birth	Purchases	Total	Deaths of calves	Deaths of cows	Causes of deaths of cows	Causes of deaths of calves[1]	Total
Jun									
Jul									
Aug									
Sep									
Oct									
Nov									
Dec									
Jan									
Feb									
Mar									
April									
May									
June									
TOTAL									

CODE

[1] What caused the deaths of calves

1 Drought _____

2 Disease _____

3 Other _____

2.21 Does the land ownership in your farm contribute to the number of calves born (calving rate)

1 Yes _____ No _____

2.22 If yes, explain how it contributes to your calving rate

1 _____

2 _____

3 _____

2.23 When do your cows start calving (Month) _____

DOC 6

F LIVESTOCK SALES, SLAUGHETER AND OTHER TRANSACTIONS

2.30 Did you sell any cattle after the last visit?

1 Yes _____ 2 No _____

2.31 How many cattle were sold or utilized for other purposes?

Animal	Number sold	Value (P)	Where sold(1)	Reasons for sale(2)	Number utilized	Value (P)	Purposes
Bulls							
Cows							
Oxen							
Heifers							
Calves							
Total							

CODE

1 Where did you sell

1 Botswana Meat Commission (BMC)_____

2 Cooperatives (Coops) _____

3 Local Butcher _____

4 Other – specify _____

2 Why did you sell your cattle

1 Pay school fees

2 Buy food & clothes

3 Meet funeral expenses

4 Pay livestock expenses

5 Pay lobola (dowry)

6 Other – specify

2.32 How many cattle did you purchase after the last visit _____ (number)

2.33 What breeds and composition of cattle did you purchase

Breeds	Bulls	Value P	Oxen	Value P	Heifers	Value P	Calves	Value P	Place bought	Purpose of buy
Tswana										
Brahman										
Simmentaler										
Tswana cross										
Tuli										
Other– specify										
Total										

2.34 Did you exchange any cattle

1 Yes _____ 2 No _____

2.35 How many did you exchange for the following:

Activity	Month	Number	Value (Pula)
Funeral			
Lobola			
School fees			
Food & clothes			
Others			
Total	n/a		

DOC 7

G DISPOSAL OF PRODUCTS FROM SLAUGHTERED ANIMALS

2.40 Did you slaughter any cattle after the last visit

Yes _____ No _____

2.41 What was the reason for the slaughter

1 Home consumption _____ 4 Welcome baby _____

2 Funeral _____ 5 Wedding _____

3 Sale of meat _____ 6 Ancestral offering _____

2.42 How many cattle were slaughtered _____

2.43 If you slaughtered any cattle, how did you dispose of the hide, for how much P _____

1 I sold to the village _____ 3 Kept for bedding _____

2 Sold to the private trader _____ 4 Other _____

2.44 What type of curing did you use for the hide

1 sun dried _____ 4 not cured your cows _____

2 shade dried _____ 5 your cows after calving _____ (days)

3 dry salted _____

H MILK PRODUCTION

2.50 How many cows do you milk per time _____ (number)

2.51 How much milk do you get from each cow _____ (Litres)

2.52 How long do you milk your cows ____ (months)

2.53 When do you start milking

2.54 Do you sell your milk

1 Yes _____ 2 No _____

2.55 Where do you sell your milk

1 Local shop ____ 2 Village ____

3 Cooperative _____

2.56 What are the constraints in selling milk

1 _____

2 _____

3 _____

4 _____

2.57 What quantity of milk do your household consume (Litres) _____

2.58 How do you use milk

1 Drink fresh _____

2 Eat madila _____

3 Use for tea _____

4 Use as relish _____

DOC 8

I DRAUGHT POWER OF CATTLE

2.60 Did you use cattle for draught power

1 Yes _____ 2 No _____

2.61 If yes for what activity

1 Ploughing _____ 2 Planting _____

3 Weeding _____ 4 Transporting _____

5 Others _____

2.62 How many days did you use the draught power _____

2.63 Did you hire out any cattle for draught power

1 Yes _____ 2 No _____

2.64 If yes what activity were you hiring out for:

1 Ploughing _____ 2 Planting _____ 3 Threshing _____

4 Transportation _____

2.65 How long did you hire out cattle for this activity

1 12 hours _____ 2 One day _____ 3 Two days _____

4 Three days ____ 5 Four days _____ 6 More than 5 days ____

2.66 How much were you paid for such an activity (P) _____

2.67 Does the condition of draft animals ever delay agricultural operations

1 Yes _____ 2 No _____

2.68 Is the lack of draft animals hinder agricultural production

1 Yes _____ 2 No _____

J MANURE AND ITS UTILISATION

2.70 Do you use cattle manure in your farm

1 Yes _____ 2 No _____

2.71 If yes what do you use the manure for

1 Fertilizer _____ 2 Building_____ 3 Decoration (floors)__

4 Fuel _____ 5 Lining of baskets ___ 6 Others_____

2.72 How much was collected (kg/bags) _____

2.73 How much was used in the farm _____

2.74 How much was sold (kg/bags) _____

2.75 What was the value of the manure used (P) _____

DOC 9

K LIVESTOCK HUSBANDRY PRACTICES

2.80 How often do you water your cattle?

1 everyday _____

2 every other day _____

3 other, specify _____

2.81 What kind of watering points do you use most of the time?

1 own borehole _____ 2 private borehole _____

3 council borehole _____ 4 syndicate borehole _____

5 dam _____ 6 sand river well _____

2.82 How many people water their cattle in this water source _____ (number)

2.83 Who is the owner of the water source _____

2.84 Do you pay any watering fees

1 Yes _____ 2 No _____

2.85 At what time of the day do you water your cattle

1 4.00 am to 8.00 am _____ 2 8.00 am to 12.00 noon _____

3 12.00 noon to 2.00 pm _____

2.86 Do you get enough water for your cattle during the season

1 Yes _____ 2 No _____

2.87 Do you get enough grass for your cattle during the season

1 Yes _____ 2 No _____

2.88 Do your animals receive adequate grazing from:

	Yes	No
Summer range	_____	_____
Winter range	_____	_____
Winter village fields	_____	_____

2.89 Do you treat your cattle for ticks

1 Yes _____ 2 No _____

2.90 What do you use to treat ticks?

1 Hand spray _____ 2 Dip tank _____

3 Brush _____ 4 Other _____

2.91 During the last 12 months, which diseases have your cattle been vaccinated against?

1 Botulism – mokokomalo	2 Foot and mouth – tlhako le molomo
3 Black quarter (heartwater) – Serotswana	4 Contagious abortion – pholotso
5 Anthrax – Kwatsi	6 Other

2.92 Do you castrate calves for yourself?

1 Yes _____ 2 No _____

2.93 At what age? _____

2.94 Do you dehorn your cattle?

1 Yes _____ 2 No _____

2.95 Do you use artificial insemination?

1 Yes _____ 2 No _____

If no, why _____

DOC 10

L LAND MANAGEMENT AND PROPERTY RIGHTS

3.10 What grazing rights do you have on the land you are occupying?

0 ..... Open access 1..... Private access

3.11 Who assigns land tenure rights in this area?

1.....Land Board

2.....Chief/Headman

3.....Village Development Committee

3.12 Do you have restrictions on who can graze his/her cattle in the area?

1 Yes _____ 2 No _____

3.13 Can you transfer your land rights to anybody of your choice?

1 Yes _____ 2 No _____

3.14 Do you have rights to sell this land in your area?

1 Yes _____ 2 No _____

3.15 Do you pay fees for grazing in the area

1 Yes _____ 2 No _____

3.16 How many years is the lease you have on the land

.....

3.17 Are the rights you have to land exclusive or inclusive

.....

3.18 How are land rights distributed within households under this tenure system

.....

.....

.....

.....

3.19 Are the current levels of tenure security system constraining agricultural investments

1 Yes _____ 2 No _____

If so how

.....

.....

.....

.....

.....

.....

3.20 Has land title registration contributed to an inequitable distribution of land resources

1 Yes _____ 2 No _____

3.21 Has land registration increased or decreased security of land tenure

1 Yes _____ 2 No _____

3.22 Who determines the number of cattle to be kept (stocking rate)

1 Agricultural Officer _____ 2 Land Board Officer _____

3 District Commissioner _____ 4 Other _____

3.23 How does this officer ensure that the rules of ownership are observed

.....

.....

.....

.....

3.24 How many hours/days does this person spend in enforcing the rules

.....

.....

3.25 Have offenders ever been detected and prosecuted

1 Yes _____ 2 No _____

3.26 What are the penalties for breaking the rules of property ownership

.....

.....

3.27 Who enforces the penalties

.....

.....

3.28 What is your view on fencing communal land

1 Agree with it ..... 2 Do not agree with it .....

3 Desirable but has some constraints ..... 4 I can't comment at the moment .....

3.29 What is your view on individual property ownership of grazing areas

1 Agree with it ..... 2 Do not agree with it .....

4 Desirable but has some constraints ..... 4 I can't comment at the moment .....

DOC 11

M LIVESTOCK LABOUR REQUIREMENTS

Date recorded .....

Name of recorder.....

3.30 Individuals from the household involved in herding household cattle (after last v)

Activity	Name	Sex	Relationship	Number Stock	Hours Spent	Payment Cash	Payment In kind	Total Payment
Herding								
Watering								
Ploughing								
Milking								
Branding								
Castration								
Dehorning								
De worming								
Dipping								
Vaccination								
Fencing								
Manure								
Collection								
Fodder								
Production								

1) Herder Relationship Codes
   1 Child of household/spouse
   2 Sibling of head/spouse
   3 Household Head
   4 Other relationship head/spouse
   5 No relation to head

B HIRED FAMILY LABOUR

3.31 Employees engaged

Activity	Name	Sex	Relationship	Number Stock	Hours Spent	Payment Cash	Payment In kind	Total Payment
Herding								
Watering								
Ploughing								
Milking								
Branding								
Castration								
Dehorning								
De worming								
Dipping								
Vaccination								
Fencing								
Manure								
Collection								
Fodder								
Production								

2) Herder Relationship Codes

1 Child of household/spouse

2 Sibling of head/spouse

3 Household Head

4 Other relationship of head/spouse

5 No relation to head

C. HIRED LABOUR

3.32 Employees engaged

Activity	Name	Sex	Number Stock	Hours Spent	Man Days	Payment Cash	Payment in kind	Total Payment
Herding								
Watering								
Ploughing								
Milking								
Branding								
Castration								
Dehorning								
De worming								
Dipping								
Vaccination								
Fencing								
Manure Collection								
Hay making								

3.33 What other tasks do you use hired labour

1 .....

2 .....

3 .....

3.34 Are there any problems employing herdsmen?

1 Yes _____ 2 No _____

3.35 What are the problems?

Marketing costs

3.36 How far is the place you are marketing your cattle?

.....

3.37 Do you have access to a phone?

1 Yes _____ 2 No _____

3.38 How do you contact them that you will be selling cattle?

1 Phone ..... 2 Travel there ..... 3 Write .....

3.39 If yes how much do you pay to telephone buyers of your cattle?

.....

3.40 How much do you pay to transport your cattle to the market?

.....

3.41 What other costs do you incur in marketing your cattle?

.....

.....

DOC 13

N FODDER AND SUPPLEMENTAL FEEDS

3.50 Are your cattle fed any supplementary feeds?

1 Yes _____ 2 No _____

3.51 What type of supplementary feed do you use?

Supplement	Month	Quantity kg per bag	Price per unit	Government Subsidy	Total cost
Rumivite Block					
Dicalcium phosphate					
Mollases					
Dairy meal					
Bone meal & salts					
Bran					
Other					
Total	n/a	n/a	n/a	n/a	

3.52 How frequent do you feed the above supplement

1 everyday ..... 2 once a week .....

3 once a month ..... 4 other specify .....

O DRUGS AND VACCINES (USED AFTER LAST VISIT)

3.60 Were any medicines given to any of the stock?

1 Yes _____ 2 No _____

3.61 If yes, obtain the following information:

Condition treated	Month	Medicines used	No of animals	Cost of treatment per type of animal	Total cost
Blue tongue					
Black quarter					
Heart water					
Botulism					
Foot & mouth					
Anthrax					
Contagious abortion					
Other					
Total	n/a	n/a			

P OTHER EXPENSES

3.70 Which of the expenses did you incur after the last visit?

3.71

Activity	Month	From whom	Unit cost	Total cost
Watering fees				
Borehole repairs				
Crutch making				
Reservoir repairs				
Kraal making and repairs				
Rent fees				

3.72 In the last year, which of the following expenses did your household incur, and how was the expense met:

Hospital & medical							
Funeral							
School Fees							
Livestock							
Crops							
Other							

DOC 14

Q CREDIT SOURCES

3.80 Below your sources of credit for your operation

Source	Activity	Amount	Amount of Payment	Period of payment

DOC 15

R PRODUCTION CONSTRAINTS

4.0 Below your sources of credit for your operation

Factor Rank

1. Inadequate funds to produce animals .....
2. Inadequate funds to purchase other input .....
3. Family labour .....
4. Local herding labour .....
5. Expense of herding labour .....

6. Management .....

7. Availability of winter fodder .....

8. Expense of winter fodder .....

9. Winter grazing around village .....

10. Winter cattle post grazing .....

11. Summer grazing around village .....

12. Summer cattle post grazing .....

13. Overstocking .....

14. Drought .....

4.1 Was any assistance received from:

Livestock specialists of Ministry of Agriculture	.....	.....
Veterinary assistants of Ministry of Agriculure	.....	.....
Project Personnel of MoA	.....	.....

If yes, what kind of assistance

1.....
2.....
3.....
4.....

END OF QUESTIONNAIRE

Notes on the document

1 Doc 1	1.11	to be filled at the start and at the end of study
2 Doc 2	1.12 - 1.13	to be filled at the start and at the end of study
3 Doc 3	1.14	to be filled at the start and at the end of study
4 Doc 4	2.10 – 2.11	to be filled once at the start and every month
5 Doc 5	2.20-2.2.24	to be filled once at the start and every month
6 Doc 6	2.30-2.34	monthly recording
7 Doc 7	2.40-2.5	monthly recording
8 Doc 8	2.60-2.75	monthly recording
9 Doc 9	2.80-3.11	recording once at the beginning and once at the end
10 Doc 10	3.20 – 3.39	recording once at the beginning and once at the end
11 Doc 11	3.40-3.44	recording once at the beginning and every month
12 Doc 12	3.50-3.3.81	recording once at the beginning and every month
13 Doc 13	3.90 – 3.91	recording once at the beginning and once at the end
14 Doc 14		recording once at the beginning and every month
15 Doc 15		recording once at the beginning and once at the end